Supplement

July 2014

CBRNE NEWSLETTERRORISM

E-Journal for CBRNE & CT First Responders

DISASTER ROBOTICS

www.cbrne-terrorism-newsletter.com

Rescue Robotics

There is no doubt that Robotics will be our coworkers in the near (?) future. Especially in rescue operations and potential deadly environments. They can walk, crawl, climb, fly and dive already. They can operate into swarms, alone or indermendently and are not affected by fatigue, emotions or other disturbing factors like humans do. This special collection of articles will highlight some of the most recent advances on Rescue Robotics and their existing or future applications and possibilities.

The Editor-in-Chief
CBRNE-Terrorism Newsletter

Robot

Source: http://en.wikipedia.org/wiki/Robot

The word *robot* can refer to both physical robots and virtual software agents, but the latter are usually referred to as bots. There is no consensus on which machines qualify as robots but there is general agreement among experts, and the public, that robots tend to do some or all of the following: move around, operate a mechanical limb, sense and manipulate their environment, and exhibit intelligent behavior — especially behavior which mimics humans or other animals. In practical terms, "robot" usually refers to a machine which can be electronically programmed to carry out a variety of physical tasks or actions.

KITT (a fictitious robot) is mentally anthropomorphic

ASIMO is physically anthropomorphic

There is no one definition of *robot* that satisfies everyone and many people have their own. For example Joseph Engelberger, a pioneer in industrial robotics, once remarked: "I can't define a robot, but I know one when I see one." The two ways that robots differ from actual beings are, simply stated, in the domain of cognition, and in the domain of biological form. The general consensus is that a "robot" is a machine and not a being simply because it is not intelligent (it requires programming to function), regardless of how human-like it may appear. In contrast, an imaginary "machine" or "artificial life form" (as in science fiction) that could think near or above human intelligence, and had a sensory body, would no longer be a "robot" but would be some kind of "artificial being" or "cognitive robot", (cyborg).

According to the Encyclopaedia Britannica a robot is "any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner." Merriam-Webster describes a robot as a "machine that looks like a human being and performs various complex acts (as walking or talking) of a human being", or a "device that automatically performs complicated often repetitive tasks", or a "mechanism guided by automatic controls".

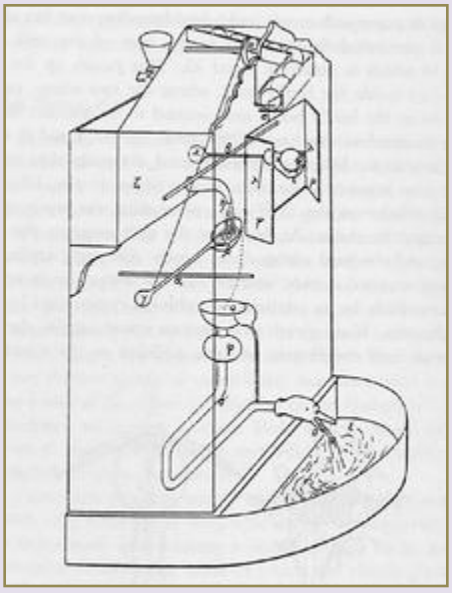
History

The idea of automata originates in the mythologies of many cultures around the world. Engineers and inventors from ancient civilizations, including Ancient China, Ancient

Greece, and Ptolemaic Egypt, attempted to build self-operating machines, some resembling animals and humans. Early descriptions of automata include the artificial doves of Archytas, the artificial birds of Mozi and Lu Ban, a "speaking" automaton by Hero of Alexandria, a washstand automaton by Philo of Byzantium, and a human automaton described in the *Lie Zi.*

Early beginnings

Many ancient mythologies, and most modern religions include artificial people, such as the mechanical servants built by the Greek god Hephaestus (Vulcan to the Romans), the clay golems of Jewish legend and clay giants of Norse legend, and Galatea, the mythical statue of Pygmalion that came to life. Since circa 400 BC, myths of Crete include Talos, a man of bronze who guarded the Cretan island of Europa from pirates.



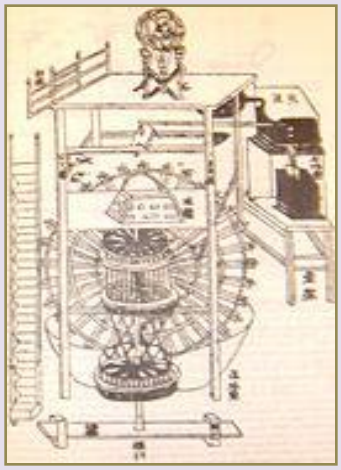
Washstand automaton reconstruction, as described by Philo of Byzantium (Greece, 3rd century BC).

In ancient Greece, the Greek engineer Ctesibius (c. 270 BC) "applied a knowledge of pneumatics and hydraulics to produce the first organ and water clocks with moving figures." In the 4th century BC, the Greek mathematician Archytas of Tarentum postulated a mechanical steam-operated bird he called "The Pigeon". Hero of Alexandria (10–70 AD), a Greek mathematician and inventor, created numerous user-configurable automated devices, and described machines powered by air pressure, steam and water.

Al-Jazari's toy boat, musical automata

The 11th century Lokapannatti tells of how the Buddha's relics were protected by mechanical robots (bhuta vahana yanta), from the kingdom of Roma visaya (Rome); until they were disarmed by King Ashoka.

In ancient China, the 3rd century text of the *Lie Zi* describes an account of humanoid automata, involving a much earlier encounter between Chinese emperor King Mu of Zhou and a mechanical engineer known as Yan Shi, an 'artificer'. Yan Shi proudly presented the king with a life-size, human-shaped figure of his mechanical 'handiwork' made of leather, wood, and artificial organs. There are also accounts of flying automata in the *Han Fei Zi* and other texts, which attributes the 5th century BC Mohist philosopher Mozi and his contemporary Lu Ban with the invention of artificial wooden birds (*ma yuan*) that could successfully fly. In 1066, the Chinese inventor Su Song built a water clock in the form of a tower which featured mechanical figurines which chimed the hours.

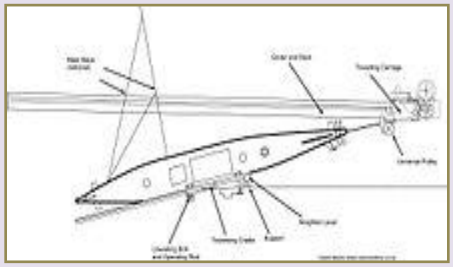


Su Song's astronomical clock tower showing the mechanical figurines which chimed the hours.

The beginning of automata is associated with the invention of early Su Song's astronomical clock tower

featured mechanical figurines that chimed the hours. His mechanism had a programmable drum machine with pegs (cams) that bumped into little levers that operated percussion instruments. The drummer could be made to play different rhythms and different drum patterns by moving the pegs to different locations.
In Renaissance Italy, Leonardo da Vinci (1452–1519) sketched plans for a humanoid robot around 1495. Da Vinci's notebooks, rediscovered in the 1950s, contained detailed drawings of a mechanical knight now known as Leonardo's robot, able to sit up, wave its arms and move its head and jaw. The design was probably based on anatomical research recorded in his *Vitruvian Man*. It is not known whether he attempted to build it.
In Japan, complex animal and human automata were built between the 17th to 19th centuries, with many described in the 18th century *Karakuri zui* (*Illustrated Machinery*, 1796). One such automaton was the karakuri ningyō, a mechanized puppet. Different variations of the karakuri existed: the *Butai karakuri*, which were used in theatre, the *Zashiki karakuri*, which were small and used in homes, and the *Dashi karakuri* which were used in religious festivals, where the puppets were used to perform reenactments of traditional myths and legends.
In France, between 1738 and 1739, Jacques de Vaucanson exhibited several life-sized automatons: a flute player, a pipe player and a duck. The mechanical duck could flap its wings, crane its neck, and swallow food from the exhibitor's hand, and it gave the illusion of digesting its food by excreting matter stored in a hidden compartment.

Remote-controlled systems



The Brennan torpedo, one of the earliest 'guided missiles'

Remotely operated vehicles were demonstrated in the late 19th Century in the form of several types of remotely controlled torpedos. The early 1870s saw remotely controlled torpedos by John Ericsson (pneumatic), John Louis Lay (electric wire guided), and Victor von Scheliha (electric wire guided).
The Brennan torpedo, invented by Louis Brennan in 1877 was powered by two contra-rotating propellors that were spun by rapidly pulling out wires from drums wound inside the torpedo. Differential speed on the wires connected to the shore station allowed the torpedo to be guided to its target, making it "the world's first *practical* guided missile".In 1897 the British inventor Ernest Wilson was granted a patent for a torpedo remotely controlled by "Hertzian" (radio) waves and in 1898 Nikola Tesla publicly demonstrated a wireless-controlled torpedo that he hoped to sell to the US Navy.
Archibald Low, known as the "father of radio guidance systems" for his pioneering work on guided rockets and planes during the First World War. In 1917, he demonstrated a remote controlled aircraft to the Royal Flying Corps and in the same year built the first wire-guided rocket.

Humanoid robots
The term 'robot' was first used to denote fictional automata in a 1921 play *R.U.R.* Rossum's Universal Robots by the Czech writer, Karel Čapek.

Karel Čapek — first user of the term 'robot'. He used this word in a 1921 play *R.U.R.* Rossum's Universal Robots. 'Robot' is a purely Czech word.

In 1928, one of the first humanoid robots was exhibited at the annual exhibition of the Model Engineers Society in London. Invented by W. H. Richards, the robot Eric's frame consisted of an aluminium body of armour with eleven electromagnets and one motor powered by a twelve-volt power source. The robot could move its hands and

head and could be controlled through remote control or voice control.[32]
Westinghouse Electric Corporation built Televox in 1926; it was a cardboard cutout connected to various devices which users could turn on and off. In 1939, the humanoid robot known as Elektro was debuted at the World's Fair. Seven feet tall (2.1 m) and weighing 265 pounds (120.2 kg), it could walk by voice command, speak about 700 words (using a 78-rpm record player), smoke cigarettes, blow up balloons, and move its head and arms. The body consisted of a steel gear, cam and motor skeleton covered by an aluminum skin. In 1928, Japan's first robot, Gakutensoku, was designed and constructed by biologist Makoto Nishimura.

Modern autonomous robots
The first electronic autonomous robots with complex behaviour were created by William Grey Walter of the Burden Neurological Institute at Bristol, England in 1948 and 1949. He wanted to prove that rich connections between a small number of brain cells could give rise to very complex behaviors - essentially that the secret of how the brain worked lay in how it was wired up. His first robots, named *Elmer* and *Elsie*, were constructed between 1948 and 1949 and were often described as *tortoises* due to their shape and slow rate of movement. The three-wheeled tortoise robots were capable of phototaxis, by which they could find their way to a recharging station when they ran low on battery power.
Walter stressed the importance of using purely analogue electronics to simulate brain processes at a time when his contemporaries such as Alan Turing and John von Neumann were all turning towards a view of mental processes in terms of digital computation. His work inspired subsequent generations of robotics researchers such as Rodney Brooks, Hans Moravec and Mark Tilden. Modern incarnations of Walter's *turtles* may be found in the form of BEAM robotics.

U.S. Patent 2,988,237, issued in 1961 to Devol.

The first digitally operated and programmable robot was invented by George Devol in 1954 and was ultimately called the Unimate. This ultimately laid the foundations of the modern robotics industry. Devol sold the first Unimate to General Motors in 1960, and it was installed in 1961 in a plant in Trenton, New Jersey to lift hot pieces of metal from a die casting machine and stack them. Devol's patent for the first digitally operated programmable robotic arm represents the foundation of the modern robotics industry.
The first palletizing robot was introduced in 1963 by the Fuji Yusoki Kogyo Company. In 1973, a robot with six electromechanically driven axes was patented by KUKA robotics in Germany, and the programmable universal manipulation arm was invented by Victor Scheinman in 1976, and the design was sold to Unimation.
Commercial and industrial robots are now in widespread use performing jobs more cheaply or with greater accuracy and reliability than humans. They are also employed for jobs which are too dirty, dangerous or dull to be suitable for humans. Robots are widely used in manufacturing, assembly and packing, transport, earth and space exploration, surgery, weaponry, laboratory research, and mass production of consumer and industrial goods.

A scene from Karel Čapek's 1920 play R.U.R. (Rossum's Universal Robots), showing three robots

Etymology
The word *robot* was introduced to the public by the Czech interwar writer Karel Čapek in his play *R.U.R. (Rossum's Universal Robots)*, published in 1920. The play begins in a

factory that uses a chemical substitute for protoplasm to manufacture living, simplified people called *robots.* The play does not focus in detail on the technology behind the creation of these living creatures, but in their appearance they prefigure modern ideas of androids, creatures who can be mistaken for humans. These mass-produced workers are depicted as efficient but emotionless, incapable of original thinking and indifferent to self-preservation. At issue is whether the robots are being exploited and the consequences of human dependence upon commodified labor (especially after a number of specially-forumlated robots achieves self-awareness and incites robots all around the world to rise up against the humans).

Karel Čapek himself did not coin the word. He wrote a short letter in reference to an etymology in the *Oxford English Dictionary* in which he named his brother, the painter and writer Josef Čapek, as its actual originator.

In an article in the Czech journal *Lidové noviny* in 1933, he explained that he had originally wanted to call the creatures *laboři* ("workers", from Latin *labor*). However, he did not like the word, and sought advice from his brother Josef, who suggested "roboti". The word *robota* means literally "corvée", "serf labor", and figuratively "drudgery" or "hard work" in Czech and also (more general) "work", "labor" in many Slavic languages (e.g.: Bulgarian, Russian, Serbian, Slovak, Polish, Ukrainian, archaic Czech). Traditionally the *robota* was the work period a serf (corvée) had to give for his lord, typically 6 months of the year. The origin of the word is the Old Church Slavonic (Old Bulgarian) *rabota* "servitude" ("work" in contemporary Bulgarian and Russian), which in turn comes from the Proto-Indo-European root **orbh-*. *Robot* is cognate with the German root *Arbeit* (work).

The word robotics, used to describe this field of study, was coined by the science fiction writer Isaac Asimov. Asimov created the "*Three Laws of Robotics*" which are a recurring theme in his books. These have since been used by many others to define laws used in fact and fiction.

Modern robots

A laparoscopic robotic surgery machine

Mobile robot

Mobile robots have the capability to move around in their environment and are not fixed to one physical location. An example of a mobile robot that is in common use today is the *automated guided vehicle* or *automatic guided vehicle* (AGV). An AGV is a mobile robot that follows markers or wires in the floor, or uses vision or lasers. AGVs are discussed later in this article.

Mobile robots are also found in industry, military and security environments. They also appear as consumer products, for entertainment or to perform certain tasks like vacuum cleaning. Mobile robots are the focus of a great deal of current research and almost every major university has one or more labs that focus on mobile robot research.

Mobile robots are usually used in tightly controlled environments such as on assembly lines because they have difficulty responding to unexpected interference. Because of this most humans rarely encounter robots. However domestic robots for cleaning and maintenance are increasingly common in and around homes in developed countries. Robots can also be found in military applications.

Industrial robots (manipulating)

A Pick and Place robot in a factory

Industrial robots usually consist of a jointed arm (multi-linked manipulator) and an end effector that is attached to a fixed surface. One of the most common type of end effector is a gripper assembly.
The International Organization for Standardization gives a definition of a manipulating industrial robot in ISO 8373:
"an automatically controlled, reprogrammable, multi-purpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications."
This definition is used by the International Federation of Robotics, the European Robotics Research Network (EURON) and many national standards committees.

Service robot

Most commonly industrial robots are fixed robotic arms and manipulators used primarily for production and distribution of goods. The term "service robot" is less well-defined. The International Federation of Robotics has proposed a tentative definition, "A service robot is a robot which operates semi- or fully autonomously to perform services useful to the well-being of humans and equipment, excluding manufacturing operations."

Educational Robot

Robots are used as educational assistants to teachers. From the 1980s, robots such as turtles were used in schools and programmed using the Logo language.
There are robot kits like Lego Mindstorms, BIOLOID, OLLO from ROBOTIS, or BotBrain Educational Robots can help children to learn about mathematics, physics, programming, and electronics. Robotics have also been introduced into the lives of elementary and high school students in the form of robot competitions with the company FIRST (For Inspiration and Recognition of Science and Technology). The organization is the foundation for the FIRST Robotics Competition (photo), FIRST LEGO League, Junior FIRST LEGO League, and FIRST Tech Challenge competitions.

There have also been devices shaped like robots such as the teaching computer, Leachim (1974), and 2-XL (1976), a robot shaped game / teaching toy based on an 8-track tape player, both invented Michael J. Freeman.

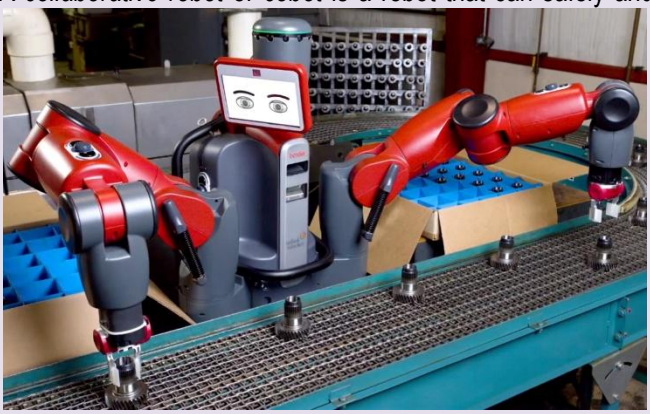
Modular robot

Modular robots are a new breed of robots that are designed to increase the utilization of robots by modularizing their architecture. The functionality and effectiveness of a modular robot is easier to increase compared to conventional robots. These robots are composed of a single type of identical, several different identical module types, or similarly shaped modules, which vary in size. Their architectural structure allows hyper-redundancy for modular robots, as they can be designed with more than 8 degrees of freedom (DOF). Creating the programming, inverse kinematics and dynamics for modular robots is more complex than with traditional robots. Modular robots may be composed of L-shaped modules, cubic modules, and U and H-shaped modules. ANAT technology, an early modular robotic technology patented by Robotics Design Inc., allows the creation of modular robots from U and H shaped modules that connect in a chain, and are used to form heterogeneous and homogenous modular robot systems. These "ANAT robots" can be designed with "n" DOF as each module is a complete motorized robotic system that folds relatively to the modules connected before and after it in its chain, and therefore a single module allows one degree of freedom. The more

modules that are connected to one another, the more degrees of freedom it will have. L-shaped modules can also be designed in a chain, and must become increasingly smaller as the size of the chain increases, as payloads attached to the end of the chain place a greater strain on modules that are further from the base. ANAT H-shaped modules do not suffer from this problem, as their design allows a modular robot to distribute pressure and impacts evenly amongst other attached modules, and therefore payload-carrying capacity does not decrease as the length of the arm increases. Modular robots can be manually or self-reconfigured to form a different robot, that may perform different applications. Because modular robots of the same architecture type are composed of modules that compose different modular robots, a snake-arm robot can combine with another to form a dual or quadra-arm robot, or can split into several mobile robots, and mobile robots can split into multiple smaller ones, or combine with others into a larger or different one. This allows a single modular robot the ability to be fully specialized in a single task, as well as the capacity to be specialized to perform multiple different tasks.
Modular robotic technology is currently being applied in hybrid transportation, industrial automation,duct cleaningand handling. Many research centres and universities have also studied this technology, and have developed prototypes.

Collaborative robots

A *collaborative robot* or *cobot* is a robot that can safely and effectively interact with human workers while performing simple industrial tasks. However, end-effectors and other environmental conditions may create hazards, and as such risk assessments should be done before using any industrial motion-control application.



The collaborative robots most widely used in industries today are manufactured by Universal Robots in Denmark.
Rethink Robotics—founded by Rodney Brooks, previously with iRobot—introduced Baxter (photo) in September 2012; as an industrial robot designed to safely interact with neighboring human workers, and be programmable for performing simple tasks. Baxters stop if they detect a human in the way of their robotic arms and have prominent off switches. Intended for sale to small businesses, they are promoted as the robotic analogue of the personal computer. As of May 2014, 190 companies in the US have bought Baxters and they are being used commercially in the UK.

Robots in society

TOPIO, a humanoid robot, played ping pong at Tokyo International Robot Exhibition (IREX) 2009.

Roughly half of all the robots in the world are in Asia, 32% in Europe, and 16% in North America, 1% in Australasia and 1% in Africa. 40% of all the robots in the world are in Japan, making Japan the country with the highest number of robots.

Autonomy and ethical questions

An android, or robot designed to resemble a human, can appear comforting to some people and disturbing to others

As robots have become more advanced and sophisticated, experts and academics have increasingly explored the questions of what ethics might govern robots' behavior, and whether robots might be able to claim any kind of social, cultural, ethical or legal rights. One scientific team has said that it is possible that a robot brain will exist by 2019. Others predict robot intelligence breakthroughs by 2050. Recent advances have made robotic behavior more sophisticated. The social impact of intelligent robots is subject of a 2010 documentary film called *Plug & Pray*.

Vernor Vinge has suggested that a moment may come when computers and robots are smarter than humans. He calls this "the Singularity". He suggests that it may be somewhat or possibly very dangerous for humans. This is discussed by a philosophy called Singularitarianism.

In 2009, experts attended a conference hosted by the Association for the Advancement of Artificial Intelligence (AAAI) to discuss whether computers and robots might be able to acquire any autonomy, and how much these abilities might pose a threat or hazard. They noted that some robots have acquired various forms of semi-autonomy, including being able to find power sources on their own and being able to independently choose targets to attack with weapons. They also noted that some computer viruses can evade elimination and have achieved "cockroach intelligence." They noted that self-awareness as depicted in science-fiction is probably unlikely, but that there were other potential hazards and pitfalls. Various media sources and scientific groups have noted separate trends in differing areas which might together result in greater robotic functionalities and autonomy, and which pose some inherent concerns.

Military robots

Some experts and academics have questioned the use of robots for military combat, especially when such robots are given some degree of autonomous functions. There are also concerns about technology which might allow some armed robots to be controlled mainly by other robots. The US Navy has funded a report which indicates that, as military robots become more complex, there should be greater attention to implications of their ability to make autonomous decisions. One researcher states that autonomous robots might be more humane, as they could make decisions more effectively. However, other experts question this.

One robot in particular, the EATR, (photo) has generated public concerns over its fuel source, as it can continually refuel itself using organic substances. Although the engine for the EATR is designed to run on biomass and vegetation specifically selected by its sensors, which it can find on battlefields or other local environments, the project has stated that chicken fat can also be used.

Manuel De Landa has noted that "smart missiles" and autonomous bombs equipped with artificial perception can be considered robots, as they make some of their decisions autonomously. He believes this represents an important and dangerous trend in which humans are handing over important decisions to machines.

Relationship to unemployment

A recent example of human replacement involves Taiwanese technology company Foxconn who, in July 2011, announced a three-year plan to replace workers with more robots. At present the company uses ten thousand robots but will increase them to a million robots over a three-year period.

Service robots of different varieties including medical robots, underwater robots, surveillance robots, demolition robots and other types of robots that carry out a multitude of jobs are gaining in numbers. Service robots are everyday tools for mankind. They can clean floors, mow lawns and guard homes and will also assist old and handicapped people, do some surgeries, inspect pipes and sites that are hazardous to people, fight fires and defuse bombs.

Contemporary uses

At present, there are two main types of robots, based on their use: general-purpose autonomous robots and dedicated robots.

Robots can be classified by their specificity of purpose. A robot might be designed to perform one particular task extremely well, or a range of tasks less well. Of course, all robots by their nature can be re-programmed to behave differently, but some are limited by their physical form. For example, a factory robot arm can perform jobs such as cutting, welding, gluing, or acting as a fairground ride, while a pick-and-place robot can only populate printed circuit boards.

General-purpose autonomous robots

General-purpose autonomous robots can perform a variety of functions independently. General-purpose autonomous robots typically can navigate independently in known spaces, handle their own re-charging needs, interface with electronic doors and elevators and perform other basic tasks. Like computers, general-purpose robots can link with networks, software and accessories that increase their usefulness. They may recognize people or objects, talk, provide companionship, monitor environmental quality, respond to alarms, pick up supplies and perform other useful tasks. General-purpose robots may perform a variety of functions simultaneously or they may take on different roles at different times of day. Some such robots try to mimic human beings and may even resemble people in appearance; this type of robot is called a humanoid robot. Humanoid robots are still in a very limited stage, as no humanoid robot can, as of yet, actually navigate around a room that it has never been in. Thus, humanoid robots are really quite limited, despite their intelligent behaviors in their well-known environments.

Factory robots

Car production

Over the last three decades, automobile factories have become dominated by robots. A typical factory contains hundreds of industrial robots working on fully automated production lines, with one robot for every ten human workers. On an automated production line, a vehicle chassis on a conveyor is welded, glued, painted and finally assembled at a sequence of robot stations.

Packaging

Industrial robots are also used extensively for palletizing and packaging of manufactured goods, for example for rapidly taking drink cartons from the end of a conveyor belt and placing them into boxes, or for loading and unloading machining centers.

Electronics
Mass-produced printed circuit boards (PCBs) are almost exclusively manufactured by pick-and-place robots, typically with SCARA manipulators, which remove tiny electronic components from strips or trays, and place them on to PCBs with great accuracy. Such robots can place hundreds of thousands of components per hour, far out-performing a human in speed, accuracy, and reliability.

Automated guided vehicles (AGVs)

An intelligent AGV drops-off goods without needing lines or beacons in the workspace

Mobile robots, following markers or wires in the floor, or using vision or lasers, are used to transport goods around large facilities, such as warehouses, container ports, or hospitals.

Early AGV-Style Robots
Limited to tasks that could be accurately defined and had to be performed the same way every time. Very little feedback or intelligence was required, and the robots needed only the most basic exteroceptors (sensors). The limitations of these AGVs are that their paths are not easily altered and they cannot alter their paths if obstacles block them. If one AGV breaks down, it may stop the entire operation.

Interim AGV-Technologies
Developed to deploy triangulation from beacons or bar code grids for scanning on the floor or ceiling. In most factories, triangulation systems tend to require moderate to high maintenance, such as daily cleaning of all beacons or bar codes. Also, if a tall pallet or large vehicle blocks beacons or a bar code is marred, AGVs may become lost. Often such AGVs are designed to be used in human-free environments.

Intelligent AGVs (i-AGVs)
Such as SmartLoader (photo), SpeciMinder, ADAM, Tug Eskorta, and MT 400 with Motivity are designed for people-friendly workspaces. They navigate by recognizing natural features. 3D scanners or other means of sensing the environment in two or three dimensions help to eliminate cumulative errors in dead-reckoning calculations of the AGV's current position. Some AGVs can create maps of their environment using scanning lasers with simultaneous localization and mapping (SLAM) and use those maps to navigate in real time with other path planning and obstacle avoidance algorithms. They are able to operate in complex environments and perform non-repetitive and non-sequential tasks such as transporting photomasks in a semiconductor lab, specimens in hospitals and goods in warehouses. For dynamic areas, such as warehouses full of pallets, AGVs require additional strategies using three-dimensional sensors such as time-of-flight or stereovision cameras.

Dirty, dangerous, dull or inaccessible tasks
There are many jobs which humans would rather leave to robots. The job may be boring, such as domestic cleaning, or dangerous, such as exploring inside a volcano. Other jobs are physically inaccessible, such as exploring another planet, cleaning the inside of a long pipe, or performing laparoscopic surgery.

Space probes
Almost every unmanned space probe ever launched was a robot. Some were launched in the 1960s with very limited abilities, but their ability to fly and land (in the case of Luna 9) is an indication of their status as a robot. This includes the Voyager probes and the Galileo probes, and others.

Telerobots

A U.S. Marine Corps technician prepares to use a telerobot to detonate a buried improvised explosive device near Camp Fallujah, Iraq

Teleoperated robots, or telerobots, are devices remotely operated from a distance by a human operator rather than following a predetermined sequence of movements, but which has semi-autonomous behaviour. They are used when a human cannot be present on site to perform a job because it is dangerous, far away, or inaccessible. The robot may be in another room or another country, or may be on a very different scale to the operator. For instance, a laparoscopic surgery robot allows the surgeon to work inside a human patient on a relatively small scale compared to open surgery, significantly shortening recovery time. They can also be used to avoid exposing workers to the hazardous and tight spaces such as in duct cleaning. When disabling a bomb, the operator sends a small robot to disable it. Several authors have been using a device called the Longpen to sign books remotely. Teleoperated robot aircraft, like the Predator Unmanned Aerial Vehicle, are increasingly being used by the military. These pilotless drones can search terrain and fire on targets. Hundreds of robots such as iRobot's Packbot and the Foster-Miller TALON (photo above) are being used in Iraq and Afghanistan by the U.S. military to defuse roadside bombs or improvised explosive devices (IEDs) in an activity known as explosive ordnance disposal (EOD).

Automated fruit harvesting machines

The Roomba domestic vacuum cleaner robot does a single, menial job

Used to pick fruit on orchards at a cost lower than that of human pickers.

Domestic robots
Domestic robots are simple robots dedicated to a single task work in home use. They are used in simple but

unwanted jobs, such as vacuum cleaning and floor washing, and lawn mowing.

Military robots

Military robots include the SWORDS robot which is currently used in ground-based combat. It can use a variety of weapons and there is some discussion of giving it some degree of autonomy in battleground situations.

Unmanned combat air vehicles (UCAVs), which are an upgraded form of UAVs, can do a wide variety of missions, including combat. UCAVs are being designed such as the BAE Systems Mantis which would have the ability to fly themselves, to pick their own course and target, and to make most decisions on their own. The BAE Taranis (photo) is a UCAV built by Great Britain which can fly across continents without a pilot and has new means to avoid detection. Flight trials are expected to begin in 2011.

The AAAI has studied this topic in depth and its president has commissioned a study to look at this issue.

Some have suggested a need to build "Friendly AI", meaning that the advances which are already occurring with AI should also include an effort to make AI intrinsically friendly and humane. Several such measures reportedly already exist, with robot-heavy countries such as Japan and South Korea having begun to pass regulations requiring robots to be equipped with safety systems, and possibly sets of 'laws' akin to Asimov's Three Laws of Robotics. An official report was issued in 2009 by the Japanese government's Robot Industry Policy Committee. Chinese officials and researchers have issued a report suggesting a set of ethical rules, and a set of new legal guidelines referred to as "Robot Legal Studies." Some concern has been expressed over a possible occurrence of robots telling apparent falsehoods.

Mining robots

Mining robots are designed to solve a number of problems currently facing the mining industry, including skills shortages, improving productivity from declining ore grades, and achieving environmental targets. Due to the hazardous nature of mining, in particular underground mining, the prevalence of autonomous, semi-autonomous, and tele-operated robots has greatly increased in recent times. A number of vehicle manufacturers provide autonomous trains, trucks and loaders that will load material, transport it on the mine site to its destination, and unload without requiring human intervention. One of the world's largest mining corporations, Rio Tinto, has recently expanded its autonomous vehicle fleet to the world's largest, consisting of 150 autonomous Komatsu trucks, operating in Western Australia.

Drilling, longwall and rockbreaking machines are now also available as autonomous robots. The Atlas Copco Rig Control System can autonomously execute a drilling plan on a drilling rig, moving the rig into position using GPS, set up the drill rig and drill down to specified depths. Similarly, the Transmin Rocklogic system can automatically plan a path to position a rockbreaker at a selected destination. These systems greatly enhance the safety and efficiency of mining operations.

Robot kits

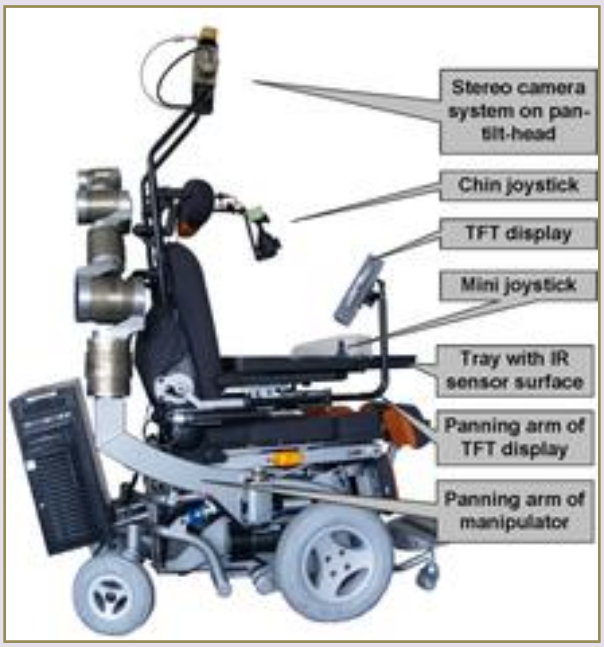
Robotic kits like Lego Mindstorms, BIOLOID, OLLO from ROBOTIS, or BotBrain Educational Robots can help children to learn about mathematics, physics, programming, and electronics.

Robot competitions
Robotics have also been introduced into the lives of elementary and high school students with the company FIRST (For Inspiration and Recognition of Science and Technology). The organization is the foundation for the FIRST Robotics Competition, FIRST LEGO League, Junior FIRST LEGO League, and FIRST Tech Challenge competitions.

Virtual tutors
Virtual tutors are some kind of embodied agent that helps children to do their homework, for example, on peer to peer basis.

Teacher assistants
Robots as teacher assistants let children to be more assertive during the class and get more motivated. South Korea is the first country deploying a program to have a robot in each school.

Healthcare
Robots in healthcare have two main functions. Those which assist an individual, such as a sufferer of a disease like Multiple Sclerosis, and those which aid in the overall systems such as pharmacies and hospitals.



Home automation for the elderly and disabled

The Care-Providing Robot FRIEND

Robots have developed over time from simple basic robotic assistants, such as the Handy 1,[125] through to semi-autonomous robots, such as FRIEND which can assist the elderly and disabled with common tasks.
The population is aging in many countries, especially Japan, meaning that there are increasing numbers of elderly people to care for, but relatively fewer young people to care for them. Humans make the best carers, but where they are unavailable, robots are gradually being introduced.
FRIEND is a semi-autonomous robot designed to support disabled and elderly people in their daily life activities, like preparing and serving a meal. FRIEND make it possible for patients who are paraplegic, have muscle diseases or serious paralysis (due to strokes etc.), to perform tasks without help from other people like therapists or nursing staff.

Pharmacies
Script Pro manufactures a robot designed to help pharmacies fill prescriptions that consist of oral solids or medications in pill form. The pharmacist or pharmacy technician enters the prescription information into its information system. The system, upon determining whether or not the drug is in the robot, will send the information to the robot for filling. The robot has 3 different size vials to fill determined by the size of the pill. The robot technician, user, or pharmacist determines the needed size of the vial based on the tablet when the robot is stocked. Once the vial is filled it is brought up to a conveyor belt that delivers it to a holder that spins the vial and attaches the patient label. Afterwards it is set on another conveyor that delivers the patient's medication vial to a slot labeled with the patient's name on an LED read out. The pharmacist or technician then checks the

contents of the vial to ensure it's the correct drug for the correct patient and then seals the vials and sends it out front to be picked up. The robot is a very time efficient device that the pharmacy depends on to fill prescriptions.

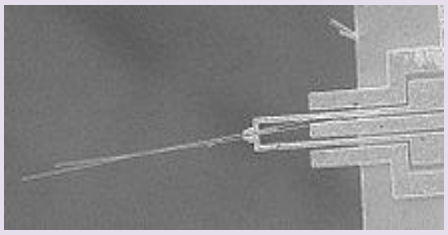
McKesson's Robot RX is another healthcare robotics product that helps pharmacies dispense thousands of medications daily with little or no errors. The robot can be ten feet wide and thirty feet long and can hold

hundreds of different kinds of medications and thousands of doses. The pharmacy saves many resources like staff members that are otherwise unavailable in a resource scarce industry. It uses an electromechanical head coupled with a pneumatic system to capture each dose and deliver it to its either stocked or dispensed location. The head moves along a single axis while it rotates 180 degrees to pull the medications. During this process it uses barcode technology to verify its pulling the correct drug. It then delivers the drug to a patient specific bin on a conveyor belt. Once the bin is filled with all of the drugs that a particular patient needs and that the robot stocks, the bin is then released and returned out on the conveyor belt to a technician waiting to load it into a cart for delivery to the floor.

Research robots

While most robots today are installed in factories or homes, performing labour or life saving jobs, many new types of robot are being developed in laboratories around the world. Much of the research in robotics focuses not on specific industrial tasks, but on investigations into new types of robot, alternative ways to think about or design robots, and new ways to manufacture them. It is expected that these new types of robot will be able to solve real world problems when they are finally realized.

Nanorobots



A microfabricated electrostatic gripper holding some silicon nanowires.

Nanorobotics is the emerging technology field of creating machines or robots whose components are at or close to the microscopic scale of a nanometer (10^{-9} meters). Also known as "nanobots" or "nanites", they would be constructed from molecular machines. So far, researchers have mostly produced only parts of these complex systems, such as bearings, sensors, and synthetic molecular motors, but functioning robots have also been made such as the entrants to the Nanobot Robocup contest. Researchers also hope to be able to create entire robots as small as viruses or bacteria, which could perform tasks on a tiny scale. Possible applications include micro

surgery (on the level of individual cells), utility fog. manufacturing, weaponry and cleaning. Some people have suggested that if there were nanobots which could reproduce, the earth would turn into "grey goo", while others argue that this hypothetical outcome is nonsense.

Reconfigurable Robots
A few researchers have investigated the possibility of creating robots which can alter their physical form to suit a particular task, like the fictional T-1000. Real robots are nowhere near that sophisticated however, and mostly consist of a small number of cube shaped units, which can move relative to their neighbours. Algorithms have been designed in case any such robots become a reality.
Soft Robots
Robots with silicone bodies and flexible actuators (air muscles, electroactive polymers, and ferrofluids), controlled using fuzzy logic and neural networks, look and feel different from robots with rigid skeletons, and can have different behaviors.

Swarm robots

A swarm of robots from the open-source micro-robotic project

Inspired by colonies of insects such as ants and bees, researchers are modeling the behavior of swarms of thousands of tiny robots which together perform a useful task, such as finding something hidden, cleaning, or spying. Each robot is quite simple, but the emergent behavior of the swarm is more complex. The whole set of robots can be considered as one single distributed system, in the same way an ant colony can be considered a superorganism, exhibiting swarm intelligence. The largest swarms so far created include the iRobot swarm, the SRI/MobileRobots CentiBots project and the Open-source Micro-robotic Project swarm, which are being used to research collective behaviors. Swarms are also more resistant to failure. Whereas one large robot may fail and ruin a mission, a swarm can continue even if several robots fail. This could make them attractive for space exploration missions, where failure is normally extremely costly.

Haptic interface robots
Robotics also has application in the design of virtual reality interfaces. Specialized robots are in widespread use in the haptic research community. These robots, called "haptic interfaces", allow touch-enabled user interaction with real and virtual environments. Robotic forces allow simulating the mechanical properties of "virtual" objects, which users can experience through their sense of touch.

Entertainment
Poledancing robots
Some robots are used for entertainment and as a demonstration of the newest technology. This nimble automoton is a perfect example of this process. Being the main attractions at Ce-BIT, the world's biggest IT trade fair in Hanover, Germany.

Technological trends
Various techniques have emerged to develop the science of robotics and robots. One method is evolutionary robotics, in which a number of differing robots are submitted to tests. Those which perform best are used as a model to create a subsequent "generation" of robots. Another method is developmental robotics, which tracks changes and development within a single robot in the areas of problem-solving and other functions.

Technological development

Overall trends

Japan hopes to have full-scale commercialization of service robots by 2025. Much technological research in Japan is led by Japanese government agencies, particularly the Trade Ministry.

As robots become more advanced, eventually there may be a standard computer operating system designed mainly for robots. Robot Operating System is an open-source set of programs being developed at Stanford University, the Massachusetts Institute of Technology and the Technical University of Munich, Germany, among others. ROS provides ways to program a robot's navigation and limbs regardless of the specific hardware involved. It also provides high-level commands for items like image recognition and even opening doors. When ROS boots up on a robot's computer, it would obtain data on attributes such as the length and movement of robots' limbs. It would relay this data to higher-level algorithms. Microsoft is also developing a "Windows for robots" system with its Robotics Developer Studio, which has been available since 2007.

New functions and abilities

The Caterpillar Company is making a dump truck which can drive itself without any human operator.

Many future applications of robotics seem obvious to people, even though they are well beyond the capabilities of robots available at the time of the prediction. As early as 1982 people were confident that someday robots would: 1. clean parts by removing molding flash 2. spray paint automobiles with absolutely no human presence 3. pack things in boxes—for example, orient and nest chocolate candies in candy boxes 4. make electrical cable harness 5. load trucks with boxes—a packing problem 6. handle soft goods, such as garments and shoes 7. shear sheep 8. prosthesis 9. cook fast food and work in other service industries 10. household robot.

Generally such predictions are overly optimistic in timescale.

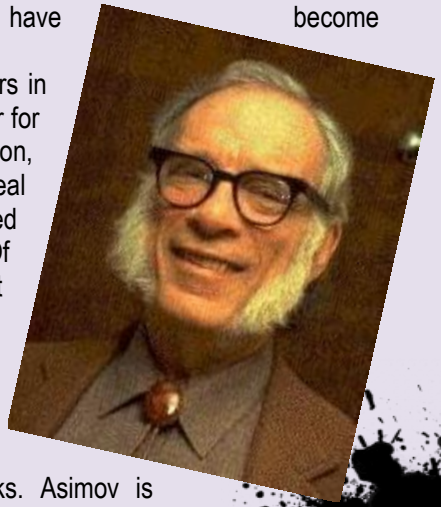
Reading robot

A literate or 'reading robot' named Marge has intelligence that comes from software. She can read newspapers, find and correct misspelled words, learn about banks like Barclays, and understand that some restaurants are better places to eat than others.

Robots in popular culture

Literature

Robotic characters, androids (artificial men/women) or gynoids (artificial women), and cyborgs (also "bionic men/women", or humans with significant mechanical enhancements) have become a staple of science fiction.



The first reference in Western literature to mechanical servants appears in Homer's *Iliad*. In Book XVIII, Hephaestus, god of fire, creates new armor for the hero Achilles, assisted by robots. According to the Rieu translation, "Golden maidservants hastened to help their master. They looked like real women and could not only speak and use their limbs but were endowed with intelligence and trained in handwork by the immortal gods." Of course, the words "robot" or "android" are not used to describe them, but they are nevertheless mechanical devices human in appearance. "The first use of the word Robot was in Karel Čapek's play R.U.R. (Rossum's Universal Robots) (written in 1920)". Writer Karel Čapek was born in Czechoslovakia (Czech Republic).

Possibly the most prolific author of the twentieth century was Isaac Asimov (1920–1992; photo) who published over five-hundred books. Asimov is

probably best remembered for his science-fiction stories and especially those about robots, where he placed robots and their interaction with society at the center of many of his works. Asimov carefully considered the problem of the ideal set of instructions robots might be given in order to lower the risk to humans, and arrived at his Three Laws of Robotics: a robot may not injure a human being or, through inaction, allow a human being to come to harm; a robot must obey orders given to it by human beings, except where such orders would conflict with the First Law; and a robot must protect its own existence as long as such protection does not conflict with the First or Second Law. These were introduced in his 1942 short story "Runaround", although foreshadowed in a few earlier stories. Later, Asimov added the Zeroth Law: "A robot may not harm humanity, or, by inaction, allow humanity to come to harm"; the rest of the laws are modified sequentially to acknowledge this.
According to the *Oxford English Dictionary,* the first passage in Asimov's short story "Liar!" (1941) that mentions the First Law is the earliest recorded use of the word *robotics*. Asimov was not initially aware of this; he assumed the word already existed by analogy with *mechanics, hydraulics,* and other similar terms denoting branches of applied knowledge.

Problems depicted in popular culture
Fears and concerns about robots have been repeatedly expressed in a wide range of books and films. A common theme is the development of a master race of conscious and highly intelligent robots, motivated to take over or destroy the human race. (See *The Terminator, Runaway, RoboCop*, the Replicators in *Stargate*, the Cylons in *Battlestar Galactica*, the Cybermen in *Doctor Who*, *The Matrix*, *Enthiran* and *I, Robot*.) Some fictional robots are programmed to kill and destroy; others gain superhuman intelligence and abilities by upgrading their own software and hardware. Examples of popular media where the robot becomes evil are *2001: A Space Odyssey*, *Red Planet* and *Enthiran*. Another common theme is the reaction, sometimes called the "uncanny valley", of unease and even revulsion at the sight of robots that mimic humans too closely. *Frankenstein* (1818), often called the first science fiction novel, has become synonymous with the theme of a robot or monster advancing beyond its creator. In the TV show, Futurama, the robots are portrayed as humanoid figures that live alongside humans, not as robotic butlers. They still work in industry, but these robots carry out daily lives. Other problems may include events pertaining to robot surrogates (e.g. the movie *Surrogates*) where tissue of living organisms is interchanged with robotic systems. These problems can leave many possibilities where electronic viruses or an electro magnetic pulse (EMP) can destroy not only the robot but kill the host/operator as well.

Rescue robot

Source: http://en.wikipedia.org/wiki/Rescue_robot

A **rescue robot** is a robot that has been designed for the purpose of rescuing people.[1] Common situations that employ rescue robots are mining accidents, urban disasters, hostage situations, and explosions. Rescue robots were used in the search for victims and survivors after the September 11 attacks in New York. The benefits of rescue robots to

these operations include reduced personnel requirements, reduced fatigue, and access to otherwise unreachable areas.

During September 11 disasters rescue robots were first really tested. They were sent into the rubble to look for survivors and bodies. The robots had trouble working in the rubble of the World Trade Center and were constantly getting stuck or broken. Since then many new ideas have been formed about rescue robots. Engineers and scientists are trying to change the shapes of the robots and take them from wheels to no wheels. “Strong government funding and support is needed if search and rescued robots are to see widespread use in fewer than 10 years.” This means that without the help of government the technology for these devices are not available or they cost too much. These robots are very important in disaster scenarios and are hopefully taking a change for the better.

People like Daniel Goldman, a biophysicist at Georgia Tech, has started building a robot that Piore says “is less like an ATV and more like a sandfish lizard”. Goldman has been spending a lot of time researching and studying the movements of sandfish lizards and trying to develop that into his own robotic idea. Piore states that his robot will be able to “burrow deeper or snake its way back to the surface” – just like a sandfish lizard. This will be helpful in many disaster scenarios. Goldman is trying to develop this robot to be able to maneuver though such terrain as rubble, like in the World Trade Center disaster.

Rescue robots in development are being made with abilities such as searching, reconnaissance and mapping, removing or shoring up rubble, delivery of supplies, medical treatment, and evacuation of casualties. Even with all these ideas coming about there are still some technical challenges that remain. Robin Murphy, a professor of computer science and engineering, says that “Real disasters are infrequent, and every one is different. The robots never get used exactly the way you think they will, and they keep uncovering new bottlenecks and problems. So it’s an emerging technology.”

Murphy states that most rescue robots are not tested in real life situations and more in a situation that the robot can handle. The possible solutions to these problems are what an associate professor of robotics-Howie Choset, is working on. Choset is working on building a “snake robot”. These snake robots are “thin, legless devices with multiple joints”. These snake robots will be used to go places where normal wheeled robots cannot go. The technology still needs some work and the trials they are going through with them aren’t going perfect. Most tests and studies are helping Choset out and are improving these snake robots. “More animal studies would help” says Choset. The robot is based on snakes and their movements, but considering that snakes are made up of 200 bones and the robot is made up of 15 links, there are problems in functionality. There are three main levels of challenges. First, the information processing of the robot. Second, the mobility of the robot. Third, the manipulation of the robot. Bringing these robots into real-world use and being able to utilize them in all situations is so close to becoming a reality. “We're just inches away” Murphy says, “a lot of software is just waiting for the hardware to catch up”.

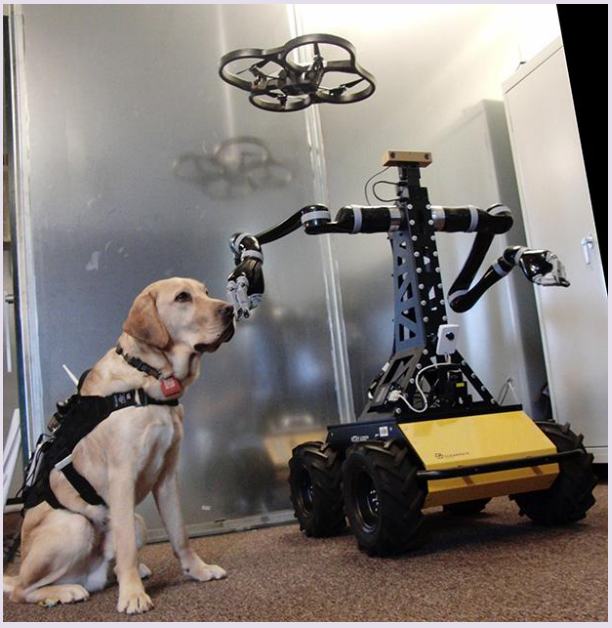
Fifteen scientists from all over the world were put together on a team of search and rescue professionals from the Federal Emergency Management Agency’s Indiana. They were put together to find problems with rescue robots. Together they put together the R4 program. Which is Rescue Robots for Research and Response. This is a three year grant and it is there to improve the rescue robot technology and human performance. Three robots were tested during this time and a fourth was introduced to the scientists. Each robot spent about an hour moving around in the rubble and was observed for their movement and how well they were able to make their way through the rubble. They tested the robots on the rubble from the World Trade Center disaster so they could better prepare for a similar disaster. They were looking for two things with these rescue robots. First, how to detect victims and unsafe conditions for rescuers in a highly cluttered, unfavorable environment. Second, how to ensure sensor coverage of a particular volume of space. In one series of tests, robots were put into dark, mine-like conditions. However, the robots were unable to locate half of their targets. Some changes will need to be made if they ever expect these robots to function properly. But once they figure out what they need they will hopefully serve a great purpose and be a greater asset to rescuers.

Emergency Response Teams Combine Mobile Robots, Drones, and Dogs

Source: http://spectrum.ieee.org/automaton/robotics/military-robots/emergency-response-teams-com bine-mobile-robots-drones-and-dogs

No matter how much time and energy and money we put into a robot, it's going to be a very very very long time before we come up with anything that's anywhere close to as capable as a dog. From a robotics perspective, dogs are utterly amazing: they're fast, efficient, able to cover all sorts of terrain, can understand both verbal and gestural commands, and they run on dog food.

Dogs do have some limitations: they can't move rubble, and they're not that great at flying, either. Robots can do these things, but in a disaster scenario, the key is getting *all* these different pieces (robots, dogs, humans, and anything else) to work together in a coherent way.



The Smart Emergency Response System (SERS) is trying to make this work, using a combination of "ground and aerial autonomous vehicles, drones, humanoids, human-operated telerobots, and trained search-and-rescue dogs equipped with real-time sensors" to save as many lives as possible in an emergency.

The project involves a number of organizations, including North Carolina State University, MathWorks, University of Washington, MIT, BluHaptics, National Instruments, University of North Texas, Boeing, and Worcester Polytechnic Institute.

This may be one of the most charmingly terrible graphics I've ever seen, but I like how it shows an ATLAS with what I think might be a dog next to it, and we all know how well dogs and robots get along.

Anyway, the SERS system combines whatever kinds of communications are available (Wi-Fi, cellular, Bluetooth, etc.) to connect autonomous and semi-autonomous robots with a centralized command center.

Photo: Alper Bozkurt/ North Carolina State University

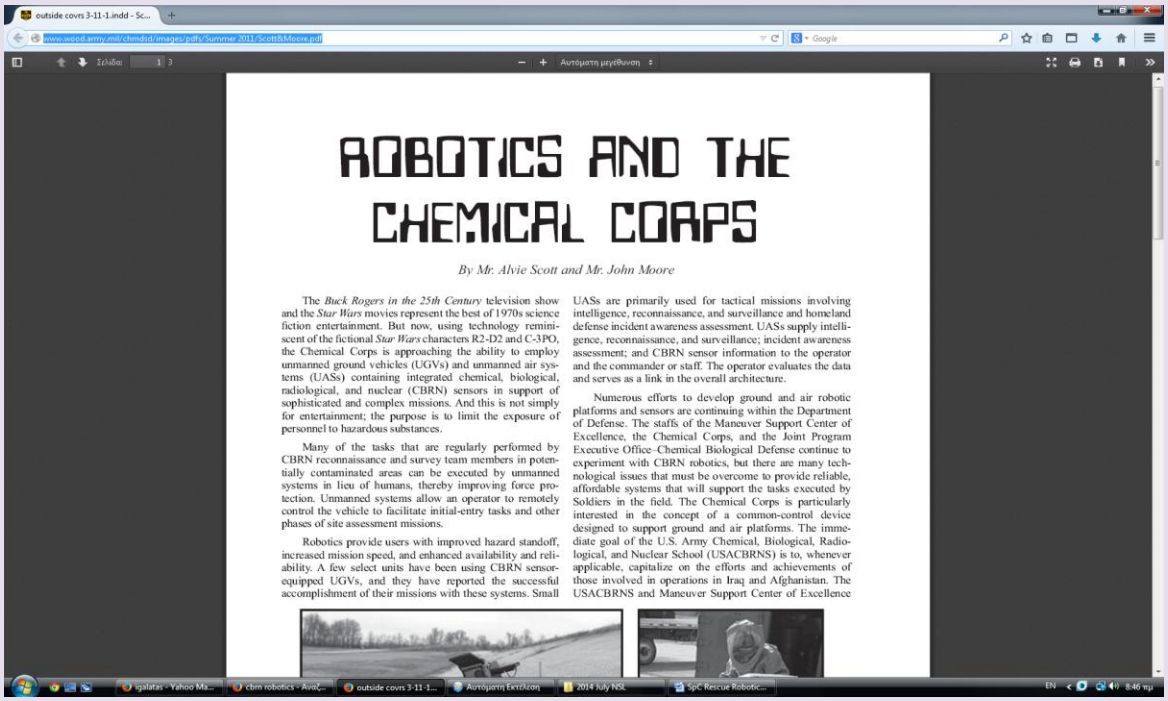
The dogs are intended to be an integral part of this system, and they're being outfitted with modular "cybernetic suits" that can be rigged up with a variety of sensors depending on the situation.

The suits also monitor the dogs themselves, sending back their heart rates so that their handlers can make sure that they're doing

okay. It works in the other direction, too, with speakers on the vests relaying vocal commands, and embedded tactile systems providing gentle nudges to steer the dogs remotely.
The idea of having dogs work closely with robots is an interesting one: dogs have successfully carried and deployed snake robots by themselves, and we're curious to see how far this level of interaction can be extended.

Robotics and the Chemical Corps

Source: http://www.wood.army.mil/chmdsd/images/pdfs/Summer%202011/Scott&Moore.pdf



ROBOTICS AND THE CHEMICAL CORPS

By Mr. Alvie Scott and Mr. John Moore

The *Buck Rogers in the 25th Century* television show and the *Star Wars* movies represent the best of 1970s science fiction entertainment. But now, using technology reminiscent of the fictional *Star Wars* characters R2-D2 and C-3PO, the Chemical Corps is approaching the ability to employ unmanned ground vehicles (UGVs) and unmanned air systems (UASs) containing integrated chemical, biological, radiological, and nuclear (CBRN) sensors in support of sophisticated and complex missions. And this is not simply for entertainment; the purpose is to limit the exposure of personnel to hazardous substances.

Many of the tasks that are regularly performed by CBRN reconnaissance and survey team members in potentially contaminated areas can be executed by unmanned systems in lieu of humans, thereby improving force protection. Unmanned systems allow an operator to remotely control the vehicle to facilitate initial-entry tasks and other phases of site assessment missions.

Robotics provide users with improved hazard standoff, increased mission speed, and enhanced availability and reliability. A few select units have been using CBRN sensor-equipped UGVs, and they have reported the successful accomplishment of their missions with these systems. Small UASs are primarily used for tactical missions involving intelligence, reconnaissance, and surveillance and homeland defense incident awareness assessment. UASs supply intelligence, reconnaissance, and surveillance; incident awareness assessment; and CBRN sensor information to the operator and the commander or staff. The operator evaluates the data and serves as a link in the overall architecture.

Numerous efforts to develop ground and air robotic platforms and sensors are continuing within the Department of Defense. The staffs of the Maneuver Support Center of Excellence, the Chemical Corps, and the Joint Program Executive Office–Chemical Biological Defense continue to experiment with CBRN robotics, but there are many technological issues that must be overcome to provide reliable, affordable systems that will support the tasks executed by Soldiers in the field. The Chemical Corps is particularly interested in the concept of a common-control device designed to support ground and air platforms. The immediate goal of the U.S. Army Chemical, Biological, Radiological, and Nuclear School (USACBRNS) is to, whenever applicable, capitalize on the efforts and achievements of those involved in operations in Iraq and Afghanistan. The USACBRNS and Maneuver Support Center of Excellence

It's about time for a European Robotic Cluster

Source: http://www.cbrneportal.com/its-about-time-for-a-european-robotic-cluster/

IB Consultancy conducted an interview with Lt Col Jean-Paul Monet, CBRNe Zonal Advisor for the French Sapeur-Pompiers. Many interesting topics were addressed including the role of the Sapeur-Pompiers in the event of CBRN accidents and attacks, robotics in the field of CBRN and EU CBRN first response.

Could you briefly outline France's main CBRN response plans?

At national level a "meta-plan" to determine general national threats is permanently active in order to conduct timely risk assessment and hence determine national preparedness and surveillance capabilities' mobilisation. It's "Vigipirate" national threat level planning.
More specific national response plans centred on national security have also been established to deal with threats against national security arising from terrorists or climate disasters, namely: Piratox and Piratom for CBRN as well as PiratNet for cyber criminality.

From the civil protection point of view, the main response planning system is ORSEC (under the authority of the Ministry of Interior) and deals with, amongst others: SEVESO sites, dangerous material transport, and electricity grid breakdown.

What is the role of the *sapeur-pompiers* in the event of a CBRN accident or attack?
The *sapeur-pompiers* (French Fire Brigade are civilian forces, linked to the Ministry of Interior) execute both the national safety response plan ORSEC as well as the specific national security plans such as Piratox, Piratom and so forth.
On the ground, first response coordination is dealt with by an officer (incident commander) from the *sapeur-pompiers*. He coordinates response efforts between the police, the *gendarmerie nationale* (Police part of the French Armed forces), ambulances and hospitals present on the ground. All the *sapeur-pompiers* are trained to deal with CBRN of accidental, industrial or terrorist nature and they have special units to deal with decontamination of chemical risks and depollution. The incident commander from the *sapeur-pompiers* reports to the strategic level represented by the Mayor (municipal level) or the Prefect (area department level) depending on the gravity and the geographical scope of the crisis. If the latter constitutes a threat to national security, the Prime Minister is responsible for nation-wide response strategy.
If the CBRN crisis is long lasting or nation-wide the French Armed Forces can assist the first response efforts. Notwithstanding, the Sapeur-Pompiers and French Armed Forces train together at the *Centre National Civilo-militaire* for CBRN CNCMFE (National Cimic CBRN centre) in order to prepare themselves against CBRN attacks for example.

I noticed you emphasized on terrorist matters, does that mean the "e" in CBRNe is becoming predominant for first response training and response?
The problem is that terrorist are not only restraint to the "e" category but have widened the scope of their activities. Our fear is that terrorists diffuse chemical products or dirty bombs. The problem nowadays is that different response departments including the police, the *sapeur-pompiers* or the armed forces have to improve their communication together. Therefore, France works hard to de-compartmentalise these departments in order to better address CBRN crises. Indeed, there is no unique crisis typology but rather different crises that are to be addressed by all the first responders together according their competencies and responsibilities. French first responders have to get into the habit of working together and coordinate properly. I sincerely hope that current budget constraints on public services will have a positive effect, on rationalisation and collaborative work, between departments involved.

As zonal CBRN technical advisor for the *Etat Major de Zone Sud,* what is your role?
The French territory is split into nine Security and Defence zones (super regions comprising many different area departments) that mutualise capabilities in order to deal with CBRN terrorist attacks, accidents and incidents (for example decontamination units, spectrometry, sample collection capabilities, water bombers and helicopters). My role is to federate the 15 area department technical advisors of my zone. Consequently, part of my work is harmonisation within my zone. For example, when it comes to decontamination practices, I have to make sure that all area departments address decontamination practices the same way.
Furthermore, as zonal CBRN technical advisor, I am in charge of operation scenarios, lessons learned, I establish civil-military zonal CBRN exercises scenarios and conduct them. Finally, within the national RADART expert group, I participate in national hazmat materials and substances advisory board and knowledge network.

What was your role in the dedicated CBRN robot programme with ECA?
In 2002, after many first response operations, we came to the conclusion that robotics could play a significant role in CBRN response. This was an innovative project that emerged from the annual meeting of the *National Fire Association* (FNSPF) and a number of dedicated CBRN conferences.

The project started off with bilateral agreements between French manufacturers and my brigade and from 2006 onwards little consortiums financed by French national funds were established for the first leg of the robotic programme from 2006 to 2009. The *Sapeur-pompiers* were at the centre of the project comprising research centres, industries and end users. The first manufactured CBRN product manufactured by ECA was released in 2009. They have since sold approximately 20 units of this CBRN robot.
Together with ECA and other companies, we are now working on the second leg of the project spreading from 2011 to 2015. We have kept the same platform: ECA's terrestrial medium weight robot (30 kilograms). The aim of this second development is to enhance the robot's CBRN capabilities but also to broaden the capability scope of the robot to other *sapeur-pompiers* operations such as fires in tunnels. The project is inter-services with the collaboration of the police and the military since nowadays robots can be used to support the armed forces during operations for support or demining, EODs or hostage crises. We are working on a common robotic platform for each service (fire brigade, police, army) that can then be adapted according to respective needs by replacing different sensors.
The *sapeur-pompiers'* main objective is to enhance the robot's thermal resistance in order to better deal with the heat of fires. Furthermore, data collection and management improvement (for manoeuvring, detection, sounds…) is a priority in order to enhance accurate data processing capabilities so that crises are addressed more efficiently. We are also focusing our efforts on inter-robots communication, dealing with interferences amongst robots for example. However, we are not interested in developing remotely autonomous robots for first response operations. The only autonomous application that immediately comes to my mind is for CBRN perimeter and detection scanning.

What is the French State's implication in robotics projects? Is it considered as an R&D priority?
The French State participates in R&D projects through the *Agence Nationale de Recherche* ARN (National Research Agency) and the *Banque Publique d'Investissement* BPI (National Investment Bank). The French State has contributed approximately 1 million euros for R&D robotic research projects. For the moment the budget allocated by the French State is important but remains still quite reasonable.
In March 2013, Mr Montebourg, Minister for Production Recovery, launched a special programme dedicated to national robotic research and development for industries and personal assistance purposes mainly. However, Minister Montebourg did acknowledge that robots could also play an important role in the field of security. Consequently, I believe this is only the first step towards more state investment in robotics R&D.

What are French strategic priorities when it comes to CBRNe?
It is not my role to talk about the State's priorities but in my opinion through the national strategic documents called the *Livre Blanc de la Defense* (White book for Defence) published in 2013; the French State enumerated a number of key strategic priorities for the military and civilian units for the fight against terrorism.
Due to harsh constraints on defence and internal security budgets, I cannot predict what future evolutions will be. However, I have noticed that the French State has stepped up its efforts to address malicious and accidental activities in order to increase citizens' security. At the *Sapeur-Pompiers'* level we have really noticed first hand that the scope of our prerogatives has been broadened in order to encompass national security threats emanating both from accidental causes but also criminal, terrorist and political activities. I will give you an example; we could have to deal with environmental activists that carry out biological attacks: this is not a fictional scenario. As a matter of fact, we have already witnessed an attack on a laboratory carried out by environmental activists who were fighting against animal epxerimentations.
Overall the French State is dedicated to taking into account a broad range of threats whatever their origin in order to protect its citizens. Consequently, CBRN threats remain high on France's strategic agenda.

What is your opinion when it comes to the mutualisation of CBRN response capabilities at the European Union's (EU) level?
This is a very good idea that was initiated a while ago by the Commissioner Michel Barnier who had drafted a project for E4 capability mutualisation. However, I regret that these

recommendations have not been sorely followed. At the EU level there is a civil security response mechanism with its' command centre under the authority of the Directorate General ECHO and there is also a training platform at the EU level. This mechanism does not have its own capabilities but it can send specialised teams of experts and coordinate the redistribution of air transport equipment. Eventually, this EU civil response mechanism can deploy CBRN capabilities in the event of an oil spill for example.
In my opinion the EU should go even further and mutualise its capabilities, in the wide spectrum of threats, to security and safety including CBRNe operations.

What is your view on joint EU Robotics research? Do you participate in any of these projects?
No I do not participate in such EU projects. However, I am very interested in new Horizon 2020 research projects that combine the development of robotic platforms as well as data transmission and management applications. In my opinion these robotic projects are not only for industrial purposes but also for the field of security, directly usable by end-users.
I strongly advocate for a European Robotic Cluster that would bring together European robotic manufacturers. EADS was established in 1992; Now I would like to see the EADS of robots. However for the moment, the European robotic Market is scattered, we are witnessing an expansion of the market and every day a new company enters the market so to speak.

Cameleon CBRNe Robot

Source: http://www.eca-robotics.com/ftp/ecatalogue/507/CAMELEON_CBRNe_GB.pdf

MSCoE CBRN Soldiers Experiment with Robotic Standoff Detection Capability

Source: http://www.arcic.army.mil/Articles/aid-MSCoE-CBRN-Soldiers-Experiment-With-Robotic-Standoff-Detection-Capability.aspx

The iRobot Warrior, using a tool on the end of its arm, is able to grab, lift and carry heavy items. The arm can lift up to 350 pounds and the Warrior can carry a payload of up to 150 pounds.
(Photo courtesy of iRobot)

Robotic value to the warfighter. When one accesses the Robotic Systems Joint Project Office (RSJPO), the ever present banner touting the number of lives saved by robots is a constant reminder of their importance.
Robots provide the warfighter with a standoff capability that effectively reduce risk when faced with dangerous missions, and is a critical component for decreasing fatalities in potentially-lethal situations. In 2012, RAND published the "Assessing the Impact of Autonomous Robotic Systems on Army Force Structure" study. An excerpt of that study concluded "that the application of robotic systems had a net positive impact on Army operations including significant cost savings, effectiveness improvements, manpower reductions, and casualty reductions or avoidance."
The Army Capabilities Integration Center Accelerated Capabilities Division (ARCIC ACD) sponsored a Limited Objective Experiment (LOE) with the Maneuver Support Battle Lab at Ft Leonard Wood, Missouri from 9-20 September 2013 to look at the use of robots integrated with chemical detection systems. The two week experiment provided Chemical, Biological, Radiological, and Nuclear (CBRN) Specialist with an opportunity to experiment with the Talon IV Robot as a standoff chemical detection platform; a capability recently approved and planned for Chemical Units Modified Table Organizational Equipment (MTOE). In addition, the experiment also recruited the assistance of Combat Engineers from the 509th Engineer Company to provide feedback on use of the Multi Modal Tactical Robot Controller (MM-TRC) in lieu of the legacy Operator Control Unit (OCU) routinely used within the Route Clearance Platoon. The Engineers operated their respective platforms from both armored HMMWVs and the MRAP Buffalo.
ARCIC ACD formed a project team consisting of the Marine Corps Warfighting Lab (MCWL), RSJPO, Program Manager CBRN, and Army Test & Evaluation Command (ATEC) to integrate three specific CBRN sensors onto the Talon IV platform and to integrate those sensors with the MM-TRC. The three sensors integrated for the experiment included the Joint Chemical Agent Detector (JCAD) chemical warfare agent sensor, the RAE Systems Multi-RAE Plus hazardous gas detector, and the Canberra AN/UDR-14 radiation sensor.
Soldiers from the 4th Maneuver Enhancement Brigade, 92nd Military Police Battalion and the 509th Engineer Company at Ft Leonard Wood were provided certification training on the Talon Robot and legacy operator control unit by the RSJPO Robotics University at Ft Leonard Wood during the first week of experimentation. During the second week, the legacy Operator Control Units (OCUs) were replaced with the MM-TRC and soldiers received training from the equipment manufacturer. The objective of the LOE was to investigate the integration, application, and capability of a CBRN sensor payload on a robotic platform. The mission for the Unmanned Ground Vehicle, equipped with a CBRN Sensor Module, was to be a force protection/survivability tool for dismounted forces by providing soldiers with standoff detection in contaminated areas. The objective of the experiment, while providing the chemical and engineer soldiers an opportunity to conduct standoff missions, also provided an opportunity to gain insight on the lighter, more mobile control unit as an effective substitute for the Original Equipment Manufacturer (OEM) equipment with the ability to support multiple platforms, payloads, and missions.
Scenarios were established for both the CBRN and Combat Engineer soldiers. CBRN soldiers focused on initial entry operations performed by CBRN reconnaissance and survey team members.
The experiment used non-hazardous placebos to target the mounted sensors and simulate the existence of Toxic Industrial Chemicals and Toxic Industrial Materials in a fixed facility as well as abandoned vehicles. Soldiers also had the opportunity to use the robot and

sensors in the Chemical School radiation lab; maneuvering through the hallways to a designated isotope to validate the integration of the sensors to the OCU. Manipulation of the robot arm became second nature as Soldiers opened doors and became masters of placing the sensors near the placebo to determine chemical concentrations. One CBRN NCO participating in the experiment stated that the use of the robot and the mobile OCU provided a "safer way to control a HAZMAT scene without risking human life."

The combat engineer scenarios were developed through the NCOIC of the Route Reconnaissance and Clearance Course (R2C2). Using the R2C2 training area, training aids were placed throughout the lanes. The training aids represented various types of improvised explosive devices. Soldiers employed the Talon using both the OEM OCU and the TRC (single screen) from a mounted position. Soldiers found the TRC much easier to operate with control sensitivity for robot movement much better when compared to the legacy OCU. While the screen size was reduced on the TRC, soldiers found that the better clarity allowed them to locate and identify wires and triggers on the training aids more easily.

Soldiers from both the Chemical and Engineer Corps quickly mastered both operation of the and MM-TRC/TRC; providing invaluable input to the tactics, techniques, and procedures and the form, fit, and function of the lighter and mobile OCU. Information garnered from this experiment will inform ongoing requirements documentation for common controllers, and chemical standoff detection capabilities. In addition, the experiment provided participating unit CBRN NCOs with an opportunity to influence capabilities they are likely to see at company level in the very near future. Future Chemical Corps forces will field the Man-Transportable Robotic System Increment 2 (MTRS Incr 2). In the interim, MSCoE and the Chemical Corps are working with the Army to provide a Unmanned Ground Vehicle solution utilizing assets returning from theater. One of these assets includes the Engineer's Talon Robot that was used for this experiment.

TAR CBRN Sensor Robot

Source:http://www.tarideal.com/Solutions/C.B.R.N./DETECTION_|famp|___IDENTIFICATION/CB-

TA10029/CBRN_SENSOR_ROBOT

The modular CBRN robot offers a mobile, self-protected platform for identification of chemical, biological, radiological and nuclear threats. The robot detection systems offer a

versatile solution for collection of precise, accurate, current data, which can be processed in-vehicle or securely transmitted for analysis on centralised systems.

INDIA – CBRN Chemical - Biological - Radiological - Nuclear Mini-UGV Unmanned Ground Vehicle

Source:http://www.armyrecognition.com/defexpo_2014_show_daily_news_coverage_report/cbrn_chemical_biological_radiological_nuclear_mini-ugv_unmanned_ground_vehicle_1202146.html

At Defexpo 2014, the Indian Defense Company Hi-Tech Robotic Systemz presents its new CBRN Mini UGV Unmanned Ground Vehicle especially designed to perform missions in CBRN (Chemical, Biological, Radiological & Nuclear) environment.

Hi-Tech Robotic Systemz is pioneering company in India working in the field of Robotics, Artificial Intelligence and Control technologies, spanning the entire value chain starting from requirement analysis, concept development to system integration and beyond. With more than 15 patents, state-of-the-art technologies, the company is engaged in developing solutions to bring in effective and efficient robotic systems for mass utility.

In futuristic warfare scenario, CBRN (Chemical, Biological, Radiological & Nuclear) weapons cause hazardous effects including contamination of environment & terrain. UGV (Unmanned Ground Vehicle) being unmanned/ tele-operated vehicle provide an edge over conventional manned NBC recce vehicles in terms of personnel safety for the Armed forces.

Tele-operated CBRN UGV can be used for detection, sample collection and marking of contaminated zones without risk of exposing personnel.

In collaboration with DRDO (Defence Research & Development Organisation) of India, Hi-Tech Robotic Systemz has designed and manufactured a new mini tracked unmanned

ground vehicle with CBRN equipment mounted on the top of the vehicle able to enter into hazardous areas to detect CBRN contamination and collect sample for post processing.
The CBRN Mini-UGB is able to perform missions including day/night inspection and marking CBRN hazardous area on digital map. The transmission of contamination data is achieved through wireless communication link to operator control unit.
The operator control unit shall be housed in the manned NBC recce vehicle.

Dstl Introduces Cutting Edge Robot to Test CBRN Suits

Source: http://globalbiodefense.com/2014/04/09/dstl-introduces-cutting-edge-robot-to-test-cbrn-suits/

The Defence Science and Technology Laboratory (Dstl) has taken delivery of a new robotic mannequin that will be used to test chemical and biological (CB) protective suits and equipment for the UK's Armed Forces.
The animated technology unit is able to walk, march, run, sit, kneel and even lift its arms as if to sight a weapon just like an infantry soldier. It means new equipment such as chemical and biological suits can be thoroughly tested in a realistic but secure environment.

This newest recruit is named 'Porton Man' after the home of the Defence Science and Technology Laboratory (Dstl), at Porton Down in Wiltshire. Built using advanced lightweight materials developed for Formula One racing cars, he is able to walk, march, run, sit, kneel and can even lift his arms to sight a weapon like an infantry soldier.

More than a hundred sensors all over the robot's body record data during tests, enabling scientists to carry out real-time analysis on equipment such as chemical and biological suits in a realistic but secure environment.
Mannequins have been used by Dstl in the past but this animatronic version is a unique capability that puts the UK at the forefront of testing. Designed by i-bodi Technology Ltd, based in Buckingham, the robot is built to accurately represent the military user.

Supplement: Rescue Robotics

Dstl in Porton Down, Wiltshire is the only place in the world that that can use chemical warfare agents to assess the effectiveness of complete clothing systems. Previous test results helped influence the final design of the chemical, biological and radiological (CBR) suits used by UK Armed Forces and the updated technology in the new mannequin will help design the next generation of protection.

Jaime Cummins of Dstl's Chemical and Biological Physical Protection group said: "Significant advances in animatronics, material design and sensing technologies have all been incorporated into this new Porton Man mannequin. As a result, we will be able to assess and characterise protective clothing in ways which were not previously possible. We are immensely proud to have this mannequin as part of our capability to protect against the threat posed by chemical and biological agents".

"Our brief was to produce a light-weight robotic mannequin that had a wide range of movement, fitted the anthropometric data and was easy to handle. Of course there were a number of challenges associated with this and one way we looked to tackle these challenges was through the use of Formula One technology," said Jez Gibson-Harris, CEO, i-bodi Technology. "Using the same concepts as those used in racing cars, we were able to produce very light but highly durable carbon composite body parts for the mannequin."

Minister for Defence Equipment, Support and Technology, Philip Dunne, said: "This technology, designed by a British company is enabling the UK to lead the way in this important testing. Increased investment in science and technology by the MoD is not only enabling battle winning and life saving equipment to be developed but also helping innovative companies like i-bodi Technology to develop cutting edge capability."

Smiths Detection Supplies Lightweight Chemical Detector to Advanced CBRN Detection Robot

Source: http://www.businesswire.com/news/home/20060817005309/en/Smiths-Detection-Supplies-Lightweight-Chemical-Detector-Advanced#.U60NCUBpfgI

Smiths Detection, part of the global engineering business Smiths Group, has been selected by US Army's Edgewood Chemical and Biological Center to supply the Lightweight Chemical Detector (LCD) for use with a new advanced reconnaissance robot.

Under the CBRN Unmanned Ground Reconnaissance Advanced Concept Technology Demonstration program, Edgewood Chemical and Biological Center will fit iRobot PackBot robots with the Smiths Detection LCD. The LCD detects a wide range of chemical warfare agents including nerve, blister, blood and choking agents.

"The CUGV gives soldiers the option to send a robot in first, providing vital threat detection before humans are put into a dangerous situation."

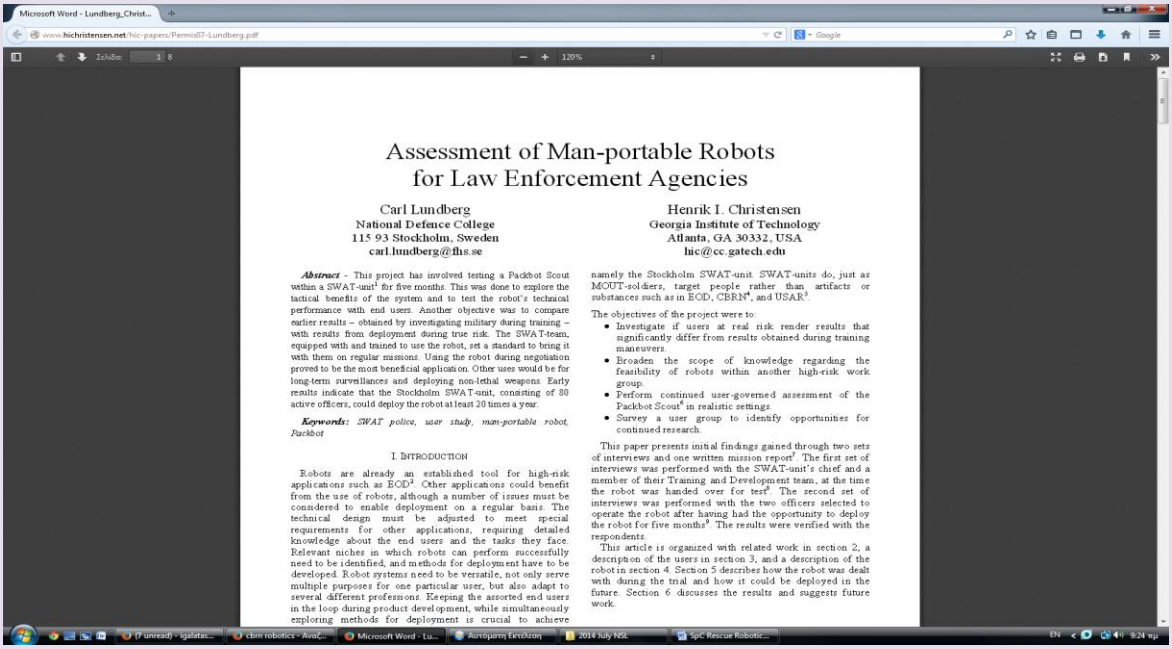
The new robots, which will be known as the CBRN Unmanned Ground Vehicle or CUGV, recently completed technical demonstrations at Aberdeen Proving Ground. They will be evaluated by soldiers of the 95th Chemical Company, US Army Alaska, at Ft Richardson and Elemdorf Air Force Base in September. If it is determined that the CUGV has military utility, it will be retained by the 95th Chemical Company in Alaska for two years.

"Smiths Detection is proud to provide our lightweight chemical agent detectors for the new advanced CUGV", said Stephen Phipson, Group Managing Director of Smiths Detection. "The CUGV gives soldiers the option to send a robot in first, providing vital threat detection before humans are put into a dangerous situation."

The CUGV is designed to inspect potentially hazardous areas that other tactical vehicles cannot access. The sensor payload, utilizing Smiths Detection's LCD, can detect chemical warfare agents and toxic industrial chemicals. Additional sensors can detect oxygen levels, lower explosive limits and gamma radiation. The robot will then send data back to other manned systems or a command post, allowing soldiers and first responders to stay out of harm's way. In addition, the CUGV is capable of collecting samples for further analysis.

Assessment of Man-portable Robots for Law Enforcement Agencies

Source: http://www.hichristensen.net/hic-papers/Permis07-Lundberg.pdf



Assessment of Man-portable Robots
for Law Enforcement Agencies

Carl Lundberg
National Defence College
115 93 Stockholm, Sweden
carl.lundberg@fhs.se

Henrik I. Christensen
Georgia Institute of Technology
Atlanta, GA 30332, USA
hic@cc.gatech.edu

Abstract - This project has involved testing a Packbot Scout within a SWAT-unit[1] for five months. This was done to explore the tactical benefits of the system and to test the robot's technical performance with end users. Another objective was to compare earlier results – obtained by investigating military during training – with results from deployment during true risk. The SWAT-team, equipped with and trained to use the robot, set a standard to bring it with them on regular missions. Using the robot during negotiation proved to be the most beneficial application. Other uses would be for long-term surveillances and deploying non-lethal weapons. Early results indicate that the Stockholm SWAT-unit, consisting of 80 active officers, could deploy the robot at least 20 times a year.

Keywords: *SWAT police, user study, man-portable robot, Packbot*

I. INTRODUCTION

Robots are already an established tool for high-risk applications such as EOD[2]. Other applications could benefit from the use of robots, although a number of issues must be considered to enable deployment on a regular basis. The technical design must be adjusted to meet special requirements for other applications, requiring detailed knowledge about the end users and the tasks they face. Relevant niches in which robots can perform successfully need to be identified, and methods for deployment have to be developed. Robot systems need to be versatile, not only serve multiple purposes for one particular user, but also adapt to several different professions. Keeping the assorted end users in the loop during product development, while simultaneously exploring methods for deployment is crucial to achieve namely the Stockholm SWAT-unit. SWAT-units do, just as MOUT-soldiers, target people rather than artifacts or substances such as in EOD, CBRN[4], and USAR[5].

The objectives of the project were to:

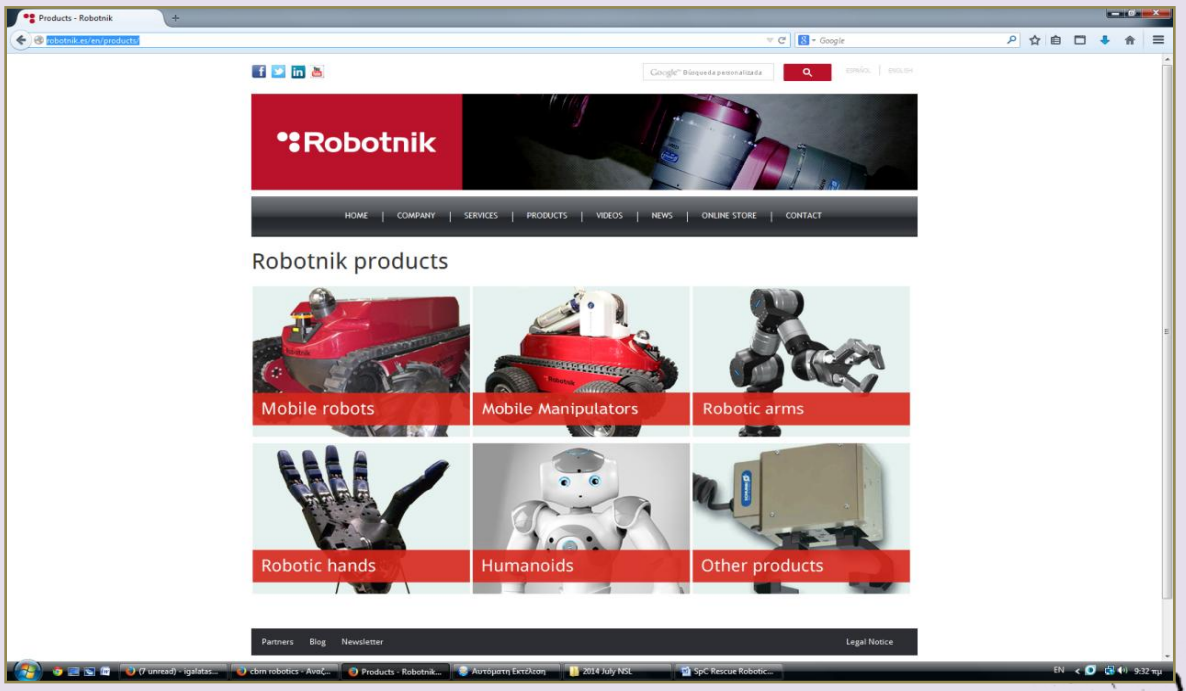
- Investigate if users at real risk render results that significantly differ from results obtained during training maneuvers.
- Broaden the scope of knowledge regarding the feasibility of robots within another high-risk work group.
- Perform continued user-governed assessment of the Packbot Scout[6] in realistic settings.
- Survey a user group to identify opportunities for continued research.

This paper presents initial findings gained through two sets of interviews and one written mission report[7]. The first set of interviews was performed with the SWAT-unit's chief and a member of their Training and Development team, at the time the robot was handed over for test[8]. The second set of interviews was performed with the two officers selected to operate the robot after having had the opportunity to deploy the robot for five months[9]. The results were verified with the respondents.

This article is organized with related work in section 2, a description of the users in section 3, and a description of the robot in section 4. Section 5 describes how the robot was dealt with during the trial and how it could be deployed in the future. Section 6 discusses the results and suggests future work.

Robotnik

Source: http://robotnik.es/en/products/



Altay Robotics

Source: http://www.altay.com.tr/pages/804/803/t/en-US/AUNAVNEXT.aspx

The **aunav.NEXT** robot is the next step for EOD/IED/CBRN robots. Designed and developed by Proytecsa, it is the result of all our experience based in our collaboration with task forces and EOD units in the fight against terrorism.

Thanks to its second arm and the continuous rotating manipulator, the **aunav.NEXT** features a superior maneuverability well over any other robot in the market. Preprogramed movements are included to ease and improve handling.

A dual permanent traction system featuring wheels and caterpillar tracks enhances its mobility, it can maneuver over all types of rugged terrain including snow, mud and sand.

WHEN YOU NEED BOTH HANDS

The **aunav.NEXT** is the first EOD robot with two synchronized arms. It allows operations and millimetric movements that are just impossible to perform by any other robot in the market.

Both arms are mounted on a turret with 360º angular rotation, ensuring full movement capabilities in the most enclosed places.

MOST ADVANCED ROBOT IN THE MARKET

Designed using the latest technologies in the most demanding areas, the **aunav.NEXT** preserves the capabilities that makes the aunav family the most powerful in the market.

Built with aerospace components that ensure a ruggedness and unprecedented reliability, the streamlined design reduces potential damage due to blast. The **aunav.NEXT** can execute orders faster, climb up to 45° stairs and thanks to its dual wheels and tracks can operate over any terrain.

FEATURES

- Up to 10 x High resolution cameras
- Extreme power and precision, from a few grams up to hundreds kilos
- Clamp based movements
- Bidirectional audio system
- Anti deflagration design
- LEDs illumination
- Autonomous navigation system
- Distance sensors
- Protected fire system
- Unlimited preprogramed and synch movements
- IP65 certified

SPECIAL ACCESSORIES

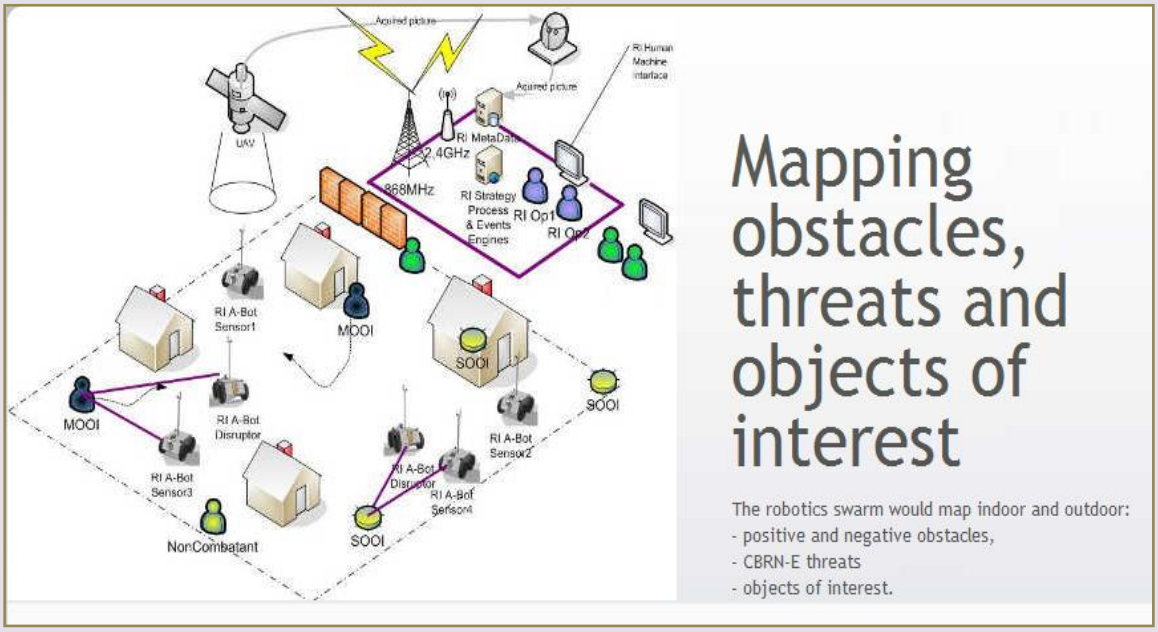
- Water disruptors

- Thermal cameras
- X-rays
- CBRN sensors
- CBRN sample holders
- Shotgun cradle
- Multiple tools (drill, cutter, …)
- Barrel claws
- ATV-type wheels
- Other accessories under request

RI Fleet (c) - the system to control of any robotics swarm

Source: http://www.roboticsinventions.com/productsFleet.jsp

Robotics Inventions FLEET is the unique worldwide class system to control group of robots (a swarm of



robots).
Robotics Inventions has been developing a system to control robots from a single central unit (based on a NATO BMS class system). The system controls any type of robots or vehicles to be working as a group of autonomous robots. Autonomy and control of the robots is based on the autonomy component - RI Spirit.
RI Fleet could be adjusted to any set of missions and as such is being licensed together with services necessary to adjust the software and overall solution accordingly with the specific requirements of the target fleet applications.

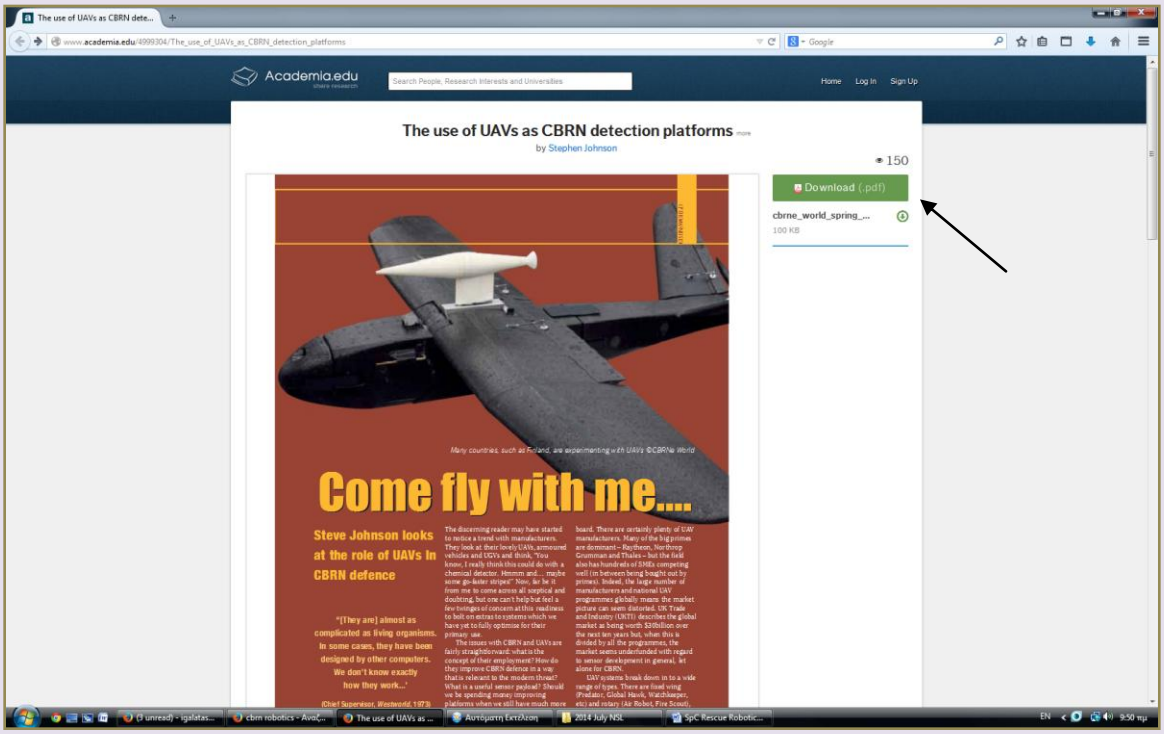
The typical scenarios of RI Fleet applications:

- One Person Controls RI Fleet - from a single control unit decide what the swarm of robots is doing,
- Autonomous Navigation - outdoor and indoor,
- Cooperative Mapping - marking positive and negative obstacle coordinates as well as zones of CBRN-E threats, Image Recognition - looking for objects of interest,
- Collaboration - moving in a formation and processing autonomous tasks with other robot members

- CIVIL PROTECTION & DISASTER RECOVERY Fleet missions: scouting, patrolling, terrain exploration.

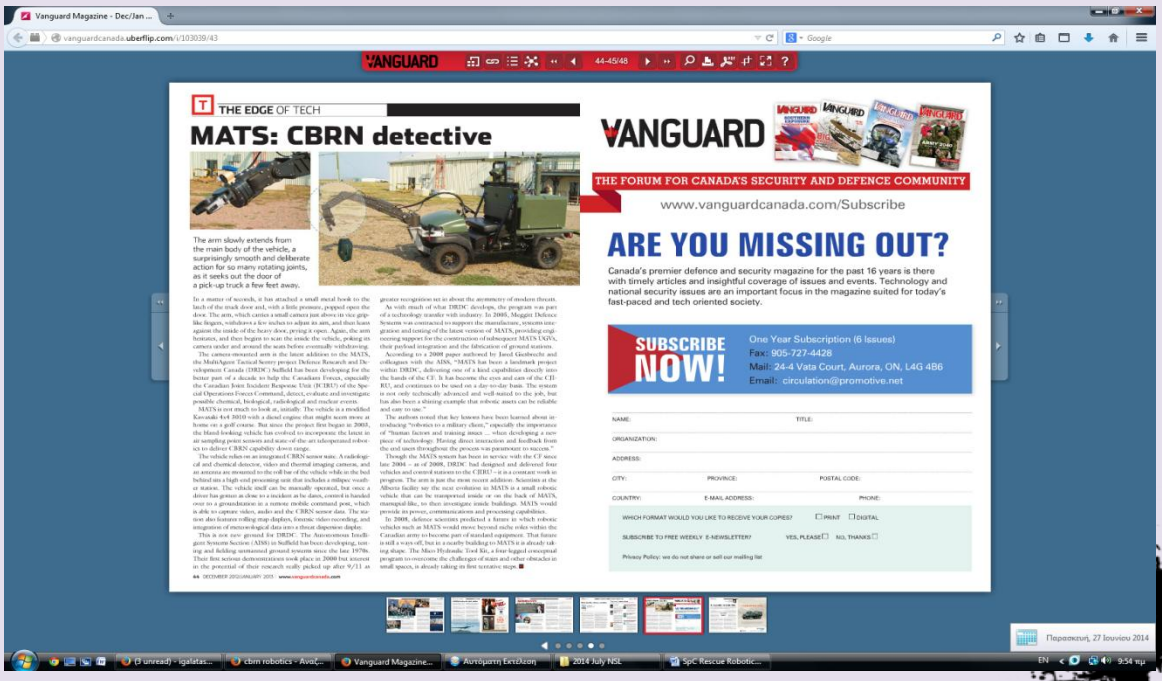
The use of UAVs as CBRN detection platforms

Source: http://www.academia.edu/4999304/The_use_of_UAVs_as_CBRN_detection_platforms



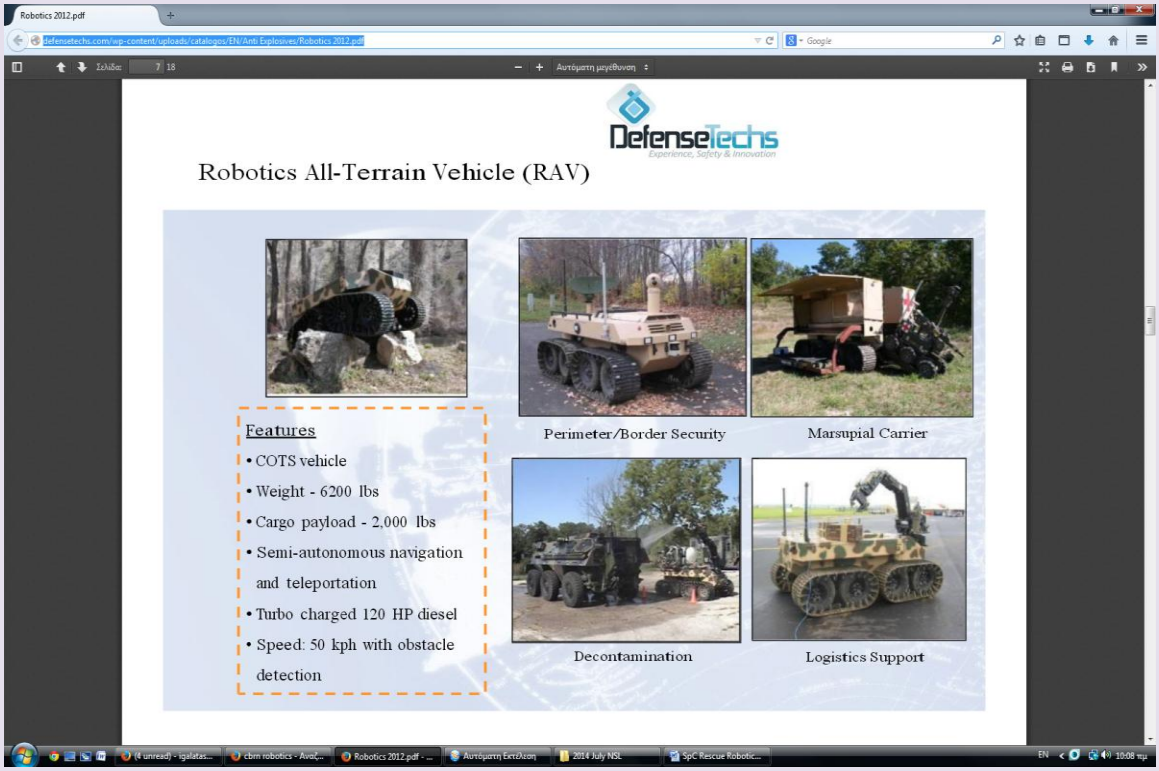
MATS – CBRN Detective

Source: http://vanguardcanada.uberflip.com/i/103039/43



ROBOTICS All Terrain Vehicle

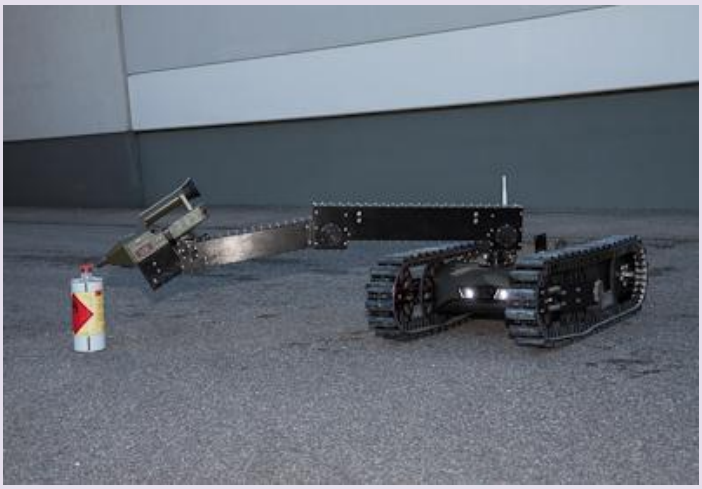
Source: http://defensetechs.com/wp-content/uploads/catalogos/EN/Anti%20Explosives/Robotics%202012.pdf



CBRNE ROBOT HOTTECH 1

Source: http://www.hotzonetech.com/products/robot.html

We have developed our first CBRNE Robot HOTTECH 1 together with the AUSTRIAN company TAUROB. HOTTECH 1 will support CBRNE reconnaissance missions. It is equipped with detection devices and cameras, which make it ideal to assist in mission critical tasks.



First-Hand Situational Awareness

Our robot is remotely controlled and provides camera images and CBRN situational awareness in stressful and hazardous enviroments. Hottech 1 is built to collect and send data as well as video streams to the controller; moreover, it helps identifying CBRN risks and possible solutions for various situations. The robot is controlled via a ruggedized Tablet PC.

Hottech 1 with CWA detector AP4C

Built for Extreme Conditions

Our CBRN robot is deployed where danger of possible structural collapse, explosion, radiation or chemical substances is imminent. The robot is ATEX certified, which allows for operations in areas with a high explosion risk. Its main purpose is to save lives and reduce risk for first responder teams.

Our robot will undergo Live Agent testing in 2013, in the following areas:

- Chemical warfare agents
- Radiological environments.

The robot is ruggedized and easy to use. Furthermore it can - as novelty - be decontaminated, thanks to its design and accessories. All ist decontamination features will extensively be tested by HZT in the upcoming weeks and months

Center for Robot-Assisted Search and Rescue (CRASAR) at Texas A&M University

Source: http://crasar.org/

CRASAR
Center for Robot-Assisted Search and Rescue
Texas A&M University
Director: Dr. Robin R. Murphy, Raytheon Professor of Computer Science and Engineering

CRASAR is a Texas A&M Engineering Experiment Station Center whose mission is to improve disaster preparedness, prevention, response, and recovery through the development and adoption of robots and related technologies. Its goal is to create a "community of practice" throughout the world for rescue robots that motivates fundamental research, supports technology transfer, and educates students, response professionals, and the public. CRASAR is a dynamic mix of university researchers, industry, and responders.

CRASAR has participated in 15 of the 35 documented deployments of disaster robots throughout the world and have formally analyzed 9 others, providing a comprehensive archive of rescue robots in practice. Our industry partners and funding agencies make a wide range of small land, sea, and air robots available for use by responders at no charge through the Roboticists Without Borders program. Our human-robot crew organization and protocols developed first for UGVs, where studies show a 9 times increase in team performance, and then extended for small UAVs during our flights at Hurricane Katrina has been adopted by Italian and German UAV response teams and was used by the Westinghouse team for the use of the Honeywell T-Hawk at the Fukushima nuclear accident.

CRASAR helps organize and sponsor conferences such as the annual IEEE Safety Security Rescue Robotics conference and workshops such as the recent NSF-JST-NIST Workshop on Rescue Robots.

Fun facts from "Disaster Robots":

- All ground, aerial, and marine robots have been teleoperated (like the Mars Rovers) rather than fully autonomous (like a Roomba), primarily because the robots allow the responders to look and act in real-time; there's always something they need to see or do immediately

- Robots have been at at least 35 events, and actually used at at least 29 (sometimes the robot is too big or not intrinsically safe)
- The biggest technical barrier is the human-robot interaction. Over 50% of the failures (a total of 27 at 13 incidents) have been human error.
- Robots are not used until an average of 6.5 days after a disaster; either an agency has a robot and they use it within 0.5 days or they don't and it takes 7.5 days to realize a robot would be of use and get it on site

Japan's Earthquake Search-and-Rescue Robots

Source: http://www.popsci.com/technology/article/2011-03/six-robots-could-shape-future-earthquake-search-and-rescue?dom=PSC&loc=recent&lnk=5&con=read

Though the earthquake that struck Japan's eastern coast earlier today has left the country with massive destruction and hundreds of deaths, modern technology (and Japan's impressive level of readiness) are helping the country track survivors and dampen the damage as much as possible. In the future, our ability to cope with natural disasters will only increase, due in large part to the particular talent earthquake-vulnerable areas--especially Japan (and to a lesser extent, California)--have for robotics.

Predicting earthquakes is still a remarkably fruitless effort--seismologists are not reliably able to predict even a particular month in which an earthquake will occur, let alone a day. So the work done to mitigate the damage done by earthquakes is often in post-quake search-and-rescue tactics. Interestingly, two of the most earthquake-prone places in the world are also two of the world's hotbeds of robotics engineering. Japan is situated along the so-called Pacific Rim of Fire, at the point where the Pacific and Eurasian tectonic plates collide. The country is continually at risk of massive earthquakes, and as a technological world power, is uniquely capable of creating technological salves for 'quakes.

No, it's not a robot uprising. This is the Tokyo Fire Department's Rescue Robot, also known as RoboCue, taking a mock patient to safety as part of a training exercise for dirty-bomb containment and casualty rescue, held late last year in Tokyo. Designed by the fire department itself, the search-and-recover 'bot is tethered by a 328-foot cable and equipped with infrared cameras, a megaphone, and ultrasonic sensors that find victims in places where human rescuers cannot go, such as burning houses. It also has an onboard oxygen canister for those who might need it. Two feeler appendages gently load the victim, whether injured by the blast or trampled in the ensuing chaos, onto a sleigh bed before wheeling him safely out. The only drawback: Hauling multiple victims is not possible with this particular model.

Robot to the rescue

By Gill A. Pratt
Source: http://thebulletin.org/robot-rescue

On March 12, 2011—the day after a powerful earthquake and tsunami struck the Fukushima Daiichi Nuclear Power Station—a team of plant workers set out to enter the darkened reactor buildings and manually vent accumulated hydrogen to the atmosphere. At first, the workers made progress inside the buildings, but soon their dosimeters showed they had reached their maximum emergency radiation exposure limits, and they had to turn back. In the days that followed, with vents still closed, hydrogen built up in each of three reactor buildings, fueling explosions that extensively damaged the facility, contaminated the environment, and drastically complicated stabilization and remediation of the site.

News of the earthquake galvanized those in charge of robotics programs at the US Defense Advanced Research Projects Agency (DARPA). Humanitarian assistance and disaster relief is a primary mission of the Defense Department, and DARPA had responded to a disaster before, sending robots whose development it had funded to New York City in the days after the 9/11 attacks. The robots found no survivors then, but perhaps this time, robots could help mitigate the evolving disaster.

DARPA officials contacted researchers who had designed robots for the Three Mile Island and Chernobyl disasters and coordinated with companies that DARPA had funded to develop other robots—the iRobot PackBot, the QinetiQ TALON, and the Honeywell T-Hawk. The PackBot and TALON are man-portable ground robots originally developed for tactical reconnaissance. The T-Hawk is a tactical reconnaissance unmanned aerial vehicle. Each company was already making plans to send its robots and training personnel to Japan.

Although these robots were designed for austere environments, they were not designed for a radiological disaster. DARPA took on the task of projecting whether they would work or succumb to the radiation. The results looked promising: The robots' materials and electronics would operate for at least several hours in all but the closest encounters with reactor fuel. It also seemed likely that the robot cameras would act as primitive "too close" warnings, displaying increasing amounts of "snow" before radiation levels got high enough to crash the robots' computers.

The robots sent from the United States were joined in Japan by one from Tohoku University and eventually by several others from around the world. But weeks passed before power plant personnel completed training to operate the robots. By then, the best the robots could do was help survey the extensive damage that had already occurred and take radiation readings; the golden hours for early intervention to mitigate the extent of the disaster had long since passed. Officials at DARPA, and the robotics community in general, felt that a significant opportunity had been missed. In Japan, citizens and robotics experts reacted similarly, asking why companies that had developed wonderful industrial and entertainment robots had nothing to offer when disaster struck.

The world's population is continuing to grow and move to cities situated along flood-prone coasts. The population over age 65 in the United States is forecast to increase from 13 percent to 20 percent by 2030, and the elderly require more help in emergency situations. Climate change and the growing threat of proliferation of weapons of mass destruction to non-state actors add to the concern. Today's natural, man-made and mixed disasters might be only modest warnings of how vulnerable society is becoming. Robots failed to find survivors after 9/11 and ended up being of only long-term help at Fukushima. Could they do better?

Better technology through competition. Between 2004 and 2007, DARPA used a competition series—two Grand Challenges, followed by an Urban Challenge—to accelerate the development of technology for self-driving ground vehicles that would help to reduce the vulnerability of military logistics convoys to improvised explosive devices. In the wake of the Fukushima catastrophe, DARPA decided to take the same competitive approach with the DARPA

Robotics Challenge (DRC), which aims to speed development of robotics technology for disaster response. The overarching goal of the challenge is to develop technology that allows human beings to effectively intervene during a disaster, without being held back by the dangers such a situation poses to humans. In particular, the competition aims to improve the mobility and dexterity of robots working in degraded environments; to give robots the ability to use human tools, from screwdrivers to vehicles; and to drastically reduce the training needed to operate robots during emergencies.

After consulting with first responders and other disaster experts, DARPA officials selected a series of challenge tasks that require capabilities that might have been useful during the first days of the Fukushima response. The competing robots would have to drive a utility vehicle, exit, and walk a short distance. They would have to travel dismounted over rough terrain. They would need to clear rubble blocking a doorway, open a door, and go through it. They would have to climb a steep ladder. They would be able to cut an access hole in a wall with a power tool, without damaging nearby infrastructure. They would have to close an industrial valve. And they would need to pull a fire hose over a selected distance and connect it to a standpipe.

The Humanoid Robot That Won the DARPA Challenge (2013) - The two-legged S-One from SCHAFT Inc, scored 27 points.

Following the successful model of its earlier challenges, DARPA broke the robotics competition into three sequential events. The first, the Virtual Robotics Challenge (VRC), was held in June 2013. A cloud-based, real-time simulation, the VRC had contestants from all over the world program and operate a standard, computer-simulated robot in the driving, rough terrain, and fire hose tasks just described. More than 100 teams and individuals initially signed up, with members of the top 10 performing teams coalescing to form seven software teams that would compete in the second event, the DRC Trials. Those seven software teams have either purchased or received through DARPA a physical humanoid robot called ATLAS, developed by Boston Dynamics with DARPA funding. All seven software teams were also provided with research funding to continue their software development work until the trials. (The software teams are led by the Florida-based Institute for Human

and Machine Cognition, Worcester Polytechnic Institute, MIT, the Texas-based robotics and automation firm TRACLabs, Inc., Virginia-based TORC Robotics LLC, Lockheed Martin, and Hong Kong University.)

DARPA also funded seven systems teams through a proposal evaluation process to develop their own hardware and software systems to compete in the DRC Trials. One team was eliminated after design reviews, leaving six systems teams to compete in the DRC Trials, each with a physical robot of its own design. (These are led by Carnegie Mellon University's National Robotics Engineering Center, Drexel University, NASA Jet Propulsion Lab, NASA Johnson Space Center, SCHAFT Robotics of Tokyo, and Virginia Tech.) In addition to the 13 funded teams mentioned above, DARPA is accepting teams without funding that wish to challenge the other robots. Based on the results of a qualification event in October 2013, a total of 17 teams will compete.

The DRC Trials were scheduled to occur at the Homestead-Miami Speedway in December 2013, just weeks after publication of this article. Although attendance was limited, the event was open to the public and available through video updates provided via the DRC website.

Successful task completion is generally more important than speed in disaster scenarios, and DARPA expects the robots at the DRC Trials to operate very slowly, taking up to 30 minutes to perform each task. After two days of testing, up to eight of the best-performing teams will each be eligible for $1 million of DARPA research funding for one year, after which the agency will hold its third event, the DRC Finals, which will provide more difficult, faster-paced tests designed to mimic an actual disaster scenario. For example, the DRC Trials will be conducted with tethers to deliver electricity to the robots and safety lines to protect them from falling or otherwise damaging themselves; the DRC Finals will be conducted with neither. The winner will receive a $2 million prize.

Don't be scared of the robot. Most of the public's response to the first stage of the DARPA Robotics Challenge has been positive. Disasters make plain the fragility of human life, so systems that enhance individual protection and societal resilience are widely appreciated. Still, new technologies often raise broad moral, ethical, and societal questions, and DARPA encourages discussion among experts and stakeholders about the laws and policies that should apply to new capabilities developed through the agency's efforts. Five such issues are particularly relevant in robotics, and DARPA carefully considered each one when designing the DRC.

First, although the DRC will not develop lethal or fully autonomous systems, some of the technology being developed in the competition may eventually be used in such systems. This is equally true for technology now being developed in civilian robots, for example, those meant to assist workers in factories or to aid the elderly. DARPA has worked diligently, particularly with those teams that are sensitive about accepting Defense Department funding, to honestly characterize the dual-use nature of the technology being developed in the DRC.

Second, society is now wrestling with moral and ethical issues raised by remotely operated unmanned aerial vehicles that enable reconnaissance and projection of lethal force from a great distance. While it is very difficult to predict the future use of any technology, the remote supervision technology being developed for the DARPA challenge is more immediately applicable to surgical robots than to such remotely operated aircraft.

Third, the tempo of modern warfare is escalating, generating a need for systems that can respond faster than human reflexes. The Defense Department has considered the most responsible way to develop autonomous technology, issuing a directive in November 2012 that carefully regulates the way robotic autonomy is developed and used in weapons systems. Even though DRC robots may look like those in the movies that are both lethal and autonomous, in fact they are neither.

The fourth issue involves the general impact of automation, which has been debated for decades. Like the Industrial Revolution's impact on standards of living and working conditions, the development of robots will have both positive and negative effects. By analogy, the DARPA-developed ARPANET (which later became the Internet) has enabled significant gains in economic productivity, jobs, quality of life, and political freedom around the globe, but it has also made it easier for terrorists to learn how to build improvised explosive

devices. DARPA believes the development of robots for disaster response represents a net gain for society because of the great danger to human life posed by disasters.

The final issue raised by the DRC has an emotional element. Disaster-response robots must operate in human environments, so they tend to be designed with limbs instead of wheels and tracks. This can give the robots a disturbing, not quite human appearance. Since the Golem of Prague, Western literature has included frightening tales of human-like monsters, with Frankenstein's monster and the Terminator standing out as more recent examples. Being social creatures, human beings are skilled at observing and predicting one another's behavior, so the first sight of a human-like robot with hard-to-discern intentions may induce fear. Disaster-response robots such as those involved with the DRC are specifically designed to avoid harm to humans, and history has shown that humans quickly learn to trust machines with proven track records of safety, like automobiles and airplanes.

While the technology in the DARPA Robotics Challenge will provide action-at-a-distance, with supervised autonomy of simple tasks, none of the robots being developed will act autonomously. Each robot will be supervised by one or more human operators, located out of sight of the robot, but connected via electronic communication. Because electronic communication is usually difficult in disasters, due to degraded infrastructure and higher-than-normal traffic (at Fukushima it was also made worse by heavy steel reinforcement of concrete and radiation shielding), the robotics challenge will purposefully vary the quality of communications infrastructure during events. Under these conditions, the challenge for the teams will be to provide the robots with just enough autonomy to execute small tasks, such as "take a step up the ladder" or "turn the valve clockwise," without requiring continuous operator communications.

Still, DARPA expects the robots at the trials to demonstrate capabilities that extend beyond what robots could do at Fukushima. The DRC robots will be able to affect their environment, not just take sensor readings, and they will have just enough autonomy to deal with significantly degraded communications. But there likely will be many failures and very slow operation—robots with roughly the mobility and dexterity of a one-year-old child who can barely walk, falls down frequently, and can't execute complex manipulation tasks. The trials provide 30 minutes for each task to be accomplished, and most of the comprehension of the scene will be done inside the brains of human operators looking at compressed robot sensor feeds, not independently by the robots.

Reducing the cost of robotic disaster relief. When DARPA ran its first Grand Challenge in 2004 for driverless vehicles, none made it past 7.3 miles of the 150-mile route. But a number of vehicles did succeed in the second Grand Challenge and the final Urban Challenge. Similarly, by the time of the DRC Finals, DARPA hopes the competing robots will demonstrate the mobility and dexterity competence of a 2-year-old child, in particular the ability to execute autonomous, short tasks such as "clear out the debris in front of you" or "close the valve," regardless of outdoor lighting conditions and other variations. The robots will still need to be told by human operators which tasks to chain together to achieve larger goals, but DARPA hopes they will clearly demonstrate the impact robotics could have during the critical early hours of future disasters.

Vehicle manufacturers are now capitalizing on the earlier DARPA challenges by building cars that assist drivers or drive themselves. Similarly, the government and the private sector will need to engage in additional development efforts to maximize the disaster-mitigating potential demonstrated in the DARPA Robotics Challenge. Recently, Japan's Ministry of Economy, Trade and Industry signed a collaboration agreement with the US Department of Defense in the field of disaster-response robotics, and the agencies are planning several collaborative workshops in the coming months, in hopes of inspiring other countries to join in developing technology to improve the world's response to natural and man-made disasters.

Beyond governmental collaboration, private companies will have to step up to transfer the technology developed by the DRC into robots across a wide range of applications, from health care to agriculture to defense. Cost will be a prime consideration. Even though they are not hardened against truly dangerous environments, the robots competing in the challenge cost up to several million dollars each. To prepare for the next disaster, government and private industry must not only design disaster-response robots; they must reduce costs significantly so robots can be purchased and available before disaster strikes.

Supplement: Rescue Robotics

Because of the significant efforts of the Defense Department and manufacturers in the nine years since the first Grand Challenge, unmanned defense logistics convoys may soon preserve warfighter lives, and civilian driverless cars could also begin reducing the approximately 1.3 million automobile accident fatalities that occur each year worldwide. That is not to mention the effect self-directed autos would have on traffic jams and the quality of life of those (including the elderly) who cannot drive.
If manufacturers can harvest the technology that will emerge from the DARPA Robotics Challenge, these disaster-response systems could drive innovation in the health care, industrial, agricultural, and defense sectors, significantly improving the world's common security and quality of life.

Gill A. Pratt *is a DARPA program manager on loan from Franklin W. Olin College, where he is a professor of electrical and computer engineering. He oversees robotics research into novel mechanisms and control methods for mobility and manipulation, low-cost fabrication, human/machine collaboration, actuation, and application of neuroscience-inspired techniques to perception. He formerly directed the Leg Lab at the Massachusetts Institute of Technology.*

Robots to the rescue

Source: http://news.harvard.edu/gazette/story/2014/02/robots-to-the-rescue-2/

On the plains of Namibia, millions of tiny termites are building a mound of soil, an 8-foot-tall "lung" for their underground nest. During a year of construction, many termites will live and die, wind and rain will batter the structure, yet the colony's life-sustaining project will continue.
Inspired by the termites' resilience and collective intelligence, a team of computer scientists and engineers at the Harvard School of Engineering and Applied Sciences (SEAS) and the Wyss Institute for Biologically Inspired Engineering at Harvard University has created an autonomous robotic construction crew. The system needs no supervisor, no eye in the sky, and no communication. It uses simple robots — any number of robots — that cooperate by modifying their environment.
Harvard's TERMES system (photo) demonstrates that collective systems of robots can build complex, 3-D structures without requiring a central command structure or prescribed roles. The results of the four-year project were presented this week at the AAAS 2014 Annual Meeting and published in the Feb. 14 issue of Science.

The TERMES robots can build towers, castles, and pyramids out of foam bricks, erecting staircases that let them reach the higher levels and adding bricks wherever they are needed. In the future, researchers say, similar robots could lay sandbags in advance of a flood or even perform simple construction tasks on Mars.
"The key inspiration we took from termites is the idea that you can do something really complicated as a group, without a supervisor, and, secondly, that you can do it without everybody discussing explicitly what's going on, but just by modifying the environment," said principal investigator Radhika Nagpal, the Fred Kavli Professor of Computer Science

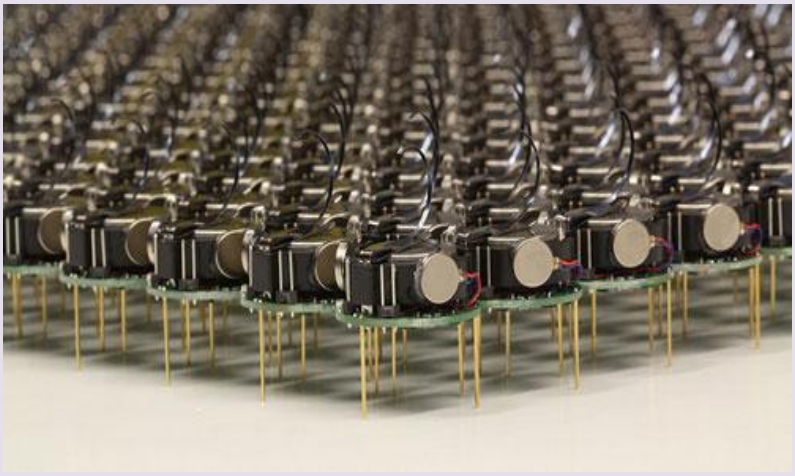
at SEAS. She is also a core faculty member at the Wyss Institute, where she co-leads the bio-inspired robotics platform.

Most human construction projects are performed by trained workers who operate in a hierarchical organization, said lead author Justin Werfel, a staff scientist in bio-inspired robotics at the Wyss Institute and a former SEAS postdoctoral fellow.

"Normally at the beginning, you have a blueprint and a detailed plan of how to execute it, and the foreman goes out and directs his crew, supervising them as they do it," he said. "In insect colonies, it's not as if the queen is giving them all individual instructions. Each termite doesn't know what the others are doing or what the current overall state of the mound is."

Instead, termites rely on a concept known as stigmergy, a kind of implicit communication. They observe each other's changes to the environment and act accordingly. That is what Nagpal's team has designed the robots to do. Supplementary videos published with the Science paper show the robots cooperating to build several kinds of structures, and even recovering from unexpected changes to the structures during construction.

Each robot executes its building process in parallel with others, but without knowing what else is working at the same time. If one robot breaks, or has to leave, it does not affect the others. This also means that the same instructions can be executed by five robots or 500. The TERMES system is an important proof of concept for scalable, distributed artificial intelligence, researchers say.

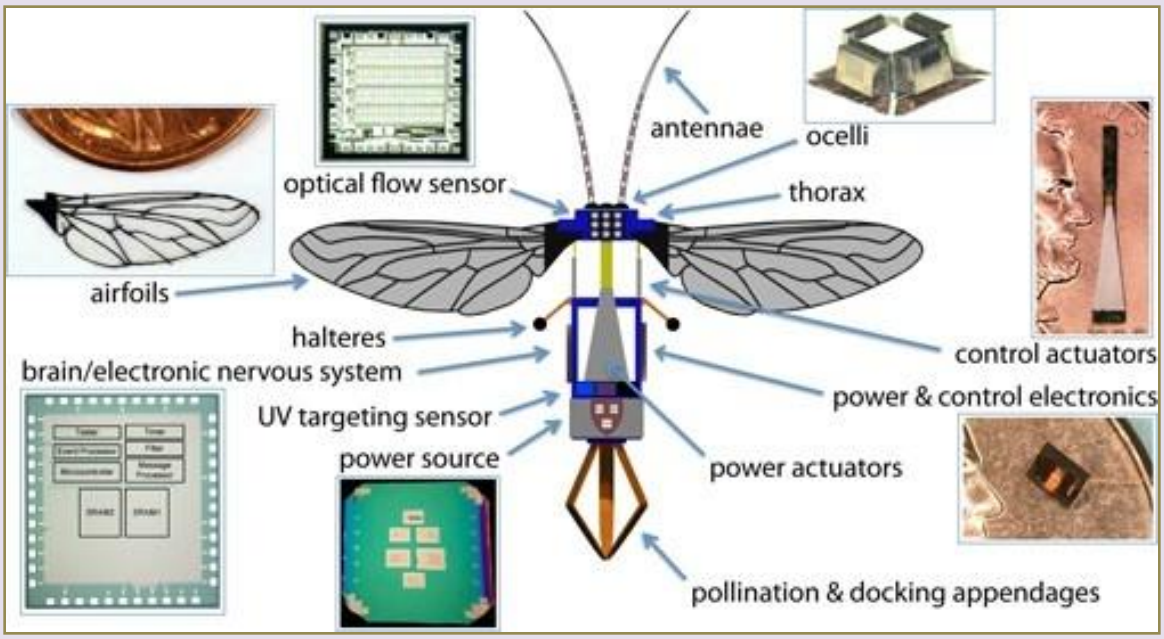


Nagpal's Self-Organizing Systems Research Group specializes in distributed algorithms that allow very large groups of robots to act as a colony. Close connections among Harvard's computer scientists, electrical engineers, and biologists are key to her team's success. The researchers created a swarm of friendly Kilobots (photo – left), a few years ago and are contributing artificial-intelligence expertise to the ongoing RoboBees (photo – bottom), project, in collaboration with Harvard faculty members Robert J. Wood and Gu-Yeon Wei.

"When many agents get together — whether they're termites, bees, or robots — often some interesting, higher-level behavior emerges that you wouldn't predict from looking at the components by themselves," said Werfel. "Broadly speaking, we're interested in connecting what happens at the low level, with individual agent rules, to these emergent outcomes."

Co-author Kirstin Petersen, a graduate student at SEAS with a fellowship from the Wyss Institute, spearheaded the design and construction of the TERMES robots and bricks. These robots can perform all the necessary construction tasks — carrying blocks, climbing

the structure, attaching the blocks, and so on — with only four simple types of sensors and three actuators. "We co-designed robots and bricks in an effort to make the system as minimalist and reliable as possible,"



Petersen said. "Not only does this help to make the system more robust, it also greatly simplifies the amount of computing required of the onboard processor. The idea is not just to reduce the number of small-scale errors, but more so to detect and correct them before they propagate into errors that can be fatal to the entire system."

In contrast to the TERMES system, it is currently more common for robotic systems to depend on a central controller. These systems typically rely on an "eye in the sky" that can see the whole process, or on all of the robots being able to communicate frequently with each other. These approaches can improve group efficiency and help the system recover from problems quickly. But as the number of robots and the size of their territory increase, these systems become harder to operate. In dangerous or remote environments, a central controller presents a single failure point that could bring down the whole system.

"It may be that in the end you want something in between the centralized and the decentralized system. But we've proven the extreme end of the scale: that it could be just like the termites," said Nagpal. "And from the termites' point of view, it's working out great."

The research was supported by the Wyss Institute.

Fire Ants Could Inspire the Next Rescue Robots

Source: http://www.popularmechanics.com/technology/engineering/robots/fire-ants-could-inspire-the-next-rescue-robots-15498631

In the direct aftermath of disasters such as yesterday's devastating tornado in Oklahoma, time is very much of the essence. While crews and trained canine units dig through the wreckage of collapsed buildings, the search for survivors quickly turns into a search for bodies.

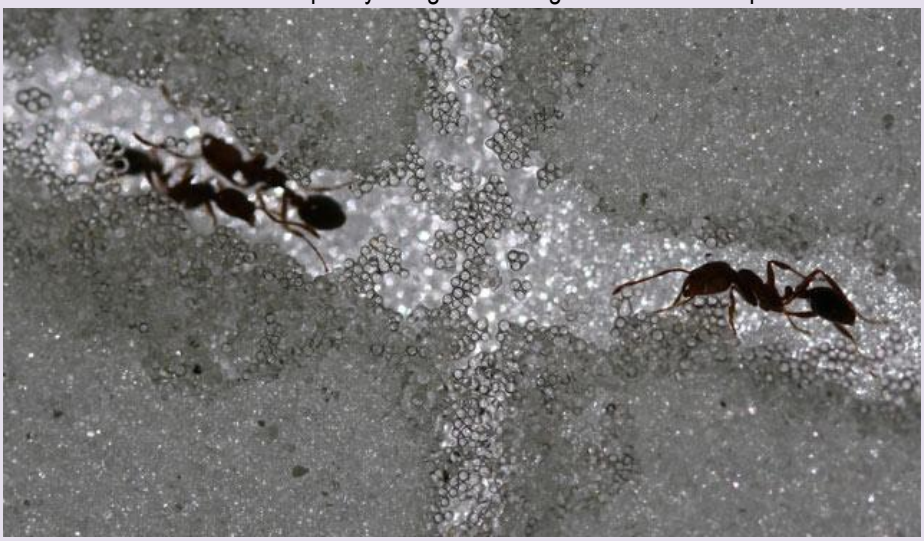
Engineers hope that someday more robots will help out after a disaster, finding more victims in time to save more lives. Robots so far have played only a limited role in disaster recovery, but a paper published in the *Proceedings of the National Academy of Sciences* suggests that a new generation of search-and-rescue robots could take a cue from an invasive pest—the fire ant.

"These animals dig for a living," says Daniel Goldman, a physicist at Georgia Tech and coauthor on the new paper. "You can throw them into any soil and they will do the same behavior, and that is dig."

▶ **Read the full paper at:** http://www.pnas.org/content/110/24/9746.full

Ant Gymnastics

Goldman and coauthor Nick Gravish took some of the stinging, biting bugs into the lab and watched as they bored tunnels through a laboratory-made soil comprising tiny glass beads. They then measured the tunnels and monitored how the ants quickly navigated through such confined spaces.



"This is probably the first study to really detail-out the features of moving in confined environments," Gravish says. "It's so different from traditional biomechanics studies of running and climbing, where you're watching animals move around in a featureless environment."

By watching the ants burrow through glass tunnels, the researchers discovered that the optimal diameter of a fire-ant tunnel is roughly the same as a fire ant's body length. This tunnel diameter presumably provides enough room for two-way-traffic flow through the tunnel while remaining snug enough that the bugs can find something to grab onto when they slip.

Although the ants zip through the tunnels pretty rapidly, the study reveals that the ants change their climbing posture depending on the tunnel's structure. For wider tunnels, they adopt a sprawled posture with their legs thrown out wide, whereas for narrower tunnels they tuck their middle legs beneath the abdomen and use them to generate a forward thrust. In all terrains the ants use their antennae as extra appendages to grab on to the walls to prevent falls.

The Georgia Tech researchers haven't yet built a robot that implements these new principles. But Robin Murphy, a computer scientist who heads up the Center for Robot-Assisted Search and Rescue at Texas A&M University, said this is the first study that really addresses the types of steep and convoluted voids that rescuers see in rubble from building collapses.

"Search-and-rescue robots have been used in 35 disasters," she says. "Most of the time the robots have been very successful, but they could have been more successful if they could handle this twisty, tortuous terrain. Understanding how animals get through these environments is hugely important."

Better Bots

Current search-and-rescue robots are a lot like the bomb-squad robots seen in movies such as *The Hurt Locker*. They operate aboveground, driving over mostly level terrain and moving in straight lines. "Right now what we're seeing is miniaturized tanks," Murphy says. "We're not really using any insights from biology; for the most part people are just trying to take existing solutions and make them smaller." Those types of robots aren't very helpful when you're looking for survivors after a building collapse.

The new study suggests that instead of seeing the environment as an obstacle, engineers can let the environment do some of the work—such as how the fire ants' snug tunnel dimensions prevent the insects from falling. With such mechanisms built into the structure of the tunnel, engineers wouldn't need to write complex commands to teach the robot how to catch itself when it's falling. That means engineers would be able to build cheaper, more robust, and more reliable robots.

This isn't the first time engineers have looked to nature for rescue-robot design. The snake robots (photo) developed in Howie Choset's lab at Carnegie Mellon University can navigate through tight spaces to potentially locate victims trapped in the rubble of a collapsed building or mine. But the snakebots are also mechanically complex and use a lot of power, Murphy points out. Another creation, the caterpillar-shaped Active Scope Camera, is smaller and uses a vibrating locomotion style rather than slithering. But when researchers tested it after a building collapse in Cologne City, Germany, the robot failed to navigate the rubble.

Can fire-ant bots do better? Future rescue robots will almost certainly utilize legs, although robotic legs raise significant biomechanical and computing challenges in robotics today. Added appendages add more complexity. "Legs still remain a longer-term issue," Murphy says. "We haven't really used them in search and rescue yet. But using the environment makes it more practical and much more likely . . . I think that with a concerted effort you could see prototypes as early as five years from now."

"As robots move into more natural environments, it is anyone's guess as to what the 'best' form or locomotion behaviors should be," Goldman says.

Pars aerial robot delivers a payload of life preservers to drowning victims

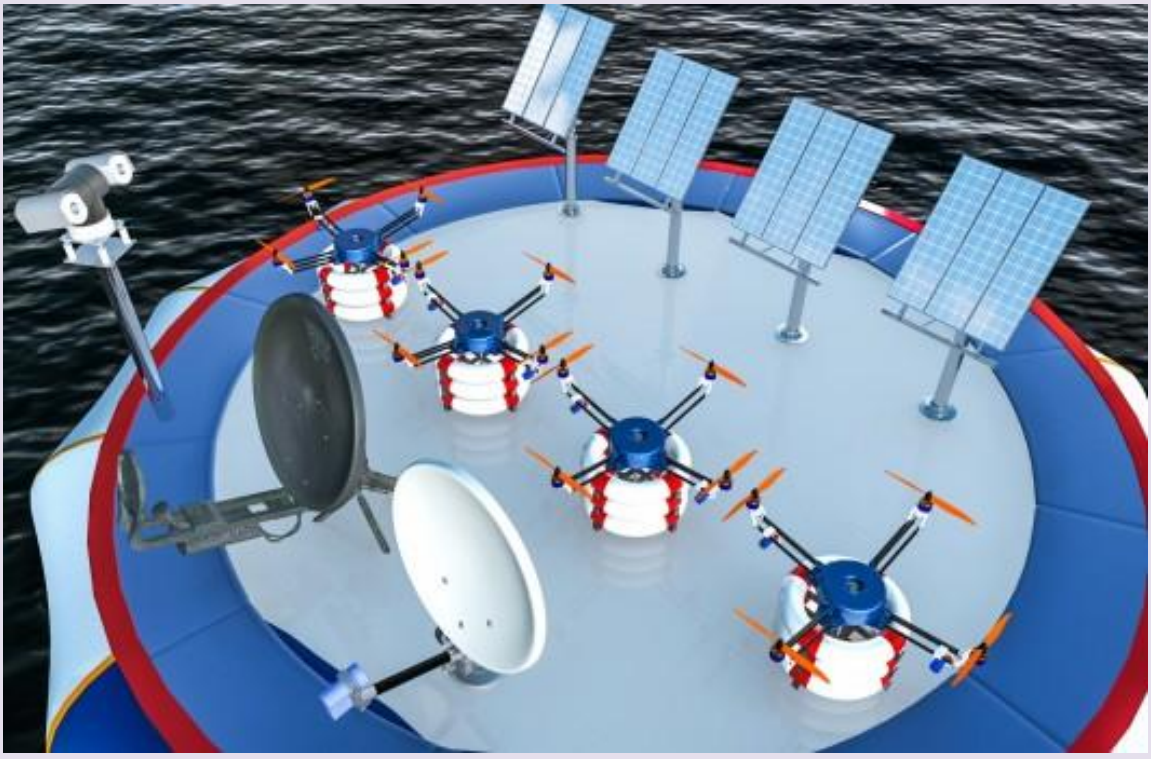
Source: http://www.gizmag.com/pars-aerial-robot/26878/

If current technology trends are any indication, it's possible that human lifeguards could be replaced by robots in the future. So far, we've seen a remote-controlled rescue buoy and a salamander-like bot that travels on both water and land, among many others. Rather than having to cut through rough water to get to folks in trouble like many search and rescue robot designs, an Iranian research center proposes a quadcopter called Pars that launches from a floating platform and drops life preservers precisely where they're needed.

RTS Lab began developing Pars to address the high number of drowning victims in the Caspian Sea along the Iranian coastline. After creating a short-range rescue bot to help people near beaches, the team set to work on an improved model with much better capabilities.

The Pars design calls for a lightweight quadcopter equipped with a slew of sensors, including accelerometers, gyroscopes, GPS, a barometer, and an electronic compass. It's most distinguishing feature, however, is a series of latches underneath that can hold and release life preservers one at a time. The most recent design can hold three tubes at once, but the developers claim future models could stock over 15 by using a chemical material that expands the padding after release.

An operator would be able to remotely control the robots manually or an onboard artificial intelligence could allow it to act autonomously in certain situations. RTS Lab says it has made a point of keeping the controls simple, so that a rescue worker could learn to operate them with just a few days of training.



The group also designed a charging station that would use solar energy to recharge several Pars units when they are docked. The designers claim the platform could be attached to the top of a rescue boat or offshore structure and could even be modified into a standalone floating station. In the event of system failure or low power, the aerial bot floats in water even without the life preservers, so it can easily be recovered later.

If Pars works as well as its designers claim, it could have quite a few notable advantages over most rescue robots we've seen before. For one, it could attend to multiple people in one trip, whereas most amphibious robots are only equipped to handle one person at a time.

Flying over the waves also allows Pars to bypass any obstacles or rough water conditions that might be inaccessible to anything traveling by water (or even full-sized helicopters by air). Though how it would handle in a violent storm remains to be seen.

The quadcopter could also be equipped for aerial reconnaissance, giving rescuers a bird's-eye viewpoint of an emergency situation and allowing them to get the proper equipment ready before they even reach the site of an accident.

According to RTS Lab, most of the initial design work for the robot itself has been completed and tested, though the current model does not include ultrasound sensors or artificial intelligence. Right now, the researchers are seeking funding to build an industrial prototype and eventually mass produce Pars to get it into the hands of rescue workers worldwide.

Japanese first responders to wear robotic exoskeletons

Source: http://www.gizmag.com/japanese-first-responders-robotic-exoskeleton/24555/

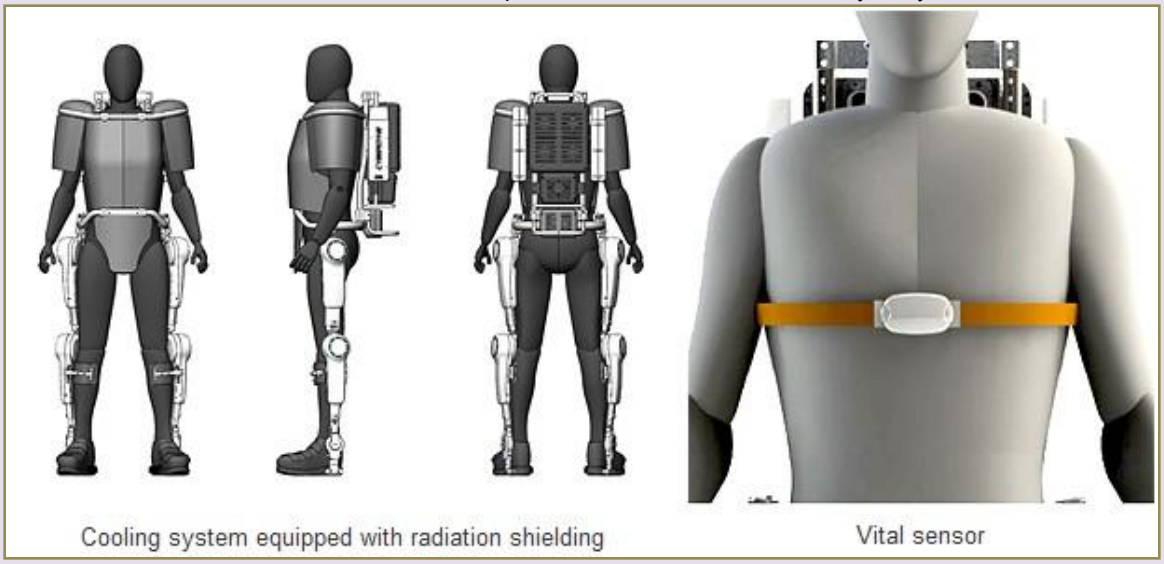
Professor Yoshiyuki Sankai presents the modified HAL exoskeleton during Japan Robot Week 2012

Since the Fukushima Daiichi nuclear disaster in March 2011, the Japanese government has been testing robotic technologies to help deal with future accidents. The Hybrid Assistive Limb (HAL) exoskeleton, developed by the University of Tsukuba spin-off Cyberdyne, is being considered for first responders.

For protection the suit incorporates tungsten shielding which reduces radiation exposure by about 50 percent, as well as a cooling system to prevent heatstroke. Much of the weight of the suit, including tools used for repairing damaged pipes, can be carried by the exoskeleton's legs. Vital signs such as heart rate and body temperature will also be measured in real-time.

As part of the same initiative, the Chiba Institute of Technology (CIT) is developing remotely-operated robots that can enter radioactive areas. CIT researchers have already built two generations of search-and-rescue robots, which have been tested in annual competitions like the RoboCup Rescue challenge. Their latest unmanned robot, Sakura, can be used to inspect pipes, radiation levels, temperature, humidity, among other things. It negotiates stairwells and narrow passages by moving on tank-like treads and is equipped with a camera and other sensors. The team expects the robot to be maintenance-free for three years after carefully selecting build materials, which will further help reduce radiation exposure.

The New Energy and Industrial Technology Development Organization (NEDO) says the robots will be unveiled to the public in the coming days during Japan Robot Week 2012. In the future a mock-up facility will be built where further research and development can be done. Until now Cyberdyne has marketed the



Cooling system equipped with radiation shielding

Vital sensor

HAL (photo – above) suit as a walking aid (and for rehabilitation), though the company has also shown it with an upper-body extension that multiplies the wearer's lifting strength by a factor of 10. And, with further miniaturization, it is expected that Sakura may go just about anywhere within a reactor building.

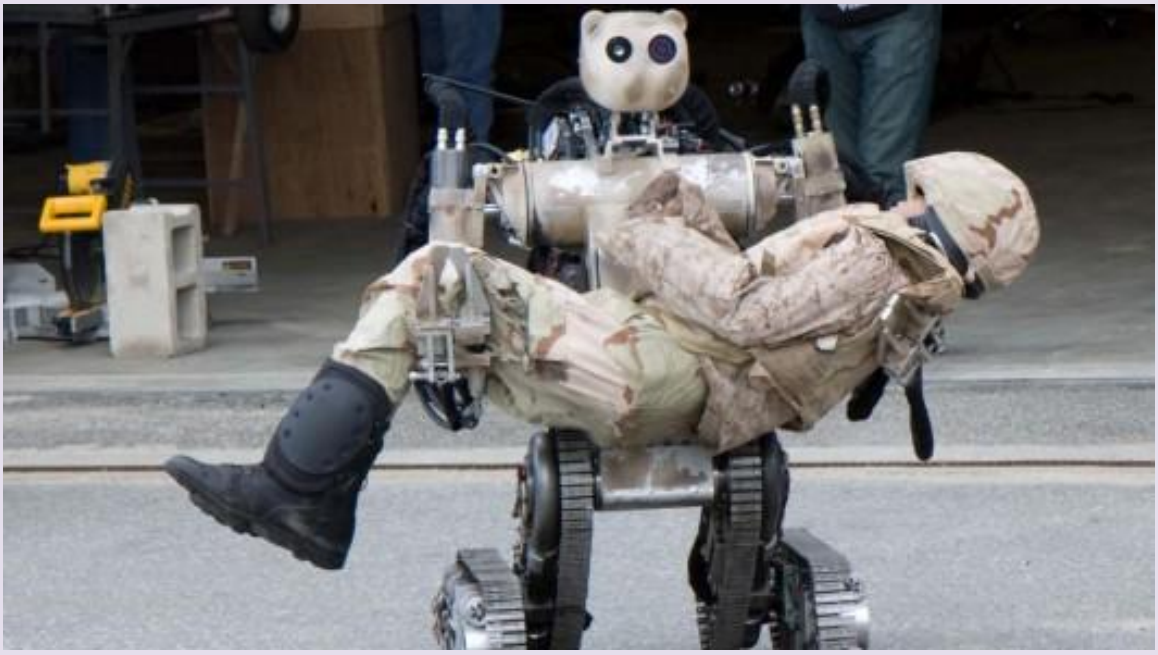
The Japanese government has been widely criticized for its lack of preparedness in the face of nuclear accidents, including its reliance on foreign robot technology (remote-controlled Warrior robots developed by Roomba maker iRobot trumped their own systems). However, the Japanese government has actually invested millions into related technologies, with the cooperation of industry giants and academia, since the 1980s.

Battlefield Extraction-Assist Robot to ferry wounded to safety

Source: http://www.gizmag.com/battlefield-extraction-assist-robot/17059/

The U.S. Army is currently testing a robot designed to locate, lift and carry wounded soldiers out of harm's way without risking additional lives. With feedback from its onboard sensors and cameras, the Battlefield Extraction-Assist Robot (BEAR) can be remotely controlled through the use of a special M-4 rifle grip controller or by hand gestures using an AnthroTronix iGlove motion glove. This equipment would allow a soldier to direct BEAR to a wounded soldier and transport them to safety where they can be assessed by a combat medic.

Built by Vecna Robotics, BEAR maneuvers via two independent sets of tracked "legs" and is able to stand up and dynamically balance on the balls of its ankles, knees or hips while carrying a load. At full height



BEAR stands 1.8 m (6 ft) tall, allowing it to look over walls or to lift its cargo onto a raised surface. To ensure it can handle a fully equipped soldier, BEAR's hydraulic arms are capable of carrying up to 500 pounds (227 kg), while its hands and fingers allow it to carry out fine motor tasks. It also has a "teddy bear" face that is designed to be reassuring.

BEAR has been undergoing tests over the past year in simulations and live exercises by soldiers at the U.S. Army Infantry Center Maneuver Battle Lab at Fort Benning, Georgia. These tests are designed to provide BEAR's developers with feedback on the real-world operational capabilities and requirements for the robot.

Anthronix, the makers of the iGlove, which is available commercially as the AcceleGlove, (photo – left) plans to develop a new glove for controlling the robot that will include more accelerometers and a digital compass to allow for greater control using only hand gestures – to instruct the robot to disable an improvised explosive device or travel exactly 500 meters east for example.

The alternative method of remote control, a "Mounted Force Controller" which is mounted on the grip of an M-4 rifle, allows a user to control BEAR without having to put down their weapon.

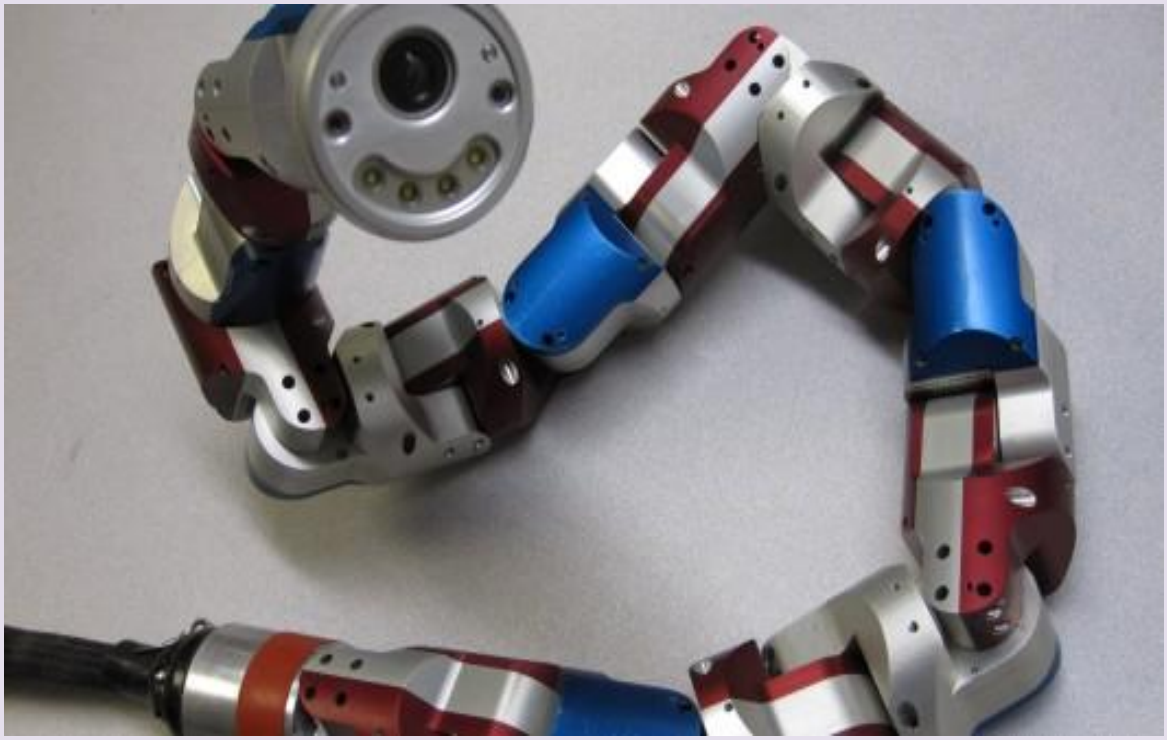
Currently all BEAR's actions are controlled by a human user but the developers are working to give BEAR more complicated semi-autonomous behaviors that will allow it to understand and carry out increasingly complicated commands.

Vecna Robotics says BEAR could also be used for search and rescue, handling hazardous materials, surveillance and reconnaissance, mine inspection, lifting hospital patients, or even warehouse automation. However, the battlefield is where we're probably most likely to first see BEAR.
"If robots could be used in the face of threats such as urban combat, booby-trapped IEDs, and chemical and biological weapons, it could save medics' and fellow soldiers' lives," says Gary Gilbert of the U.S. Army Medical Research and Materiel Command's Telemedicine and Advanced Technology Research Center (TATRC), which helped fund BEAR's development.

CMU's snake robot explores defunct nuclear power plant

Source: http://www.gizmag.com/cmu-snake-robot-explores-nuclear-power-plant/28235/

Several snake-like robots have been developed around the world, and while we keep hearing about their potential applications few have managed to slither outside of their research labs. Earlier this year Carnegie Mellon University's Biorobotics Lab put its modular snake robot's practicality to the test in an abandoned nuclear power plant, where it provided clear, well-lit images from the inside of pipes.



Austria's Zwentendorf nuclear power plant is the perfect testing ground for inspection robots. The plant was built in the 1970s but was never turned on, so there's no radiation to worry about. That makes it the next best thing to an operational plant, with a multitude of tricky pipes to explore.
Recently, several robots have been developed to help explore the Fukushima Daiichi nuclear plant, which was damaged in the 2011 earthquake and tsunami. However, most plants contain miles of pipes, which other robots can't adequately inspect. The snake robot, which has a camera and LEDs on its head, crawled into 15 cm (6 in) wide steam pipes, providing operators with a clear view of what was inside. The robot moves by rolling itself in a corkscrew pattern, so the resulting video feed is automatically corrected in software to align with gravity.
"Our robot can go places people can't, particularly in areas of power plants that are radioactively contaminated," explains Robotics Professor Howie Choset. "It can go up and

around multiple bends, something you can't do with a conventional borescope, a flexible tube that can only be pushed through a pipe like a wet noodle."
The robot, which is just 2 in (5 cm) in diameter and 37 in (97 cm) long, has 16 joints allowing it to move a bit like a snake. The body can twist around a cylindrical shape, such a leg, to climb up and down. The only

problem is it's tethered by a power and control cable. In this experiment the team was hesitant to explore much beyond 18 meters (60 ft), but it could go much further.
Already the robot has investigated rubble in mock search-and-rescue missions, and in the future the team plans to make it water-proof. Another possible enhancement would allow the snake to map a nuclear plant's pipe network as it explores it.

Rescue robot that can clear debris and lift heavy weights

Source: http://robotzeitgeist.com/tag/rescue-robots

Rescue robots are one application for which there has been much excitement during the last decade. These robots are designed to be small and versatile carrying a comprehensive sensor payload in order to detect victims under heavy debris in disaster areas. Everyone who has watched the news after a major earthquake or hurricane with many buildings destroyed can easily understand the need for such robots as rescuers are frantically

searching for survivors under heavy debris.

Researchers from the Tokyo Institute of Technology have recently proposed a new type of rescue robot that is capable of not only detecting victims in need of help but also clearing and lifting heavy debris to reach them.
The prototype robot named Bari-bari-II has a unique design that allows it to navigate over and lift debris. Its front is designed to have a step structure which can grip on debris, lift it and move under it. Once under, the robot uses oil hydraulic power to lift up to 600Kgrs. Like traditional rescue robots, a sensor payload consisting of a camera and microphone help rescuers to find victims in the rumble. The robot weighs 25Kgrs and it measures 48x28x14cm in size. Rescuers can use more than one robots at the same time to lift even heavier debris.

Search-and-Rescue Robots Tested at New York Disaster Site

Source: http://news.nationalgeographic.com/news/2001/09/0914_TVdisasterrobot_2.html

Three experimental robots, each about the size of a shoebox, are being used to search for victims in the mountain of rubble that was once the World Trade Center in New York City.
Researcher Robin Murphy and three of her graduate students have been clambering over the jagged piles of debris—powdered concrete and twisted steel—with the camera-carrying robots, lowering them into voids that are inaccessible to people, dogs, and other cameras involved in the search for bodies.
"So far the robots haven't found a survivor," said engineering professor Robin Murphy of the University of South Florida, who is developing the robots specifically for urban search and rescue missions.
"We've only seen body parts and bloody splotches," said Murphy. "At this point we don't have much hope. We are trying to find remains so that they can be handled with dignity."

Urgent Response

All of the robots have microphones to detect voices or other sounds of possible human presence within the ruins. Some of the robots carry thermal cameras that can detect body heat; others have cameras that search for colors distinctive from the gray dust that has blanketed the debris.
"Everything is gray and computers are really good at looking for color," said Murphy. "A tiny dot of red, whether it is fabric or blood, can be easily identified and used to alert a rescue team."
Murphy said that in most cases, rescue workers need to retrieve victims within about 48 hours. "After that it is pretty much a recovery mission," she said. In this disaster, she added, many hours passed before large numbers of human rescuers were able to begin searching for victims.
That situation, Murphy explained, illustrates why there is a need for search-and-rescue robots that are small, cheap, and light. Hundreds of them could be released immediately after a disaster in which the conditions are too dangerous for people and dogs to begin searching for victims.

Limited Use So Far

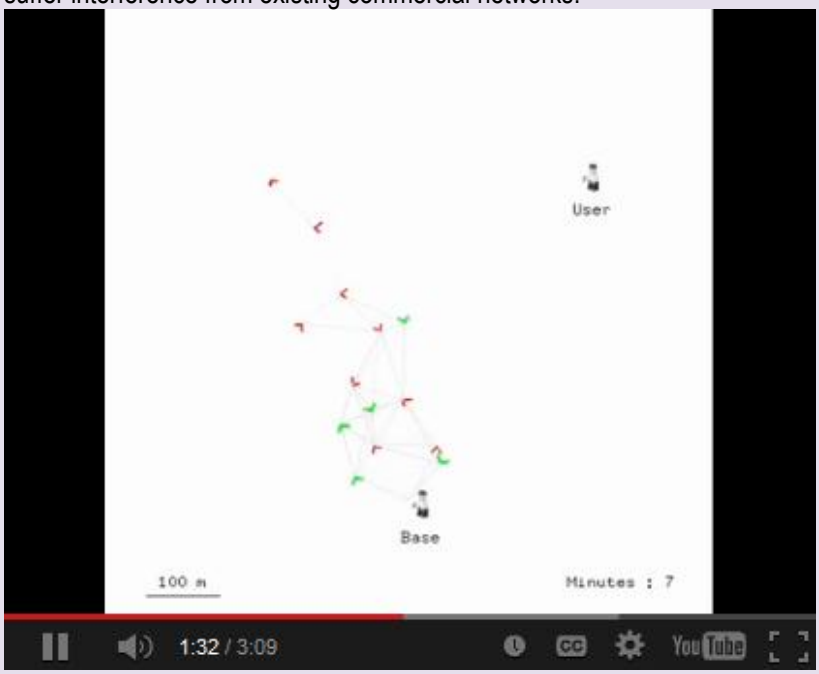
When Murphy and her students drove up from Florida—an 18-hour drive—just hours after word of the attacks in New York City, they carried about eight different robot models with them.

The researchers found that most of the robots were not yet sophisticated enough to roam the rubble. Some were too big and heavy to maneuver the terrain. The "hot zone" of the rubble is in vertical piles, which the robots are not capable of climbing, Murphy noted.
In this disaster, officials have found that even dogs trained for search and rescue have not been able to climb across much of the debris, and the dust-laden air has diminished the dogs' keen sense of smell.
The experimental robots that did prove useful in New York look like mini-tanks with treads. Using a device similar to a joystick, Murphy can direct the small machines to wiggle, crawl, and travel into voids as deep as 30 feet (10 meters).
Murphy said the experimental robots have had "no real impact" on the rescue mission in part because there are so few of them. "It's like one guy showing up to a construction site with six nail guns. You need everybody to have a nail gun to make an impact," she said. "This is truly like finding needles in a haystack."
Instead, the simplest kind of technology—"bucket brigades"—has been one of the most effective search techniques at the World Trade Center site. Hundreds of rescue workers are removing rubble by passing buckets of it from hand to hand.
The experience in New York, however, gives Murphy and other engineers insights that can help them design search-and-rescue robots that are smarter, faster, and more independent, which is critical in most disasters.

Flying robots could help in disaster rescue

Source: http://www.scidev.net/global/disasters/news/flying-robots-could-help-in-disaster-rescue.html

Swarms of flying robots inspired by insect behaviour could be used to establish emergency rescue networks following natural disasters, say Swiss researchers who plan to start testing their system from April.
In the aftermath of earthquakes and other disasters, when communications infrastructure is damaged or overloaded, the first thing rescue teams do is set up temporary radio or mobile communication networks to coordinate the search for survivors.
But these networks have limited data transmission capacity, take time and specialists to establish, and can suffer interference from existing commercial networks.



Now a team of scientists at the Swiss Federal Institute of Technology in Lausanne, has developed a quick way to establish a wireless network using 'swarming micro air vehicles' — flying robots.
"The main point is to provide high bandwidth digital communication, for instance to transmit high-resolution images, video streams and voice," Jean-Christophe Zufferey, the project leader, told *SciDev.Net*.
A fleet of vehicles would hover above a disaster zone with a module in the wing of each robot emitting a wireless signal to enable communication between rescuers.

Each vehicle is made from lightweight, flexible polypropylene plastic, weighs less than half a kilogram and has a wing span of 80 centimetres. A battery-powered motor enables each vehicle to fly for up to half an hour before visiting a recharging station.
The team is preparing a paper describing how it flew 10 robots — enough to establish and autonomously maintain a 1.5-kilometre communication line — to link up two rescuers on the ground.
To distribute the vehicles effectively above a designated zone, Zufferey's team took inspiration from the way ants leave chemical trails to guide colonies to sources of food. Some of the vehicles hover in small circles linked to the location of rescuers and the other vehicles navigate around these markers.
Renzo De Nardi, a robotics researcher at University College London in the United Kingdom, is impressed by the ease with which the system can deliver a high quality wireless signal, a feature that would be particularly useful in developing countries lacking fixed communication networks.
De Nardi warned, however, that the lightweight vehicles would likely be affected by wind and bad weather.
Julian De Hoog, head of the Robotic Search and Rescue project at the UK-based University of Oxford, described the aerial robot swarm as an "impressive achievement", but said the main challenge will be to boost vehicle durability while keeping them light enough to be safe if they crash.
He added that rescuers have many other factors competing for their attention so using the technology "would have to be very simple and straightforward".
The researchers will begin testing the technology in mock rescue contexts this spring.
It will take up to three years to prove the robustness of the technology in real-life situations, according to Zufferey, although a simpler, single-robot system for crop and biodiversity monitoring has already been rolled out through a spin-off company, senseFly.
Meanwhile his team is also working to develop ground-based robots and flying vehicles that can enter buildings and scan for survivors.

Rescue robots ‘can aid safety, but faster use is key’

Source: http://www.scidev.net/global/disasters/news/rescue-robots-can-aid-safety-but-faster-use-is-key.html

Equipping rescue teams with smart robots could dramatically improve the efficiency and safety of operations after disasters, according to experts speaking on the sidelines of a recent robotics workshop.

But for this to happen, scientists have to be able to deploy robots faster and rescuers need more training on how to use them, the experts said at the Fifth EUCogIII Members Conference, organised by the European Network for the Advancement of Artificial Cognitive Systems, Interaction and Robotics last month (19-20 March) in Germany.

Understanding how robots can assist rescuers, and encouraging scientists to deploy robots more rapidly in real-life situations are two constraints to using them in disaster relief, according to Hartmut Surmann, a researcher at the Fraunhofer Institute for Intelligent Analysis and Information Systems in Germany.

As part of the European Union-funded NIFTi (Natural Human-Robot Cooperation in Dynamic Environments) project, Surmann’s team tested robots during the rescue operation that followed the magnitude 6 earthquake that struck northern Italy in May 2012. Both ground-based robots and aerial drones were used to help firefighters assess if the ruins of the town of Mirandola were safe enough for them to go in to look for survivors.

Scientists worked alongside Dutch, German and Italian firefighters, who were shown how to use the robots and provided feedback to the research team.

“We realised that we need to train firefighters in advance, before a natural disaster occurs. Only by doing this can we make sure that both humans and robots know what they can do for each other and really help in [disaster] situations,” Surmann told *SciDev.Net*.

The northern Italian earthquakes created a "chaotic and stressful situation", where rapid decisions were needed, said Surmann, but his team found it difficult to pass on the large amount of data collected by the robots in real time.

In addition, his team learned it was impractical to bring their robots to the disaster area and assemble them there because that could take two to three hours, he says. Instead, the robots need to be ready to be used in as little as ten minutes, to allow the rescue operation itself to start, he adds.

Robots provided images of buildings affected by the quake, said Surmann, adding that these helped rescuers, engineers and architects decide if it was safe to send in human teams.

"Also, if a building has collapsed, we can use a laser scanner to measure how much debris there is and how many trucks are needed to carry that away," Surmann added.

But rain and successive tremors over the following two months caused more damage to buildings, many of which collapsed, he said, rendering much of the data useless.

"We need to provide information over the whole period of time during which rescue operations are taking place. Maybe we should do a robot survey mission every day, especially if new earthquakes take place," Surmann says.

A number of papers explaining the results of the project and a list of all the open source software used to control these robots have been uploaded to the project's website to allow researchers in developing countries to adapt this work to their own circumstances and risk environments.

Surmann says he hopes to apply all this knowledge to the second generation of robots that are due to be tested over the next four years, as part of a new project that started last November.

The Long-Term Human Robot Teaming for Robot-Assisted Disaster Response (TRADR) project builds on the results of NIFTi. It aims to use human-robot collaboration to explore and gather samples from disaster environments. The ultimate goal is for robots and humans to develop their understanding of the disaster area over multiple missions, learning how best to work in the area and how to improve teamwork.

Ricardo Téllez, an artificial intelligence researcher at the Polytechnic University of Catalonia in Spain, said that most robots currently used after natural disasters are controlled by humans in real time and even these face problems when working among concrete and metal debris because their wireless signal then becomes difficult to detect.

"Robots have improved in the last years, but we are still very far from achieving their autonomy. We need to improve this and their perception of their surroundings," he told *SciDev.Net*.

Robots work well in controlled environments such as laboratories, but struggle when used somewhere that has been hit by an earthquake or a flood, he added.

"We can teach them to recognise a series of objects under a number of circumstances, but the reality is much more complex than that," said Téllez. "Robots need to learn by themselves from their environment."

Disaster Robotics

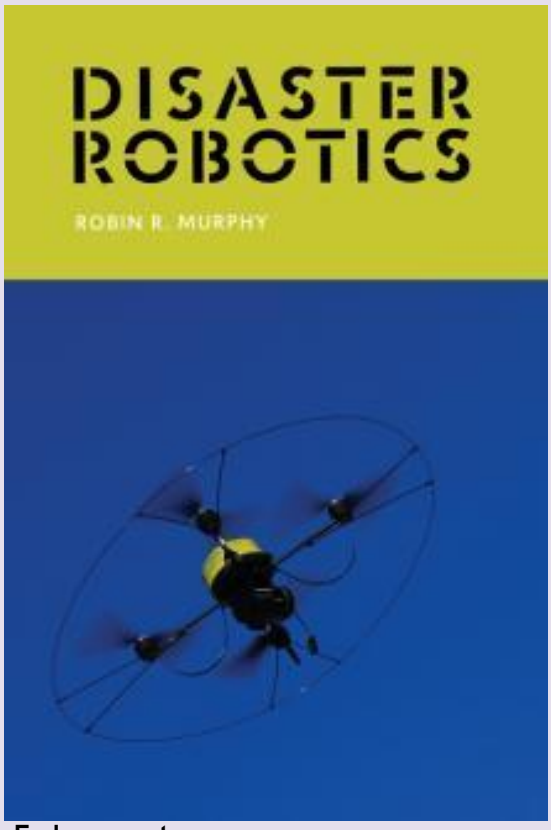
By Robin R. Murphy

Source: http://mitpress.mit.edu/books/disaster-robotics

This book offers the definitive guide to the theory and practice of disaster robotics. It can serve as an introduction for researchers and technologists, a reference for emergency managers, and a textbook in field robotics. Written by a pioneering researcher in the field who has herself participated in fifteen deployments of robots in disaster response and recovery, the book covers theory and practice, the history of the field, and specific missions.

After a broad overview of rescue robotics in the context of emergency informatics, the book provides a chronological summary and formal analysis of the thirty-four documented deployments of robots to disasters that include the 2001 collapse of the World Trade Center, Hurricane Katrina, the 2010 Haiti earthquake, the Deepwater Horizon oil spill, the 2011 Japanese earthquake and tsunami, and numerous mining accidents. It then examines disaster robotics in the typical robot modalities of ground, air, and marine, addressing such topics as robot types, missions and

tasks, and selection heuristics for each modality. Finally, the book discusses types of fieldwork, providing practical advice on matters that include collecting data and collaborating with emergency professionals.



The field of disaster robotics has lacked a comprehensive overview. This book by a leader in the field, offering a unique combination of the theoretical and the practical, fills the gap.

Robin R. Murphy *is Raytheon Professor of Computer Science and Engineering at Texas A&M University and directs the Center for Robot-Assisted Search and Rescue (CRASAR). An IEEE Fellow and a founder of Roboticists without Borders, she has worked in disaster robotics research and deployment since 1995.*

Reviews

"I would strongly recommend this book for anyone doing (or looking to do) disaster robotics or work in difficult environments. I would recommend this book for the last section even if the other sections were not in existence. I give this 5 out of 5 stars (I think this is my first review that I am giving 5 stars, it almost feels wrong)."—**David Kohanbash**, *Robots for Roboticists*

Endorsements

"A thorough overview and intellectually stimulating treatment of foundational and advanced concepts by one of the pioneers in the field, this book is an authoritative reference for the library of every researcher and professional working in the area of disaster robotics."
—**Bruno Siciliano**, Professor of Robotics at University of Naples Federico II, Italy, and Past President of IEEE Robotics and Automation Society

"Robin Murphy's book is the one-stop resource for rescue robotics for three key reasons: it provides a well-thought-out taxonomy of rescue robots; it contains supporting data on where, when, and how robots were used; and it reflects on Murphy's experiences in using these robots in her vast deployment experience."
—**Howie Choset**, Professor, Robotics Institute, Carnegie Mellon

"This book is an excellent introduction to rescue robotics for both researchers and practitioners. Robin Murphy is the most well-known world leader in applying robots to disaster response. Her long-term research and experiences have given her deep insight into the humanitarian application of robots described in this book, particularly in human-robot interaction and fieldwork."
—**Satoshi Tadokoro**, International Research Institute of Disaster Sciences, Tohoku University

"As one of the top international researchers in search and rescue robotics and a true pioneer in multiple respects, Robin Murphy has focused her considerable expertise from field exercises into a concise manual that doubles as both an accessible tutorial and an authoritative reference. An excellent resource!"
—**Richard Voyles**, Associate Dean for Research, Purdue College of Technology

Rescue Robots: The Future of Nuclear Cleanup

Source: http://forumonenergy.com/2013/12/30/rescue-robots-the-future-of-nuclear-cleanup/

iRobot 710 Warrior

The events at the Fukushima Daiichi plant brought to light a never-before thought of scenario — that a nuclear power plant meltdown could occur and create a disaster area that is too radioactive for humans to clean up.

The weekend of December 20, the Defense Advanced Research Projects Agency (DARPA) of the United States Department of Defense hosted a Grand Challenge for robotics — an obstacle course for humanoid robots that are specifically designed to operate in environments such as the Fukushima Daiichi nuclear reactor buildings. It is hoped that this Challenge will lead to the development of robotic technology that functions beyond its current uses. In Japan, these kinds of robots are used in the household and for nursing care for the elderly. American robots are built for battle in dangerous and uncertain terrain, and another breed of robots are used for the uncertain environments of space exploration.

The following is a round-up of robot technologies — starting with the first line of robots that helped out in the immediate aftermath of the tsunami, the robots that are designed with the nuclear power plant cleanup in mind, and a new breed of robots inspired by the emergency at Fukushima that are being put to the test at DARPA.

Let the games begin.

Extreme radiation called for robots

Honda Motor Co's Asimo humanoid

At the time of the Fukushima Daiichi meltdown, Japan produced one of the highest tech robots available, Honda Motor Co's Asimo humanoid. This robot is designed to provide household assistance and human-like interactions. To the disappointment of many, the robot was not designed for search and rescue operations and its circuitry was not able to withstand the radiation levels, according to *The Japan Times*.

Robots that have worked in Fukushima

Instead, the first robots to enter the nuclear reactors were designed by Americans for combat environments. UK defense technology firm QinetiQ also supplied a range of remote controlled machines that helped engineers assess the situation inside the Fukushima nuclear plant. For photos of the QinetiQ robots in action, check out this BBC photo gallery.

iRobot's 710 Warrior, a rugged, gear-footed prototype went into damaged buildings at Fukushima and surveyed high-dose areas within turbines, sucking up radioactive dust into a vacuum cleaner taped to its arm, according to *Popular Mechanics*.

iRobot 510 PackBot

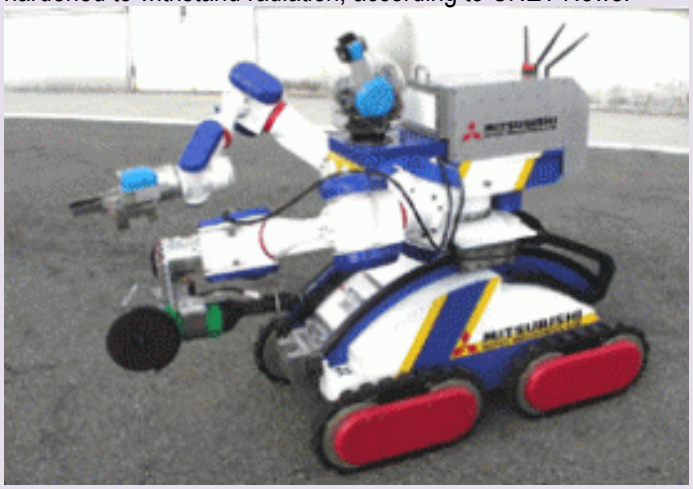
Two of iRobot's PackBots were used to survey the inside and outside of damaged reactor buildings. Their HAZMAT kits — sensors that detect radioactivity, temperature, environmental oxygen levels, and hazardous chemicals — monitored temperatures inside the reactor buildings. The Bots wove through wreckage, and removed up to 30 pounds of hazardous debris unsafe for human contact.

Although several robots worked inside the plant immediately after the crisis, they were not designed to repair a nuclear reactor. The operational environment within a large complex such as a power station poses high demands on these robots, such as obstacles and unforeseen circumstances.

"The biggest problem associated with robots deployed into such zones was maintenance, because if repairs were needed, it would be difficult for humans to get anywhere near. The solution would be to fix everything remotely, or while wearing heavy protective clothing," reported BBC News, from a discussion with Mark Clark, a spokesperson for robotic firm Qinetiq, who also cautioned that using machines not designed for the specific conditions of a nuclear plant would always be a compromise.

Since 2011, Japanese companies received funding to design robots specific to the environments of Fukushima, and creating what is hyped to be a "robot revolution." The technology is still nascent, and the robots have been a mixed success.

In 2012, Mitsubishi, Toshiba and Hitachi demonstrated their newly minted clean-up robots. MEISTeR (Maintenance Equipment Integrated System of Telecontrol Robot) is Mitsubishi's "tankbot." It stands about 1.3m (4ft) tall and has two arms, each able to hold loads of up to 15kg (33lb). The robot's electronics are hardened to withstand radiation, according to CNET News.



MEISTeR, Mitsubishi's "tankbot"

Toshiba's quadruped can negotiate stairs and uneven terrain, and is able to avoid low-lying obstacles. But it initially did not fare well during its demonstration. It wobbled and froze, but was cleared for work regardless of the glitches, reported FOX News and CNET.

Hitachi's ASTACO-SoRa model is designed to move rubble. Gizmag reports: "The ASTACO-SoRa robot and its control station were developed by the subsidiaries Hitachi Engineering & Services and Hitachi Construction Machinery… Measuring 98 cm (3 feet, 2 inches) across with its arms tucked in, the robot is small enough to enter most areas. It weighs 2.5 tons (2.3 tonnes), moves at up to 2.6 km/h (1.6 mph), and can operate for up to 15 hours thanks to its diesel engine, but it cannot move up stairs."

Robotic competitions spur innovation

Competitions have assisted in the development of robotic technologies. Quince 2, one of the major robotic contributors to the clean-up effort thus far, was developed as part of Robocup 2013.

The U.S. government, through its experimental technologies research lab DARPA, hosted a competition over weekend for "Gladiator Robots," which are designed to overcome the very challenges that robots were confronted with at Fukushima.

Located at the Homestead Miami Speedway in Homestead, Fla., the competition hosted robot prototypes that were run through a challenge course consisting of eight tasks to evaluate robots' perception, autonomous decision-making, mobility, dexterity and strength — all the qualities DARPA expects robots would need to work in disaster scenarios, according to *WIRED magazine.*

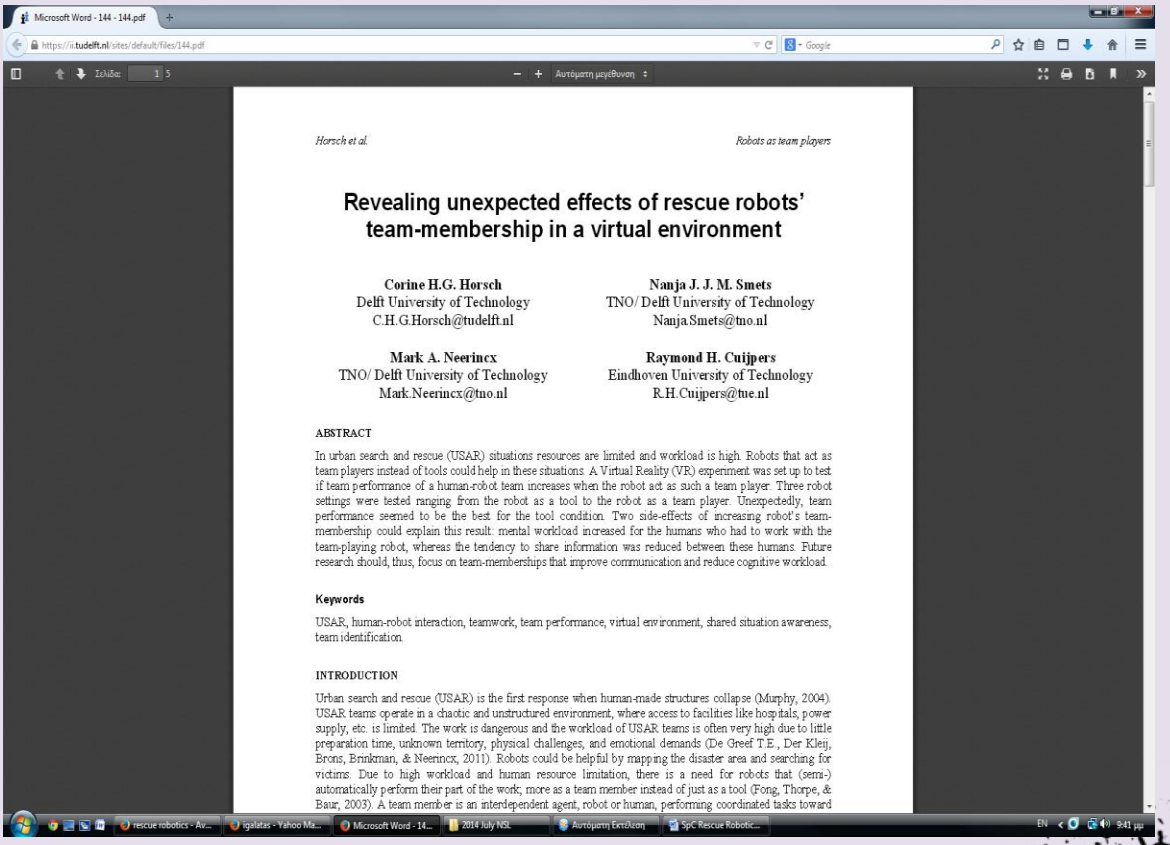
While an anthropomorphic robot named Atlas, by Boston Dynamics, had been hyped as the front runner, by Saturday, it appeared as if a team from the University of Tokyo has emerged as a dominant player as the top eight robots moved into the second round. Team "Schaft" executed each of the eight challenges nearly flawlessly, losing points only because the wind blew a door out of its robot's grasp and because the robot was not yet able to climb out of the vehicle after it successfully navigated an obstacle course, reported the *Herald-Tribune*.

Schaft is one of several robotics companies, including Boston Dynamics, that NBC News reported to be purchased recently by Google's new and mysterious robotics division.

Perhaps Schaft will redeem Japan's confidence in its leadership in the robotics industry.

Revealing unexpected effects of rescue robots' team-membership in a virtual environment

Source: https://ii.tudelft.nl/sites/default/files/144.pdf



Horsch et al. *Robots as team players*

Revealing unexpected effects of rescue robots' team-membership in a virtual environment

Corine H.G. Horsch
Delft University of Technology
C.H.G.Horsch@tudelft.nl

Nanja J. J. M. Smets
TNO/ Delft University of Technology
Nanja.Smets@tno.nl

Mark A. Neerincx
TNO/ Delft University of Technology
Mark.Neerincx@tno.nl

Raymond H. Cuijpers
Eindhoven University of Technology
R.H.Cuijpers@tue.nl

ABSTRACT

In urban search and rescue (USAR) situations resources are limited and workload is high. Robots that act as team players instead of tools could help in these situations. A Virtual Reality (VR) experiment was set up to test if team performance of a human-robot team increases when the robot act as such a team player. Three robot settings were tested ranging from the robot as a tool to the robot as a team player. Unexpectedly, team performance seemed to be the best for the tool condition. Two side-effects of increasing robot's team-membership could explain this result: mental workload increased for the humans who had to work with the team-playing robot, whereas the tendency to share information was reduced between these humans. Future research should, thus, focus on team-memberships that improve communication and reduce cognitive workload.

Keywords

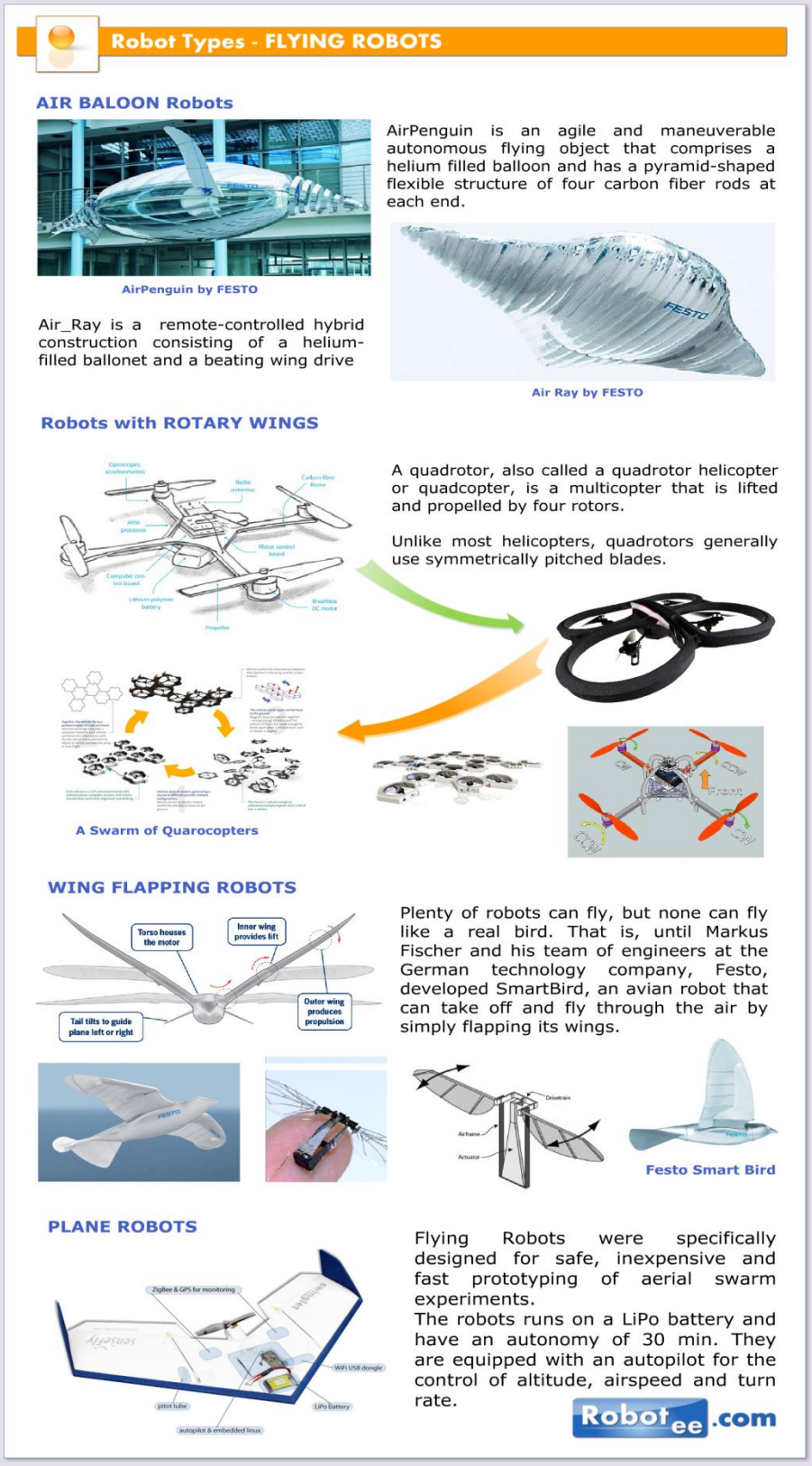
USAR, human-robot interaction, teamwork, team performance, virtual environment, shared situation awareness, team identification.

INTRODUCTION

Urban search and rescue (USAR) is the first response when human-made structures collapse (Murphy, 2004). USAR teams operate in a chaotic and unstructured environment, where access to facilities like hospitals, power supply, etc. is limited. The work is dangerous and the workload of USAR teams is often very high due to little preparation time, unknown territory, physical challenges, and emotional demands (De Greef T.E., Der Kleij, Brons, Brinkman, & Neerincx, 2011). Robots could be helpful by mapping the disaster area and searching for victims. Due to high workload and human resource limitation, there is a need for robots that (semi-) automatically perform their part of the work; more as a team member instead of just as a tool (Fong, Thorpe, & Baur, 2003). A team member is an interdependent agent, robot or human, performing coordinated tasks toward

Flying Robots

Source: http://www.robotee.com/index.php/all-types-of-robots/flying-robots/



It is not easy to group Flying Robots into sub groups. As Flying robots use various kinds of technologies we will group these robots by their flying system. For now we have defined the following types *(Other Types will be added soon)*

-Air Baloon Robots: These type of Flying robots use an air baloon to float in the sky.
-Robots with Rotary Wings: Robots which fly like a Helicopter (Quadrocopters)
-Wing Flapping Robots: These robots fly like a bird with the help of their wings.
-Airplane Robots: Robots which fly like an airplane

AIR BALOON ROBOTS:

AirPenguin – Autonomous Flying Robot

AirPenguin is an agile and maneuverable autonomous flying object that comprises a helium filled balloon and has a pyramid-shaped flexible structure of four carbon fiber rods at each end.

Not only is this but the AirPenguins also flaps wings as the birds do. This is made possible via new type of wing span that can produce forward or reverse thrust and 3D Fin Ray structure. Wings are controlled by two actuators wherein flapping actuator helps up and down movements and a further unit that displaces the wing struts to alter the pressure point of the wings.

Also, there is a rotational actuator for the two flapping wings, directing thrust upwards or downwards, thus making the AirPenguins rise or descend accordingly.

Air Ray

Air_ray, modelled on the manta ray, is a remote-controlled hybrid construction consisting of a helium-filled ballonet and a beating wing drive. Its lightweight design enables it to “swim” in the sea of air using the lift from the helium in a similar way to the manta ray in water.

Propulsion is achieved

by a beating wing drive. The servo drive-controlled wing, which can move up and down, utilises the Fin Ray Effect® and is based on alternate pulling and pushing flanks connected via frames. When pressure is exerted on one edge, the geometrical structure automatically curves against the direction of the influencing force. A servo drive pulls the two flanks alternately in longitudinal direction, thus moving the wing up and down.

ROBOTS WITH ROTARY WINGS

Quadrotor, Quadcopter,Quadrocopter

A quadrotor, also called a quadrotor helicopter or quadcopter, is a multicopter that is lifted and propelled by four rotors. **Quadrotors are classified as rotorcraft, as opposed to fixed-wing aircraft,** because their lift is generated by a set of revolving narrow-chord airfoils. Unlike most helicopters, quadrotors generally use symmetrically pitched blades; these can be adjusted as a group, a property known as 'collective', but not individually based upon the blade's position in the rotor disc, which is called 'cyclic' (see helicopter). Control of vehicle motion is achieved by altering the pitch and/or rotation rate of one or more rotor discs, thereby changing its torque load and thrust/lift characteristics.

Swarm of Quadrocopters

A team at the Swiss Institute of Technology in Zurich has developed intelligent robots that can dock with each other and fly in a swarm.

The Distributed Flight Array robots locate each other using infrared and then lock together magnetically to create a sophisticated multi-propeller flight system.

Each hexagonal quadrocoptor robot, built of low-density expanded polypropylene (EPP) foam, has its own fixed-pitch mini-propeller and sensors. They are powered by a 50W brushless DC motor with an off-the-shelf electronic speed controller which produces more than three Newtons of thrust.

Embedded in the chassis is a lithium-ion polymer battery that is capable of powering both the motors and the electronics for up to five minutes of flight.

The units can take off and land vertically and fly independently, but erratically. Small wheels let them crawl around on the ground to locate each other.

Once they've hooked up, though, they become capable of more efficient flight, communicating information from their altitude sensors via infrared to make flight more even by controlling roll and pitch. If one fails, the others can compensate. And when they land, the robots can simply detach from each other and crawl away.

The developers are continuing to work on the system, with plans for larger-scale driving and flying experiments. "The goal is to have many modules assemble at random, fly to a predetermined altitude, hover, break apart, fall back down, and repeat the cycle," says the team.

WING FLAPPING ROBOTS

Festo Smart Bird

Plenty of robots can fly, but none can fly like a real bird. That is, until Markus Fischer and his team of engineers at the German technology company, Festo, developed SmartBird, an avian robot that can take off and fly through the air by simply flapping its wings.

SmartBird was inspired by the herring gull, Larus argentatus. It is a bit larger than this gull species, with a two-metre wingspan and a carbon-fiber "skeleton" that weighs 450 grams. Like live birds, SmartBird's "torso" can flex, providing directional control and is radio-controlled and monitored from afar.

As you would expect, the wings move up and down, generating lift, but the wings also twist and flex in flight like those of a real bird. This torsion keeps the wing's leading edge pointed upwards during the upward stroke, so that the wing adopts a positive angle of attack. This smooth sequence of wing movements generates thrust.

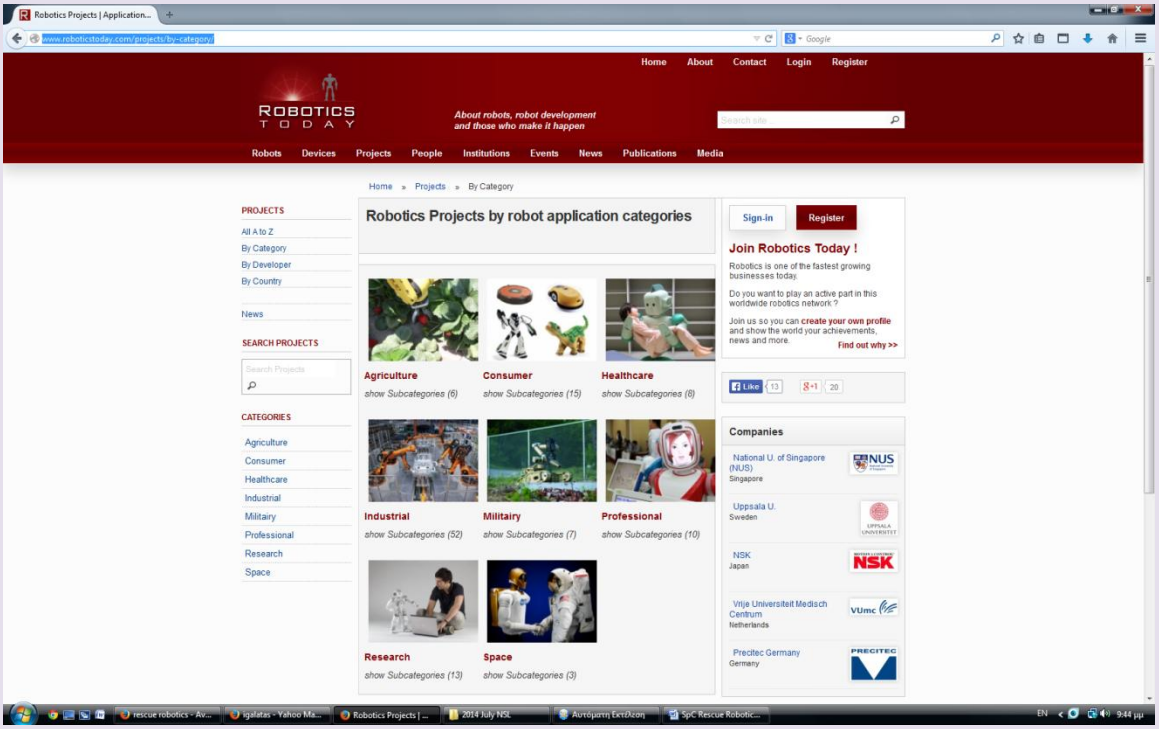
AIRPLANE ROBOTS

Smawnet Project

The SMAVNET project aims at developing swarms of flying robots that can be deployed in disaster areas to rapidly create communication networks for rescuers. Flying robots are interesting for such applications because they are fast, can easily overcome difficult terrain, and benefit from line-of-sight communication.
From a software perspective, controllers allow flying robots to work together. For swarming, robots react to wireless communication with neighboring robots or rescuers (communication-based behaviors). Using communication as a sensor is interesting because most flying robots are generally equipped with off-the-shelf radio modules that are low-cost, light-weight and relatively long-range. Furthermore, this strategy alleviates the need for position which is required for all existing aerial swarm algorithms and typically requires using sensors that depend on the environment (GPS, cameras) or are expensive and heavy (lasers, radars).

Robotics Today

Source: http://www.roboticstoday.com/projects/by-category/



Swarm Robotics

Source: http://www.robotee.com/index.php/all-types-of-robots/7-swarm-robots-swarm-robotics/

Swarm Robotics is a new approach to the coordination of multirobot systems which consist of large numbers of mostly simple physical robots. It is supposed that a desired collective behavior emerges from the interactions between the robots and interactions of robots with the environment. This approach emerged on the field of **artificial swarm intelligence**, as well as the biological studies of insects, ants and other fields in nature, where swarm behaviour occurs.
The research of swarm robotics is to study the design of robots, their physical body and their controlling behaviors. It is inspired but not limited by the emergent behavior observed in social insects, called swarm intelligence. **Relatively simple individual rules can**

produce a large set of complex swarm behaviors. A key-component is the communication between the members of the group that build a system of constant feedback. The swarm behavior involves constant

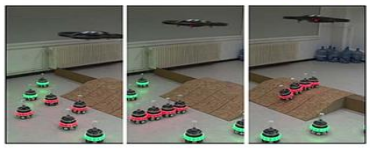
Robot Types - Swarm Robots - Swarm Robotics

What is Swarm Robotics

As robots become more and more useful, multiple robots working together on a single task will become commonplace. Many of the most useful applications of robots are particularly well-suited to this "swarm" approach.

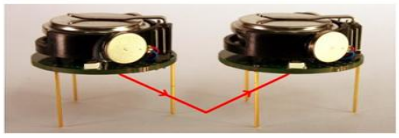
Groups of robots can perform these tasks more efficiently, and can perform them in fundamentally different ways than robots working individually.

Robotic Swarm with Ground and Air Units Working Together



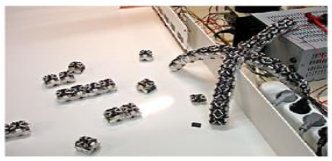
It is supposed that a desired collective behavior emerges from the interactions between the robots and interactions of robots with the environment. This approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behaviour occurs.

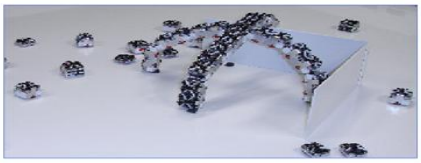
Robots in a Swarm use local Communication



Unlike distributed robotic systems in general, swarm robotics emphasizes a large number of robots, and promotes scalability, for instance by using only local communication.

That local communication for example can be achieved by wirelesstransmission systems, like radio frequency or infrared.



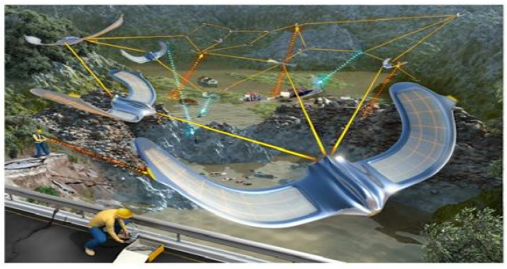


Very Small Robots can be used in a Swarm

It is inspired by the emergent behavior observed in social insects, called swarm intelligence.

Flying Robotic Swarm Projects

Flying robots have a great potantial for Swarm projects.



Robotee.com

change of individuals in cooperation with others, as well as the behavior of the whole group.
Unlike distributed robotic systems in general, swarm robotics emphasizes a large number of robots, and promotes scalability, for instance by using only local communication. That local communication for example can be achieved by wirelesstransmission systems, like radio frequency or infrared.
Video tracking is an essential tool for systematically studying swarm-behavior, even though other tracking methods are available. Recently Bristol robotics laboratory developed an ultrasonic position tracking system for swarm research purposes. Further research is needed to find methodologies that allow the design and reliable prediction of swarm behavior when only the features of the individual swarm members are given.

What is a "Swarm"?

As robots become more and more useful, multiple robots working together on a single task will become commonplace. Many of the most useful applications of robots are particularly well-suited to this "swarm" approach. Groups of robots can perform these tasks more efficiently, and can perform them in fundamentally different ways than robots working individually. However, swarms of robots are difficult to program and coordinate.

Applications of Robot Swarms

There are many applications for swarms of robots. Multiple vacuum cleaner robots might need to share maps of areas where they've previously cleaned. A swarm of mars rovers might need to disperse throughout the environment to locate promising areas, while maintaining communications with each other. Robots used for earthquake rescue might come in three flavors: thousands of cockroach-sized scouts to infiltrate the debris and locate survivors, a few dozen rat-sized structural engineers to get near the scene and solve the "pick-up-sticks" problem of getting the rubble off, and a few brontosaurus-sized heavy-lifters to carry out the rescue plan.
In all these applications, individual robots must work independently, only communicating with other nearby robots. It is either too expensive (robot vacuums need to be very cheap), too far (it takes 15 minutes for messages to get to Mars), or impossible (radio control signals cannot penetrate into earthquake ruble) to control all of the robots from a centralized location. However, a distributed control system can let robots interact with other nearby robots, cooperating amongst themselves to accomplish their mission.

The Future

Robots are going to be an important part of the future. Once robots are useful, groups of robots are the next step, and will have tremendous potential to benefit mankind. Software designed to run on large groups of robots is the key needed to unlock this potential.

NANO ROBOTS – Nanobots, Nanoids, Nanites, NanoMachines, Nanomites

Source: http://www.robotee.com/index.php/all-types-of-robots/nano-robots/

Nanorobotics is the emerging technology field creating machines or robots whose components are at or close to the **scale of a nanometer** (0,000000001 Meters – 10−9 Meters).More specifically, nanorobotics refers to the nanotechnology engineering discipline of designing and building **nanorobots**, with devices ranging in size from **0.1–10 micrometers and constructed of nanoscale or molecular components**. The names

- **Nanobots**
- **Nanoids**
- **nanites**
- **nanomachines or**
- **nanomites**

have also been used to describe these devices currently under research and development.

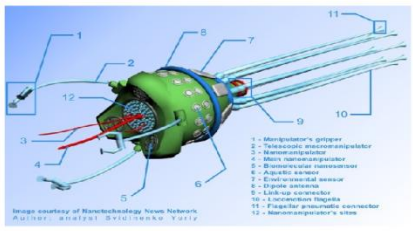
Nanomachines are largely in the research-and-development phase, but **some primitive molecular machines have been tested**. An example is a sensor having a switch approximately 1.5 nanometers

Robot Types - NANO ROBOTS - Nanorobotics

What is Nanorobotics ?

Nanorobotics is the emerging technology field creating machines or robots whose components are at or close to the scale of a nanometer.

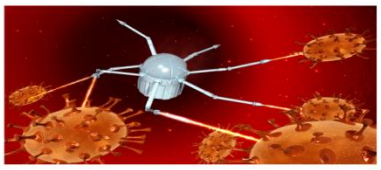
More specifically, nanorobotics refers to the nanotechnology engineering discipline of designing and building nanorobots, with devices ranging in size from 0.1–10 micrometers and constructed of nanoscale or molecular components.



Nanomachines are largely in the research-and-development phase, but some primitive molecular machines have been tested. An example is a sensor having a switch approximately 1.5 nanometers across, capable of counting specific molecules in a chemical sample.

Nanomedicine

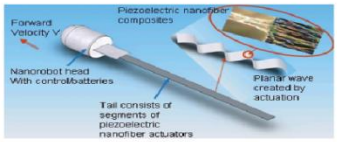
The first useful applications of nanomachines might be in medical technology, which could be used to identify and destroy cancer cells.

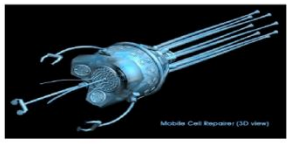


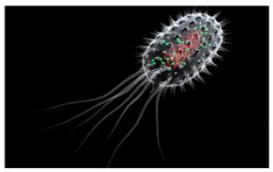
A nanomachine designed to carry human sperm cells

The joint use of nanoelectronics, photolithography, and new biomaterials provides a possible approach to manufacturing nanorobots for common medical applications, such as for surgical instrumentation, diagnosis and drug delivery.

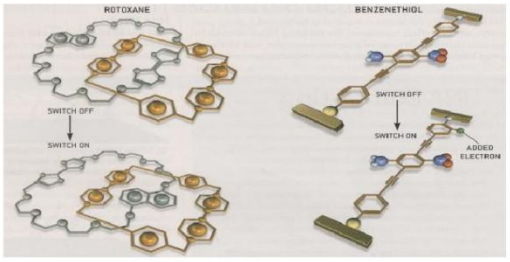
Practical nanorobots should be integrated as nanoelectronics devices, which will allow tele-operation and advanced capabilities for medical instrumentation.







Nubot is an abbreviation for "nucleic acid robot." Nubots are organic molecular machines at the nanoscale. DNA structure can provide means to assemble 2D and 3D nanomechanical devices. DNA based machines can be activated using small molecules, proteins and other molecules of DNA.



Nano Transistors

A nanotransistor is a transistor - the component that acts as an electronic signal switch or amplifier - that is near the scale of a billionth of a meter (or nanometer) in size.

Although there is currently no transistor of this scale in practical use, a number of approaches toward achieving such a remarkable component of nanotechnology appear promising.

Robotee.com

across, capable of counting specific molecules in a chemical sample. The first useful applications of nanomachines might be in medical technology, which could be used to identify and destroy cancer cells.
Another potential application is the detection of toxic chemicals, and the measurement of their concentrations, in the environment. Rice University has demonstrated a single-molecule car developed by a chemical process and including buckyballs for wheels. It is actuated by controlling the environmental temperature and by positioning ascanning tunneling microscope tip.
Another definition: is a robot that allows precision interactions with nanoscale objects, or can manipulate with nanoscale resolution. Such devices are more related to microscopy or scanning probe microscopy, instead of the description of nanorobots asmolecular machine. Following the microscopy definition even a large apparatus such as an atomic force microscope can be considered a nanorobotic instrument when configured to perform nanomanipulation. For this perspective, macroscale robots or microrobots that can move with nanoscale precision can also be considered **nanorobots.**

Nanorobotics Theory

Since nanorobots would be microscopic in size, it would probably be necessary for very large numbers of them to work together to perform microscopic and macroscopic tasks. These **nanorobot swarms**, both those incapable of replication (as in utility fog) and those capable of unconstrained replication in the natural environment (as in grey goo and its less common variants), are found in many science fiction stories, such as the Borg nanoprobes in Star Trek and The Outer Limits episodeThe New Breed.
Some proponents of nanorobotics, in reaction to the grey goo scare scenarios that they earlier helped to propagate, hold the view that nanorobots capable of replication outside of a restricted factory environment do not form a necessary part of a purported productive nanotechnology, and that the process of self-replication, if it were ever to be developed, could be made inherently safe. They further assert that their current plans for developing and using molecular manufacturing do not in fact include free-foraging replicators.
The most detailed theoretical discussion of nanorobotics, including specific design issues such as sensing, power communication, navigation, manipulation, locomotion, and onboard computation, has been presented in the medical context of **nanomedicine** by Robert Freitas. Some of these discussions remain at the level of unbuildable generality and do not approach the level of detailed engineering.

Biochip

The joint use of nanoelectronics, photolithography, and new biomaterials provides a possible approach to manufacturing nanorobots for common medical applications, such as for surgical instrumentation, diagnosis and drug delivery. This method for manufacturing on nanotechnology scale is currently in use in the electronics industry.So, practical nanorobots should be integrated as nanoelectronics devices, which will allow tele-operation and advanced capabilities for medical instrumentation.

Nubots

Nubot is an abbreviation for **"nucleic acid robot**." Nubots are organic molecular machines at the nanoscale. DNA structure can provide means to assemble 2D and 3D nanomechanical devices. DNA based machines can be activated using small molecules, proteins and other molecules of DNA. Biological circuit gates based on DNA materials have been engineered as molecular machines to allow in-vitro drug delivery for targeted health problems.Such material based systems would work most closely to smart biomaterial drug system delivery,while not allowing precise in vivo teleoperation of such engineered prototypes.

Positional Nanoassembly

Nanofactory Collaboration, founded by Robert Freitas and Ralph Merkle in 2000 and involving 23 researchers from 10 organizations and 4 countries, focuses on developing a practical research agenda specifically aimed at developing positionally-controlled diamond mechanosynthesisand a diamondoid nanofactory that would have the capability of building diamondoid medical nanorobots.

Bacteria-Based

This approach proposes the use of biological microorganisms, like the bacterium Escherichia coli. Thus the model uses a flagellum for propulsion purposes. Electromagnetic fields normally control the motion of this kind of biological integrated device.

Open technology

A document with a proposal on nanobiotech development using open technology approaches has been addressed to the United Nations General Assembly. According to the document sent to the UN, in the same way that Open Source has in recent years accelerated the development ofcomputer systems, a similar approach should benefit the society at large and accelerate nanorobotics development. The use of nanobiotechnology should be established as a human heritage for the coming generations, and developed as an open technology based on ethical practices forpeaceful purposes. Open technology is stated as a fundamental key for such an aim.

Journal of Field Ropotics

Source: http://www.journalfieldrobotics.org/Home.html

Journal of Field Robotics

Home Editors Info For Authors Special Issues Archive Covers

Aims & Scope

The Journal of Field Robotics seeks to promote scholarly publications dealing with the fundamentals of robotics in unstructured and dynamic environments. Articles describing robotics research with applications to the environment, construction, forestry, agriculture, mining, subsea, intelligent highways, search and rescue, military, and space (orbital and planetary) are encouraged. Papers in sensing, sensors, mechanical design, computing architectures, communication, planning, learning, and control, applied to field applications are encouraged.

The journal focuses on experimental robotics and encourages publication of work that has both theoretical and practical significance. Authors are encouraged to implement their work and demonstrate its utility on significant problems with emphasis on the underlying principles. That is, the journal encourages reporting on what was learned in doing the work, rather than merely on what was done. Also encouraged are comparative or meta-studies and verification of previously published results as well as reports of extended field experiments that seek to validate autonomous systems in representative environments. Systems papers are welcome but they must include analysis and insight into why approaches work and the challenges still to be addressed. Studies of systems that have been fielded over extended durations are encouraged. The journal will publish only articles of high quality rather than achieving a particular number of papers or a ratio of accepted papers to those submitted. JFR will not publish articles in which the experimental validation is restricted to simulation or controlled laboratory experiments.

JFR is published by Wiley Blackwell. Wiley Blackwell provides on-line access to the journal and a web-based system for paper submission/review. The first issue of each year is available for free online access.

The 2012 2-year Impact Factor for JFR is 2.152. The 5-year Impact Factor is 2.747

Subscription Information

March/April 2014

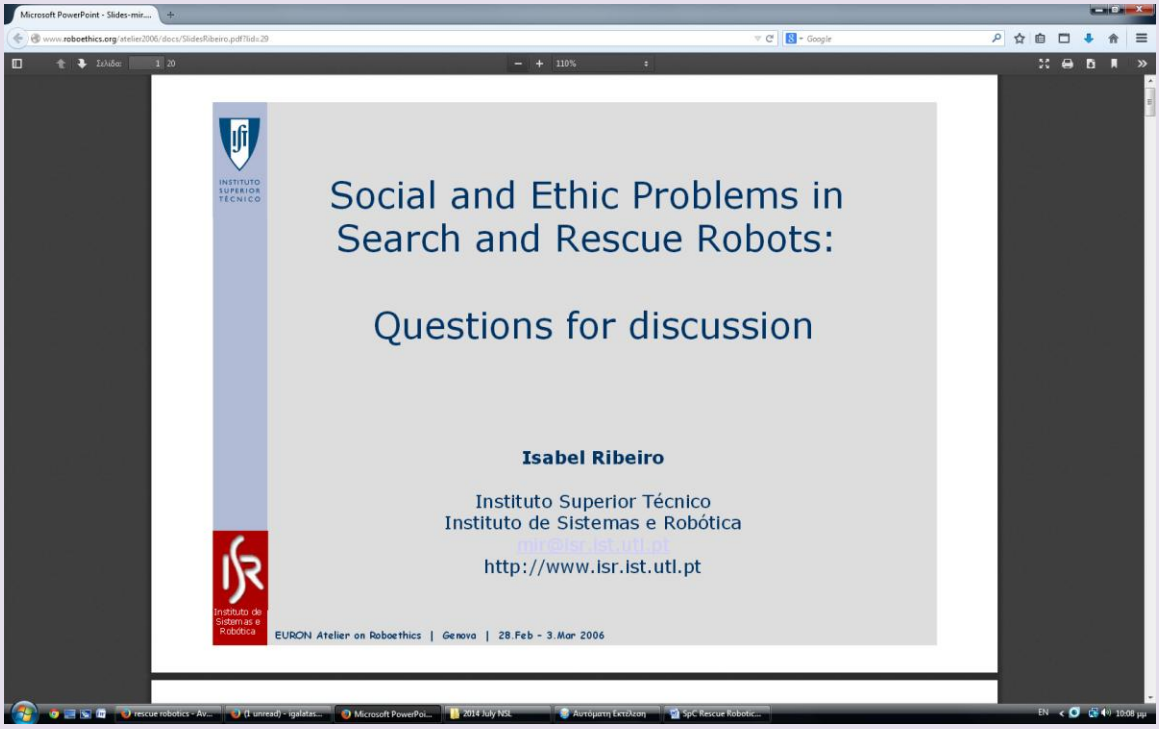
- Experiments on Surface Reconstruction for Partially Submerged Marine Structures
- A Multisensor Integration Approach toward Astronaut Navigation for Landed Lunar Missions
- Using Embodied Data for Localization and Mapping
- Cautious Greedy Strategy for Bearing-only Active Localization: Analysis and Field Experiments
- A Robot Application for Marine Vessel Inspection

Jan/Feb 2014: Space Robotics II

- Reconfigurable Integrated Multirobot Exploration System (RIMRES): Heterogeneous Modular Reconfigurable Robots for Space Exploration
- Towards Coordinated Multirobot Missions for Lunar Sample Collection in an Unknown Environment
- Mapping, Planning, and Sample Detection Strategies for Autonomous Exploration
- SPARTAN: Developing a Vision System for Future Autonomous Space Exploration Robots
- Simulations of Mars Rover Traverses
- Parameter Identification of a Planetary Rover Wheel-Soil Contact Model via a Bayesian Approach
- Service Oriented Robotic Architecture for Space Robotics: Design, Testing, and Lessons Learned
- Robotics and Automation for "Icebreaker"
- Development of a Transformable

Social and Ethic Problems in Search and Rescue Robots

Source: http://www.roboethics.org/atelier2006/docs/SlidesRibeiro.pdf?lid=29



Hazardous devices teams to compete at Robot Rodeo

Source: http://www.homelandsecuritynewswire.com/dr20140627-hazardous-devices-teams-to-compete-at-robot-rodeo

June 27, 2014 – Hazardous devices teams from around the Southwest will wrangle their bomb squad robots at the eighth annual Robot Rodeo beginning Tuesday, 24 June at Los Alamos National Laboratory.

"The Robot Rodeo gives bomb squad teams the opportunity to practice and hone their skills in a lively but low-risk setting," said Chris Ory of LANL's Emergency Response Group and a member of the Lab's hazardous devices team.

The rodeo gets under way at 8 a.m. in Technical Area 49, a remote section of Laboratory property near the entrance to Bandelier National Monument. Eight teams are scheduled to participate in the three-day competition. Teams compete in events and simulations, such as:

- searching vehicles for explosive devices
- recovery of a stolen weapon
- navigating obstacle courses
- investigating a possible homemade explosives lab
- operating in darkened buildings
- using common hand tools to disable a device
- attacking and rendering safe large vehicle bombs
- dealing with suicide bombers

An LANL release reports that teams scheduled to participate in this year's event include New Mexico State Police, Los Alamos and Albuquerque Police departments, Dona Ana County Sheriff's Office, Kirtland Air Force Base Explosives Ordinance Disposal team,

Colorado Regional Bomb Squad, a team from the British army, and a U.S. Army team from Fort

Carson, Colo.

The Laboratory — along with Sandia National Laboratories, the Region II International Association of Bomb Technicians and Investigators, REMOTEC, U.S. Technical Working Group, QinetiQ, WMD Tech, Tactical Electronics, iRobot, ICOR Technology Inc., NABCO, Mistral Security Inc., QSA Global and Stratom — sponsor the Robot Rodeo.

Teleoperated robots for smarter disaster response

Source: http://www.homelandsecuritynewswire.com/dr20140509-teleoperated-robots-for-smarter-disaster-response

University of Washington electrical engineers have developed telerobotics technology which could make disaster response faster and more efficient.

They are working with a team of eight other organizations as part of the SmartAmerica Challenge, an initiative designed by two of this year's Presidential Innovation Fellows to encourage new technologies that help society in our increasingly connected world. "We are working on an application of technology that's clearly for the public good, and that's what motivated our team's idea," said Howard Chizeck, a UW professor of electrical

engineering and team leader from the university.
A UW release reports that UW engineers and partner organizations will test and demonstrate their disaster-response technology for the news media and university community from 1:00 to 4:00 p.m., 13 May in the Electrical Engineering Building atrium (second floor), before presenting their project in Washington, D.C., in June. The team formed about six months ago at an initial brainstorming gathering in D.C.
The group, called the Smart Emergency Response System team, aims to combine existing "smart" technologies better to serve society during disaster and crisis response. This includes using teleoperated robots for rescues and safety operations; a high-tech dispatch system that gathers information from cameras and sensors and pushes it out to first responders; drones for damage surveillance and rescues; and vests outfitted with sensors and GPS tracking to be worn by search-and-rescue dogs.
"The key is we're taking many developed technologies from different organizations and putting them together in a way that's innovative," Chizeck said.
In addition to the UW, the Smart Emergency Response System team members are BluHaptics, Boeing Co., MathWorks, Massachusetts Institute of Technology Media Lab, National Instruments, North Carolina State University, University of North Texas, and Worcester Polytechnic Institute.
At the UW, engineers in Chizeck's lab as well as at spinout company BluHaptics are leading the effort to develop robots that can interact more seamlessly with human operators. The technology lets a robot operator actually feel feedback in the form of pressure on his or her hand controller from a robot on the ground. This force feedback can help the operator avoid objects and realize when the robot's arm has reached its limits. Known as haptic feedback, this technology essentially instructs the human operator through touch sensation as though the person were in the field with the robot.
"The idea is really to combine the skills and situational awareness of a human operator with the precision and repeatability of an autonomous robot. This way we can rely as much on a robot as we can on a human," said Fredrik Ryden, co-founder and vice president for engineering at BluHaptics, and a postdoctoral researcher with the UW Center for Commercialization.
For example, a first responder at a disaster scene could control a robot from a nearby command center to go into the field and turn off a gas valve. The responder could see on a computer screen from the robot's field of vision and steer it toward the valve. When the robot approaches the correct valve, it would send force feedback to help the human operator make a safe and efficient valve turn.
Using a robot from National Instruments, based in Austin, Texas, the UW engineering team mounted a camera and high-end router to allow the human operator to see from the robot's perspective. The idea is for the human to feel immersed in the robot's landscape, seeing depth and real-time movements and receiving force feedback from the robot.
This telerobotics technology, combined with the other smart systems, could help with future disaster responses and even create jobs, particularly for veterans, team leaders said. The robotics technology itself is not complicated to operate and could be used by anyone, not just highly trained technicians.
"We are trying to show that these robotics and communication system can be used by anyone. It's really about making something that's simple to use," Ryden said.

Border's New Sentinels Are Robots, Penetrating Deepest Drug Routes

Source: http://www.nytimes.com/2014/02/23/us/borders-new-sentinels-are-robots-penetrating-deepest-drug-routes.html?_r=2

Tom Pittman has made a career as a Border Patrol agent here guarding this city's underground drainage system, where the tunnels that carry sewage and storm runoff between the United States and Mexico are also busy drug-smuggling routes. Over the years, he has crawled and slithered past putrid puddles, makeshift latrines and discarded needles left behind by drug users, relying on instincts, mostly, to gauge the risks ahead.
It is a dirty and dangerous business, but these days, there is a robot for that.

Supplement: Rescue Robotics

Three robots, out of four in use by the agency along the entire southern border, are newly assigned to the Border Patrol station here. The reason is in the numbers: Most of the tunnels discovered along the border lead from Nogales, Mexico, to Nogales, Ariz., out of sight of the agents, cameras and drones that blanket the ground above. This month, federal agents closed the largest one found so far, a 481-foot passageway aired by fans and lit by lamps hanging from wires that ran along the tunnel's walls.

The robots are just the latest tactic in a vexing battle by the federal authorities to try to stem the flow of drugs through the tunnels, considered prime pieces of real estate by the smuggling groups that build and control them. Border Patrol agents have tried dumping concrete inside the tunnels to render them unusable, and installing cameras and motion detectors to alert them of suspicious movement underground. But still the tunnel diggers persist.

The robots, valued for their speed and maneuverability, can serve as the first eyes on places considered too risky for humans to explore.

"If anyone is going to get hurt, it better be that robot," said Mr. Pittman, a supervisory agent here.

Along the southern border, drug smuggling has remained stubbornly prolific, with seizures happening not just in the tunnels, but also at legal ports of entry and among illegal border crossers carrying bales of marijuana in their backpacks. Some 2.9 million pounds of drugs, mostly marijuana, were seized by Customs and Border Protection agents in the past fiscal year; 1.3 million of those pounds were seized in Arizona, the largest amount among the four states that border Mexico, according to agency statistics. Of the 45 cross-border tunnels found in the Southwest in the past three fiscal years, 25 were in Nogales — not counting the partly finished tunnels the agents found — and three more have been uncovered this year.

The tunnels are part of a sophisticated enterprise. The groups that control the smuggling routes in the Mexican Nogales — the Sinaloa cartel on the east side of the city, the Beltrán-Leyva cartel on the west — have an understanding: One side pays the other to use the areas it holds, both "above ground and underground," said Special Agent Alex Garcia of Homeland Security Investigations, who leads the border tunnel task force here.

A senior American law enforcement official said Saturday that the leader of the Sinaloa cartel, Joaquín Guzmán Loera, the world's most-wanted drug lord, had been captured.

Many of the tunnel diggers are believed to come from the copper mines of Cananea, Mexico, about 45 miles southeast of Nogales. They use tools with short handles because, in the tunnels here, there is no room to stand up straight, Mr. Garcia said.

That does not bother the tunnel-detecting robots. They have cameras that look up, down and sideways, in front of them and behind them. Controlled remotely by joysticks, they glide, bump and scrape along dark, cramped areas, where the air is not safe for humans to breathe for long. One model sounds and looks like the remote-controlled Humvees sold in toy stores. The other, with its bullet-shaped body and shiny blue and silver shell, seems as if it had been pulled right off a sci-fi movie set.

Among the daily duties shared by Mr. Pittman and a small group of agents certified to search confined spaces is to comb through Nogales's drainage lines, which the smugglers often tap into to push their loads north. The agents look for signs of disturbance, like a patch of plastic on a steel pipe or scarring where the metal should be smooth.

To get ready for this work, the human agents "have to put on kneepads, elbow pads — we've got to put on helmets, gloves," said Kevin Hecht, the deputy patrol agent in charge of the Border Patrol station in Nogales and one of the agency's foremost experts on illicit tunnels. "Sometimes we have to put on Tyvek suits," he said, referring to the coveralls that protect against the hazards that can lurk below drainage lines.

The robots, on the other hand, need no preparation other than the flick of a switch.

They scour the tunnels much faster than the agents can, and in the complicated work of securing the border underground, to waste time is to risk losing ground to the smugglers. Eric S. Balliet, assistant special agent in charge of Homeland Security Investigations in Nogales, said the agents in the tunnel task force had closed, on average, one tunnel a month in Nogales since October 2010. (The Border Patrol and its parent agency, Customs and Border Protection, and the Drug Enforcement Administration are also part of the task force.)

"At any given moment, there's a tunnel being planned, under construction or in operation in and around this city," Mr. Balliet said.

The large tunnel found here this month linked an abandoned home in Mexico to an occupied house not far from the border. The drugs were taken from there in hollowed-out

couches or inside washing machines, according to the criminal complaint; three men were arrested on drug-conspiracy charges.

Many of the tunnels that are found end in inconspicuous places like this. One of them, discovered in December, exited into a backyard shed. Another, found last February, ended at an embankment behind the border fence, near a spot where a different tunnel had been closed in March 2012.

Nogales, Ariz., recently banned parking on a section of International Street, which runs parallel to the fence, after a tunnel exit was found there, less than 100 feet from a border crossing. Smugglers inside the tunnel had used a jackhammer to raise a piece of concrete cut from the pavement. Then they pushed bales of marijuana through the fake bottom of a refrigerated truck parked right above the hole.

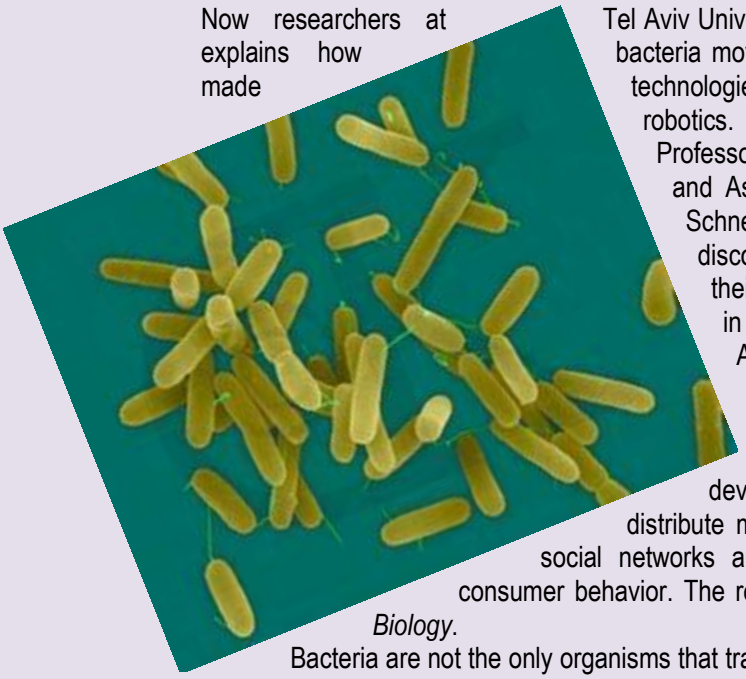
Task force agents sometimes observe a tunnel for months before moving in. A whiteboard in the bunker from which they operate in Rio Rico, a town just north of Nogales, listed the nine open investigations they have had since January 2013. An inquiry might start with a tip from a disaffected tunnel digger or a breach found by one of the robots along the drainage lines in the United States.

"At the end of the day," Mr. Balliet said, "there's an organizational structure behind these tunnels, and that's what we're after. The end game of every tunnel investigation is in Mexico."

The navigational skills of bacteria inspire robotics researchers

Source: http://www.homelandsecuritynewswire.com/dr20111121-the-navigational-skills-of-bacteria-inspire-robotics-researchers

Humans may regret this, but bacteria have superior survival skills. Their decision-making processes and collective behaviors allow them to thrive and even spread efficiently in difficult environments.



Now researchers at Tel Aviv University have developed a computational model that better explains how bacteria move in a swarm, and this model can be applied to man-made technologies, including computers, artificial intelligence, and robotics. Ph.D. student Adi Shklarsh, with her supervisor Professors Eshel Ben-Jacob of TAU's Sackler School of Physics and Astronomy, Gil Ariel from Bar Ilan University, and Elad Schneidman from the Weizmann Institute of Science, have discovered how bacteria collectively gather information about their environment and find an optimal path to growth, even in the most complex terrains.

An American Friends of Tel Aviv University release reports that studying the principles of bacteria navigation will allow researchers to design a new generation of smart robots that can form intelligent swarms, aid in the development of medical micro-robots used to diagnose or distribute medications in the body, or "de-code" systems used in social networks and throughout the Internet to gather information on consumer behavior. The research was recently published in *PLoS Computational Biology*.

Bacteria are not the only organisms that travel in swarms, says Shklarsh. Fish, bees, and birds also exhibit collective navigation. Bacteria, however, as simple organisms with less sophisticated receptors, are not as well-equipped to deal with large amounts of information or "noise" in the complex environments they navigate, such as human tissue. The assumption has been, she says, that bacteria would be at a disadvantage compared to other swarming organisms.

In a surprising discovery, however, the researchers found that computationally, bacteria actually have superior survival tactics, finding "food" and avoiding harm more easily than swarms such as amoeba or fish. Their secret? A generous amount of self-confidence.

Many animal swarms, Shklarsh explains, can be harmed by "erroneous positive feedback," a common side effect of navigating complex terrains. This occurs when a subgroup of the swarm, based on wrong information, leads the entire group in the wrong direction. Bacteria, however, communicate differently, through molecular, chemical, and mechanical means, and can avoid this pitfall.

Based on confidence in their own information and decisions, "bacteria can adjust their interactions with their peers," Prof. Ben-Jacob says. "When an individual bacterium finds a more beneficial path, it pays less attention to the signals from the other cells. But at other times, upon encountering challenging paths, the individual cell will increase its interaction with the other cells and learn from its peers. Since each of the cells adopts the same strategy, the group as a whole is able to find an optimal trajectory in an extremely complex terrain."

The release notes that in the computer model developed by the TAU researchers, bacteria decreased their peers' influence while navigating in a beneficial direction, but listened to each other when they sensed they were failing. This is not only a superior way to operate, but a simple one as well. Such a model shows how a swarm can perform optimally with only simple computational abilities and short term memory, says Shklarsh, It is also a principle that can be used to design new and more efficient technologies.

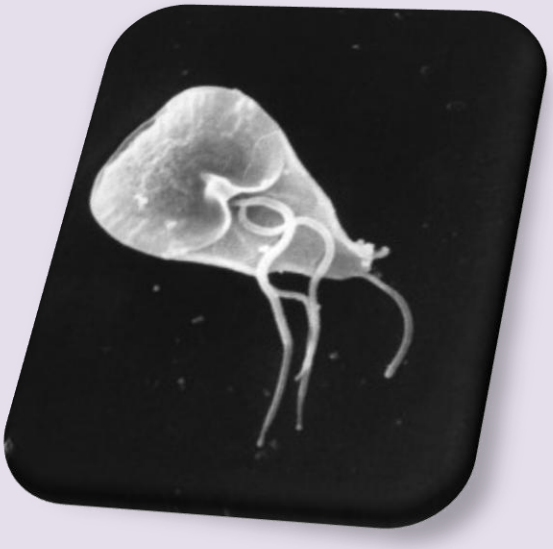
Robots are often required to navigate complex environments, such as terrains in space, deep in the sea, or the online world, and communicate their findings among themselves. Currently, this is based on complex algorithms and data structures that use a great deal of computer resources. Understanding the secrets of bacteria swarms, Shklarsh concludes, can provide important hints toward the design of new generation robots that are programmed to perform adjustable interactions without taking up a great amount of data or memory.

— Read more in Adi Shklarsh, "Smart Swarms of Bacteria-Inspired Agents with Performance Adaptable Interactions," *PLoS Computational Biology* 7, no. 9 (29 September 2011).

Research inspires robotics design for medicine, military

Source: http://www.homelandsecuritynewswire.com/research-inspires-robotics-design-medicine-military

A pathogen that attacks the small intestines of humans and animals is serving as the inspiration for developing robots that can fight disease and aid in military operations.



Mingjun Zhang, associate professor in mechanical, aerospace and biomedical engineering, at the University of Tennessee, Knoxville, and his team have made significant findings about the swimming and attachment of the microorganism *Giardia*. Giardia causes one of the most common gastrointestinal diseases in the world, giardiasis.

For 250 years, scientists have tried to understand how the microorganism is able to attach to a multitude of surfaces and swim in harsh environments — enabling it to infect many kinds of species while most parasites have specific hosts. A University of Tennessee, Knoxville release reports that Zhang and his team have made significant progress to solve the puzzle.

"We found each of the four pairs of flagella conducts different functions," Zhang said of some of the team's findings. "This is amazing considering the length of the flagella is only about eight to twelve micrometers each, with a diameter of a few hundred nanometers."

The team's discovery can aid in fighting the pathogen's attack and others like it. The discovery may help to develop a way to block its attachment in the human intestine as an alternative for treating the disease. The discovery may also lead to bio-inspired swimming micro-robots for nanomedicine, such as site-specific controlled drug delivery

and less invasive surgical procedures. For instance, micro-robots can navigate through the body to break up kidney stones, deliver drugs to specific sites after injection and reduce the invasiveness of surgery.

On a larger scale, knowing Giardia's inner workings may buoy an energy-efficient propulsion system for underwater vehicles or designs for quick turn and agile control of underwater vehicles. The findings of Giardia's unique attachment and landing procedures may also inspire a more accurate and quick surface attachment mechanism.

"Giardia seems to be one of the most sophisticated swimming microorganisms and is very efficient and intelligent in terms of controlling its swimming behavior and energy utilization," Zhang said. "It is a source rife with bio-inspiration and innovation."

Zhang conducted this study with Scott Lenaghan, a post-doctoral research associate; Zhili Zhang, assistant professor in the department of Mechanical, Aerospace and Biomedical Engineering, and Corinne Davis and William Henson, Chancellor's honors students in the department of Mechanical, Aerospace and Biomedical Engineering.

Their findings are published in the current edition of the *Proceedings of the National Academy of Sciences*.

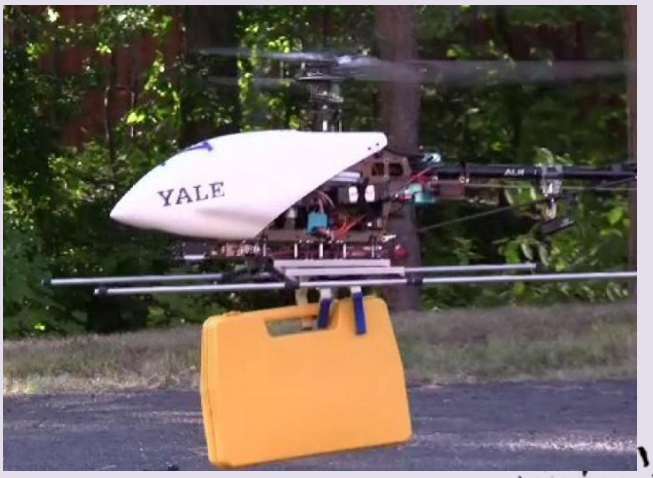
The research is being funded by the Office of Naval Research 2011 Young Investigator Program. UT was one of only two universities to have two professors receive the award this year. The award gives Zhang $170,000 in annual research grants every year for three years.

Flying robotic arm can pick up bombs, packages

Source: http://www.homelandsecuritynewswire.com/flying-robotic-arm-can-pick-bombs-packages

A robotic hand attached to a small helicopter can successfully and autonomously grip objects while the helicopter is hovering, as demonstrated by a group at Yale University led by Aaron Dollar.

Kristina Grifantini writes that the helicopter hand, dubbed the Yale Aerial Manipulator, could be used in spots that are difficult for ground robots to get to, such as high or roughly terrained places. It could also be used to pick up bombs or packages, or even as a form of delivery, moving packages in urban environments where trucks would have a hard time, suggests Paul Pounds, first author of the work.



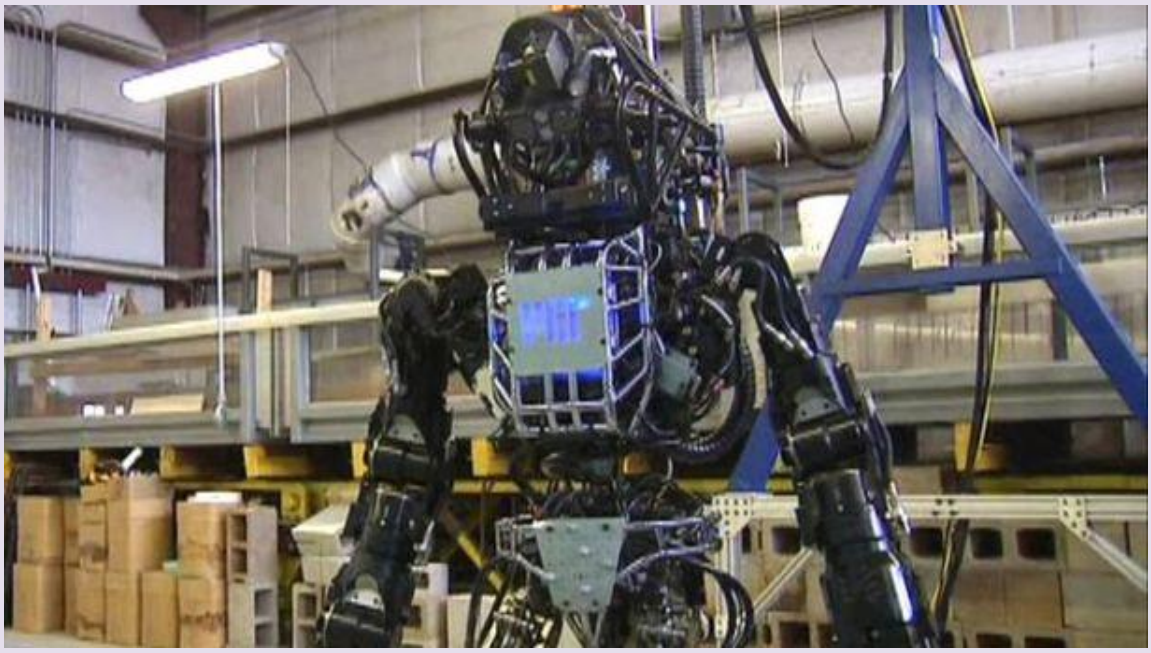
The hand helicopter can carry objects that weigh up to two kilograms, at speeds reaching 130 kilometers an hour. The robotic hand, which is made of a flexible plastic, is operated by a single motor that controls four fingers. The simple, lightweight design of the hand also absorbs vibrations when the hand grips an object, letting the helicopter hover stably.

The researchers will present their results at the ASME Dynamic Systems and Control Conference next month (Cambridge,

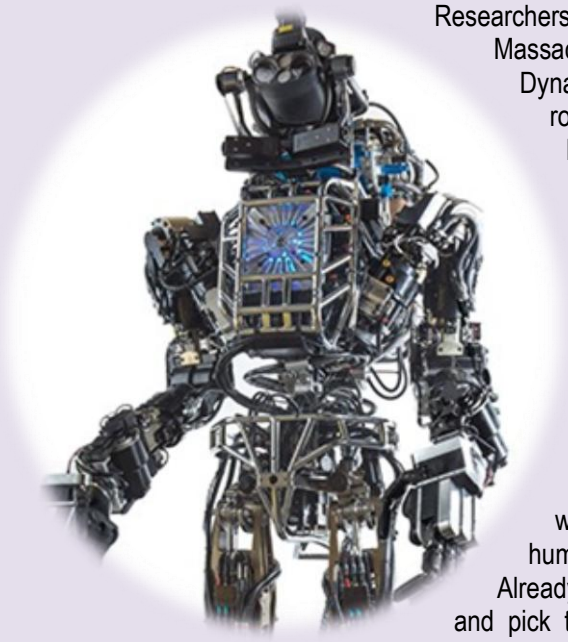
Massachusetts, 13-15 September 2010). They will detail how the helicopter hand was able to pick up a wooden block successfully in twenty grasp attempts, even when the hand was not positioned over the block's center.

Robot rescue: First-responders of the future

Source: http://www.foxnews.com/tech/2014/06/10/robot-rescue-first-responders-future/



From nuclear disasters, to natural catastrophes and blazing hot fires, robots that can stand-in for humans in dangerous places are under development.



Researchers at the Massachusetts Institute of Technology in Cambridge, Massachusetts are working with one called Atlas, created by Boston Dynamics, a Waltham, Massachusetts based technology company. The robot is 6'2" and weighs roughly 350 pounds. There are only seven like it in the world and MIT researchers are working to create the software needed to enable the robot to move.

"Because it's hydraulically actuated, it's very strong," said Pat Marion, a robotics software engineer at MIT. "So it can lift very heavy objects and it can move very quickly with its legs when it's walking."

Their efforts are part of a government-sponsored contest called the DARPA (Defense Advanced Research Projects Agency) Robotics Challenge.

Prof. Seth Teller of MIT's Computer Science and Artificial Intelligence Lab (CSAIL) says the aim is "to develop a robot that can walk into a dangerous place like Fukushima, which is inhospitable to human life, and actually do something useful there."

Already, with minimal guidance, Atlas can walk, balance and pick things up-- tasks that would be critical in debris clearing situations.

Supplement: Rescue Robotics

But what happens when the challenge is burning hot? At Virginia Tech, mechanical engineers are leading a team, including researchers at UCLA and the University of Pennsylvania, to create a firefighting robot for the U.S. Navy, one that will be protected with a resin shield to prevent heat and water damage.
The humanoid creation at Virginia Tech is part of the Shipboard Autonomous Firefighting Robot -- or (SAFFiR) program.
It can balance on unstable surfaces- like a ship at sea- navigate tight quarters and using clues, like smoke, locate a fire.
"We've seen robots go from walking very slowly and not being able to balance well to being able to balance like on a ship and being able to navigate on a ship," said Prof. Brian Lattimer, the director of the Extreme Environments, Robotics & Materials Laboratory (ExtReMe Lab) at Virginia Tech.
The robot will be tested later this year on the Navy's fire test ship, the ex-U.S.S. Shadwell which is moored in Alabama.
The ultimate goal- to keep people out of harm's way.
"We're not only looking to use the technology for ships but for fires in buildings," said Lattimer. "Our big push is to not be sending people into burning buildings and structures but to send robots into these harsh conditions."
Teller believes many of the advancements only researchers are seeing in elite labs will soon be available to people in everyday life.
"The future of machines that are in our homes, in our work spaces, doing at least simple tasks for us is not that far away," said Teller. "It's no more than a couple of decades away. Now I know you've been hearing that for 50 years... this time we think it's really fairly close."

Robots as First Responders

By Tom Mashberg
Source: http://www.technologyreview.com/news/405157/robots-as-first-responders/

William L. "Red" Whittaker is director of the Field Robotics Center and founder of the National Robotics Engineering Center at Carnegie Mellon University in Pittsburgh. His expertise includes developing robots for hazardous duty and for performing 3-D mapping and remote sensing in environments such as coal mines and volcanoes.
Soon after a near-fatal mine disaster at Quecreek, PA, in mid-2002 (in which nine miners using an outdated map mistakenly broke through a rock wall, flooding their tunnel), interest grew in his center's subterranean robotics and its mapping capabilities. A prototype machine they'd built, an autonomous, four-wheeled robot with heavy-duty tires, called Groundhog (photo), was sent into an abandoned coal mine near Pittsburgh in May 2003, and was able to create accurate three-dimensional maps of its surroundings. It proved the ability of a robot to map the rooms, pillars, and corridors left by generations of mining.

In the aftermath of the January 2 disaster at the Sago Mine in West Virginia, which cost the lives of 12 miners, Technology Review asked Whittaker to discuss the possible role of robots in aiding and rescuing miners. Whittaker did not discuss the specifics of the Sago disaster, but instead spoke about the potential of underground rescue robotics.

Technology Review: What could robots do in mine rescue situations?
Red Whittaker: First, it's important to realize that, although the technologies exist, robots are not yet certified or deployed as standard tools in mine rescue today.

Rescue robots in the future will certainly enter mines – under the unknown conditions of dust and gas and inundation and roof fall – and will be crucial for exploring and characterizing conditions and reporting back to command centers. They can carry gas sensors that characterize the atmosphere of a mine. Typically, they would deploy two of those sensors on each machine to make sure there is no mistake in the instruments.
Once robots have the capability to get in and get around, they could also provide communications and visual and map sensing, deliver objects to aid trapped people, like oxygen tanks, and detect vital life signs.

TR: What is the state of the technology?
RW: The state-of-the-art technology for automated navigation in a mine -– a robot sensing and planning and driving and getting from point A to B, knowing where it is, and staying out of trouble, and getting back to an egress point – is pretty well understood. Further, robots can carry sensors that would alert people to the presence of methane gas or poisonous air. Also, in most mine accident response scenarios, there is a prior map – that is tremendous information for a robot and a rescue crew.

TR: So robot locomotion in a mine is practicable?
RW: In a mine there are corridors and intersections and walls and floors and a roof – for a robot's navigation and reasoning that's a lot of information. But it's still a lot different than sending a robot into rush-hour traffic, for instance, to head two miles across town. A mine is a relatively simple world for a robot because it is uncluttered by many unanticipated items. In an office building there is far more complexity and clutter – desks, water coolers, signs, and people. So a mine is an amenable environment for a robotic device designed for simple navigation.
There is no fundamental barrier to good locomotion or moving through mine conditions or getting command and control via that robot or appending sense detectors or illumination devices or scanners. So useful rescue response robots could be specialized and deployed in the near term – there's no leap of physics or big missing piece of technology for machines that could move quickly and effectively in mines.

TR: What will it take to deploy rescue robots?
RW: All the things that help any technology develop: market forces, political pressure, humanitarian impulses, and teams committed to the challenge. Five years ago the technologies would not have been competent for or capable of mine mapping; but after Quecreek there was a motivation for progress. The great strides in mine mapping since then are powered by resources that were a response to what was viewed as a shortfall – a need. It didn't just come to pass that old pencil-drawn maps of mines were digitized, it became a necessity. There was a political, business, and humanitarian impulse at work that led to the creation and deployment of robotics to map mines, to promote the safety and health of the people in the mines.
After Sago, the charter might be for capabilities to enter mines robotically in accident conditions and traverse and obtain information and get to trapped miners and deliver what's needed to them.

TR: Do you think that will happen?
RW: Twenty years ago this would all have been science fiction; but now it is a matter of integrating all the existing systems. Robots are now a tool of the trade for bomb squads. Ten years ago we wouldn't have been talking about that as a reality. So the issue is no longer whether the technology will work, but of culture, policy, economics, and initiative. Every technology has to earn its keep – it's not an entitlement. I believe that mine rescue response is one application where robots would inevitably make good sense.

TR: You grew up in coal country. What was your reaction when you learned of the Sago disaster?
RW: Any time I hear about a mine accident my first reaction is human and my thoughts are related to hope for the wellbeing of the people. My work is heavily motivated by my own background as a Pennsylvania native who grew up near the Quecreek mine. But mining accidents and incidents are not unique to any corner of the world – entrapments and natural disasters are world issues, not backyard issues.

The Newsletter of the First Responder Technologies Program

Source: http://www.firstresponder.gov/Newsletters/September%202008.pdf

First Responders Slow to Take Up Robot Technology

Source:http://www.nationaldefensemagazine.org/archive/2008/June/Pages/FirstResp2239.aspx

Bomb squads in the United States are taking notice of what's happening in the streets of Iraq.
Robots are keeping explosive ordnance disposal personnel out of harm's way.
Robot manufacturers are finding more customers among first responders charged with investigating unattended bags in train stations, orphaned military explosives and rudimentary pipe bombs.
But other parts of the emergency services community have been slow to take up the technology.
Hazardous material response and special weapons and tactics teams can use robots, but members of these sectors either don't know about the machines' benefits, or don't have the funds to buy them, experts have said.
Those first responders who have used robots swear by them.
"If you can save one life with the robot, it's worth the money you pay for it," Sgt. Tom Calabro, a member of the Houston SWAT team, said at the Robo Business conference.
His unit has used a robot for one year and he already has numerous anecdotes proving their worth.
They are mostly used in situations where criminals, or suicidal people, have barricaded themselves in buildings.
In these situations, gathering intelligence is key. Most often, these barricaded individuals are armed, and they sometimes have hostages. Booby-traps are also possibilities, he said. Previously officers had to do the reconnaissance themselves. Now robots are taking their place, and allowing the SWAT team to stay at safe distances.
His team recently sent a robot into a house where a chemist operating a methamphetamine lab had barricaded himself in a room. The robot was able to map out every room in the house except the one where the suspect was holed up.

"You can't plan without intelligence," Calabro said. "If we have to send in a team, we want to know what the layout of the house is."

In another case, an armed and wounded burglar had escaped into his house and was keeping three of his children hostage. He swore he would come out shooting.

After negotiating the release of the children, the team sent in the robot. The suspect was so terrified of the machine, he immediately surrendered.

For Lt. James Melton, a haz-mat specialist with the Santa Ana, Calif., fire department, robots not only provide valuable reconnaissance, they buy time.

The fastest haz-mat teams take 20 minutes to put on their protective gear after arriving on a scene. But 40 minutes is more typical.

If there are victims inside a building, "the robots will be their salvation," Melton said. Operators can send them into a toxic building within five minutes.

The fire department's robot has a suite of sensors to determine what chemicals might be present. It can also carry a trailer with about 20 doses of nerve-agent antidotes. The robot can unhook the trailer, then use its gripper, or claw, to administer the shots.

The claw can be used to turn off valves that might be expelling gas or move chemicals in containers that might react with one another. It can also stick plugs on leaking tanks or other containers.

Yet there are many police and fire departments that cannot afford robots, Melton said.

"The city next door doesn't have a robot. And they're not getting a robot, either. The price is too prohibitive," he added.

Helen Greiner, chairman of iRobot and manufacturer of the PackBot, said her company has sold less than 10 units to first responders.

Marty Foley, an executive with Foster-Miller, manufacturer of the Talon robot, said he has about 40 customers, which is small compared to the thousands of police and fire departments across the United States.

"You have to get people to understand what the applications are," he said. "Twenty-five years ago, bomb squads wanted to continue wearing suits." Now they are embracing the technology, he added.

Selling robots to these diverse communities is more challenging than selling to the military, Greiner said.

The Navy, for example, buys hundreds of EOD robots and distributes them to the other services. For the police and fire response markets, company representatives must go from department to department to make their pitches.

Large cities such as Los Angeles or New York might want a few robots, but these smaller jurisdictions will probably only buy one, she said.

And then there is the cost.

Foley said Department of Homeland Security grants are a major source of funding for some cities.

Cpl. Matt Strange, a member of the Pennsylvania State Police bomb squad, said if it weren't for DHS funds "we would probably have lesser quality robots or maybe none at all."

Federal requirements, along with the acceptance of the technology in the bomb disposal community, are pushing the EOD market forward. To be an FBI certified bomb disposal squad, such units are now required to have at least one robot, Strange said.

His unit has two robots: one large 600-pound machine that can carry x-ray equipment to peer into suspicious packages and a smaller Talon that can maneuver more easily inside buildings.

While the problem of improvised explosive devices is well known in Iraq and Afghanistan, domestic bomb squads are busy as well.

Pennsylvania state patrol bomb squads respond to about 200 calls per year. These are cases where explosives are involved, and not bomb

scare hoaxes, he said. Pipe bombs are relatively common. There are also cases of orphaned military ordnance and dynamite.

"We use them almost every chance we get … We do what we can with the robot before putting on a 'dome of ignorance,'" he said. That is the nickname for the 80-plus pounds of protective bomb suit gear that is not only hot, but restricts movement and dulls the senses.

The bomb squad has loaned its Talon to a special emergency response team — the state patrol's version of SWAT — to use in a barricade situation.

"I think on the SERT side they are coming around to see how useful robotics can be," Strange said.

Melton, and others, said robot prices can be brought down if they weren't constructed to meet military specifications. But the U.S. military, as the largest customer for ground robots, is driving the development of the robots that first responders are using.

Greiner said first responders are a secondary market for the PackBots.

"But as that market expands, they have their own user requirements. We are starting to look into bringing out a homeland security version," she said. The domestic versions don't have to be as rugged.

iRobot has partnered with Taser International to mount a nonlethal weapon onto a **PackBot** (photos).

Calabro said mounting weapons on a robot has been discussed within the SWAT community, but he said the target tracking would have to be improved.

The first responders echoed what military EOD specialists have been saying about making the robots more effective. They all want more human-like grippers. They would like to see a three-dimensional view of what they are looking at through the view screen and have better communication links when the robot enters a building.

Melton said it is wrong to assume that first responders are not as tough on their robots as soldiers.

"We break things. We're rough. We flip them over trying to do things they probably weren't designed to do," he said. "We will push the tool until we break the tool as long as we can justify that we saved a person's life, their property or the environment."

He would like to see less expensive plastic replacement parts that are easy to swap out when the machine inevitably breaks.

Beyond the cost factor, there is also acceptance in a first responder community that Allen Jones, vice president of Advanced Manufacturing Technology Ventures LLC, said is "notoriously averse to change."

AMTV runs a Defense Department sponsored technology transfer program, FirstLink, which puts military hardware into the hands of first responders. Among the program's efforts is the Navy robotics loan program. The Space and Naval Warfare Systems Center in San Diego gives robots to state and local first responders to use for up to six months.

"They get to play with them first and figure out what they want to buy," Jones said. Some manufacturers have donated robots to put in the program's pool, and Jones encouraged other companies to follow suit.

The first responders are required to provide feedback and data to the companies on how the machines performed. But the bigger tradeoff might be expanding the market.

"Let them fall in love with the technology," he said.

Meanwhile, the robotics industry as a whole is looking to expand beyond the niche military and homeland security markets.

iRobot is among those that sell the technology to the consumer market. It makes robots that vacuum floors and clean gutters.

Companies are finding that they can sell more robots if they market them in sectors other than defense and homeland security. Examples include submersible robots, which are touted as a way to improve port security. VideoRay LLC and Ocean Server Technology Inc. are two companies that are attempting to sell their undersea robots as a means to patrol harbors and check under hulls for explosives or contraband being smuggled into ports.

But company spokesmen at the conference said there are numerous other applications including oil exploration, scientific research and checking water quality.

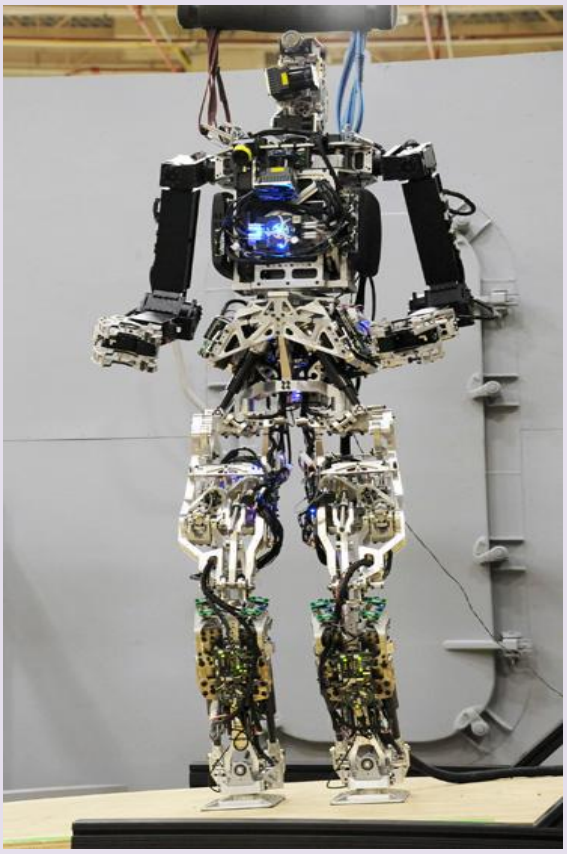
Tony Diodato, chief technology officer at CSSRobotics, said he has been trying to sell security robots designed to patrol perimeters or keep watch inside buildings, but has had few customers.

Then the healthcare industry came calling. Hospitals have an acute need to efficiently deliver lab samples or food. It is costly and time consuming for a lab technician to take a single vial of blood to the other side of a hospital complex, he said. The company reprogrammed its security robots to autonomously deliver food and lab samples in medical complexes. Diodato already has one major hospital in Delaware as a customer, and he has several other requests for his services in the pipeline.

“Lab managers have said ‘if you build it, we will come.’ We’re getting further and further entrenched in the medical field,” Diodato said.

NRL demonstrates Shipboard Autonomous Firefighting Robot

Source: http://www.usfra.org/forum2/topics/shipboard-autonomous-firefighting-robot?xg_source=activity#.U65gsUBpfgI

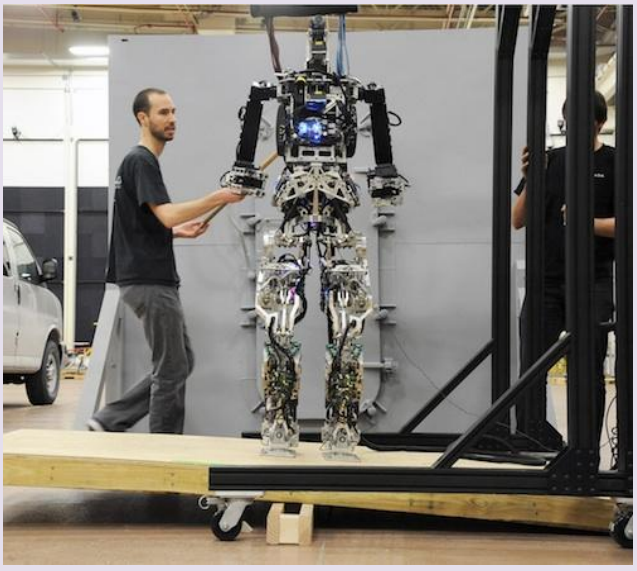


The U.S. Naval Research Laboratory (NRL) Laboratory for Autonomous Systems Research (LASR), partner in the Navy's Damage Control for the 21st Century project (DC-21), recently hosted robotics research teams from the Virginia Polytechnic Institute and State University (Virginia Tech) and the University of Pennsylvania (Penn) to demonstrate the most current developments of advanced autonomous systems to assist in discovery, control, and damage control of incipient fires.

The **Shipboard Autonomous Firefighting Robot** (**SAFFiR**) autonomous robot is capable of finding and suppressing shipboard fires and working seamlessly with human firefighters.

Fighting fires, inherent by its extreme unpredictability, high temperatures, and rapid decline of environmental and structural integrities, can at times prove challenging to even the most seasoned firefighting veteran. Add to this scenario a cloistered platform, say many levels down inside a seagoing ship, and the challenge is exponentially increased resulting in extreme risks to human life. Yet, given these risks, a shipboard fire

must be contained and extinguished for the safety of the crew and continued mission readiness of the ship.
To mitigate these risks, NRL researchers at LASR and NRL's Navy Center for Applied Research in Artificial Intelligence (NCARAI), under direction and funding from the Office of Naval Research (ONR), are working with university researchers to develop advanced firefighting technologies for shipboard fires using humanoid robots, an effort led by the NRL Chemistry Division.
"As part of the Navy's 'leap ahead' initiative this research focuses on the integration of spatial orientation and the shipboard mobility capabilities of future shipboard robots," said Dr. Thomas McKenna, managing program officer, ONR Computational Neuroscience and Biorobotics programs. "The goal of this research is to develop the mutual interaction between a humanoid robotic firefighter and the rest of the firefighting team."
This highly specialized research, to promote advanced firefighting techniques, includes development of the novel robotic platform and fire-hardened materials (Virginia Tech), algorithms for perception and navigation autonomy (Penn), human-robot interaction technology, and computational cognitive models that will allow the robotic firefighter to work shoulder-to-shoulder and interact naturally with naval firefighters (NCARAI).
"These advancements complement highly specialized NRL research that focuses specifically on the human-robot interaction technology and shipboard-based spatial interrogation technology," said Alan C. Schultz, director of LASR and the Navy Center for Applied Research in Artificial Intelligence. "Developments made from this research will allow a Navy firefighter to interact peer-to-peer, shoulder-to-shoulder with a humanoid robotic firefighter."
The NRL LASR, where the artificial intelligence portion of the research is performed, hosted the consortium of university researchers to demonstrate their most current developments. The LASR facility allows the researchers from Virginia Tech and Penn to demonstrate, in a controlled environment, progress in the critical steps necessary for shipboard fire suppression using variants of their SAFFiR. In 2013, human-robot interaction technology and cognitive models, developed by NRL, were also demonstrated at the laboratory.
"The LASR facility, with its unique simulated multi-environments and state-of-the-art labs allows us to 'test out' our ideas before we go to the field." Schultz said. "In essence, our facility gives us a cost saving method for testing concepts and ideas before we go to the expense of field trials."



While at LASR, the students demonstrated the complex motion, agility, and walking algorithms of the robots over natural and manmade terrain and simulated shipboard sea state (pitch and roll) conditions. Also demonstrated were 'seek-and-find' algorithms for locating a fire emergency, in this case an open flame, and the use of 'artificial muscle' for the lifting and activation of fire suppression equipment, such as opening a water valve, lifting and walking with a fire hose, and activating a nozzle.
"SAFFiR is being designed to move autonomously throughout a ship to learn ship layout, interact with people, patrol for structural anomalies, and handle many of the dangerous firefighting tasks that are normally performed by humans," McKenna said. The robot is designed with enhanced multi-modal sensor technology for advanced navigation and a sensor suite that includes a camera, gas sensor, and stereo infrared (IR) and ultraviolet (UV) cameras to enable it to see through smoke and detect sources of excess heat. SAFFiR is also capable of walking in all directions, balancing in sea state conditions, and traversing obstacles such as 'knee-knocker' bulkhead openings.

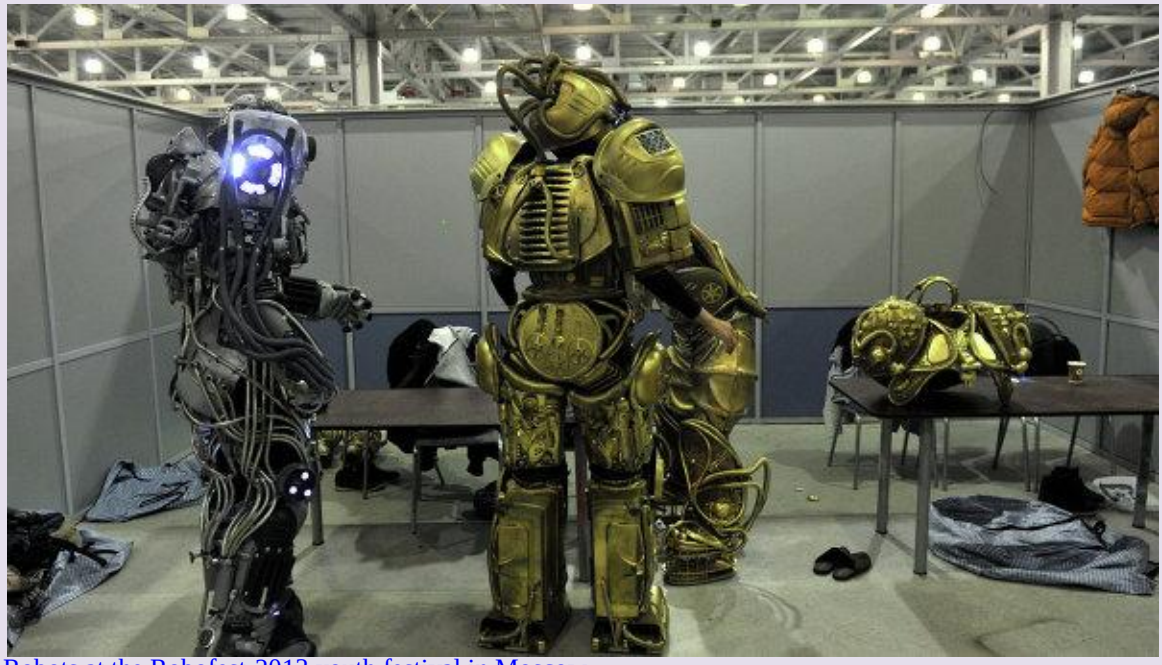
"Today's display demonstrates the integration of perception through multiple sensors, and of locomotion through biped walking," said Dr. Daniel Lee, director, General Robotics Automation, Sensing, Perception Lab and professor at the University of Pennsylvania. Tasks as humans we take for granted, such as standing and remaining upright, become increasingly complex with the addition of full body mobility required for walking and lifting. Dr. Brian Lattimer, associate professor at Virginia Tech's Department of Mechanical Engineering, additionally commented that what we are now seeing is the result of a multidisciplinary project combined to perform all the critical tasks necessary for fire suppression by a humanoid robot.

"In dark or smoke occluded and noisy environments found in shipboard firefighting conditions, tactile feedback—touch—is an important form of communication between human firefighters," said John Farley, project officer ex-USS Shadwell, NRL Chemistry Division. "Moving forward, the team will integrate NRL's human-robot interaction technology with the SAFFiR platform so that there is a greater focus on natural interaction with naval firefighters."

In the short term, however, to protect robotic mechanisms and electronics from intense heat, researchers at NRL's Advanced Materials Section have developed a class of light-weight, high temperature polyetheretherketone (PEEK)-like phthalonitrile-resin that can be molded to any shape and remain strong at temperatures up to 500 degrees Celsius. Later this year, the robotic teams are expecting to conduct shipboard trials onboard the Navy's only full-scale fire test ship, the ex-USS Shadwell, moored in Mobile, Ala.

Russia Is Building Robots To 'Neutralize' Terrorists

Source: http://www.popsci.com/technology/article/2013-05/russia-building-robots-will-neutralize-terrorists?dom=PSC&loc=recent&lnk=2&con=russia-is-building-robots-to-neutralize-terrorists



Robots at the Robofest-2013 youth festival in Moscow

It's hard to tell sometimes what's real and what's bluster in the world of arms development, but it's notable nonetheless that Russian Deputy Prime Minister Dmitry Rogozin has publicly revealed that Russian experts are developing robots designed specifically to minimize casualties in terrorist attacks. Oh, and also to neutralize those terrorists. What could possibly go horribly, horribly, terribly wrong?

The Russian defense industry (which Rogozin oversees) has not yet revealed exactly what these robots will be capable of or when they will be deployed, only that it is building them and that they would be able to evacuate injured soldiers and police or civilians from the scenes or terrorist attacks. They will also be able to engage terrorists at a distance without harming any hostages they might have.
Again, they haven't said exactly how they are going to engage terrorists at a distance without harming hostages, but what's most important here is that they're going to. The robots are being developed alongside other anti-terror technologies, including those that can see terrorists through obstacles.
Ostensibly these robots will also be able to disperse crowds of terrorists, round up terrorists for imprisonment or questioning, or even "neutralize" terrorists that haven't yet done anything wrong but that the Russian state finds to be potential threats. Fortunately these robots will only be used against terrorists, because if you replace "terrorist" with just about any other group of people this paragraph becomes fairly unsettling.

Human Rights Watch has criticized fully autonomous weapons, known as "killer robots," which would be able to select and engage targets without human intervention and called for the preemptive prohibition on such weapons.
“Fully autonomous weapons do not exist yet, but they are being developed by several countries and precursors to fully autonomous weapons have already been deployed by high-tech militaries,” HRW said in a statement on its website. “Some experts predict that fully autonomous weapons could be operational in 20 to 30 years.”
“These weapons would be incapable of meeting international humanitarian law standards, including the rules of distinction, proportionality, and military necessity. The weapons would not be constrained by the capacity for compassion, which can provide a key check on the killing of civilians,” the human rights watchdog said. “Fully autonomous weapons also raise serious questions of accountability because it is unclear who should be held responsible for any unlawful actions they commit.”

Robo-Surgeons Get a New Set of Eyes

Source: http://www.popsci.com/scitech/article/2008-05/robo-surgeons-get-new-set-eyes?dom=PSC&loc=recent &lnk=3&con=robosurgeons-get-a-new-set-of-eyes

Robo-Surgeon, Duke University

Duke University engineers think they've made an important step towards developing robotic surgeons that operate independently. The robot they used in their experiments—which were just feasibility studies, and were not performed on real people—uses 3-D ultrasound as its eyes, and an AI program that processes the 3-D information it gathers to determine the robot's next steps.
The robot has successfully performed several simulated procedures—directing catheters inside synthetic blood vessels, carrying out needle biopsies and even removing a fake cyst. A tiny 3-D ultrasound transducer gathers the images, effectively providing the robot's arm with a map of where it needs to go.
And while the long-term goal is to have some future version of their robot perform more complex tasks in animal models, the engineers also say that the 3-D ultrasound

tech they use could prove to be a valuable tool to today's surgeons.

Student robot will explore chemical dumps hidden in the Baltic waters

Source: http://www.naukawpolsce.pap.pl/en/news/news,396908,student-robot-will-explore-chemical-dumps-hidden-in-the-baltic-waters.html

Warsaw University of Technology students are building a robot that will investigate the chemical weapons dumps in the Baltic Sea. It will allow researchers to assess how corroded are the containers containing chemicals and the risks they pose for the environment.

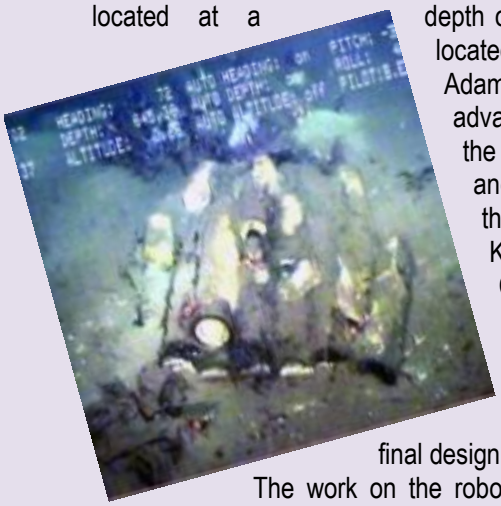
After World War II, together with bombs and ammunition 50 thousand tons of chemicals were dumped into the Baltic. Containers containing chemicals corrode in seawater, and the knowledge of scientists about their condition is limited. Classification and monitoring of chemical weapons dump sites has become the task of an international team of scientists in the project "CHEMSEA". Scientists, whose work is coordinated by the Institute of Oceanology PAS, will get help for Warsaw University of Technology students.

Members of Students Space Association at Warsaw University of Technology are working on a remote-controlled underwater robot. "Its task will be to explore chemical dump sites. Our robot will perform measurements allowing to assess the potential risk to the environment from such dumps" - told PAP student team member Adam Karcz.

"Visual assessment will be its primary task. Our robot, swimming at the bottom, will be able to assess how damaged, corroded the weapon containers are, and whether there is a risk of potential leakage of these hazardous materials. In addition, the robot will carry out water temperature and pH measurements, collect water samples from the vicinity of the containers, which will then be tested in the lab" - Karcz told PAP.

Among the chemical dumps are those whose location and size is well known, but also those that still have to be explored. They are in different places, including the so-called

Gdańsk Deep, on the edge of the Bay of Puck, near Bornholm and in Gotland Deep. Shallowest dumps are located at a depth of 100-150 meters, but the students want their robot to reach those located much deeper.



Adam Karcz explained that the experts from the Institute can use the advanced water robots, but these are usually disturb the seabed, stirring the silt at the bottom of the Baltic Sea. "It distorts the image, readings and hinders the study sites. We want to prepare our design to minimize the interference with the seabed and not cause disturbance" - said Karcz.

Currently, the students are building the first, test version of the robot. "For now, we want to check its performance in underwater conditions and see how it operates at the bottom of the Baltic Sea" - said Adam Karcz. The first tests will be held in September. After their completion, in October and November the students will work on the final design.

The work on the robot involves several members of the Students Space Association at Warsaw University of Technology. Students have obtain funds for the robot construction from sponsors and the university. "You might wonder what a space association has to do with the study of the seabed. First of all, the oceans are as unexplored as space. This is due to the harsh conditions at great depths. Deep Robotics is an area of enormous potential, which leads to its continuing development" - Karcz told PAP.

The "CHEMSEA" participants include: Sweden, Lithuania, Finland and Germany. The cost of the project is 4.5 million euros.

Mexico Uses Robot To Safely Remove 'Dirty Bomb' Material From Cornfield

Source: http://latino.foxnews.com/latino/news/2013/12/11/mexico-uses-robot-to-safely-remove-radioactive-cobalt-60-from-cornfield-nuclear/

A robotic arm recovers radioactive cobalt-60 and deposits it in a safe container on a field in the town of Hueypoxtla, central Mexico, Tuesday Dec. 10, 2013. (AP)

Mexico's nuclear safety director says workers have succeeded in safely removing a shipment of radioactive **cobalt-60** that had sat in a cornfield for almost a week after being abandoned by thieves.

Juan Eibenschutz says a robot completed scooping up the dangerous material Tuesday evening. He says the cobalt-60 was put in a safe container and is now being transported to a nuclear waste treatment facility.
The cobalt-60 was being carried in a truck that was stolen in central Mexico on Dec. 2.
Authorities found the truck two days later with the shipping container empty. The radioactive material was then tracked down to the field near the truck.
Five people are being held as suspects in the case.
Of the detained men, ages 16 to 38, only the 16-year-old showed signs of radiation exposure and he was in good health, a spokeswoman for Hidalgo's Health Department said on condition of anonymity because she isn't allowed to discuss the case.
After being cleared by health authorities on Friday, the men were turned over to federal authorities in connection with the case of the cargo truck stolen Monday at gunpoint outside Mexico City. The cobalt-60 it was carrying was from obsolete radiation therapy equipment.
Hidalgo state Health Minister Pedro Luís Noble said earlier Friday the men suffered from skin irritations and dizziness, but that none were in serious condition. Only one was vomiting, a sign of radiation poisoning.
The theft triggered alerts in six Mexican states and Mexico City, as well as international notifications to the U.S. and the International Atomic Energy Agency in Vienna. It raised concerns that the material could have been stolen to make a dirty bomb, a conventional explosive that disseminates radioactive material.
The atomic energy agency said the cobalt has an activity of 3,000 curies, or Category 1, meaning "it would probably be fatal to be close to this amount of unshielded radioactive material for a period in the range of a few minutes to an hour."
The cobalt-60 was from a hospital in the northern city of Tijuana and was being transported to nuclear waste facility in the state of Mexico, which borders Mexico City.
Authorities maintained a 500-meter (yard) cordon around the site where the cobalt-60 still remains in the state of Mexico and continued to work Friday to extract it safely, said Juan Eibenschutz, director general of Mexico's National Commission of Nuclear Safety and Safeguards.
"It's quite an operation and it is in the process of being planned," he said. "It's highly radioactive, so you cannot just go over and pick it up. It's going to take a while to pick it up."

Flying UAV Laboratory (COTS system)

Source: http://www.resrchintl.com/Flying_UAV_Lab.html

Research International has developed a pioneering UAV-based product called the "Flying Laboratory" that has full CBRN monitoring capabilities. A second-generation ion mobility spectrometer (IMS) is mounted onboard to provide toxic gas detection. Up to 20 chemical warfare agents and toxic industrial gases can be detected at part per billion to part per million concentrations. A UV particle fluorometer is used to detect any unusually high biological aerosol levels, and a gamma spectrometer is used in combination with two Geiger counters to detect and identify nuclear materials and monitor radiation levels. One of the Geiger tubes is used for monitoring general background radiation levels, while the second, capable of detecting either alpha, beta or gamma radiation, is mounted so that it monitors radiation emitted from particulates captured by an aerosol sampling filter included in the payload.

Flying UAV Laboratory Components

Figure 1: Biodetector hardware based on ultraviolet-stimulated biofluorescence.

Figure 2: 300 liter/minute aerosol sample collector components.

Figure 3: Radiation detector subsystem shown in a previous application, mounted in a cylindrical enclosure to the underside of a miniature UAV helicopter.

Figure 4: Vibration stabilized camera mount and IR camera.

Figure 5: Second-generation IMS gas detector module.

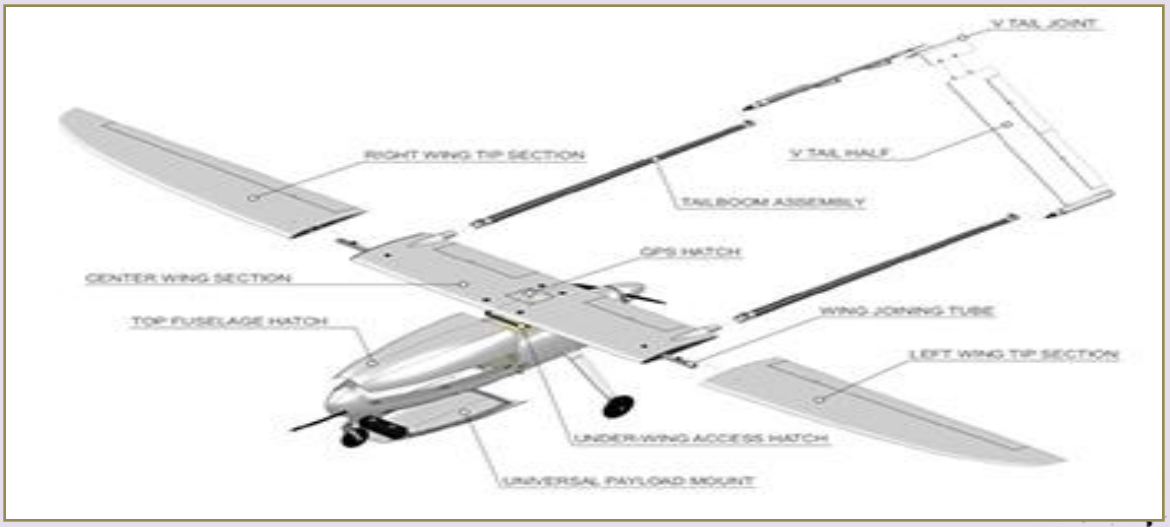


Figure 6: UAV airframe views.

UAV-Based Aerosol Collectors and Detectors

Source: http://www.resrchintl.com/UAV_Index.html

Research International, Inc. is partnering with the Russian company ENICS to offer the world community unmanned aerial vehicles (UAVs) with integrated CBRN capability. These systems offer the user new levels of capability and flexibility. Most CBRN detection devices are point sensors — that is, they provide target detection and identification at one location. This can be mitigated to an extent by mounting the sensor to a person or vehicle, but in either case travel is limited to the area accessible by foot, vehicle, or boat. Typically the only solution for wide area monitoring is to deploy a sensor array, locating them at what are hoped to be optimal points as determined by average seasonal or yearly weather conditions and local topography.

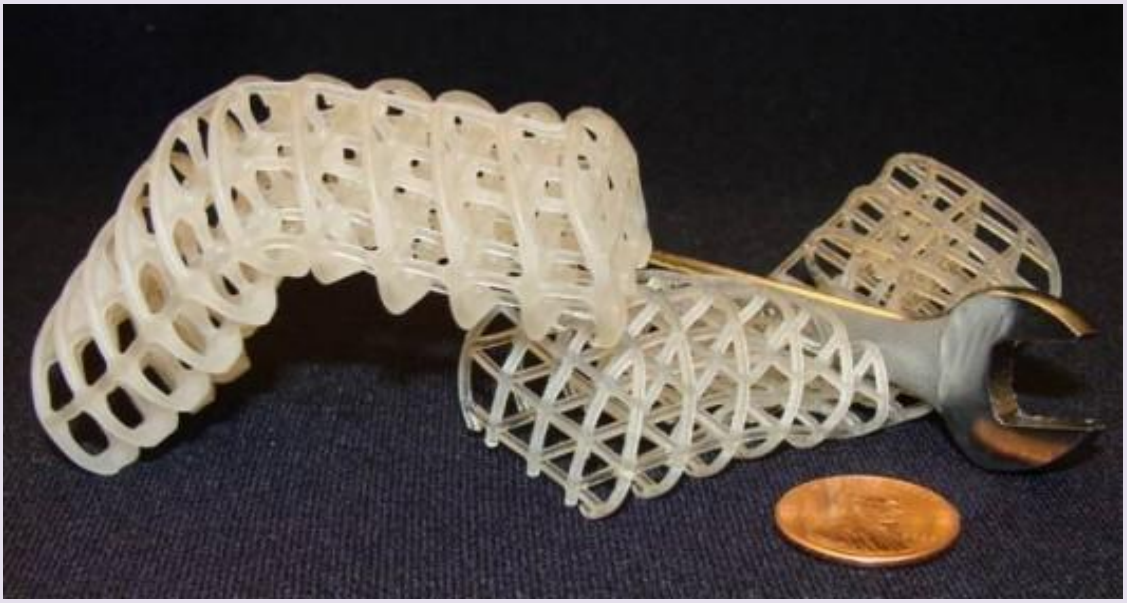
In contrast, sensors on a UAV platform can perform monitoring and surveillance tasks virtually independent of ground conditions; search patterns can be varied in response to immediate weather conditions; and sensors can be deployed to other venues with little advance notice. One sensor-equipped UAV can perform the same level of surveillance as 12 to 24 fixed location sensors and with greatly increased flexibility. Possible application areas include:

- Agriculture
- Public health
- Oil industry
- Environmental protection
- Homeland security
- First responders
- Police
- Military
- Public event security

Users typically require a customized solution that reflects their needs and local government regulations that impact on the use of UAVs. To determine basic feasibility, potential users are urged to first examine the information provided here on detectors and UAV platforms in terms of volume and weight compatibility, flight duration, and surveillance distance.

Phase-change material could let robots be soft or hard-bodied as needed

Source: http://www.gizmag.com/phase-change-soft-hard-robots/32964/



The robotics material in its hard (left) and soft states

If you've ever watched an octopus, you may have noticed how they can deliver powerful grasping force when necessary, yet can also squeeze through tiny openings by essentially making themselves "liquid." Now imagine if there were robots that could do the same thing. They could conceivably squirm through debris to reach buried survivors at disaster sites, or even travel through patients' bodies to perform medical procedures. An international team of scientists is working on making such technology a reality, using a combination of polyurethane foam and wax.

Although robots that were in a permanently soft state might have no problem wriggling into tight spaces, they wouldn't be able to deliver much force when performing tasks that involved any kind of manual dexterity. As MIT's Prof. Anette Hosoi explains, it would be like trying to manipulate an object using a bowl of Jell-O. That's why her and colleagues from MIT, Germany's Max Planck Institute for Dynamics and Self-Organization, and Stony Brook University in New York are developing materials that would allow robots to alternate between soft and hard states.

To that end, she's already created a material that consists of a three-dimensional scaffold of polyurethane foam coated in wax. The wax remains hard when at room temperature, allowing the material to support weight and deliver torque. When the wax is heated, however, it becomes soft and pliable, letting the material be squashed down, stretched and otherwise reshaped. As an added bonus, any cracks or chips that appear in the wax while it's cool are melted away when it's heated, bringing it back to its original undamaged state once it cools again.

In order to allow a robot to facilitate the temperature changes, the researchers believe that flexible wires could be run along each of the foam struts. The robot would deliver an electrical current to those wires as needed, causing them to heat the surrounding wax or leaving it to cool.

Besides allowing the robot's whole body to become soft, it would also be possible to heat only selected parts of it. This could allow an otherwise-rigid robot to bend at given "joints" where the wax is warm. It could even be temporarily locked in that position, if the current in that area was subsequently shut off.

Given that wax might not be durable enough for use in practical applications, however, Hosoi is looking into using solder instead. She's also investigating magnetorheological and electrorheological fluids, which consist of particles suspended within a liquid, and that can be made soft or rigid via the application of a magnetic or electric field.

Robots Built for Battle Are Patrolling the World Cup

Source: http://www.popularmechanics.com/outdoors/sports/technology/robots-built-for-battle-are-patrolling-the-world-cup-16940719

June 30 – **A team of 30 battle-ready robots is patrolling** the World Cup stadiums in Brazil this month. Known as PackBots, these roving, remote-controlled bots are on hand to investigate any suspicious packages spotted in the stadiums. The concept is that rather than putting a security officer in harms way in order to investigate a suspicious package, the robot can be the first responder.

Weighing about 65 pounds and able to travel at speeds of up to 5.9 miles per hour, these robots, designed by the Massachusetts-based iRobot, are similar to those American troops have used in Iraq and Afghanistan since 2002. Tim Trainer, iRobot VP of robotic products, says that once a package is spotted, the robot investigates using a six-foot extendable arm and four cameras. The machine can lift packages of up to 30 pounds and move them to a safer location.

Brazil paid $7.2 million for 30 Packbots and three years of support from iRobot. The contract started in 2013, in advance of the Confederations Cup—a warm-up tournament that happens a year before the World Cup. The timing gave the more than 170,000 security personnel on hand in Brazil – including police, military, and private contractors – ample time to train with the technology. But there isn't much of a learning curve, Trainer says: PackBots are controlled with something like an ordinary game controller.

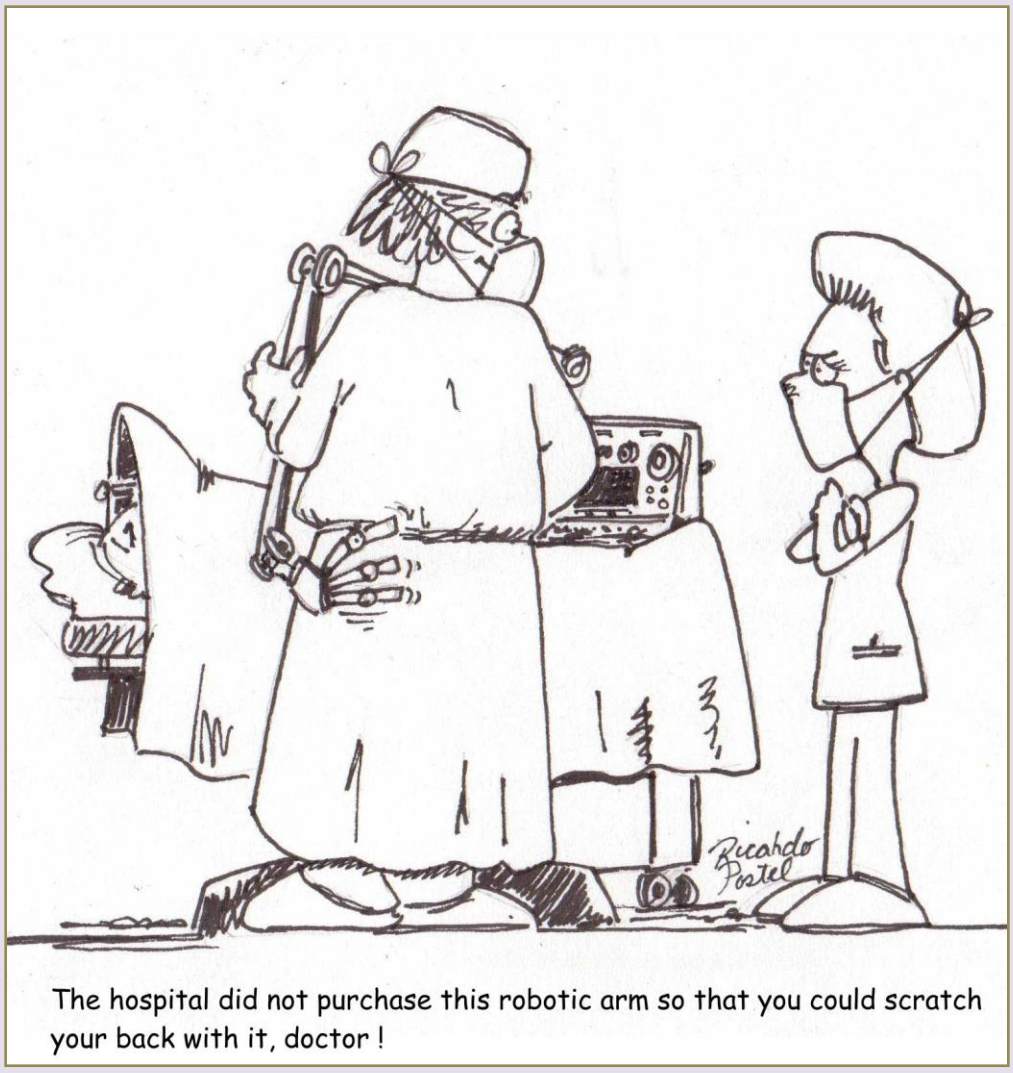
"Everybody knows how to operate them," he says. "My son is able to drive the robots much better than me. They're simple, inexpensive, rather robust in an operational environment." And a human operator can control a PackBot from up to 800 meters away.

While there is nothing unique about the controllers, the laptop that they interface with is specially designed for the PackBot. That laptop controls the device's four cameras. There is a head camera that can tilt, zoom, and pan 360 degrees. Another camera sits in the front of the robot, serving as a driving tool.

The PackBots' rechargeable batteries last about six hours (the battery life varies depending on whether they're driving uphill or downhill). One of the more unique features is a high-velocity water gun that shoots a stream of water fast enough to detach a bomb trigger from the rest of the package.

These features are all part of the standard model PackBot, Trainer says. Those that soldiers use in war zones have a hazmat system to analyze chemical, biological, and radiological agents in the air. The military bots also have digital mapping features and mechanical lifting tools. They can right themselves when they flip over, and, if they lose contact with home base, return automatically to the last spot of good communication.

Other versions of PackBot have been used to investigate an attempted bombing in New York City's Times Square in 2010, as well as in cleanup of the 9/11 attacks in New York and the Fukushima nuclear power plant disaster in Japan.



The hospital did not purchase this robotic arm so that you could scratch your back with it, doctor !