Robotica (2005) volume 23, pp. 449–454. © 2005 Cambridge University Press
doi:10.1017/S0263574704001511 Printed in the United Kingdom

Reports and Surveys

AUTO WITH EMOTIONS

Researchers from the Japanese company Toyota have designed and patented a motor car that, they claim, expresses emotions. They say that the car is able to laugh, cry or show anger and is also capable of singing to its occupants.

The patent, which has been registered in Washington DC, USA, refers to these innovative features as a 'vehicle expression system', and it says that such a system is vital for today's traffic conditions.

The Toyota developers believe that as:

> "traffic jams increase with more cars on the road, cars with "expression functions such as crying and laughing" could create "a joyful, organic atmosphere". The headlights, antenna, windscreen and exterior panels can be regarded as the vehicle's eyes, tail and body surface."

They describe the car as being able to 'sleep' with its 'headlight shutters closed, antenna limp and with its chassis lowered'. It can then change to another mode when it can, in the next instant, 'awake' with its shutters uncovered, headlights fringed 'with eyebrows', its antenna erect and glass looking bright. Eyelids have been designed by arranging for lights to appear above the headlights. Even a tear can be introduced, for breakdowns, it would seem, by a light that appears below the headlights.

In case readers of this report are becoming sceptical about the Toyota's design team's new car that shows its feelings, perhaps we should include more of the design data included in the patent that has already been deposited. It says that the:

> "windscreen is to be made of material that transmits light by changes of voltage. Panelling would also be able to change colour."
>
> Data is fed into a computer, attributing points to certain factors such as "the occupant reacting to reckless cutting in", or speed. This builds into an angry response, turning the car red, with the front lights glowing red. 'The state f 'angry' will be changed either over time or in response to soothing input supplied by the occupants.
>
> "When the number of points is reduced below the threshold value, the vehicle no longer shows 'angry'." It would move to "irritated"

The inventors say that in contrast to this 'angry' or 'irritated' mode the car can 'wink' if the driver feels happy by producing a quick switch of its headlights. Further reactions have been built-in to respond to the all too familiar 'sudden appearance of an other vehicle or a pedestrian' which may result in sudden braking. The car is then capable of showing 'surprise' by having its bonnet lights turn orange and the vehicle going down at the rear.

The Toyota researchers say that they have used colours and arranged the positions of the lights after a study of human psychology. They have choosen red to indicate 'passion' in the driver's seat, or danger, whilst using green or blues to denote 'inspiration', 'aplomb', 'sadness' and 'sophistication'. For example, 'relief' is expressed in green.

The patent for the system included a design so that a robot could be incorporated so that a 'happy atmosphere' can be created in the car.

Unfortunately, no details are given of the computer program that inputs data about the various reactions that the car is able to display. Although the system, Toyota say, is not in a stage where it can be realistically marketed, a much less sophisticated version, which is activated by the car occupants in response to their immediate reactions to a situation, could well be viable. The current road rage may well be reduced if drivers were able to signal their emotions through the vehicles themselves, using a selection of the modes described in Toyota's patent.

The four inventors of the car who work for Toyota have won their US patent for a vehicle they say will help drivers better communicate with others on the road.

Reports are also included in the *New York Times* (2004) and in the *Communications of the ACM* (**Vol. 47**, No. 10, Oct 2004). They quote the Toyota team as claiming:

> "The car will learn from experience and express that emotion when warronted. Such emotive, organic vehicles could lead occupants to have a great affinity for their cars and make the driving experience more comfortable."

It would seem that an automobile with emotion is not just the figment of the imagination of film makers, and if the Toyota team succeed in their developments it could well become a reality.

CHIP-CARRYING HUMANS

1. New chip implants bring problems

We are familiar with the 'card-carrying worker' and, indeed, the chip-impregnated animal, motorcar or other object we need to identify. We have even published reports of implanted chips that can control and interact with a variety of systems. One university scientist has had both himself and his wife fitted with chip implants and has written about their emotional interactions.

Now, however, implanted chips for humans are becoming a reality and in consequence raise many problems of privacy. The chips will need to be monitored as well as simply read to gain immediate information about its host. A great infrastructure for potential surveillance is regarded by the privacy rights movements worldwide, as an obvious danger. Industrial workers, for example, might agree to under-the-skin chips for identification purposes so that entry to certain areas or for access to certain information, but would baulk at having their whereabouts monitored.

https://doi.org/10.1017/S0263574704001511 Published online by Cambridge University Press

2. Under-the-skin medical chips

The chips which are being implanted are only the size of grain of rice and are placed under a person's skin. The chips themselves can be simple storage devices with information that can be accessed from an external device, or from more intelligent systems: in their own right. In the application of the chips to medicine, the chips fitted to patients contain their medical records and they can, for example, be accessed by a hand-held scanner. There are, of course, various systems. In one, doctors can read the chips with a scanner and then immediately gain access to the patient's medical record held on a central database. Such a system could give quick access to the records of patients suffering from life-threatening illnesses such as heart conditions. Patients who are unconscious can still be scanned for life-saving information.

3. System implementation

One particular chip called VeriChip has already received approval for its use in the USA. The powerful US Food and Drugs Administration (FDA) has given its approval and as a result other countries are anticipating that they too will get the go ahead from their governments. In the UK for, example, it is reported that one company has ordered 9,000 VeriChips because of an expected demand in UK hospitals. A London UK company plans to sell them at £150 each.

Chips can be inserted under the skin of a person's upper arm in some 20 minutes. Each of the devices has an identification number so that doctors can access patient information from the centrally held records. In the UK, the National Health Service (NHS) has already commissioned a centralised data-base for patient's medical histories.

4. Applications using the VeriChip

The VeriChip is produced by Applied Digital Solutions, Florida, US. Its chief executive believes that since the approval from the FDA the credibility of VeriChip has been boosted. He reports:

> "... that patients implanted with chips stood to receive more effective medical care because doctors and other health workers would have access to patient records regardless of where they were.
>
> So far, the devices have had some success as security devices. Earlier this year Mexico's attorney general, Rafael Macedo de la Concha, and scores of his colleagues received VeriChip implants that controlled their access to premises and documents.
>
> Since then, however, around 1,000 Mexicans have had implants that provide access to medical records.
>
> 'I've believed all along that the medical application was best, followed by security and financial applications,"

To encourage the use of implanted chips this company is providing free scanners, which usually costs about £300, to 200 Mexican casualty units.

Other companies worldwide are also entering the market, particulain finding innovative applications. Surge IT, London UK, for example, are considering their use as tags in the military and in prisons. The latter application could well be taken up since more and more parole prisoners are being released under 'tagging' schemes in the UK.

Another application of VeriChips has also been publicised in Brazil. A deal has been signed with distributors in that country for potential use in using the chips to track the victims of the frequent kidnappings, using satellite systems.

5. Future researches

The potential applications of implanting chips are surely limitless. Those involving humans are the most obvious ones. Research is, however, being carried out at many centres, (in the UK the University of Reading) in the use of implanted chips for purposes other than identification of an individual or the storage of essential personal details. Chips can form part of much more sophisticated information systems and in consequence provide the facilities needed for interaction between human with human or human with machine. The potential for interaction between a chip-implanted human and a robotic system has yet to be fully explored.

COMPUTING FOR COMPLEXITY

In the United Kingdom funding is bring made available for researchers to use new computing paradigms to improve understanding of complex systems.

The UK's Engineering, Physical Sciences Research Council (EPSRC) is seeking to improve the understanding of complex systems by what it describes as offering support to adventurous, non-conventional and multidisciplinary research. The aim is to develop new computational approaches to dealing with complex systems. To do this, because of what they say is the rather rarefied nature of the subject area, a somewhat unconventional approach was taken to identify the projects that were candidates for support. This approach is described in the EPSRC *Connect* publication (Issue 25, 2004):

> "16 Research Clusters were funded under the banner of 'Novel computation: coping with complexity', following EPSRC's successful bid to the 2002 Spending Review. This secured additional money, to be matched pound-for-pound by EPSRC, to develop research in complex systems. The clusters were given funds to enable them to spend six or 12 months engaged in networking activities, in order to prepare novel proposals for specific funding. Only proposals from these approved clusters would be considered, and the bids would be judged competitively."

The six-month clusters produced a total of 22 research proposals which were considered by a panel which spanned the disciplines covered by the Council's remit. The five successful proposals were awarded support funding totalling £5 million.

The funded projects are aiming for adventurous, non-commercial multi-disciplinary research combining recent adavances in disparate fields to develop new compuational approaches to dealing with complex systems. The funded projects are:

- Non-Linear media based computers: chemical and neuronal networks through machine learning – led by L Bull, *University of the West of England.*

https://doi.org/10.1017/S0263574704001511 Published online by Cambridge University Press

- Function of distributed plasticity in a biologically-inspired adaptive control algorithm: from electrophysiology to robotics – led by P Dean, *University of Sheffield*.
- Extended particle swarm (XPS) – led by R Poli, *University of Essex*.
- Market based control of complex computational systems – led by N Jennings, *University of Southampton*.
- Novel approaches to networks of interacting autonomes – led by G Ackland, *University of Edinburgh*.

Proposals from the 12-month clusters are being considered during 2004–5.

Researchers in robotics and automation will recognise that the ability to deal with complexity is becoming a major goal in many endeavours. These areas of research range from understanding cell division to the management of complex networks. Such complex systems are evident in many applications in our research activities. The study of behaviour in colonies of insects or in swarms of bees where co-operation is achieved to the overall benefit of group members has already produced researches which have directly affected the way in which we approach solutions to complex system problems. The design of robotic systems and individual robots has benfited from the observations made by scientists of the animal kingdom, and their improved understanding of its complexity. The UK research programme will undoubedly improve our knowledge-base. Further information about developments in these researches can be found on www.epsrc.ac.uk.

NANOTECHNOLOGY

Whilst we call know that nanotechnology is the science of very small components and numerous reports tell us that it will revolutionise science the general public still need reassuring. The possible dangers of nanotechnologies are already in the public domain and many scientists see a repeat of what they believe was the GM ill-informed debate which has resulted in decisions not always in keeping with the current scientific opinions. Whatever peoples' opinions finally dicate, scientists need to keep those involved in the debate well informed in an effort to avoid the worries that are already being expressed. To this end, in the United Kingdom, a warning that nanotechnology is set to be the next 'GM scare' to the detriment of the debate has been given by Tracey Brown the Director of Sense About Science*. She writes (UK Times, 25.10.2004) that:

> "Given its vast possibilities, scientists ought to be looking forward to public discussion of this nascent science. Unfortunately, this is not the case. Many fear that discussion will be limited to the potential risks and dangers of nanotechnologies, and that this could impede or even halt the progress of the new science."

She points out that the National Consumer Council (UK) and other campaign groups appeared at a debate about nanotechnology held by the Royal Society and the Royal Academy of Engineering of the United Kingdom, but little has been done to inform the public of the issues involved.

*More information on "Sense about Science" at www.senseaboutscienc.org.

In the UK and worldwide, governments and the science and industrial bodies are aware of the need to head off the controversy that is forecast. Numerous programmes for the development of nanotechnogy have been initiated but very few concerned with providing the world's population with enough information to clarify the field. This is a field of endeavour very much in its infancy and is one that could revolutionise medicine, electronics and many other scientific pusuits. When it is envisaged that components that could be as small as one thousand millionth of a metre could be produced there is a real need to consider their use.

Such advances have already been publicised as being able to breed speck-like robots that will be able to hunt down germs in the human body. But what other applications could there be? It takes only a little imagination to envisage 'little green Goblins' of the Science fiction world taking over the world. Tracy Brown of Sense About Science says that:

> "Public opinion should be free to emerge (or not) from a less-structured airing as new developments come about. The contributions that really allow people to start thinking and talking about nanotechnologies come from the experienced scientists who try to explain the field. If we want the public to be interested in scientific research and its applications, then we need to hear more from them."

ROBOT INFILTRATOR

Scientists in France, Switzerland and Belgium are working on a project whose aim is to develop a robot, or robot-like artefact, that will be capable of integrating and communicating with animals. It sounds an impossible task and one that is hardly likely to meet with any success. But to the contrary, it has now produced a robot called InsBot that, it is claimed, is capable of infiltrating a group of cockroaches, and is able to both influence them and actually alter their behaviour. The researchers say that InsBot behaves like a cockroach, smells like one and has proved to be accepted by other cockroaches. There is no doubt that this, if it is as successful as its inventors claim is a breakthrough in our aim to control the animal world. A report in the *UK's Times* (15.11.04) discusses the prospects. The researchers say that this is but the first step in their pioneering programme. Jean–Lois Deneubourg, of the Belgium National Fund for Scientific Research, the co-ordinator of the endeavour, has said that:

> "The idea of using decoys to control animals is very old. Hunters and fishermen have used them for many years. The aim of this project is to develop a robot-like artifact capable of both integrating and with communicating with animals. Cockroachs research was the first step. Cockroaches are not an objective in their own right. But this shows what it is possible to do."

Scientists at the *Centre for Research on the Cognition of Animals (CRCA)*, Toulouse (France) carried out the intial task of analysing cockroach behaviour. The Centre reports that:

> "Cockroaches, like ants, are egalitarian creatures, without a group leader. They congregate as a result of a "collective intelligence" that depends upon interaction within the group".

https://doi.org/10.1017/S0263574704001511 Published online by Cambridge University Press

The results of this study showed that cockroaches like contact with each other. When they meet, they stay still. Apparently they are seen to be 'happy' when they are with a friend for a few moments, and the more 'friends' around them the longer they stay. The robot InsBot was developed at *Switzerland's Federal Polytechnic School* in Lausanne. It is described as being green in colour and the size of a matchbox. It is equipped with lasers and a light sensor. It development is said to be the second stage of the €2 million (About £1.4) programme called *Leurre*, which was given the task of:

- Building a robot that would be capable of detecting cockroaches,
- Distinguishing the cockroaches from any other objects
- Moving about like a cockroach.
- Becoming inactive in the dark.

We are told that the robot has been successfully designed with these features so that when it bumps into a cockroach, it does what they do, stops moving and the more cockroaches that approach the longer it remains stationary.

The Centre for Scientific Research laboratory at Rennes, Brittany, France, undertook the third stage of the project. It was given the task of isolating the molecules that give cockroaches their smell. The aim being to create a cockroach perfume that could be sprayed onto the robot.

Professor Deneubourg says that he hopes to publish a report of their findings in the near future, that will demonstrate InsBot's capacity to modify its 'friends' 'behaviour'. This will include the results of a number of experiments involving the robot and the cockroaches.

The prospects for further developments of this research are extremely good and numerous potential applications have already been discussed. Some examples have already been considered. It may well be that infestations by cockroaches could be tackled by robots. The computer programs developed for the *Leurre* research may be used to build other types of robots. Chicken-like robots have been mentioned, to be used to stimulate poultry. Sheep control by InsBot type robots could also prove productive.

The control of animals by machines in this fashion is now a distinct possibility, and the inventors of InsBot believe that within a decade many of these applications will be marketable.

ROBOCOPTERS

Recent global conflicts have heightened military researchers interest in designing viable unmanned aircraft. The aim of the scientists is to develop the unmanned craft so that they have the minimal guidance from the ground. Already we have witnessed the use of missiles being launched from sites thousands of miles from the control centres and directed to targets by guidance systems that are becoming more sophisticated. Unmanned aircraft are also in use for reconnaissance missions with many being extremely small yet well equipped to carry out their missions. Their engagement capabilities may well be limited.

Military scientists are now developing pilotless helicopters that are capable of carrying out air strikes with the minimum control from ground centres. They are flying robots equipped with a range of sensors that allow them to detect friend from foe, and anticipate: the dangers from gunfire or missiles or grenade launchers etc., from a safe distance, currently estimated to be at a distance of some 1500 feet.

Table I Robocopters are autonomous, allowing both manned and unmanned units to interact and to exchange information.

Contractor:	*Northrop Grumman*	*Lockheed Martin*
Weight	6,350 lbs	5,500 lbs
Speeds	200 mph +	200 mph +
Payload	2,300 lbs	650 lbs
Endurance time	10.5 hrs	9.5 hrs

Many countries are involved in this research and development area of military robotics. Foremost it would seem is the USA where, it is reported two defence contractors are building the robotic aircraft which are known as unmanned combat armed rotorcraft. They are the Northrop Grumman Robocoper and the Lockheed Martin Robocopter.

The military scientists developing them claim that the:

> "helicopters will be almost undetectable to radar, capable of distinguishing between hostile and friendly forces, and be able to locate and destroy hidden enemy positions by day or night in all weathers. They also believe that they will have the capacity to take autonomous decisions with little guidance from human controllers."

Table I gives some idea of the design of robocopters by the two US contractors.

The Northrop Grumman US defence contactors who are developing the new systems claim:

> "that the capacity for the machines to operate autonomously means they will be able to undertake a variety of missions alongside manned helicopters.
>
> These will include identifying and engaging enemy targets or protecting manned aircraft by, for example, flying directly into the path of a ground-to-air missile."

The current pilotless aircraft are extremely limited by existing technology. This means that unmanned air drones such as the US's Predator and Britain's Phoenix, used at present for reconnaissance, have to be pre-programmed or, ofcourse, controlled remotely.

The advantages of using the new robocopters are quite obvious but in addition they have the advantage of being able to be integrated into a military information system that will allow for manned and unmanned units to co-operate and exchange sensor information that will give a broad view of the theatre of operations.

This is, ofcourse, an ongoing development and various stages are being planned where basic systems will be available. The timing for the more sophisticated versions has been put at some eight years. It is anticipated that the cost of the new robocopters will be some £5 million each, which, in military terms at least, is regarded as low-cost. This, of course, will allow them to be considered as 'expendable', unlike the current manned helicopers which cost around £10 m each. A spokesman of the US Defence Advanced Research Projects Agency has suggested these robocopters will enter service with the US army in 2012.

https://doi.org/10.1017/S0263574704001511 Published online by Cambridge University Press

ROBOTICS WORLDWIDE (EUROPEAN INITIATIVES)

1. Preservation of digital information

Reports that digital information carefully burned on to CD-ROMS can in fact become unreadable and corrupt after a few years caused alarm amongst lay users of computer systems. Researchers and institutions that need secure archives that will, they believe, last the test of time are aware that digital information is in fact fragile, and at risk. In the early years of computing similar problems arose with paper tape, magnetic film and, of course the once popular magnetic tapes. At the time elaborate measures were taken to preserve data. The advent of digital storage hardware appeared to remove this once pressing problem.

As far as computing systems are concerned, hardware is continually changing in response to advances in new technology. A recent article in *Research Information* Issue 13, Autumn 2004, highlights the problem from the point of view of computer system users who need to preserve digital information. Geoffrey Adams, Elsevier's Director of IT Solutions is but one computer professional who is attempting to cope with the difficulties. He writes that because of this constant re-invention of hardware, applications, platforms and formats it makes:

> . . . "the task of capturing, archiving and, above all, safely retrieving vital content a vast challenge: one requiring new skills, different infrastructures and, of course, more money.
>
> Since much of scientific research these days is 'born digital', and is increasingly accessed digitally too, the stability of these 'minutes of science' is not of purely academic concern. Preservation of these 'digital objects', and ensuring permanent access to them, has become one of the key tasks of national libraries."

No one has a glib answer to this situation and research tools and procedures for permanent access are still in their infancy. Some institutions and publishers are, however, taking on pioneering roles. A good example of this is the development of partnerships between those whose business is to capture and communicate digitial data and those who specialise in archiving. One obvious example is of course, the libraries of the world which have such a background. It was therefore encouraging to read of a partnership between the Dutch National Library and the publishers Elsevier Other publishers were also involved, and a three year European NEDLIB (Networked European Deposit Libraries) project was initiated bringing together national deposit libraries in France, Germany, Italy, the Netherlands, Norway, Portugal and Switzerland together with technical partners. As a result the, concept of the 'safe place' for electronic content has been accepted.

In this initiative we should see a build-up to develop permanent digital stores that will take account of the ever changing storage media reseachers are introducing. Currently, digital archiving and information preservation are becoming a major cause of concern and affects not only the technologist or scientist but all who use computer systems.

2. Ion-propulsion system

Smart-1, which is powered by an ion-propulsion engine reached its lunar orbit in November 2004. It was captured by the Moon's gravity after a voyage of more than 13 months. The probe, which is about the size of an ordinary kitchen washing machine, fired its thrusters to stabilise its orbit prior to reaching its final egg-shaped orbit early in 2005.

This is the first lunar probe that has so far been successfully launched by scientists at the European Space Agency.

We are told that Smart-1 has achieved the main aim of the planned mission by reaching the Moon and testing the revolutionary ion-propulsion system. This system, the Agency says, could cut years off the journey to planets such as Mars and Mercury, and are ten times more efficient than standard chemical rockets. The acceleration generated builds up, over time, it is claimed, to produce speeds of up to 36,000 mph.

Many questions have apparently remain unanswered about the Moon for more than 30 years since the Apollo landings. At that time samples of rock and soil were collected by the mission's astronauts. Smart-1 is designed to survey the lunar surface to determine its chemical composition. British scientists from the Rutherford Apple Laboratory UK have designed and built an X-ray Spectrometer called the D-CIXS which is one of Smart-1's very sophisticated tools to be used for this task.

Whilst rocks brought back from the Apollo mission gave data about limited areas of the lunar surface Smart-1 will survey a crater, the South Pole-Aitken Basin which has appeared through the Moon's mantle.

We have already reported in this section the researches that have led to the design and production of robot vehicles whose tasks were to search terrains and gather data. Some have produced successful surveys. Smart-1 is, however, a new endeavour which although currently collecting data to help scientists test out their theories about the formation of the Moon, has 'spin-offs' which, like so many other space ventures, will benefit many other projects in science and engineering.

3. Best toy in the United Kingdom

A robot toy has been choosen by a panel of the UK's Radio 2 competition for the best toy for 2004. The robot, called Robosapien is said to be able to grunt, snore and sing. It was designed by a Nasa scientist Mark Tilden. It is described as being knee-high and is fully programmable using a remote control and 'it is claimed' that it can perform 67 different manoeuvres, some of which are highly intricate.

Robosapien was produced by Character Options and is available currently in London. Robot toys and the very many robot pets are marketed world wide and as well as giving pleasure to those who buy or receive them also has the virtue of featuring new scientific ideas and developments not only it would seem amongst the younger generation but also in a much more adult market.

4. Engineering research in the UK

The United Kingdom is constantly aware that the quality, standing and potential of its research activities should be reviewed by independent international scientists. To this end the international standing of Engineering research has been the subject of the sixth in the series of international reviews of UK research quality.

https://doi.org/10.1017/S0263574704001511 Published online by Cambridge University Press

This review was jointly organised by the Royal Academy of Engineering (RAEng.) and the UKs Research Council for Engineering and Physical Scienecse (EPSRC). The review panel was charged with providing an independent assessment of the quality of UK engineering research compared with international standards. The review was scheduled for late autumn 2004.

The chosen panel consists of Professor Tom Everhart (President Emeriras at Caltech) as chairman, and Professor Sir Alec Boers (President RAEng.) as chair of the steering group overseeing the management of the review. A key component of the review with the title, 'A Celebration of UK Engineering Research and Innovation' was arranged.

Further information and a review of this exciting, high profile publicity event, which was held at the Excel Exhibition Centre, London (November 2004) will be given in future reports from this section.

5. New high-energy X-ray source (UK)

The *National Centre for Electron Spectroscopy and Surface Analysis* (NCESS)* at Daresbury (UK) has unveiled a new high-energy X-ray source for its X-ray photoelectron spectrometer which is now available to members of the UK academic community called the Scienta ESCA300 it is a unique state-of-the-art instrument capable of high intensity, high energy resolution and high spatial resolution. The X-ray photoelectron spectroscopy (XPS) is a powerful technique widely used for the surface analysis of materials. In its usual form XPS employs low energy X-rays and provides qualitative and quantitative information, chemical speciation, depth profiling and spatial resolution for elements present in the near surface region (2–10 nm) of a sample. Its applications are wide-ranging but in particular it can be used to study polymers, catalysts, composites, fibres, ceramics, alloys and other materials. NCESS reports that:

> "In collaboration with the Universities of Liverpool (Professor Peter Weightman) and Surrey (Professor John Watts) NCESS has developed the new high energy X-ray source (HEXyS) for use in XPS. It makes use of Cu Kα radiation (8048eV) and allows photoionisation of deep core levels such as Fe 1s. This is important for studying electron charge redistribution in metallic alloys, and the ultimate aim is to use XPS data to assist in the design of novel and improved alloys for technological applications. The project puts NCESS at the forefront of physics and has attracted international attention."

This new facility will be welcomed by researchers in a variety of fields, especially those involved in technological endeavours.

6. PatrolBots in useful debut (USA)

PatrolBots were billed initially as security robots but now, as expected, they can be versatile assistants.

Currently available from ActiveMedia Robotics† the robot can carry out a variety of tasks. Already set to work by many well-known companies in the US it can take on roles from being a compound supervisor with the ability to control multifunctional systems to being a company tour guide. ActiveMedia Robotics say that the PatrolBot can carry 12 kg of sensors and surveillance equipment moving over 2 cm sills and 2-cm cables traversing ADA-compliant slopes whether in daylight or in darkness. It uses ARCS controls, also employed by AR MobileRobot's AGVs and rover devices.

To carry out its versatile roles it has been equipped with sensing devices and elaborate software systems. It is able to map out its area of activity and moves around it without any control cables or other physical linkages. PatrolBots can work together sharing their maps, sensing obstacles and avoiding them by taking other routes. One of its selling features is its ability to integrate into other networks or operate independently. Typical applications cited by ActiveMedia Robotics are its integration with other systems such as those controlling security, air quality, heating, cooling, lighting and power. Equally it is able investigate work areas and can scan them or work automatically to perform its tasks. Current prices from $30,000.

7. Robotic traffic cones

It is reported from the University of Nebrasta at Lincoln, USA that researches have developed robotic traffic cones. It is aimed to produce robotic systems in the form of traffic signs, barricades, and cones with the potential to cruise automatically on the highway from the backs of trucks so that they can automatically take up designated positions.

This development system was initiated in an attempt to reduce an estimated $100 billion loss to the USA economy because of traffic lane closures, accidents, and other highway delays. The Nebraska scientists are using a 'shepherd unit' to control a 'flock' of cheaper units. Each of these units are designed as highway markers and are equipped with a battery driving two electric motors that can travel no faster than a walking pace. The design is by Professor Shane Farritor of the University of Nabraska who says that the system includes software that is able to capture an image of the highway ahead and will allow operators to mark the precise position of each cane. Use is made of the Satellite global positioning system (GPS) technology to calculate the grid reference for each position. These are then transmitted to the 'sheperd' which then places its 'sheep' in position. In the UK cones are currently placed manually by road workers who drop them from slow-moving trucks. It is accepted that there is a need to remove these workers from a potentially dangerous situation so that such an innovative system could prove popular with highway agencies.

It is suggested, however, that the marketing and production of robot systems is not imminent and much research and development is needed to 'prevent rogue cones from storming across the highways', Evenso, although the developers at Nebraska University are not forecasting a date for the availability of their systems which they price at $700 each other projects may produce and market similar systems in the short term.

Professor B. H. Rudall
Norbert Wiener Institute and University of Wales (UK)

*Further information can be obtained from: www.d1.ac.uk/NCESS.
†Further information from : www.MobileRobots.com

https://doi.org/10.1017/S0263574704001511 Published online by Cambridge University Press