Robotica (2003) volume 21, pp. 107–116. © 2003 Cambridge University Press
DOI: 10.1017/S026357470200454X Printed in the United Kingdom

Reports and Surveys

ADVANCED NEURO-ROBOTICS

1. 'Robo Rat' project

United States scientists from SUNY Downstate Medical Centre have reported on a Robo Rat project that they have initiated. In a research paper published in *Nature* (May, 2002) they describe some of their remarkable results. It may soon be possible, we are told, that because of their researches, a remote-controlled living 'Robo Rat' could be involved in numerous and varied applications. Their work is a spin-off from research to give paralysed people the ability to move and feel artificial limbs. The report of the project presents their findings and described how five rats carrying a special backpack, which contained a battery, radio receiver and brain stimulator, were controlled by a human operator sitting up to 500 yards away. The human operator was able to make them weave in and out of obstacles and navigated them over a course. Instead of using the traditional methods of animal training which associated behaviour with rewards, the researchers directly stimulated the parts of the animals' brains that responded to the movements of their whiskers and to receiving rewards of food. Electrical signals were sent to parts of the brain and provided a virtual contact to the animal's whiskers, showing them which way the operator wished them to go. In their research paper it is shown how by stimulaling these 'whisker centres' the rats could be steered and by stimulating the brain's reward centre, they could reinforce the correct behaviour. The report describes the demonstration which resulted when;

- a radio receiver that was fitted inside the backpack linked the brain electrodes via an interface on the rat's skull.
- These electrodes that have been implanted in brain areas that receive stimulation from left or right whiskers (in the Neocortex).
- Rats turn left or right in response to stimulation.
- They are rewarded by stimulation of a part of the brain sensing reward (in the Hypothalamus). They are also stimulated when they move forward.
- By rewarding both forward movement and the correct responses to left and right whisker stimuli, rats can be steered through a slalom or obstacle course.

As a result of being trained, the rats could then be made to turn, run, jump and climb through an unconfined three-dimensional environment following the commands given from a laptop computer.

2. Research findings and future developments

Dr Sanjiv Talwar of SUNY Downstate Medical Centre summarises the researchers findings:

> Our lab has been in the forefront of a field that may be called neuro-robotics. The main motivation behind the study was to obtain a further insight into developing suitable brain-machine interfaces in order to give paralysed patients the ability to control artificial limbs through 'thought patterns'.
>
> When combined with electronic sensing and navigation technology the rats could offer many advantages over current robots. This animal has 200 million years of evolution behind it. Rats have a native intelligence which is a lot better than artificial intelligence. It is a hard problem to make a robot move properly over unpredictable terrain.

The team's main aim, Dr Talwar said, was to develop neurorobotics. He also said for the record, 'we're pretty strong on animal rights and our rats are very well treated'.

3. Some applications

There are many applications of the use of this new research. One suggested was that a rat could now be easily used as a search and rescue tool. Indeed, after this remarkable demonstration, another use suggested was that of hunting for landmines. The research team were at pains, however, to point out that 'much would depend on the humanitarian needs of a situation'.

The obvious application, as already described, would result from the development of 'brain-machine' interfaces. The 'spin-off' to so many areas concerned with understanding the functions of the brain in both the human and the animal could have enormous potential in the development of 'human-robot machine', 'human animal' and, indeed, 'human/machine-animal' systems. Calling the studies neuro-robotics has the worthwhile benefit of focusing attention on what could be an innovative area of endeavour.

ANALYSING HUMAN BEHAVIOUR

1. Automating behavioural analysis

That we can learn a great deal by examining human behaviour may be one of the most obvious remarks that we can make. Unfortunately in many scenarios we have failed to do this. Now, however, it is becoming more and more acceptable that such examinations are more revealing than we first believed. Suddenly, new systems have been designed to examine the behaviour of airline passengers before they are allowed on flights. Customs officers now study the behaviour of those entering a country, football supporters are now carefully monitored using CCTV as are the crowds in demonstrations in the hope that facial expressions and bodily movements might give some indication of their possible action and reaction. These are, of course, only some of the many examples of behavioural monitoring using human analysis from digital images or, exceptionally at present, where computer systems are harnessed to assist. The breakthrough in human facial

recognition systems and facial expression analysis has enabled many behavioural scientists to produce some quite remarkable analysis applications many of which like image-recognition monitoring has become computer system-oriented. Their importance in designing and operating fail safe systems, particularly in the public transport systems, is encouraging. The actions of a public transport driver of a train, bus or car can be monitored so that his/her behaviour can be predicted. Facial expression, heart rate, etc. can provide a great deal of information and a warning that action needs to be taken perhaps to avert an impending disaster. A very unusual system that has recently been highlighted is one that will help predict criminal activity by using computers that can analyse human behaviour.

2. Predicting behaviour with computer systems

The idea of predicting behaviour say, before a criminal carries out a crime was discussed at the British Machine Vision Conference held at Cardiff University (September, 2002). The strategy put forward for this form of behavioural analysis was to develop cameras that can lock on to a person standing still for an unusually long time in a crowd. Studies, it is reported, have shown that such 'furtive' behaviour is associated with the build-up to crimes such as muggings or assaults and also with attempted suicides on the London Underground. Dr Paul Rosen of Cardiff's (UK) Computer Science Department said that:

> "A study done in collaboration with London Underground to monitor crowding levels on platforms found it was possible to identify individuals who were more likely to jump in front of a train, attack someone or vandalise something by the length of time they stayed stationary.
>
> The normal behaviour was that people waited for a train, moved around a bit, got on a train, then left. But when people stay still for ten minutes or more, it is definitely abnormal behaviour."

Although the technology is said to be at the development stage it is expected to be available within five years. To produce the cluster of lenses that records the numerous images and then compares them for movement has been based on an insect's compound eye. A spokesperson for the London Underground said that they carry more than 3 million people a day and have probably more CCTV cameras installed than anywhere else in the world, so we are well aware of the new technology. The cameras are not only needed, we are told, for crime prevention but also to keep watch on the system, a task that could not be accomplished without them, even with a very large staff.

It is reported that London Underground has to deal with over 100 suicide attempts each year. The closed–circuit-television cameras being developed at Cardiff University Computer Science department may well help this and possibly other railway companies to combat what is a real problem, which not only involves the loss of life or injury but also involves great disruption of services.

Obviously, this concept discussed at the British Machine Vision Conference amongst many other systems involving behavioural analysis of humans can yield worthwhile dividends in so many areas where such promising applications are being developed.

AUTOMATED TOOLS FOR SOFTWARE

1. Automated software testing

The manual testing of software can never catch all the errors, so can automation help? David Norfolk looks at the pros and cons of automated testing in an article published in *The Computer Bulletin* **Vol. 4**, Part 2, 24 (2002). One of the main problems of introducing automation to the software production and testing process is that it requires proven methods of specification that includes both syntactic and semantic considerations of the language interface that enables the problem to be communicated to the system has to be well defined. Finally, it is desirable that the resulting programs can be proved. Each one of these requirements is still very much in its early stages of research development. The result is that a compromise has to be reached on all of these stages of the process of creating and testing software. David Norfolk sensibly concentrates on software testing that involves considering all possible paths and combinations of paths through a realistically large program. He writes that:

> "The tests will never be anything like exhaustive, so they must be made cost effective: you must find the greatest number of defects with the resources available."

As a result, he concludes that:

- You cannot afford to run tests that do not find defects, so structured testing plans that maximise the chances are vital.
- Automation, to maximise the use of resources, makes a lot of sense, but only if the automation fits the demands of the structured test plan.

Automated testing goes back to earlier keystroke recording utilities. We are told, that if you record the keystrokes made by someone entering a test case, you can rerun the test case at very little cost, perhaps to check that a defect that caused the test to fail on its initial run has now been fixed. In fact, we have a stored regression test that can be run after any code maintenance, to ensure that unexpected errors have not been introduced elsewhere in the program while part of it was being changed. It is shown that an important facility in any automated testing tool is a repository of test specifications. These, we are told, can be developed early before coding, and used to develop 'what if' scenarios for validating requirements specifications and so on. The article describes an interesting new application of automated testing in extreme programming. The author says that every

> "functional requirement has its associated test case – prepared before coding – and these are run regularly, and the results published, to keep developers focused on the user requirements. Unit test cases are also prepared for all code and regression test cases for all bugs (to prevent their return) and code must pass all the tests before it is released. Managing and running all these tests would be impractical without automated test tools.

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

Automated testing is a real godsend to development quality in general, and although the basic principles still apply, the products have become increasingly sophisticated.

Nevertheless, automation has its limits and certainly has not de-skilled the process. It is easy for the inexperienced to confuse high volumes of test results – easily produced with automated tools – with effective testing."

In addition to giving advice the author also provides some warnings. Traditional automated tools have been weak at the early stages. The situation David Norfolk reports is improving:

"Rational, for example, has a tool called Quality Architect which lets you test Web-based applications for expansion and other factors, from a UML design, before any code is available, it then generates the code harnesses you will need for early testing of code."

2. Future scope

There is no doubt that automated testing is set to expand in scope. We all know that the large commercial systems have run routine test transactions, for example, since the early days of computing. In looking at future trends we are informed that:

"The Australian Department of Health's pharmaceutical benefit system, written in the late 1970s, for example, ran a standard artificial payment transaction once a month, to ensure that the basic arithmetic of the system had not been compromised. Modern automated testing tools can do something similar: evaluating the end-to-end service of a Web transaction, for example, so that potential performance problems can be addressed proactively. Mercury Interactive's Topaz product is an example: www-svca.mercuryinteractive.com/products/topaz."

Of most interest to those who are developing and testing software in the automation and robotics industry is information about the progress of 'pattern matching programs' and the evolution of mathematically-based development methods, and tools to produce provably correct software components for building systems. The use of these methods has been discussed in the literature but it is useful to be updated with the report on their use in significantly sizable systems. These were described recently by a spokesperson from Praxis* who reported that:

"the use of formal proof was easily cost-justified: developing a formal specification took 5% of the project effort and found 3.25% of the faults, but proving this specification then took only 2.5% of the effort and found 16% of the defects. Against this, unit testing also found 16% of the defects found, but took 10 times the effort (25%)."

* Praxis - at www.praxis-cs.co.uk

DEVELOPING THE SMART CAR

1. The smart car concept

The use of computer systems in motor vehicles is hardly new; as they become more sophisticated, the concept of a 'smart' car becomes a reality. Modern cars produced using the latest automation techniques are then equipped with computers that are able to monitor and control almost all aspects of its operations, even to the extent of plotting its exact position using the Global Positioning System (GPS). Projects are now in being to control its speed from remote state-controlled centres and to monitor its position so that special levies can be charged for entry to cities, and restricted tourist areas. Cars can be banned from secure areas and can be tracked at will. In essence, vehicles that are now designed using computer systems, are manufactured using automation systems, run by computers and likely to be controlled and tracked by 'Big Brother' computer centres. Vehicles are therefore already 'smart' and are likely to get smarter. Manufacturers already realise this and many accept that, as technology advances, new devices can be implanted to improve their performance and to make them environmentally more acceptable to society. With this in mind, one car maker in the United Kingdom, Lotus, is developing the 'Intelligent engine' or the 'thinking engine' as some developers would prefer it to be called.

2. The thinking engine

In developing the 'Intelligent engine', Lotus say that they are responding to the need to produce vehicles that react to different driving conditions, that can reduce exhaust emissions and save fuel while stuck in traffic jams. In specifying this 'thinking engine' Lotus say that:

"When the driver hits traffic, the new *Lotus* automatically shuts down two of its four cylinders and trundles along with the power of a lawnmower, cutting petrol consumption by a quarter and exhaust emissions by 90%. But when congestion clears and the car reaches the open road, the engine kicks in with the hallmark thrust of a typical *Lotus* sports car. The new engine would make an average 1.6 litre family saloon perform like a 2.2 litre turbo on the motorway and a 0.8 litre supermini in town."

The company have indicated that the new engine works by:

- Having an on-board computer that activates a 'Flexible valve sytem' which enables the engine to react to different traffic environments.
- Producing improved combustion stability.
- Reducing fuel consumption toxic emissions.
- Having new operation speeds of up to 7000 rpm.
- Cutting engine power in congested areas by reducing the number of cylinders in use and so cutting back on unnecessary power so that it acts like a small car.
- Allowing maximum power to give sportscar-like acceleration on the open road with 'footdown' action.

3. Future developments

Currently *Lotus* are testing prototypes of its new engine at its factory in Norfolk, UK. They plan to use it in future

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

models or even market it to other companies. They believe the new smart engine will provide sportscar performance and will be environmentally friendly, thus proving attractive to those drivers who enjoy fast cars and are also aware of their present impact. The company say that future engines would be electronically controlled with the accelerator connected to a computer rather than a mechanical throttle. Some of this technology has already been used on the Formula One active suspension systems to create their Active Valve Train engine. Development we are told will cost some £100 million, but half of this sum could come from UK government research funding. The technology is expected to be in a test car in the near future.

4. Smart can be safe

Many new devices are being designed to make vehicles safe. Whilst in the UK the government has concentrated on enforcement of the speed restrictions with 'state-of the art' cameras that check your speed and, if you disobey the speed limits, print your 'penalty ticket' to arrive in a day or so; some companies are profiting by their development of radar-speed detectors which drivers can fit to their cars. To many drivers a 'smart car' is a car that is so 'intelligent' that it enables you to disobey the current motoring laws and get away with it!

One new smart car feature that even these drivers are likely to accept is one that targets sleepy drivers. This is not merely a national problem but a truly global one. In Europe alone we are told, an estimated 30% of fatal accidents are caused each year by drivers who become sleepy at the wheel. The result is that the European Union is funding a project to the tune of £4 million, together with private investment, to reduce this unacceptably high rate.

The project designers report that:

> "Mercedes estate cars and Fiat runarounds are being used to test up to 22 different monitors designed to detect if a driver is falling asleep at the wheel and trigger a series of devices designed to wake them up. The test cars have been fitted with infrared cameras which monitor eye movements, touchpad sensors that measure the driver's grip on the steering wheel and chassis monitors which check for veer. Should drivers start to doze off they can be woken by sudden blasts of airconditioned cold air, while at the same time a vibrating alarm will sound and the driver's seat will be made to shake."

The system is called the **Awake System** and will be patented by Daimler Chrysler, the owners of both Mercedes and Fiat.

The system should be installed in cars as soon as 2004. The European Union, we are told, will, if the trials are successful, issue a directive which would make the system compulsory in long-distance lorries. These are regarded as one of the leading causes of sleep-related road accidents.

Some scientists have reservations about the system believing that drivers may well be encouraged to drive 'sleepless cars', when they are tired. At the moment the system relies on three monitoring devices that are designed to check very small changes:

- Out of lane: unusual veering across lanes picked up by sensors
- Eye-movement: Driver's eyes monitors for blink rate; infrared cameras
- Steering: Loss of grip on steering wheel; touchpad sensors

In addition to this basic data about the way a car is driven, the system also monitors braking frequency and can detect movement towards the rear and side mirrors. The designers do recognise, however, that no-one drives in exactly the same manner so that the system has to find out the particular features of the car's owner (or owners). The three warning 'wake-up' alarms used by the current system were chosen after trying versions that squirted smelling salts at the dozing driver, opened windows or activated the brakes automatically. All of these were deemed to be dangerous.

5. Other smart-car devices

As our technology advances, more smart devices will be installed many of which will depend on the ability to construct systems with a degree of 'intelligence'. Developments in Artificial Intelligence (*AI*) will, of course, bring in an enhanced degree of sophistication to such systems. On the basis of the present *AI* studies, much can be done to improve both car safety and performance. The smart airbag, which relies on the monitoring of various sensors which provide data about the car seat occupant, is but another example of the application of our presentday 'state-of-the art' system programming.

ELECRONIC TRACKING SYSTEMS

1. Corporate Tracking

The events of September 11, 2001, have increased the awareness of corporate employers to the need to keep track of their employees more efficiently. It was inevitable that new computer systems would be designed for the tasks involved. Initially, there was the perceived threat of 'employee privacy' but this was soon dismissed by both companies and their employees when the benefits were realised. It was reported that in 2001, corporate kidnappings, for example cost companies £300 million a year (see *Business Travel*, 2002). Some companies, in consequence, have developed technology to keep in touch with staff at all times.

The World Bank is one such organisation whose staff make an estimated 27,000 business trips a year, and has consequently implemented a travel alert system called *iJet's WorldCueTraveler* which is able to track employees automatically. Employees of the organisation input information about their travel itineraries into their office computers before leaving. The system receives the information and is designed to monitor staff, passing advice before their actual departure and during the period they are away from the office. The communicating systems use e-mail, or wireless devices such as mobile phones, wearable computers or the handheld variety.

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

Such links enable those monitored by the system to receive advance warnings of civil unrest or information about general travel disruption. *iJet's WorldCueTraveler* is now being updated to cover from 154 to 180 countries whilst doubling its list of African nations reported on by the system. To provide all this up-to-date information the system collates information from some 5,000 sources. These cover such areas as health, entry/exit regulations, security, transport, finance, culture, the environment, legal issues and language.

The issue of employee privacy is still one that is being addressed by companies despite the obvious advantages of being monitored when on corporate business. A spokesman from Archer Daniels Midland, the agricultural multinational reports that none of its 2,000 international travellers believe their privacy is being compromised. Mark Cheviron the Director of Corporate Security for the company says that:

> "We have been using the *iJet's* system for almost two years and the purpose is dual. We use it to track our international travellers, so that we know where they are at any given time in case of emergency, and for providing intelligence to our employees before they get to a location."

2. Employee privacy

Obviously, in the sensitive matter of employee privacy, companies need to consult with those who use their tracking system. The best approach is one where the computerised tracking system is regarded as another useful company information system with employer guarantees that the information it contains is secure and personal movements of its users are available to only nominated senior staff. We are already aware that with many mobile phones their usage can disclose the user's location, but this information remains secure unless there are very compelling reasons for its release. The problems that arise because a tracking system is being used will increase as more and more are put into operation in our automated society. Current projects, for example, to monitor the location of motor vehicles will undoubtedly lead to calls for the safeguarding of the privacy of those affected. Whether, as one scientist has forecast, we will all have not merely identity cards that can be monitored by computer systems but also an implanted chip that will transmit and receive information. Systems of this description were once confined to science fiction but are now slowly becoming a reality. As to the questions of personal privacy it will remain a hotly debated issue as to whether we will be able or allowed to turn-off such a tracking system. It would, of course, as the business technology director of Hogg Robinson, the business travel agency says:

> "The Big Brother syndrome is nearly with us. Five years from now, we could all be tracked wherever we go, all over the world. But how do you use that? Is it something that companies actually want? I think there are going to be some interesting lines drawn."

There is no doubt that the issue of the threat to privacy that modern technology poses cannot be dismissed easily and will have to be part of the brief to any new system designer who is charged with producing such potentially invasive automated tracking devices.

> **Section Editor's note**: Since this report was compiled there has been increased concern about child abduction in the UK and the US. Professor Kevin Warwick, who is the Professor of Cybernetics at Reading University UK, and a pioneer in the use of 'chip implants' has advocated thar parents consider such implants for their children. 'Tracker' implants in theory would allow the location of a human, animal, or machine, but there are still many technical problems to be overcome before such systems are marketed.

FAILURE OF IT PROJECTS

In the United Kingdom the number of failures of IT projects is causing a great deal of concern. Many of the projects in question are multi-million pound (sterling) systems that are required to update or change existing systems, many of them established and regarded as essential for public administration at a national level. Others involve industry and commerce where it is essential that new initiatives are supported by new software developments. In the *British Computer Society Review* (2001) a survey of some 1,027 mainly private sectors showed that only 130 or 12.7% succeeded. As far as software development projects are concerned, of more than 500 projects surveyed only three were regarded as having succeeded. We are told in the *London Times* (14 August, 2002) that a similar situation exists in the United States. A correspondence in that newspaper attempted to give reasons for this dismal and worrying failure. One letter from Professor Martyn Thomas, a visiting professor of software engineeering at the UK's Oxford University Computing Laboratory highlighted some of the main reasons. Profeesor Thomas wrote:

> "I have audited many software projects in both public and private sector organisations and in my experience the many and complex reasons for failures boil down to this: most customers and most suppliers fail to recognise that complex software development is an engineering task. Every step needs engineering rigour, based on sound computer science and supported by formal quality control.
>
> Companies who work this way produce software much closer to their planned timescales and at lower cost. Their customers are asked detailed questions to fix the requirements early in the project, and every subsequent change can be quickly analysed to see what it will cost, in money and time. Their software contains so few errors that maintenance costs are negligible."

He echoes what so many project designers believe, that is, that the global software industry regards software development as a 'craft that requires only technician-level skills'. There has to be a complete change in the way that such projects are handled and in the way in which the software is produced. Unless this happens, as Professor Thomas says, ". . . projects will continue to suffer massive delays and cost overruns".

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

For such a change to occur we need to analyse very carefully all the reasons for failure. When billions of pounds are spent worldwide we do need to consider very urgently what the roots of our failures are and much information about them can only be obtained by examination of both those projects that have been successful and those that have failed so miserably.

ROBOTICS WORLDWIDE

1. France

A new analysis* that covers both United Kingdom and French companies in the Automation and Control Systems industry has revealed a huge difference in performance levels. According to this analysis:

> "The comparisons are overwhelmingly in France's favour. On average French Automation & Control Systems companies are stronger financially with essentially less debt giving these companies an edge. The market is also expanding faster. Average sales growth in the French Automation & Control Systems industry is 14.5%, compared to the UK average of 1.5%."

The financial analyst for the publishers of the report says that:

> "For some years now the UK market has shown very little growth. Any growth by individual companies has been at the expense of others. I believe this has been feeding intense competition and fuelling reduced margins.
>
> The resulting problem is that UK companies have been forced to finance capital and losses to fight the competition. Whereas the French market is booming, levels of debt are well below that of a UK company and the level of profitability is excellent. They (the French) seem to be able to finance growth out of normal cash flow,
>
> Any entrepreneur wanting to cast their net over the Channel now has a solution. Not only does the analysis carry a complete financial profile of every one of the Top 452 French Automation & Control Systems companies, it also carries directors' names, fax and telephone numbers.
>
> The Top 452 French Automation & Control Systems companies is printed in English and analysed in Euros. The layout is exactly the same as that of the UK Top 319 analysis and each of the Top 452 French companies is analysed."

2. Germany

2.1. Technological expertise. It will be appreciated that Germany is a major political and economic force by virtue of its size and its central European location. Dr Wolfgang Axmann writing in the *EUREKA Bulletin* Issue 16, 12, 2002, says that "the country has a reputation as a leading innovator in traditional technology sectors such as vehicle production (automative, trains and ships), chemicals, tool machinery and production engineering and electrical and electronic products." Dr Axmann continues:

> "We have a population of 82 million and an impressive number of enterprises of all types and sizes. That amounts to a great deal of technological know-how and potential, and financial capital. We are also a major market for companies from other European countries and offer foreign enterprises and research institutions considerable opportunities for co-operation and collaboration."

2.2. Innovative ideas. He also points out that Germany's highly developed social security system leads to high labour costs and causes some inflexibility. In practice, this can prevent people with innovative ideas from realising them and they go abroad instead. He says that there is also:

> "a lack of incentive to be innovative – not because of a lack of money for research but because our government has chosen to subsidise basic rather than market-orientated research. Consequently, many organisations find it quite a problem to obtain funding and when they do find it, there are usually too many bureaucratic obstacles in the way to acquiring it. Matters aren't helped by our venture capital market being underdeveloped compared to the UK and the US. It's not that there is not enough venture capital available, but that German companies are not accustomed to considering it as a potential source of financing innovation.
>
> The major portion of R&D funding is directed towards IT projects, although the highest number of projects generated are in biotechnology, medicine and environmental issues, followed by traditional engineering technologies such as robotics and new materials. Transport and traffic-orientated projects are also generating a lot of political interest and incentives.
>
> One of our primary goals is the development of solutions which enable us to reduce freight transport on roads by transferring it to other forms of transportation such as trains and ships. Such activities are carried out under the LOGCHAIN umbrella project, which was initiated by Germany."

Finally, Dr Axmann makes a plea for a much more practical commitment to European corporation on the part of both governments and enterprises. Even so, Germany is still one of the leading member countries of the European Community and *EUREKA* in particular, when it comes to the number of projects generated.

3. Israel

Israel's robotics company, Friendly Robotics, was founded in May 1995 and has been developing robotic devices that can carry out basic chores.* It has already produced a robotic Lawn Mower for the marker some two years ago. The second robotic device produced and being marketed now is a robotic vacuum cleaner. Now, of course, there is

* Published by Plimsoll Publishing Ltd (UK): Telephone +44 (01642) 626400; Facsimile: +44 (01642) 626410.

* Based on a report in the International issue of the *Jerusalem Post* – Digital Israel, 2002.

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

competition from companies worldwide who are also in this market. The company, however, is meeting the opposition and sell their products under its own brand name in the US and in Europe. In 2001 the company changed its focus and the Managing Director, Udi Peless, says that their US sales have slowly picked up. Last year, he claims, the company sold some 15–20,000 units worldwide, and saw between $5 million–$6 million in sales of which 50% came from the US. Despite earlier problems the company believe that they are now in a solid position, Udi Peless says:

> "It is clear our vision of a home robotics market was correct. Home robotics is rapidly becoming a consumer category and there are more and more players trying to compete in the field."

Friendly Robotics say that it has two main competitors: the Swedish manufacturer Husqvarna, which introduced their robotic mower two years before them, and the Italian manufacturer Ambrozia, which introduced its robotic mower this year (2002). The overall market for lawn mowers in Europe and the US is about six million units a year. Robotic mowers are likely to capture some 10%. Vacuum cleaners produce a far larger market. Every year 40 million units are sold. Friendly Robotics will be producing its new robotic vacuum in late 2002, marketing it at about $1000. To stay ahead of its rivals the company say that:

> "To stay ahead of the crowd, Friendly already has plans for further home robots. These include a wet-floor cleaner, which can vacuum and mop the floor, and will probably be introduced in 2003; a robotic snow shoveller; a robotic golf caddy that carries clubs around a golf course, and even a robotic garbage can that finds its own way to the street. The main problem here are the steps. Friendly has the technology, it's just too expensive for a consumer product."

Udi Peless sums up his company's market strategy and philosophy by publishing his belief that:

> "People are looking for liberation from chores. They simply don't want to do these jobs any more. That's how household chores have been going in the last couple of decades. Either you get someone else to do it for you, or you get a robot to do it. In the past it wasn't possible to mechanize this process, because technology wasn't intelligent enough. Now it is."

3. United Kingdom

3.1. Manufacturing gets R&D support

12 university-based Innovative, Manufacturing Centres have been created as part of a Government-backed £60 million manufacturing initiative. Located at Cambridge, Loughborough, Salford, Liverpool, Reading, Warwick, Nottingham, Bath, UCL and Cranfield, the centres will be led by a team of academics and research specialists and will support all aspects of manufacturing from aerospace to bio-pharmaceuticals. The centres will be working in partnership with industry, with a strong emphasis on business processes research to ensure that activities add value and maintain competitive edge in the market place.

3.2. Boost for IT industry. The UK government announced a new £24 million programme to support the UK's computer and information technology industry. A new LINK information Storage and Display programme has been set up to fund a range of collaborative projects between companies and the universities, with the aim of helping UK-based companies to exploit the global market which could reach more than £100 billion by the end of the decade.

Half of the funding is provided by the Department of Trade and Industry and the Engineering and Physical Sciences Research Council.

3.3. Research spin-offs. A UK research report published in the *Higher Education Business Interaction Survey* shows that British universities are establishing stronger commercial links with the business sector. The report says that the universities

> "are involved in more spin-off companies and have an increasing role in economic development. By comparison with North America, UK universities generated one spin-off firm for every £8.6 million of research expenditure, while in Canada the ratio was one for every £13.9 million and in the USA, one for every £53.1 million!"

NEW ROBOTICS PRODUCTS

1. New software for industrial robots

TM Robotics, the partner for *Toshiba Machine* Industrial robots in the European market, has announced new simulation software for its full range of robots. Developed by BYG Systems of Nottingham, the new software is a Toshiba version of *BYG's Grasp2000* software. This is a 3-D simulation program that gives users the opportunity to generate off-line simulations of robots, thus reducing downtime and increasing profitability. The company say that:

> "BYG's *Grasp2000* can generete specific application menus for arc welding, palletising and spraying. The program allows the user to validate and optimise programs off-line for reach evaluation, joint constraints and cycle time calculation. Programs can be downloaded directly to the robot in the appropriate software language.
>
> An important factor in off-line programming is the inherent inaccuracies of most robots (not to be confused with their repeatability). *Grasp2000* counters this with in-depth mathematical calculations to calibrate both robot and 3D model to match the real world. It only requires the demonstration of a number of robot poses, which are then read into *Grasp2000* and analysed by the calibration software."

The Toshiba version of the *Grasp2000* uses a Windows™ style interface and menu system with easy to interpret icon-based toolbars. It offers full configuration checks, dynamic collision and near-miss detection. It can support simulations of multiple robots and synchronised external axes. The

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

software offers macro driven, real-time, interactive simulation and playback for the presentation and demonstration of results. *Grasp2000* uses accurate robot and work-cell collaboration techniques and requires no external measuring equipment.

The software will find applications in PC-based cell lay out and design, analysis, offline programming and process planning throughout the full range of Toshiba SCARA robot applications.

Spokesperson from TM Robotics* says that the company believe:

> "This piece of software is enormously versatile and must inevitably lead to massive savings in downtime, surely the biggest problem facing manufacturers today."

The development company BYG Systems say that they have worked successfully with Toshiba on this project and consider that the inclusion of their robots in the *Grasp2000* software lends it further depth as well as adaptability.

2. De-flashing robotic tool

The range of de-flashing tool solutions from †Tatem Industrial Automation Ltd. has been extended to include Flexifile 2000. This is a high-spec compliant product which can be robot or even tool-stand mounted. It has been designed for use in de-burring, fettling and flash removal from aluminium diecastings, and is ideal for use in a wide range of general engineering applications including the automotive, aerospace and defence industries.

Standard files and needle files can be used, and the file tip is compliant in all directions with radial springs providing the filing pressure. The reciprocating speed is fully variable and can be remotely adjusted by the robot or separate controller. The degree of compliance can also be similarly tuned to suit the work in hand, from virtually rigid for harder materials down to highly compliant movement where more delicate products are involved. The company believe that:

> "The Flexifile 2000 can be used in any orientation and is particularly suited for high production conditions for both metallic and non-metallic products. It is well suited to the removal of internal and external burrs on castings or small parts, and provides easy access to narrow slots and groovest."

3. Waterjet cutting using ROIbot

The producers‡ of machine robots have extolled the virtues of ROIbot which they say:

> "is part of the Toshiba Machine robots in the TM Robotics Series that uses a modular building block design, allowing single/multiple axis configurations.
>
> Among a variety of applications, this makes the ROIbot ideal for operating a water jet cutter, particularly in the textiles and plastics industries, as well as in the aerospace industry, machine shops, die-casting, metal stamping and food preparation.
>
> The system can be used for normal cutting, using standard tap water, or abrasive cutting, using water mixed with solid particles. The properties of the cut can be adversely affected by changes in cutting distance or the speed of cutting and, as a result, the ROIbot provides very accurate acceleration and deceleration, as well as consistent speed of movement and excellent repeatability."

One of the biggest issues to be addressed is controlled acceleration, particularly in abrasive cutting. The company state that:

> "Indeed, controlled acceleration is the biggest issue that has to be addressed, particularly in abrasive cutting. The more precise the cut needed, the more efficient the acceleration must be. This is because the abrasive jet is a 'floppy tool', and is prone to wander during machining. On straight-line cutting, this translates into a "lag" in the cut. This 'lag' isn't a serious issue when cutting in a straight line, but becomes critical when the cut approaches or exits a corner. As the jet approaches a corner, the motion must be accurately slowed down, in order that the bottom of the jet can catch up to the top, and remain perpendicular to the material. If this can't be achieved the result will be an inaccurate cut."

ROIbot, we are told, can be used in conjunction with the Toshiba SR7000 controller which has:

> "a 'smooth' function facility that allows the corners to be completed without concern for lagging. The smooth function also finds use in sealing and gluing, where it controls the precise application of adhesive. This eliminates the non-uniform 'dumping' of glue which results in eliminating unattractive blobs along a seam or in corners. This is vital in the manufacturing of domestic goods where appearance is paramount."

Up to four controllers can be connected together in a multitasking system and each one can accept a pulse train input for movement commands, allowing an external motion control system to be easily integrated. As an option, the unit can be supplied with the TPH-2A teach pendant, which connects to a main controller and serves as an alternative programming device. It also provides the controller with home position; start, stop, reset and emergency stop instructions. It can display alarm conditions, current program step and current position data.

Further options include clean room and dust resistant versions as well as regenerative discharge units.

* TM Robotics (Europe) Ltd., Concord House, Grenville Place, Mill Hill, London NW7 3SA (UK).

† The tool is part of an extensive range of de-flashing tool solutions available from: Tatem Industrial Automation Ltd. – website: www.tatem.co.uk

‡ T. Robotics (Europe) Ltd. Tel. +44 (0)20 8778 1900; Facsimile: +44 (0)20 8959 0081.

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

4. Robots with new high precision electric gripper

A new range of electrically powered grippers has been developed by the German engineers Sommer Automatic. Leader Grippers offers cleaner work handling on robots.

The electric gripper, we are told, is a robust, precision instrument, featuring a potentiometer to adjust the gripping force rather than less accurate pneumatic controls. It does not require a pneumatic supply so that the risk of contamination from dust and fluids generated by airlines is eliminated. In consequence, in many situations the grippers offer the ideal solution for the design engineer involved in using robots and similar automation equipment for use in a clean environment for handling operations.

The gripper assembly includes a DIN rail-mounted controller. It need only be wired directly to a PLC for instant use.

The model is GED and is both compact and lightweight. It has a 3-jawed GED (in four sizes) and a choice of T-slot for larger loads or sealed round guide jaws for other applications.

The gripping forces range up to 360N and the open/close time is just 0.2 seconds. Supply is 24V as standard but the company say a 12v supply can be specified.

ULTRA WIDEBAND TECHNOLOGY

1. Ultra Wideband (UWB) technology – new advances

Whilst, as readers may know, Ultra Wideband (UWB) technology offers speedy, efficient and secure communications, it has also brought much controversy over its use. It is no longer a question of using the technology for linking computers and other electronic devices alone; a variety of other applications have become possible. Anyone concerned with privacy issues will already be aware that the technology has produced the extraordinary ability to see through walls up to 8 inches thick. This may be regarded as an advantage if you require to track a person's movements through any of our more popular building materials such as brick, concrete or steel.

What UWB does is to use lower-frequency pulses unlike the conventional radar which relies on high-frequency waves to produce fuzzy images, The result is that clearly defined images can be produced. A report from the USA says that:

> "... widespread use of the technology will allow strangers to see 'right into your bedroom'. Some US police forces have been testing special UBW 'torches' that can peer through walls to locate hidden criminals or weapons."

UBW was developed in the United States so their experiences and applications are of importance to the rest of the world. US reports say that:

> "Companies developing such devices have pointed out that they could help rescue teams to locate victims trapped under collapsed buildings and even detect heart beats in an earthquake zone."

The misuse of the new technology has already hit the media and some of its potential uses have produced great concern. The American Civil Liberties Union, for example, is concerned that the technology will be used by police conducting a 'high tech. strip search'. Its use for airport security is also under attack. The great benefits of UBW have also been highlighted and companies developing UBW devices, such as the US Time Domain Corporation, Alabama, are pressing for its widespread introduction.

2. A replacement for mobile phones

We are told that the next generation of internet-connected mobile phones could be replaced by UWB designed systems. UWB does not require a costly delicate radio frequency or new infrastructure. Instead it is able to send short pulses of data across a wide range of the allocated radio spectrum. In consequence, it could offer fast and powerful signals that are almost impossible to intercept. Although the signals, we are told, are currently only able to travel some 30 feet, which is much less than the present wireless "home networks", they are strong enough to carry high-quality video and audio. As a result, companies involved with cable television see UWB as a technology that will enable them to enormously increase the band-width that is available.

3. UWB forecasts

It will be the chip companies that will accelerate the growth of UWB. Many computer technology companies have plans to build-in this new technology into their chips. Many UBW devices based on this technology will be marketed in the coming years. One forecast given by the US market analysts, Advanced Strategies for Integrated Solutions, says that there will be 274 million UBW devices based on this technology available for use within the next five years.

4. Safety concerns for UWB-based products

There is concern about the unrestricted use of UWB devices. Claims, for example, that their use will pose safety risks to aircraft have already been made. It is also pointed out that UWB could interfere with transmissions of the Global Positioning System (GPS) network of satellites. This System is already very sensitive to interference and a number of organisations have expressed their concern, which may lead to them being banned in certain areas and applications.

The UK's Civil Aviation Authority has said that:

> "Portable electronic devices such as laptops and personal organisers might have to be prohibited because of the risks posed by ultra wide-band."

In the US it is reported that UWB devices disabled collision-avoidance systems which warn the pilot of an aircraft of the presence of converging aircraft and the instrument landing system that guides aircraft to runways in bad weather. This research is, however, ongoing and at the

https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press

moment the Civil Aviation Authority do not regard the tests that have been carried out in the USA as necessarily conclusive.

Decisions will have to be made quite soon on whether to ban such devices in certain environments since the first of such devices are due to appear by the end of 2003. Although UWB was developed by the military researchers some 30 years ago it was only approved for commercial development by the US telecoms regulator in February 2002.

Until this technology meets the most stringent requirements for aviation safety, devices based on UWB may be banned on aircraft or controlled in the same way as some current electronic products.

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https://doi.org/10.1017/S026357470200454X Published online by Cambridge University Press