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Reports and Surveys

AUTOMATION APPLICATIONS

1. Monitoring system for pipelines

A fibre optic-based monitoring system that is capable of detecting leaks in oil or petrochemical pipelines is being tested at the University of Wales at Bangor, North Wales (U.K.). Developed in conjunction with a fibre optic cable manufacturer, Pinac Communication Systems (U.K.), the newly developed device is said to represent the cutting edge of sensor technology. It is expected to provide a reliable safety system for industries operating long or complex pipeline systems.

A University spokesman says that the sensor as designed to detect hydrocarbon liquids, namely fuels, oils and chemical feedstocks which are routinely refined, processed, pumped and stored in vast quantities. He said that:

"The system under development will be able to monitor up to 10kms of pipeline and immediately identify the exact location of a spill or breakage to within a metre along its length.

It is vital, for the protection of both environment and industry, that a reliable, cost-effective monitoring system is in operation to quickly identify leaks or spillages as they occur, yet still be rigorous enough to survive the widely differing conditions that will be encountered during its operational lifetime. This project aims to satisfy all these requirements."

2. Automobiles are safer and faster with 'intelligent parts'

New systems are now being introduced in the design and production of vehicles that make them both safer and give them an enhanced performance. Such systems are the results of the work of researchers who believe that using sensors can improve handling:braking and acceleration, automatically.

The Bosch company, for example, are working on 'intelligent solutions' that they believe will make airbags even more important as life-savers. Sensors can, they say, when set around a car, for example, detect the type and intensity of a potential crash. This would involve the sensors providing information in a 'split second' about a possible head-over or roll-over situation. Such a sensor-based system would also be capable of working out the position and the size of the vehicle occupants. A Bosch spokesperson says that:

". . . it can then compute the best strategies for individually deploying both airbags and seat belt tensioners."

Sensors placed in the crumple zone just behind the front bumper would be able to send signals to an airbag's 'central control' to indicate the scale of any impact. This would allow the automatic control to inflate the airbags in different combinations, and the airbags in one, two or simultaneous stages according to the perceived need. Other sensors in the vehicle seats tell the central control where people are positioned and whether an occupant is a heavy adult or a child. This would, of course, affect the sequence of airbag deployment and sensors can be positioned in a child-restraint anchor point. Bosch says that further research is taking place to develop a radar system, which they believe will, in time, predict distance to the impact object, relative speed and impact angle.

The Bosch company say that:

"Transferring all this new information could also require a great mass of extra wiring to be housed within the bodywork. We are working on a digital communications network that dramatically reduces the complexity of the electrical system. It also enables input and command data to be processed more efficiently."

The Bosch company is but one of the many innovating organisations involved with the incorporation of 'intelligent' systems into vehicles. Such systems rely on sensors of all types to provide the essential information to on-board computing systems which have the developed software to process, analyse and make decisions that affect both safety and performance.

3. Innovative automated health checks

Automation of health checks has now taken yet another step forward. An innovative body vest that has been designed to monitor the wearer's health has been developed in California (U.S.). Called the *LifeShirt* it continually checks and measures vital bodily functions such as blood pressure, heart rate, and breathing patterns. The current prototype vest has six battery-powered sensors that have been built into a cotton lycra fabric and each one checks different parts of the body. The information the sensors collect is then transferred to a small, hand-sized computer which is worn on the patient's belt. Gathering data in this way is, perhaps not an unusual process in this technological age when similar belt-held sensors are attached with their computers, to monitor individual bodily functions such as blood pressure. What makes this new device innovative and important is that it collects so much data about the body in an acceptable manner. It is hardly as uncomfortable to wear as some of the present sensor/computer devices. It has the advantage, too,

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of being able to transmit the captured data via the Internet for analysis by doctors and technicians. They are then able to evaluate the data and contact the patient or his/her family should there be any cause for concern.

The vest weighs the same, we are told, as conventional clothing and will currently cost some £160, with a monitoring cost of about £19 a day. The developers of *LifeShirt* say that it can easily be worn under a shirt, at work, at home, even in bed and during sporting activities. Of some importance is the fact that it is said to be handwashable and reusable. The developer of *LifeShirt*, Dr Marvin Sackner is a lung specialist and in a recent interview said that:

"*LifeShirt* will give a more accurate picture of a person's health than recordings taken during medical checkups. It is more like a film than snapshot. We can look at what is going on when you are at work in a stressful situation and when you are sitting at home in a relaxed environment. If you are anxious it can detect the number of sighs and the depth of your sighs as well as your heart rate."

No one is suggesting that the technology to monitor these functions does not exist in medical centres and hospitals; it is the miniaturised systems, such as *LifeShirt* that is both convenient, portable and consequently an attractive device.

The potential uses of such an innovative system are many. In particular, those who are likely to benefit immediately include people with high blood pressure, those with anxiety problems and anyone in danger of heart failure. Asthmatics are also likely to make use of the system, and, indeed, any patient whose condition needs monitoring after an operation or who require pain management.

The manufacturers of *LifeShirt* have provided the following details of their product:

It works 24 hours a day, seven days a week and can predict a crisis before it happens. The six sensors that provide the body data are positioned from the neck to the abdomen, including a posture sensor and four 'plethysmograms', which access various blood and respiratory flows, at the neck, ribcage, stomach and chest. They monitor 35 types of bodily function derived from heart activity, breathing patterns and blood pressure. It can even measure the difference in expansion between the left and right sides of the thorax, which is symptomatic of fluid in the lungs and it can pinpoint cases of sleep apnoea – where people stop breathing many times during the night.

The actual processing of the data captured is from its storage in a digital recorder, currently downloaded every 24 hours and analysed. Presumably, there is no barrier, technically, for the data to be both monitored and transmitted, if necessary at other time intervals. The system appears to be versatile and the information received, depending on the circumstances can be despatched to a secure website where it can be analysed and assessed by the appropriate medical team or, indeed, by the patient or his/her local doctor.

The product is, we are told, currently on sale and has been generally welcomed by medical associations and patient groups. Some doubts and warnings about its general use have been voiced. One main concern is the security of the information being sent over the Internet. This, however, is not a concern that is confined to medical information, but to Internet use in general. The other concern is that since the human body is a complex organism, what functions should be monitored? The current six, which are:

- Jugular pulse monitor
- Blood flow to chest monitor
- Posture Sensor monitor
- Thoracocardiogram (measure changes in cardiac output)
- Respiratory rate and sigh counter
- Abdominal Sensor (to monitor volume of air expired)

provide a great deal of information; other potential applications will demand many more and will use the new automation techniques and devices that are continually being marketed.

AUTOMATION NEWS & REPORTS

1. Robots hit all-time high

A British Automation & Robot Association (BARA) report says that:

In 1999 worldwide orders for robots were up 20% on 1998. This is seen as a major drive to automation by Jan Karlsson, of the UN Economic Commission for Europe which together with the International Federation of Robotics surveys the international robot market. In the UK, BARA, the British Automation & Robot Association collates the robot figures.

This global position masks some significant differences between individual markets. North America is up a massive 60% while Europe shows a more modest 12% although this follows a dramatic 31% increase in 1998. Following the economic problems of the Pacific rim countries, Asia remains way down.

As would be expected the automotive industry made a major contribution with a 24% increase over 1998. Other manufacturing industries increased by 14% with the Food Industry playing an increasingly important role.

A number of factors account for this accelerated move to automation. Globally there is a move towards a shorter working week with many countries heading towards the 35hr week. One way to maintain productivity is to accelerate the move towards "lights out" manufacture. Here the robot has an obvious role.

Costs also play an important role in the increased use of robotics. If the indexes for robot and labour rates are both set at 100 in 1990, by 1998 robot cost has dropped to 60 and labour rates increased to 130.

In real terms this means the cost of robots compared to labour is now less than half what it was in 1990. Think what that means, any robot project that was marginally profitable 5–10 years ago? Today it is an absolute "earner". That's why 1998/99 have seen an explosion of robot sales and into new applications outside the main automotive car body welding and pressing lines.

The other major benefit is that robots epitomise soft or flexible automation. This gives the user the option to switch

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between different products or quickly introduce new product designs. In fact, just about everything you can't do with special purpose, or dedicated automation.

Hard or dedicated automation is without doubt highly productive, but it is out of step with today's environment of short lead times, JIT deliveries and ever reducing product life.

Further information from: British Automation & Robot Association, Aston Science Park, Love Lane, Birmingham, B7 4BJ (UK). Tel: +(0)121 628 1745. Fax: +(0)121 628 1746.

2. World's largest palletising robot?

Reports describe the launching of the world's largest palletising robot. With a massive maximum payload of 400kg it is currently being marketed by the Coventry-based Fanuc Robotics. The M410iWW, as it has been designated, can, it is reported, move at a surprisingly high speed considering the mass that is involved in its operations.

Fanuc Robotics say that:

"It can perform up to 730 standard cycles/hr. This comprises a 400mm lift, 2000mm horizontal traverse followed by 400mm down. With such a lifting capacity, it is the ideal solution for 'complete layer' lifting of cases of bottles and cases of food stuffs. "Other applications include large wood panels, steel and wire bales as well as a major automotive sheet metal panels such as the under body pans."

The company says that the robot arm sits on a pedestal with the JI axis rotating through 360° for all round success. The control system is contained within the pedestal which, it is claimed, greatly simplifies shipping and on-site installation.

Using the 360° rotation, one robot can service a number of in-feed and palletising stations. Pallet envelopes can be 1600×1600 mm square by 2100 mm high; alternatively higher 1300×1300 square by 2450 mm high pallets can be configured.

There is a hollow wrist mechanism at the end of the arm where pneumatic and electrical services to end of arm tooling can be routed. Internally carried services are better protected from chaffing or twisting.

The increased capacity has been achieved by optimising the arm design. It is twice as rigid as the previous model without any increase in weight. This can be translated into load capacity rather than increased mass of the moving parts of the robot itself.

The robot follows the same configuration of other Fanuc models with an overhung arm. This means the robot always accesses the in-feed or pallets from the upper surface. With a general purpose articulated robot there is always the risk of collision with the front of the pallet, when reaching to the back. The Fanuc M410iWW configuration eliminates this possibility.

The robot can utilise the Fanuc Pallet Tool software that allows the operator to optimise palletising patterns based on the pallet size and box size. A graphical user interface enables the operator to review stacking options without any specialised programming knowledge.

More details from: FANUC Robotics (UK) Limited, Seven Stars Industrial Estate, Wheler Road, Coventry, CV3 4LB (UK). Tel: +(0)1203 639669. Fax: +(0)1203 304333.

3. Robotic cell for automated packing and handling

Making its first appearance at the BPC exhibition this year, *Motoman Robotics (UK)** demonstrated its SP-100 robot, specifically designed for palletising applications. It is a 4-axis CNC servo-controlled model whose rigid design supports high sped movement of heavy payloads up to 160 kg.

Inside the SP-100 arm there are two separate air channels for supplying pneumatic power to the grippers as well as a 23-wire cable as an electrical supply. As an alternative to pneumatic and servo grippers, vacuum and forklift versions are available. All are normally configured for performing multiple operations.

A close-up of a Motorman robot packing bottles in an automated handling cell of the type exhibited at the BPC 2000 exhibition.

Off-line programming is assisted by user-friendly, Windows-based software developed by Yaskawa, the Japanese robot manufacturer. Basic system and load data are input and a stacking pattern is either selected from a library or created by a drag-and-drop techniques. Sequences may be simulated before the program is loaded into the robot controller and a 3D model is created on the colour screen to check for interference, palletising pattern and cycle time.

Accurate repeatability of movements makes these robots ideal for automated handling applications, especially in the bottling and packing industry. At BPC 2000, the SP-100 will be fitted with a multi-head to show the ease with which bottles can be transferred accurately and automatically from a conveyer into crates. When full, the creates will be stacked onto a pallet by the same robot, thus forming a flexible, low, cost, integrated handling cell capable of high throughput rates.

The controller will be the Motoman XRC, which is the first to be able to control 27 separate axes simultaneously – sufficient for orchestrating the actions of three 6-axis robots and synchronising them with conveyors and other peripheral equipment.

The Danish company, Anker Andersen A/S, which is sharing the stand with Motoman, will be supplying the specialised conveyor systems. Engineers were present on the stand throughout the exhibition.

A typical bottling application is illustrated in the accompanying photograph. It comprises a guarded, interlocked cell in which a Motoman robot takes bottles from a table-top, roller chain conveyor and places them into cases on a separate conveyor. The latter has two accumulation zones and a 30 degree tilt station to facilitate insertion of the bottles into the crates. Options include mechanical instead of pneumatic grippers, bar code reader, label printer/applicator and a choice of conveyor types including stainless steel versions.

* Motoman Robotics (UK) Ltd, 1 Swan Industrial Estate, Banbury, Oxfordshire OX16 8DJ (U.K.). Tel: +(0)1295 272755. Fax: +(0)1295 267127.

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Fig. 1. Close-up of a Motorman robot packing bottles in an automated handling cell of the type exhibited at the BPC 2000.

Motoman's presence at BPC 2000 reinforces the company's expertise in automated handling in the food and beverage industry throughout Europe.

4. Microsystems and nanotechnology

A report from the University of Birmingham (U.K) predicts that Nanotechnology will one day enable complete control of the structure of matter, thereby facilitating the building of complex microscopic objects with molecular precisions. The reports says that:

"Micro-scale devices (MEMs) are soon to emerge as the mechanical sector's equivalent of the silicon chip and are already the subject of intensive research in the US, Europe and the Far East. Thanks to a grant of £639,000 awarded by the Joint Research Equipment* Initiative (JREI), a total of £1.4M has now been raised by the University of Birmingham to fund its own intensive research.

The study team is led by Professor Philip Prewett from the University's School of Manufacturing and Mechanical Engineering and they will carry out research into the study of Microsystems and Nanotechnology.

The study has been awarded funds under an interdisciplinary programme including projects ranging from microelectromechanical 'MEMs' robotic microsystems to flat panel imaging displays, high speed vacuum microelectronics and microscopic implants to restore hearing. But Professor Prewett and his colleagues, Dr Mike Ward and Dr Kyle Jiang will use the money to assist the purchase of two key research tools for the team's new 'NanoFab' cleanroom.

* Joint Research Equipment Initiative is a body funded by the Higher Education Funding Council for England.

The first of these tools is the EBL 100 from Lecia Lithography Ltd, Cambridge – a state of the art electron beam fabrication tool, capable of writing patterns on the nanometre scale (a nanometre is a unit of measurement equal to a billionth of a meter, the level at which individual atoms can be measured), using a beam of electrons accelerated to an energy of 100,000 electron volts.

The second tool, an inductively coupled plasma etcher, is used to produce microscopic mechanical components in silicon.

The researchers will be engaged in pioneering research and the leader Professor Prewett believes that:

"This combination of advanced tools for writing and etching provides the Birmingham team with a unique capability for rapid and flexible manufacture of experimental microsystems. We have begun an ambitious programme of interdisciplinary research with a network of collaborators and the JREI grant provides us all with just the kind of start we need to succeed in this new scientific venture."

The programme under which the award was given is 'Networked Microsystems Research and Development in a Manufacturing Environment'.

For further information: Professor Philip D Prewett, Lucas Professor, School of Manufacturing and Mechanical Engineering, +(0) 121 414 4193 P.D.Prewtt@bham.ac.uk

BRITISH AUTOMATION AND ROBOTICS ASSOCIATION (BARA)

The British Automation and Robotics Association (BARA) has moved to the University of Warwick (U.K.). Dr Ken Young of BARA writes that:

British manufacturing robots are not attracting enough bright young people to take an interest in their current use in

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industry or their future development. Those humans who care about the future of manufacturing robotics in the UK have decided to move their British Automation and Robotics Association to the Warwick Manufacturing Group at the University of Warwick, to use its global contacts and formidable technical reputation to draw more interest to British robotics from the leading technical, academic, and business figures and organisations.

Dr Young will lead a partnership of the Warwick Manufacturing Group's automation application research group and BARA at the University of Warwick. This will allow BARA to utilize the Warwick's Manufacturing Group's facilities and draw on its global reputation among manufacturing companies to win much of the ground lost in recent years to other countries.

It is well known that the UK has been overtaken in its use of automation technology by a number of nations, including Spain. Dr Young believes that:

"If we are to maintain any manufacturing industry here it is important that this trend is reversed. This link will make independent advice on robot application available to industry and will ensure that automation is used appropriately."

One of the main problems facing the manufacturing industry, and manufacturing robotics in particular, has been the lack of quality people wishing to get involved. This is caused in the main by the poor image most people have of the industry. It is believed that BARA's new partnership with Warwick Manufacturing Group will help *"built on the interest that has been created in robots by television programmes such as "Robot Wars"* and attract a stream of technically capable graduates.

For further details please contact: Dr Ken Young, BARA, c/o University of Warwick. Tel: +(0) 24 7657 3742. Mobile: 0777 5534345. E-mail: bara@bara.org.uk www.bar.aorg.uk. Tel: +(0) 24 76 523 716.

COMPLEX FOR THE INFORMATION AGE

Complexes of houses in the USA are now built to include the facilities demanded by the information age. It would appear that whereas the American 'dream home' that featured all the latest 'mod-cons' is as attractive as ever, houses with the latest 'high tech' systems are becoming more and more essential for families that regard using these facilities as a normal way of life. Houses are now being designed and built which are already fully equipped not only for the currently available innovative devices but also for those that are predicted to be developed for the coming decades. Similar projects are being engineered in many parts of the world. Recently developed residences in London (UK), where the latest high-tech gadgetry are installed, are typical of the new movement of society into the information age. Most feature sophisticated communication devices which enable a wide and diverse range of applications to be included in the structure.

In Los Angeles, we are told, developers are marketing complexes of houses starting at prices of some £6.3 m (about $10 m). The builders claim that they are so sophisticated that they will telephone their owners anywhere in the world if the temperature in the wine cellar drops too low. They will also efficiently water the garden while the residents are away. It is reported that already some 5000 people have indicated that they will bid for the 79 homes in a seafront development. The idea of 'high-tech' estates is, apparently catching on in many parts of the US, particularly in Texas and Florida. It has been suggested that the great interest generated is yet another sign of the public interest in the US for all things involving technology in the home, particularly at a time when the Internet is receiving so much publicity. It is, of course, the continued economic prosperity of the US that allows such products to be purchased.

At present communications systems tend to be linked to the existing telephone subscriber lines which are digital (DSLs) and provide permanent internet access. All systems are also designed to be linked to a centralised computer. With appropriate communications links built into the house a range of household appliances and systems can be monitored and controlled. Stereos, garage doors, swimming pools, security surveillance systems can all be computer controlled by the specially designed software. On offer at the Los Angeles complex is the option to the house buyer of a customised door that dispenses with keys and uses a fingerprint or facial recognition device to control entry and exit. The designers say that as technological advances become viable they can be included with additional chips performing the necessary functions. It would appear that in the new millennium complex everything can be linked to the 'home director' computer systems, and increasingly sophisticated devices will lead to the creation of the much talked-about automated house which has both dynamic and static machines. The house director may, indeed, have a degree of intelligence and the ability to make decisions that could well be carried out by domestic robots.

FUTURE SUPERCOMPUTERS

1. The place of the supercomputer

Such is the pace of the development of Information Technology, particularly in relation to the Internet that many so-called computer experts have shown little interest in the development of the Supercomputer. The time, we are told, of the super-cruncher is over; it is now the 'cyber-age' when only the PC and its communications links are of importance. Most scientists and researchers know better, and the need for super-fast computers that are capable of tackling the enormous problems that we have yet to solve is as great as ever. The reason is quite simply that most of today's computer users do not have problems to solve that require tremendous computer power. A recent survey showed that a high percentage of computer 'experts' of today's generation of graduates had never tackled a 'real' problem on a computer that needed the use of a sophisticated programming language. Someone else had always provided the software that was required and invariably the machine used was a standard PC. They have yet to appreciate that some scientists have problems that existing software cannot define and current machines are not powerful enough to handle.

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Such problems, for example, occur constantly in research modelling. Researchers in biotechnology require to produce research models involving human proteins and the availability of faster super-computers could speed up the design of new drugs for the pharmaceutical industry. Many other fields of endeavour are struggling with problems that cannot be tackled unless there is a breakthrough in the design of our supercomputers so that their performance is vastly improved.

2. New developments in supercomputers

There are now indications that the main manufacturers of large mainframe machines are developing computers with such greatly enhanced performances, IBM has announced that is investing some $100 million (about £60 m), in its development project to produce a new supercomputer. It is to be, the company claims, 500 times more powerful than today's fastest machines. It is called *Blue Gene* and its tremendous computing power is expected to be 1,000 times as great as IBM's *Deep Blue*. It will be recalled that IBM's *Deep Blue* was the machine that taxed the world's chess masters and beat the world's champion Garry Kasparov in 1997.

It is also of significance for today's 'expert' PC users to note that the planned machine *Blue Gene* is to have a power which is 2 million times as great as a current desktop PC.

IBM Vice-President, Ambuj Goyal said of the machine:

"We think a tremendous gain in performance will be made possible by the first major revolution in how computers are built since the mid-1980s."

The company has described the new supermachine as having more than one million separate processors, each capable of one billion operations per second. The whole set of computer processors will work together in a single 2,000 square foot machine.

At a new York launch IBM's Senior Vice-President of research, Paul Horn, displayed a model of the circuit boards that will go into *Blue Gene*. Each will contain 64 1 gigaflop chips, and about 1,000 boards will be built into the machine. IBM said that it expects to take between 4 to 5 years to build the new supercomputer which the company claim will perform 1 million billion mathematical operations a second. One innovative feature of this powerful machine is that it is to be 'self-healing', that is, it is designed to be able to detect failing components, seal them off, and direct the work elsewhere.

But will it be powerful enough to tackle some of the enormous calculations that await processing if we are to deal with even the tip of the iceberg that has emerged in our research? Simulating the building of proteins in the body, for example. One report from an observer at the launching of *Blue Gene* assesses its challenge as 'daunting'. Proteins, it was said, start out as long strings and fold themselves to a specific shape that determines their function in the body. This process takes a fraction of a second. It was calculated that even with the great power envisaged for IBM's *Blue Gene* it would take a year to calculate how such a typical protein folds itself.

There are, however, many reports of projects that are designed to produce new 'revolutionary' computing machines with new technology and new architectures which may well change the way in which we tackle these enormous calculations. These systems are still speculative in concept and design. IBM has, however, shown us the blueprint of an actual machine that is to be built. There is no doubt that it will make an enormous contribution to science and, in particular, to our understanding of so many aspects of science that will illuminate the 'secrets of life'.

MORE DEXTROUS ROBOTS

The advances in the designs of the new breeds of robots have produced faster and more dextrous devices. One such example is the replacement of the SK series of articulated-arm robots that were produced by Motoman Robotics* by a new range, designated the UP series. The company say that:

"Each model has a significantly larger working envelope than its predecessor, and that the Motoman UP series robots have increased reach and speed in most axes, enabling a wider variety of applications (see Figure 2)."

Another feature highlighted by the developers is the flexible conduit which routes all services from the base to the upper arm, eliminating trailing hoses and cables. It is claimed that:

Whereas the upper arm of SK robots was controlled via a linkage, UP models have direct drive on all axes, allowing greater speed, accuracy and reliability. A wider variety of applications may therefore be undertaken in the fields of welding, handling and machining.

There are eight models in the range with load capacities from 6 to 400 kg. As with all Motoman reports, they enjoy simplicity of programming and smoothness of action together with the backing of a wide range of supporting software.

To illustrate the increased functionality of the robots, the mid-range model UP-130 can carry a payload of 130 kg, 10 kg more than its SK equivalent, and repetitive positioning is twice as accurate at ±0.2 mm. A notable improvement is the research of the upper arm, which extends from +240° to −130°. Comparable U-axis movements for the SK model were +35° to −115°. Improved also are the roll and twist of the wrist which now have full 360° rotation, increasing the robot's dexterity. Previously, these R and T axes fell a few degrees short of turning full circle. Speed in all six CNC axes is higher. For example, the entire robot turns on its own axis nearly one fifth faster at 130°/s, whilst wrist roll is 43 per cent faster at 215°/s. Part of the reason for this enhanced performance is the lighter 1,300 kg construction, compared with 1,500 kg for the SK. However, the strength of the UP has not been compromised and indeed it can withstand higher moments of force and inertia in the three lower axes. Alongside the launch of the UP series, Motoman has introduced a new, 27-axis con-

* Further details: Motoman Robotics (UK) Ltd, Banbury, Oxfordshire OX16 8DJ (U.K.).

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troller, the first to be capable of handling three 5-axis robots and synchronising their movements with a variety of other equipment such as gantry systems, linear tracks and rotary indexers. This in itself is an example of what is being marketed as faster and more dextrous robots.

NEW DOMESTIC ROBOTS

1. Progress in the domestic applications of robotics

Robots, we have been told for over a decade, will take over our homes, they will carry out all those routine tasks that householders find boring or unpleasant; it is only now, however, that that prediction is slowly being shown to be true. Although a great number of domestic robot prototypes have been described to us, very few proved to be marketable for the home. Last year a robot mower was marketed for use in domestic gardens. We have yet, however, to learn whether it proved to be a viable investment for both the maker and user. Probotics, the US company has already introduced in 1999, a robotic butler who was called *Cye*. The prospects for the venture seemed good and at a cost of £500 it could well be a popular addition to the home appliances that are now so easily acquired. Even Sony has been testing the market and has produced for sale a robotic dog called *Aibo*. Other commercial ventures are in the offing and predictions that our homes will be staffed by automated devices and mobile robots may well be true, but more likely at the present rate of introduction, such a scenario will not occur until 2020 rather than 2001.

2. New robot cleaners

Progress has been reported in another area of domestic importance. Robot cleaners are now not just prototypes but actually available for purchase. The company Dyson is currently offering a robotic vacuum cleaner and there are

Fig. 2. Motoman UP Series robots have increased reach and speed in most axes, enabling a wider variety of applications.

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hopes that the prototype cleaner publicised by Electrolux will be marketed.

Dyson's new robotic vacuum cleaner is on sale for £2,500. The company was the first to invent a vacuum cleaner without a bag and now once again it seems to have beaten its commercial rivals.

The target date for selling it was 2000 and it is marketed under the name Dyson DC06. The company claim that not only does the user not need to push it but once set it will move around a room avoiding any obstacles whilst it cleans the floor. It is a battery-powered machine and its rechargeable power pack will keep it running for half an hour. This is enough, the company claim, to clean several rooms. The machine has two settings. The lowest, we are told is 0.25 metres per second and at this speed it is capable of covering a room that is 3m by 4m in 11 minutes. The actual recharging process, the company say, takes about an hour. Dyson's also say that the cleaner does not need programming and they say it could cover any part of a room. It has been equipped with a 'floating head' which is designed to get the machine into tight corners. It also takes a spiral route to ensure that it gets to every spot.

The latest advances in robotics are included and it incorporates a number of features that could only have been developed from the work of researchers in this field. It has, for example, a set of more than 50 sensors feeding 3 onboard computers to assist its navigation. The company say the technological design is such that it can make 16 decisions a second, navigate without hitting furniture, children or, indeed, pets. It is also programmed so that it can work out when it is approaching the top of the stairs so that it is not in danger of falling down them.

The company have to admit, however, that the user has to empty the dust. There is therefore going to be a market for the first developer who can design the 'self-emptying' robot-vac. The robot looks extremely compact with the main part of its body housing the dust receptacle; propulsion appears to be from two wheels set at each side of the device. Dyson do not expect the price to fall in the near future. We all await the outcome of its introduction.

3. Home-care robot

Our industrialised societies are tackling the problems that ensue from population changes. In particular, where a society is ageing great difficulties are experienced in providing care and other resources for looking after the old and inform.

Countries are facing this challenge in many different ways, but one common factor is the increasing reliance on electronics and systems. Perhaps Japan has produced and publicised more devices and systems to deal with this new era than anywhere else. The government there has realised that 25% of the population is expected to be 65 or older by 2015, which is an increase from the current 17%. Japanese companies are, in consequence, encouraged to develop new devices for the new 'elderly age'.

Robotic devices and electronic gadgets have been described in this section that are aimed especially at this social group. One company, NEC has, for example, developed a home-care robot. This device responds when called and is able to operate any household computers and electrical appliances. Other companies have developed robotic systems designed especially for the infirm who are hospitalised or in need of care. Unlike some Western Societies the Japanese companies are enthusiastic about this type of project and are keen to perfect such innovative gadgets.

Few other countries would embark on a project to provide thousands of elderly people with an 'electronic cat'. The Japanese government has launched a new three-year project where thousands of its elderly citizens will receive a computerised, animatronic, interactive cat called *Tama*. It is not just a matter of pandering to the aged, because as well as serving as a companion to those living alone, it also acts as a communication terminus between its owner and local centres.

4. Monitoring healthcare using a sensor ring

The New Industry Research Organisation (NIRO), Kobe (Japan) has developed a remote healthcare sensor to be worn as a ring that is able to radio the wearer's pulse rate to a medical centre. Other systems, such as the sensor vest can produce similar data but the convenience of wearing something as simple as a ring makes this system extremely attractive in many circumstances. There are, for example, many 'call systems' designed to monitor the elderly or the housebound, but this device is able to be worn permanently with little inconvenience and is capable of transmitting other information about the wear such as the rate of oxygen absorption. The sensor works by monitoring tiny changes in light absorption on the skin when blood capillaries extend or contract. It is 3cm in diameter and 3cm thick. Chiaki Nagai of NIRO provides us with the essential reasons why it has been developed. He says that:

"The development came as a result of the Great Kansai Earthquake which hit Kobe in 1995. Many houses were destroyed and many, especially the elderly, had to move to unfamiliar places, and some of them died without anyone realising. We hope this ring will prevent such future occurrences."

It is acknowledged that the device was first researched at the Massachusetts Institute of Technology (MIT), USA. It will start its trials later this year.

INTELLIGENT VEHICLE-CONTROL SYSTEMS

1. Innovative system to control vehicle speed

Innovative systems that could make our highways safer are being researched worldwide. Recent reports of this initiative have come from Sweden, Holland, USA and the UK.

Details of such systems have recently been published in the UK where a project to control the speed of a vehicle has been described by researchers who are collaborating with the UK Department of Environment, Transport and the Regions to develop what are revolutionary systems. Trials have been held by a team from the University of Leeds and the Motor Industry Research Association (Mira). The trials have so far run for three years and have concentrated on the

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feasibility of installing what is called an 'intelligent speed adaptation'. This is a system that works using a combination of a satellite navigation system to pinpoint the location of each vehicle and an in-car computer loaded with a digital road map encoded with every street or highway in Britain, together with a device that can limit the fuel supply if the speed restrictions are breached.

It is reported that the UK government has been given the latest progress information which indicates that these new technological advances will make a variety of vehicle control, identification, and location measures both feasible and cost-effective.

In the UK safety groups say that fitting speed control devices to vehicles as standard features could save two-thirds of the 3,500 road deaths that occur on Britain's highways each year. They also estimate that the annual 320,000 road accident injuries would be reduced by as much as one-third.

Current discussion in the UK concerns what is described as the compulsory electronic speed limiter. This is regarded as ultimately mandatory, and would put a speed limiter in each vehicle. Such a system would work by:

- Pinpointing the exact position of a vehicle by using Satellite Navigation.
- Using a precise digital road map which has detailed speed limits information
- Checking continually the vehicle's position against the stored speed limit restrictions
- If the speed limit is exceeded the system's electronics reduces the fuel supply to the engine to ensure it stays within the limit.

2. Comments on proposed implementation

Some of the main comments about the implementation of such devices leave the debate unresolved. They are:

- The 'limiter' would initially be costly but this would reduce in the future as it comes into greater use.
- Motor manufacturers are expected to resist the installation of such systems since they rely largely on the image of the 'fast car' to sell their products.
- The civil liberty issue becomes important for motorists since they will lose control of their own vehicles.
- The system will be seen as a 'life saver' and legislation will have to be introduced.
- Fuel savings as well as accident prevention will become increasingly recognised.
- If some 60% of vehicles were fitted with the device traffic speed would inevitably slow down; this is regarded as a positive benefit.
- The ability to control the speed of traffic has great implications for traffic management, reducing the need for traffic calming schemes. Speed cameras and prosecutions for speeding offences could be virtually eliminated.

These are but some of the comments made about its implementation; there is no doubt that countries worldwide will be concerned at the issues that have now arrived because of the advances in technology.

WORLD'S MOST ADVANCED ROBOTIC ARM?

A claim from Barrett Technology Inc., Cambridge, Massachusetts (USA) says that the 'Guinness Work of World Records 2000 puts Barrett's WAM™ Arm as the World's Most Advanced Robotic Arm'. This issue of the *Guinness Book* is its Millennium Edition.

The technology company say that:

"It is not every day that we get such an unequivocal endorsement from a source as respected as *The Guinness Book*".

Barrett's believe that their uniquely human-friendly robots are based on extraordinarily advanced technology that enables them to feel as well as move. They say that:

Barrett's founder and Chief Executive Officer, Bill Townsend, some fifteen years ago, recognised that for robots to break from niche automation tasks, core technologies would have to be rebuilt from the ground up so that the robots could collaborate hand-in-hand with everyday people.

Townsend's work at Massachusetts Institute of Technology's Artificial Intelligence Lab led to new types of servo-drive mechanisms that enable people to teach robots directly with a feather touch. The robot simultaneously creates geometrically precise virtual surfaces, funnels, and paths in space that the user selects to slide along. But the technology depends on super-powerful computers and communications, the kind that was available at the AI Lab and almost nowhere else. "That was a real show-stopper; preventing us from addressing mainstream commercial applications," according to Townsend. "So we have been quietly perfecting the technology with support from NASA, DoD, and NSF while we wait for the power of mainstream PCs and the Internet to catch up – and it's close – within a couple of years."

Barrett may not yet be in the mainstream, but its impressive customer list includes manufacturing R&D centers worldwide, from Ford, Honda, Yamaha and MITI, to the US and Japanese space programs, to robotics and haptic research at top universities. Barrett has also begun sublicensing its technology in fields as varied as haptic sensing, surgery, and physical rehabilitation which are being propelled by the Internet communications revolution and fast, affordable PCs.

Barrett Technology and BarrettHand are the trade marks of Barrett Technology Inc. More information about their endeavours can be obtained from the company at: 139 Main Street, Kendall Square, Cambridge, Massachusetts 02142–1528 (USA). Tel. +(617) 252–9000. Fax: +(617) 252–9021. E-mail: robot@barrett.com. See also the Internet site: www.barrett.com/robot.

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