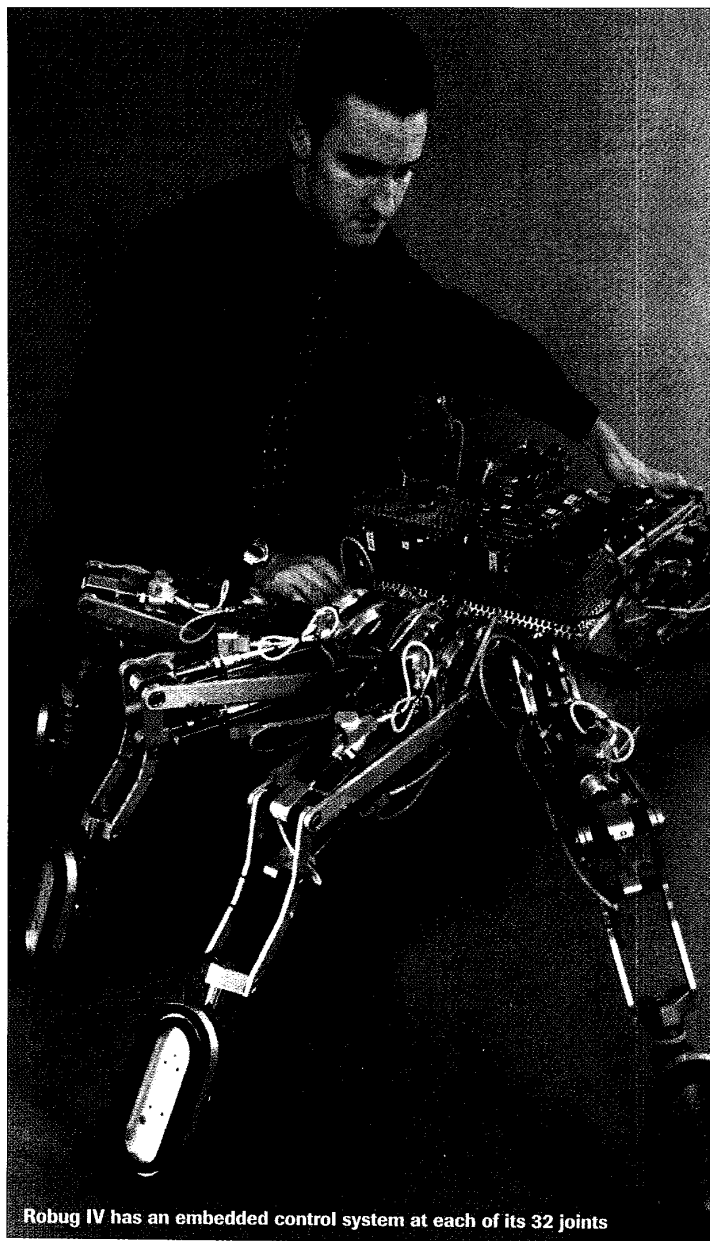

Joint effort

Distributed control has allowed British engineers to take a leap forward in the development of mobile robots for industrial applications, reports **Margaret Cecil-Wright**

According to the Star Wars movies, sophisticated wisecracking androids were an everyday part of life a long time ago in a galaxy far, far away. But here on planet Earth in the 21st century, there is little evidence so far of widespread commercialisation of walking and climbing robots, despite the large number of research groups working on them. The abundant robots developed so far have been articulated systems with some form of legs for locomotion and suction feet for adhesion. But although they can climb well on a wide range of structures they are complex and highly expensive. Each new application requires a specialist robot with tailor-made control hardware and software, and the cost and expertise required has made their use prohibitive for almost all users except those, such as the nuclear industry, with an imperative need that can override the capital outlay. Where they have to compete with high-lift platforms, scaffolding and human climbers, sheer cost has prevented robots from being adopted, leaving tasks such as painting, cleaning or inspection of high-sided structures like ships' hulls, buildings or dams to be carried out by skilled people, including experienced climbers, who are often in short supply.

Now engineers in the south of England believe that the latest member of the Robug family of walking and climbing robots could offer a solution. The use of distributed control makes the spider-like Robug IV a quantum leap forward in the evolution of advanced mobile robot design that could pave the way for a new generation of off-the-shelf, general purpose, affordable robotic systems that can be programmed by users. These intrepid creatures will be venturing into new and sometimes hazardous territories to carry out tasks that previously demanded physical skill and risk or expensive technology.

The advances that make this possible have



Robug IV has an embedded control system at each of its 32 joints

taken place in Portsmouth and Southampton, in a project sponsored by the European Commission's HPCN TTN Network (www.hpcn-ttn.org). Portech, a robotics and automation company based in Portsmouth, has built Robug IV as the latest in its range of walking/climbing robots and will market systems based on the technology. The advanced algorithms used in the robot's control systems were supplied by the Mobile Robotics Laboratory at the University of Portsmouth, while the control software infrastructure was designed by the IT Innovation Centre in Southampton.

The Robug IV concept appears to be unique in its simplicity, and the use of modular architecture supporting the use of off-the-shelf technology for several sub-systems will allow it to be deployed at a hitherto unattainable low cost. Robug IV has eight pneumatically powered aluminium legs with vacuum gripper feet to hold onto rough or vertical surfaces. It is operated remotely using a high speed data link from a host PC. The most innovative feature, however, is the embedded control system at each of its 32 joints, all of which have their own microprocessor, linked to the others by a high-performance computer network.

The design and development of the previous generation of walking and climbing robot, Robug III, took three years and a budget of €1 million. Although it provided new levels of functionality and performance, its weaknesses included bulky wiring, large components and insufficient bandwidth for efficient communication. When anything went wrong, the whole thing had to be taken apart to fix the problem. By contrast, Robug IV took only 17 months to develop at a cost of just €365 000.

The modular design means that when there is a problem in, say, a leg, the faulty part can be removed and replaced with another. Central to the success of this approach has been the use of high-performance computing and networking, enabling a degree of autonomy not previously realised in the robotics sector.

In Robug IV a distributed network of embedded microcontrollers is linked by a carefully designed communications protocol. A local on-board CANbus-based network that supports 32 Infineon C167 microcontrollers—four on each of the robot's eight legs—enables local control at the joint level using methods such as fuzzy control, neural networks and other soft computing techniques. The modular design,

in which each actuator has its own sensors, drivers and computing hardware, has the important advantage that the robot can still function even after a faulty leg has been removed for repair. It also enables more complex functionality to be shared across the robot's microprocessors.

For users who want to develop and test their own control strategies, Robug IV separates out the low-level (at the joint, for example) and high-level (goal-oriented) control strategies. The well defined interaction means that a strategy can be developed at the appropriate level; for example, the leg can react independently to the load placed on it, but the overall movement (e.g. gait, speed, direction) is controlled by the operator.

Having proved with a demonstrator model that distributed, embedded control is the way forward, Portech is now putting its work in to practice in a new project, Robosense, that could make the need for human inspection of dams and other structures at risk from earthquakes a thing of the past. Many of the Robug IV design concepts will be used to create a low-cost climbing robot, capable of adhering to and moving across vertical surfaces on large structures, that will be able to carry and deploy sensors for structural inspection or instrumentation. The dam, or dams, selected for the trial will be in northern Italy where earthquake damage is a very real risk to the local population as well as to the installations themselves.

Among the technical objectives are the development of robotic methods of attaching sensors to the structure and the development of advanced sensors for surface inspection using visual, acoustic, magnetic and radar sensing techniques. The project consortium will also develop a user interface supporting robot navigation, data acquisition and display, and analytical facilities.

Robosense is a multinational effort. The partners supporting Portech are IT Innovation, whose main role will be to develop a user interface that can handle robot navigation, data acquisition and display, and analytical facilities; ENEL, an operator of dams in Italy, whose experience in this will be used to influence regulatory guidelines; FZI, a German research institute with experience in sensor systems; and BAM, the German Federal Institute for Materials Research and Testing.



A demonstrator model drew crowds at the IST'99 Exhibition in Helsinki last November

To find out more about Robug IV, contact Margaret Cecil-Wright at IT Innovation (mcw@it-innovation.soton.ac.uk). Information about participants in the Robug project is at the websites for IT Innovation (www.it-innovation.soton.ac.uk), the University of Portsmouth (www.port.ac.uk/robug/) and Portech (www.portech.com)

Engineering justice

Robert Gaitskell's article about the role of the expert witness in the January issue of *IEE Review* ('Is there a forensic scientist in the house?') reminded me of a report by Roger Cook on BBC Radio some 20 years ago. This concerned a man approaching the end of a year's prison term who had pleaded not guilty to a charge of setting his shop on fire as the basis of a fraudulent insurance claim. He had been convicted on the forensic scientist's assertion that he had deliberately used a faulty extension lead for a radio in order to cause a fire.

As the details of the case described by the programme indicated a lack of electrical knowledge on the part of the prosecution, I asked to be shown the trial documents. The defence, without expert backing, had failed to challenge the forensic scientist's report. Following my suggestion, the defence lawyers then appointed an IEE Fellow, whose reasoning resulted in the conviction being quashed on appeal.

KEN SHINDLER (Member)
Solihull, West Midlands, UK

Who will replace lobbyists ?

I read with interest Nick Long's complaint about the manipulation of international technical committee proceedings by lobbyists ('An opportunity lost', January), but can assure him that it is not new. I worked on many Cenelec and IEC main committees and technical subcommittees in the late 1980s and it was common then.

Among the prevalent attitudes were: 'we don't use it in our country and nobody else shall', or 'we use a less compliant method but nobody shall increase the level of test', or 'we call it something else and will not have the name changed'. None of these were technical arguments, all were commercial, but they usually resulted in a dilution of the standard. Sometimes the delegates were unashamedly non-technical and there solely to prevent change.

I myself operated as a lobbyist for a British manufacturers' association with

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a zeal of which I am ashamed in retrospect, although I never betrayed my professional status. But who else will pay for this work but interested parties? I agree that the process of consultation and representation needs overhaul but, like voting in elections, only those already interested will bother. Anyone looking for technically based altruism in international dealings is going to be disappointed, I regret to forecast.

MARTIN GILBERT (Fellow)
Totnes, Devon, UK

End of an era

The recent discussion in the letters pages of *IEE Review* as to whether digital TV is worthwhile to the viewer is sterile for two reasons. The first is that digital TV is going to happen, whether merited or not, simply because a lot of lovely money is to be made by the practitioners. The second reason is that television programmes have become so trivialised and so witlessly crude that no one of any sensibility is going to extend their viewing beyond the end of the analogue era, even if they haven't stopped already.

D.L.A. SMITH (Fellow)
Loughborough, Leics, UK

Million dollar dowsing

I read with interest, amusement and ultimately disappointment the recent letters in *IEE Review* about dowsing. The IEE should not lend its credibility to claims of supernatural activities. Electrical engineering is founded on the scientific method as the term is generally understood by scientists and engineers. Let's leave it to others to publish unproven anecdotes on junk science.

Someone with a claim to paranormal skills should submit their belief to an

independent test. This is easily done, and the James Randi Educational Foundation is offering \$1 million to anyone who can demonstrate any kind of paranormal activity, including claims for dowsing. Details and an application form are at www.randi.org.

In fairness to potential claimants, I should add that James Randi cautions: 'Many applications that are received at the James Randi Educational Foundation from dowsers who express great wonderment at why the million dollar prize has not already been awarded, when dowsing is such an easy thing, they say, to demonstrate... Each dowser goes away from any trial of their powers, dismayed by their failure, puzzled at the reasons for the failure, but always capable of coming up with a reasonable, to them, excuse. That excuse may be any one of many. It may be an unfortunate arrangement of the planets, improper temperature or humidity, a problem of indigestion, too much ambient noise or too much silence or a poor attitude on the part of the observers. These are not invented excuses; they are all drawn from my personal experience in testing these folks.'

IAN S. PARRY (Member)
Richmond, Surrey, UK

Made in Manchester

I have been investigating the origins of Manchester encoding, as respected data communications authors Stallings and Halsall quote one method of generation and Tanenbaum the inverse. Numerous online searches of Inspec and Compendex, the University of Manchester website and various searches of the Internet drew a blank. After correspondence with the above authors I have been advised that a PhD thesis was written at the University of Manchester in the early 1950s which defined it. The reference was unknown. Is there any reader who knows who the PhD author was and the date, or even better how to contact the original author?

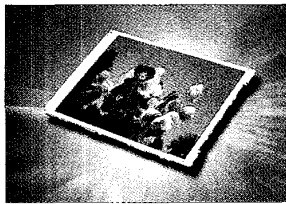
ROGER FORSTER (Member)
Systems Engineering Faculty,
Southampton Institute
roger.forster@solent.ac.uk

Colour display for Web terminals

Hitachi has announced a new SVGA colour STN display, designed for the PC and Internet browsing markets. The 10 inch display has a high contrast ratio of 50:1 and a brightness of 200 cd/m², together with a low power consumption of just 2 W. It is suitable for point-of-sale, point-of-information and Internet terminals.

The high contrast ratio of the SX25S003 is achieved through the use of multi-line drivers. The transmissive CSTN display has a resolution of 800 x 600 pixels with 265 000 colours and operates from a single +3.3 V supply. The display also boasts a response time of just 270 ms.

The SX25S003 achieves a high brightness using Hitachi's CFL backlighting system, which requires less power to run than a traditional CFL backlight. During operation, fluorescent tubes need



to reach, and maintain, a certain temperature for efficient operation. However, a large proportion of the heat generated by the tube is dissipated into the surrounding materials, so additional power has to be supplied to keep it sufficiently hot. The CFL for the SX25S003 display is completely enclosed within an evacuated glass flask, which ensures that the heat generated is used to raise the temperature of the fluorescent tube. This in turn means less power is needed to operate the display and backlighting.

Enter 901

Seaward's new Combi

The Combi Compact is the latest hand-held all-in-one installation tester from Seaward Electronic designed to comply with current legislation such as BS7671 and EN61557. The microprocessor-controlled device, with a wide range of functions, has an internal memory capable of storing up to 1500 test results for printing or downloading to a PC via an infrared RS232. Seaward also supplies a free software package that can be used to store test results.

Enter 902

Parents regain control of on-line costs

British inventor Andrew Goodwill has come up with a novel way for parents to regain control over escalating on-line telephone costs.

TIC (timed Internet connection) is a small hardware device that plugs into a computer's modem. It incorporates a telephone-style numeric keypad that allows a parent to program and therefore

control the amount of time that the modem is operative in any 24-hour period.

The user replaces their existing modem cable with the new TIC device. One end of the TIC is plugged into the modem's telephone cable socket, and the other end fits into the phone point on the wall; a small numeric keypad allows for programming.

Once the TIC has been programmed with a defined connection time, it starts to work as soon as the user connects to the Internet. Operating via several built-in timer circuits, it disconnects itself from the Internet once the pre-programmed time limit is reached. A warning signal is issued five minutes before disconnection takes place. TIC can also be programmed to ensure that the Internet connection cannot be resumed after the initial 'time out'. It features a series of LED lights that show whether the unit has been tampered with, or whether an unauthorised person has attempted to re-program it. All features are password protected for additional security.

Enter 903

Get real

Reliable timing behaviour is crucial in the demanding environment of real-time embedded systems development. Hitherto, developers have had to rely on testing to establish timing reliability. Unfortunately, this approach is unlikely to uncover all the subtle race conditions and task interactions that cause timing failures. The Real-Time Architect, from York-based Realogy, a division of Northern Real-Time, is designed to enable real-time

software developers to fix the timing behaviour of their applications right from the start, delivering 100% predictable timing behaviour at deployment.

Real-Time Architect combines the run-time kernel part of the market proven SSX5 RTOS with a new and unique off-line scheduling and optimisation tool, the Time Compiler, allowing the timing behaviour of an application to be fully analysed.

Enter 904

Machine vision gains In-Sight

Conventionally, machine vision systems can be categorised into two broad classes: general-purpose, hard-to-program, high-end systems, for the ultimate in performance, and single-purpose 'smart cameras' for the more basic vision tasks.

The In-Sight 2000, from Cognex, is designed to bridge the gap between these two very different ends of the machine vision spectrum.

To provide flexibility without the need for complex programming,

In-Sight employs a novel spreadsheet interface for configuring applications, allowing users to select tools and parameters through a series of simple menus and dialogue boxes.

A hand-held control pad allows for rapid navigation through the worksheet's cells and menus, enabling the user to quickly configure an application, and to make on-the-fly changes to the application at runtime.

Enter 905

Easy learning by solid state

A British company has invented a Minilab system that aims to revolutionise the teaching process, especially in the field of language learning.

After two years' research, with close liaison with a number of schools and colleges, Audio Design Services examined the current methods of language training. Invariably this meant the use of cassette units and the setting up of lessons was a process that normally had to be carried out outside class times to maintain lesson times.

As a consequence, ADS has produced an enhanced memory PC system that enables hundreds of hours of lessons to be stored on the hard disc at the start of the term. Any lesson can be 'dragged' down to any student station by using the mouse.

The unit allows the student all the facilities of a standard



cassette in a solid state form. It is supplied complete with headphones and microphone with the facility to listen, rewind, record and communicate with the teacher.

The fact that lessons can be downloaded individually means that a class can have as many lessons delivered as there are students, with each having the facility to record answers directly onto the hard disc for the teacher to download at the conclusion of the class.

Enter 906

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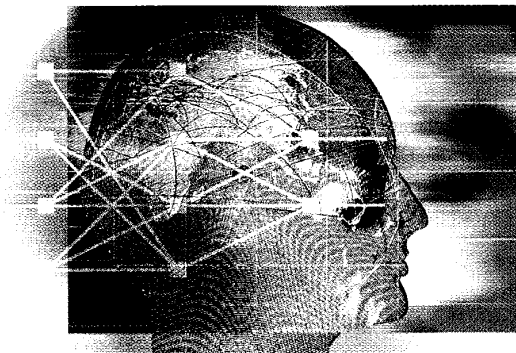


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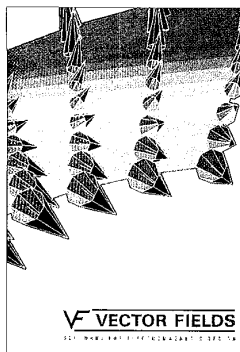
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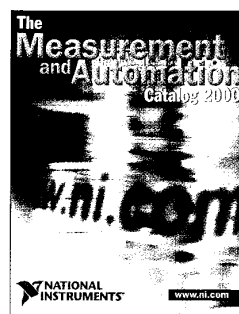
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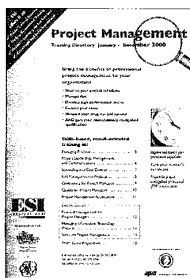


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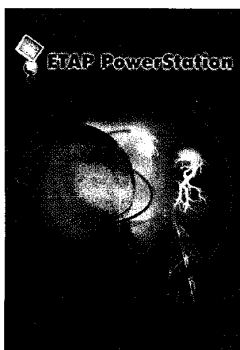
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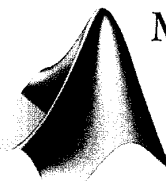
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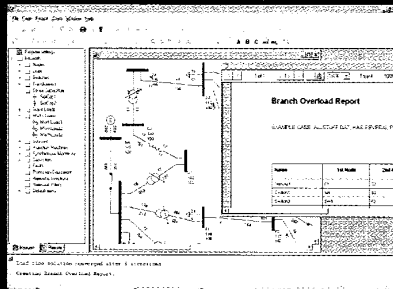
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