CENTRE FOR INTEGRATED COMPUTER SYSTEMS RESEARCH

FOCUS

CICSR

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UBC Technology Flies High with Space Station

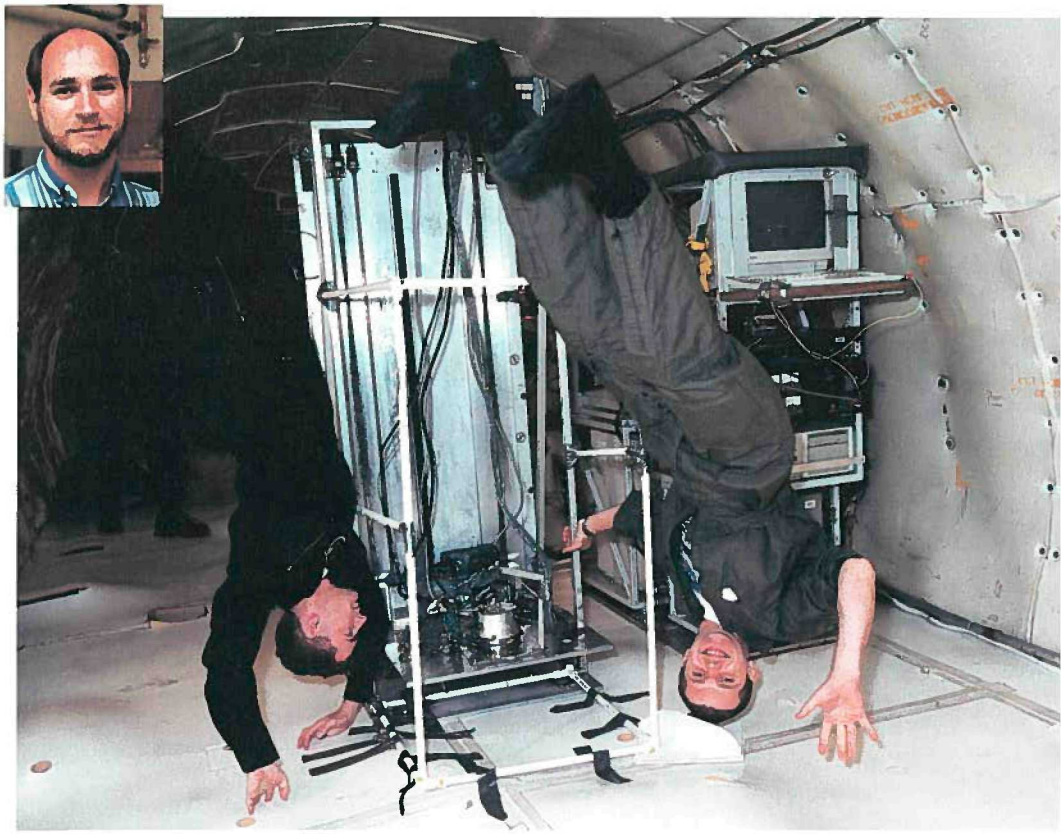
Technology developed at UBC has become a critical enabling tool for ground-breaking research being conducted in space.

Vibration isolation technology that originated in Tim Salcudean's lab at the Department of Electrical and Computer Engineering (ECE) is now being used aboard the Russian space station Mir to isolate experiments from high frequency vibration on the orbiting space platform. The Microgravity Isolation Mount (MIM) is working so well, another unit is slated to be delivered this summer to the international space station via the space shuttle Discovery.

Zero Gravity Experiments

According to Salcudean, there is strong international interest in conducting experiments in the zero gravity environment of space platforms. Experiments involving fluid flow, crystal growth and metal alloy development would be best carried out free from earth's gravitational field.

Creating a completely stable zero gravity environment, however, is no easy task. One way to achieve zero gravity is on parabolic flights on which the aircraft essentially follows the same trajectory as a thrown rock in free-fall. But zero gravity is achieved for only about ten seconds, and the path of the aircraft is usually within a few feet of a perfect parabola.



Research Engineer Niall Parker (right) & Canadian Space Agency's Bill Stewart (left) enjoy a zero gravity moment during a NASA-sponsored parabolic flight to test the UBC-developed Microgravity Isolation Mount. ***Inset:*** *Tim Salcudean.*

MIM technology has been developed by Salcudean and former UBC research engineer Niall Parker under a series of contracts with the Canadian Space Agency and in collaboration with astronaut Bjarni Tryggvason. The goal of the team was to investigate magnetic levitation technology to improve the stability of the zero-G environment on space

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Director's Corner

Research links between CICSR and industry partners in North America and around the world continue to grow. This issue of FOCUS describes many of those links; it also pays homage to two people during whose tenure CICSR was established, and who are moving on. They are Dean of Applied Science Axel Meisen, and Bob Donaldson, head of Electrical and Computer Engineering. Both are people whom I respect and admire very much, and who gave me continual support before and during the first year of my directorship.

Axel Meisen

Axel Meisen has spearheaded many exciting new research initiatives since becoming dean in 1985, and his vision has helped move the Faculty of Applied Sciences to the forefront in applied research around the world. He created international professional and educational links, and created new specialized programs here at UBC. His collegial leadership and energy is an inspiration to those who have worked with him.

Bob Donaldson

Under Bob Donaldson's direction, the Department of Electrical and Computer Engineering grew very strong, vastly increasing collaboration with industry and external research income. Since he became head in 1987, the number of graduate students has doubled, and research labs have been completely modernized. He continually put the interests of the department ahead of his own, and I believe that's why it's so strong now.

Both can take some credit for the establishment of CICSR as a major worldwide computer systems research facility. I'm sad to see them go, and wish them the very best in their continuing research and teaching endeavours.

Dr. Rabab Ward, CICSR Director

CICSR to Play Vital Role in Future Development

UBC is poised to become a leader in the area of software development says Dean of Applied Science Axel Meisen, and CICSR will play a vital role.

"I see CICSR as the lead agency in developing a major thrust in software engineering at UBC because it brings together computer science, electrical engineering and computer engineering," says Meisen.

Meisen came to UBC in 1969 and became dean of Applied Science in 1985. He has seen many changes since.

"We'll also be active in intelligent and flexible manufacturing, where companies can make a variety of products in small runs in a profitable fashion. And I see us becoming a leading agent in telecommunications and data processing, because once again those industries are computer-based."

Dean of Applied Science Axel Meisen

Unparalleled Developments

The last decade has seen unparalleled development in the industrial application of scientific research, Meisen says, because computers and software are changing the world of production.

For the Faculty of Applied Science and for CICSR, the demand for people with computer skills will mean providing more continuing education programs for people who work full-time but need to keep their skills current through evening and weekend study, or through short day courses.

Demand for Continuing Education

"Clearly the need to stay abreast as practitioners is very important. Over time, I see CICSR taking on an important role in the area of continuing education, because it's an opportunity for us to get closer to industry and learn about its problems and use that as the basis for research."

"It's also a potentially significant source of revenue," adds Meisen.

Demand for continuing education would come from engineers and scientists working in high-technology product and service development, and Meisen says British Columbia has established itself as a centre for these types of industries.

Growth and Change

Growth and change as a result of computers and related applications has affected the curriculum in the Faculty of Applied Science in several ways, Meisen notes, and so has the emergence of environmental protection as an issue of global concern.

"We see a much wider integration and application of computers throughout the curriculum, of course, but it's also led to specific new initiatives such as the Option in Computer Engineering and the Program in Electromechanical Engineering Design.

Environmental Emphasis

"As far as the environment is concerned, all engineering programs now place emphasis on that in the curriculum. At the BA level, there is an Environmental Engineering Option in chemical, civil and geological engineering. Similar options are now offered at the graduate level, and now many of the research theses have an environmental orientation at the graduate level." ■

A Decade of Change in Electrical Engineering

Change defines the past decade for Electrical and Computer Engineering Department Head Bob Donaldson as he leaves after 10 years as head. Over the last decade Donaldson has seen his department change its name (to include Computer Engineering), move into new space, increase its links with industry and within the university, and revise the undergraduate and graduate programs.

Stronger Links with Industry

The increased interaction with BC industry is one of the more significant changes Donaldson has seen. External research funding has quadrupled and 80% of that is tied in some way to industry, either from direct grants, or contracts, or from matching funds from grants tied to industry projects. The department now has three Natural Sciences and Engineering Research Council industrial research chairs, and participates in four of the federal networks of excellence in engineering.

"All of these networks include substantial industry sponsorship and support, and provide almost a quarter of our external research income."

"The department and its activities have changed markedly," Donaldson notes. "Of our 33 faculty, 20 are new and 3 of those are CICSR appointments."

Research Space has Doubled

And the department has doubled its research space through the addition of two new buildings: the CICSR/CS building and the Advanced Materials and Process Engineering Laboratory.

◀ *Bob Donaldson*

Expanded Computer Facilities

Another notable development is the substantial growth in computer network facilities. When Donaldson began, the department had fewer than 10 personal computers and workstations, and virtually no networking capability. Under his direction, the department was among the first on campus to install an intra-building network. And now, thanks to CICSR, the department has more than 200 workstations and printers.

At the Forefront of Revolution

Donaldson is stepping down as department head and will return to teaching and research. He says the future holds unlimited opportunities for education, research and industrial interaction. "We are at the forefront of the information technology revolution. The fields of computer technology, software engineering, industrial automation, signal processing, and advanced electric power engineering are essential for the rapidly growing manufacturing and service sectors. These burgeoning industries require skilled people and enhanced research and development."

Delivering Professional Education

New ways to deliver courses are likely to be added to the department's activities to meet the increased demand for professional education. Graduate courses are offered at times convenient for practicing professionals, and where warranted, at off-campus locations with the help of the local branch of the Institute of Electrical and Electronics Engineers (IEEE).

Moving On

The nature of electrical and computer engineering means the ground is constantly shifting, but Donaldson moves on with good memories and a high level of satisfaction with what he and the department have accomplished over the last decade of change.

"It has been my privilege and opportunity to serve the department, the university and the community during the past several years. The support from colleagues, the university community, and the external community has been strong, consistent and gratifying." ■

Boosting Productivity on the Machine Shop Floor

Machine shops around the world are working more efficiently now thanks to the work of Dr. Yusuf Altintas, a professor in the Department of Mechanical Engineering and CICSR member.

Machining simulation software, created by Altintas's research group, allows production engineers to simulate and visualize the consequences of machining tool operations before actually machining any metal.

Yusuf Altintas in his lab

Productivity Gains

With Altintas's software, engineers can analyze and model machining parameters and devise solutions that make the machining process more efficient. Industrial users of the software have reported productivity gains of up to 30%.

"Our ultimate goal is to improve the productivity of machining operations," says Altintas, a UBC professor since 1987.

PC and UNIX Versions

The simulation software comes in a PC version and a UNIX workstation version. The PC version is user-friendly and is used by production engineers on the shop floor. Pratt and Whitney Canada, the aerospace manufacturer, is using the PC version to help improve machining on aircraft components. Other users of the PC version are Singapore National University, the Kenne Metal/Hertel Cutting Tool Company in Germany, and Ingersoll in the US.

The UNIX workstation version is more detailed and comprehensive, and is currently being tested at the General Motors Research Center in Detroit and the National Institute of Standards & Technology in the US. They report productivity savings of up to 30% using the software.

Intelligent Machining

Altintas's group has also developed software called the Intelligent Machining Module. The program, a plug-and-play module, collects signals from sensors mounted on the machine tool as it cuts. The program allows the machine tool operator to manipulate cutting conditions and maximize material removal rate, boosting machining productivity. As well, the module automatically monitors breakage, vibration and other tool malfunctions.

Altintas is also leading an international research project dedicated to the

"Our ultimate goal is to improve the productivity of machining operations."

The product went to market in November in Japan, Germany, the US, and Canada. Currently, it is in use at Pratt and Whitney Canada's five-axis Mitsui CNC Machining Centre.

"Pratt and Whitney report a productivity increase of 265%, so we have an excellent relationship with them," says Altintas.

Open architecture motion control and Computer Numerical Control (CNC) system design comprise another research area for Altintas and his graduate students. They have developed a model CNC that is on offer to R & D labs around the world. Altintas is cooperating with CICSR professors M. Ito and G. Bond in this area.

Altintas is also leading an international research project dedicated to the Sensor Fused Intelligent Monitoring System for Machining Tasks. Research partners of SIMON (as it is called) include the Machine Tool Research Laboratory at the Technical University of Aachen, Germany, the University of Michigan, and Keio and Kobe Universities in Japan. Some of the industrial partners include Mitsubishi Materials, Daimler Benz, and Ingersoll. They will all meet at UBC for the SIMON kickoff in May 1997. ■

Multimedia Standards Link Universities and Industry

Links between university research and industry applications are getting stronger, which is no surprise to Dr. Faouzi Kossentini. His research area is communications and signal processing, with a focus on digital image and video communication. He's also contributing to several international standardization groups working on standards for digital and video compression.

Practical Research

"My work has always been linked to industry because of its direct applications," says Kossentini, a professor in Electrical Engineering at UBC since January 1996. "My leaning toward practical research is due to my involvement with standardization activities, because we look for and work toward practical real-time applications."

He's currently dividing his research time between several major projects. The first, sponsored by Rogers Cable Labs Inc. and BC Advanced Systems Institute (ASI), is called Efficient MPEG-2 Video Coding, the main application of which is real-time coding of interlaced video on general purpose platforms. "If our research is successful you'll be able to do that kind of encoding and decoding using a Pentium pro with MMX technology."

Wireless Fax Transmission

Applications involving fax transmission and paging could result from a second major project, involving JBIB and JPEG compatible image transmission. This project is sponsored by Image Power Inc. and ASI. He's focusing on wireless fax transmission, which will be compatible with the upcoming JBIG2 standard because it will have a reduced bandwidth. A third project involves building efficient image transmission strategies over the Cellular Package Digital Data (CPDD) network.

The ultimate objective is to design a CPDD-like modem that will allow faster image data transmission over wireless networks. Sponsors are Mobile Data Solutions Incorporated, ASI, and the Natural Sciences and Engineering Research Council.

Standards for the Real World

As well as research and teaching, Kossentini is active with several standardization committees of the International Telecommunication Union, the joint technical committee of JTC1 of the International Standarization Organization (ISO) and the International Electromechanical Commission (IEC).

"My work has always been linked to industry because of its direct applications."

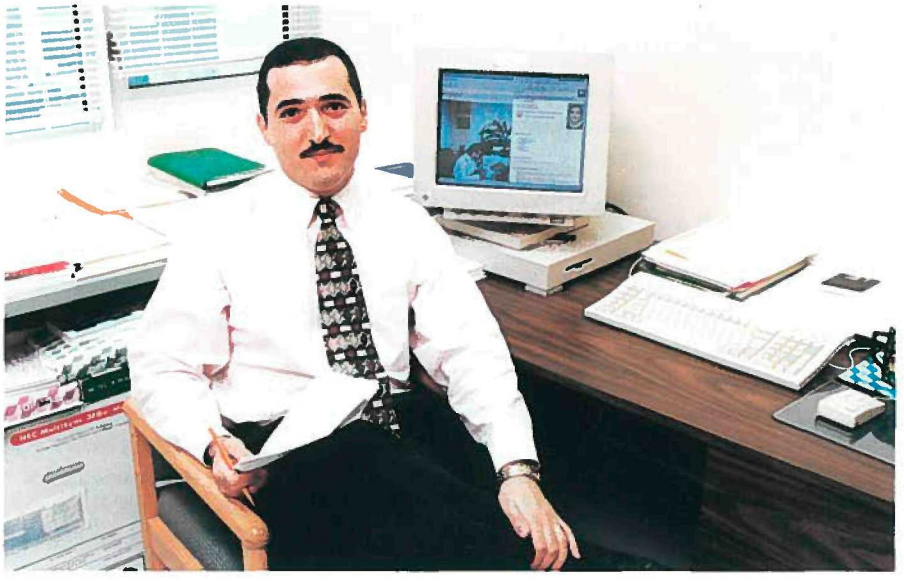
He is also a member of the Canadian Standards Association, and is a voting delegate of sub-committee SC29 of ISO/IEC JTC1, which is responsible for the coded representation of audiovisual, multimedia and hypermedia information. Film and TV producers felt the impact of the JPEG/MPEG standards: SC29 won a 1996 Emmy for its contribution to the television and film industry.

Powerful Multimedia Processing

Kossentini says the technology of the future made possible by the MPEG-4 standard will have true multimedia processing and entail communication systems that handle all types of multimedia data seamlessly. Products with these capabilities will be available by the year 2000, and they'll only be slightly more complicated than programming a VCR.

"Imagine having a powerful Pentium laptop with multimedia technology such as MMX and JAVA that you could use to send e-mail, control your digital television, play video games, and so on. You use the same unit to control these functions, and you are the programmer."

Kossentini is also a member of the Institute of Electrical and Electronics Engineers, and a technical area coordinator of the International Conference on Image Processing (ICIP-97). He and CICSR Director Dr. Rabab Ward are working to have that event held in Vancouver in the year 2000. ■



Faouzi Kossentini

Better Design for Fast Chips

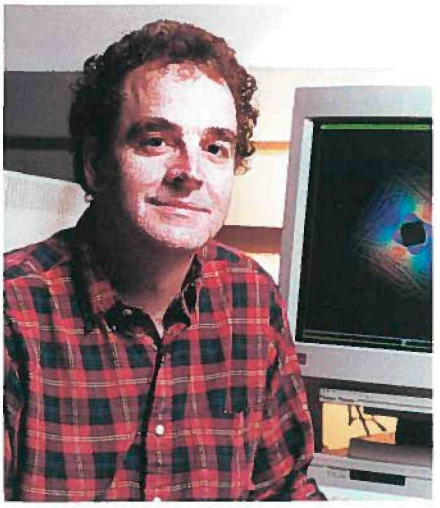
Faster chips with more features using lower power and costing less are what consumers have come to expect from rapidly evolving chip technology. To satisfy these expectations, manufacturers and engineers must achieve faster product development even as designs become more complicated.

That's not easy to achieve when design processes for hardware and software are poorly integrated, says Mark Greenstreet, assistant professor of Computer Science at UBC.

"For leading edge companies, integrated circuit design is a complex process. The complete design cycle can take anywhere from five to seven years. Integrating the different phases of the design is key to reducing design time and avoiding costly errors."

Greenstreet's current research is aimed at developing mathematical techniques and software applications that will contribute to this integration.

"Consider the problem of designing a simple circuit, a flip-flop for example. An analogue designer will see it as an analogue circuit, modelled by differential equations, where voltages change smoothly with time. A digital designer will see the same circuit as a discrete device where signals are either high or low and change when the clock changes. How do these two groups of designers talk to each other?"



Mark Greenstreet

Currently, the interface is ad-hoc. The analogue designers perform extensive simulations, and when finished, hand their circuits to the digital designers. This process leaves little room for interaction between the various specialists that could lead to faster designs.

Greenstreet came to UBC in 1992. He first began designing chips with Intel in 1980, and continued at ESL, a TRW subsidiary in California. There, he developed a high-speed chip set, a design on which he holds two patents. He then spent two years at Aarhus University in Denmark teaching chip design to researchers who introduced him to some of the more mathematical aspects of verification. From Aarhus, Greenstreet went to Princeton where he completed his PhD and continued his work on high-speed chip design.

Currently, Greenstreet is joined in his research by Ian Mitchell, a former UBC graduate student. Mitchell's position is funded by SUN Microsystems Canada and the BC Advanced Systems Institute. SUN is interested in the applications of Greenstreet's research to high-speed processor designs. For example, SUN has a design where the flow of instructions and data are regulated by a circuit called an arbiter, which acts essentially as a traffic cop. And it can be a bottleneck in the design.

"SUN wants us to analyze the arbiter, using the same kinds of methods as for the flip-flop. We hope to identify where the circuit can be optimized. If we can find a way to build a better arbiter, SUN could build a better processor." ■

Exploring the Limits of Computing Power

Computer science provides the framework for David Kirkpatrick's research, but mathematics is the tool he uses to attack theoretical problems in computational complexity and geometry.

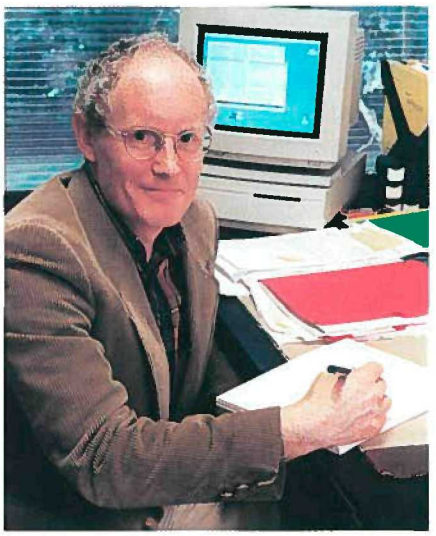
"I'm interested in understanding basic problems in computing science, the kind of thing that larger tasks are made up of, and understanding the factors that contribute to the difficulty of those problems," says Kirkpatrick.

"As computers get bigger and faster they seem more capable, but our demands are growing, so there is motivation to understand the theoretical limitations to computing, and this is a mathematical enterprise," says Kirkpatrick, a professor of Computer Science since 1979 and associate dean in the Faculty of Graduate Studies.

"The nature of my interests leads me to dwell on things that aren't going to change. It's a goal of any scientific discipline to understand what's permanent and essential. In this light, dramatic changes are really just embellishments of something that's been in place for a long time," he says.

The bulk of Kirkpatrick's teaching relates to the theoretical aspects of the discipline. While change is less rapid than in other sectors, the curriculum is by no means static. Two new courses in algorithm design and analysis were introduced just last year. "Students are being introduced to theoretical concepts earlier. There's a movement of material through the curriculum from top to bottom in that concepts that used to be taught at the graduate level now appear often much earlier."

Collaboration is an important feature of Kirkpatrick's research. He is actively collaborating with researchers around the world on a dozen different projects. He notes, however, that some of the world's top researchers in his areas of interest are colleagues here at UBC. "You really ought to be interviewing them instead," he says. ■



David Kirkpatrick

PASSING NOTES

CICSR welcomes new members

CICSR welcomes six new researchers into its ranks.

Alan Hu's research focuses on practical ways to use formal verification to help design complicated protocols, computer systems, and integrated circuits. Hu comes to Computer Science and CICSR via Fujitsu Labs of America.

Gail Murphy joined the Computer Science department in August 1996, after completing her PhD at the University of Washington. She focuses on problems related to software evolution, including source code analysis, visualization and reverse engineering, architecture, and design techniques.

Another newcomer is Michael Feeley (Computer Science), who arrived this year from the University of Washington. His main research interest is interaction between operating systems, compilers, and programming models for supporting distributed applications and managing persistent data.

Peter Cahoon (Computer Science) is another recent CICSR newcomer. His research interest is in scientific visualization, from algorithm development to image capture and analysis.

Steven Wilton came to the Department of Electrical and Computer Engineering and CICSR in December 1996 from the University of Toronto. His research interests are in the areas of chip design, computer-aided design algorithms, and computer architecture.

Carl Ollivier-Gooch joined the Mechanical Engineering Department and CICSR this January, following a postdoctoral fellowship at Argonne National Laboratory (ANL) in Chicago, Illinois. Carl continues the research he undertook at ANL in tetrahedral mesh generation. ■

Martha Salcudean wins award

Mechanical Engineering Professor Martha Salcudean has won a Meritorious Achievement Award from the Association of Professional Engineers and Geoscientists of BC. Salcudean won for her research in computational fluid dynamics and industrial processes in the pulp and paper industries.

One of the first female engineering professors in Canada, Salcudean was the first to head an engineering department when she became head of UBC's Mechanical Engineering Department in 1985. She is currently on leave. ■

Clarence de Silva wins another

Clarence de Silva has received the 1996 Outstanding Contribution Award from the Systems, Man and Cybernetics Society of the Institute of Electrical and Electronics Engineers (IEEE). De Silva was program chair of the 1995 IEEE Annual Conference on Systems, Man and Cybernetics. ■

ASI-CICSR lecture series

The lecture series continued on February 6 with Dan Gelbart, president of CREO Products. Gelbart talked about CREO's Computer-to-Plate technology, and described the evolution of his company. The lecture, the fifth in the series showcasing BC-developed technology, was well attended. Thanks to Terry Ngo (ECE) who organized the lectures and which have been a great success. ■

CICSR welcomes Gayle Kosh

CICSR is happy to welcome Gayle Kosh to the office as a part-time secretary. Gayle comes to CICSR from the Recycling Council of BC. ■

UBC Technology Flies High *continued from page 1*

stations and on parabolic flights. MIM designs were also tested on zero-G flights with the experiment free-floating within the airplane; the goal is for the MIM to provide a perfectly stable platform despite the imperfect path of the aircraft.

The MIM design and testing was Niall Parker's main project for three years. Other UBC contributors, at various stages of the project, included Harold Davis, Lab Director of Engineering Physics, who has been working with Tryggvason on large-motion isolation for parabolic flights, Electrical and Computer Engineering (ECE) students Jason Boulet and Chai-Tung Chen, and several Engineering Physics and ECE summer students.

Using the design provided by the UBC team, Pointe Claire, Quebec-based MPB Technologies has built a prototype MIM, and two more for space flight. The MIM aboard the Russian Mir space station is now being used to conduct experiments, and will be in operation for up to three years. A second MIM is scheduled to be sent into space with Tryggvason on the space shuttle scheduled for launch in July 1987. It is fitting that Tryggvason, a professional engineer and payload specialist, be on the 11-day space mission transporting the MIM since he was a principal instigator of the technology.

The goal is for the MIM to provide a perfectly stable platform.

Salcudean, currently spending the year in France on sabbatical, notes that vibration isolation has many applications, both in space and on earth. Terrestrial applications include platforms for sensitive instruments such as scanning tunnelling microscopes, and some applications in the electronics industry that require stable platforms. Salcudean says he is actively pursuing other applications of magnetic levitation technology, especially in the areas of force-feedback computer-user interfaces.

In the meantime, Salcudean is following experiments with the MIM closely. He and his team consider it an honour to have their technology onboard the space mission as physical space is at an absolute premium, with every square inch accounted for. For a piece of equipment to be carried along as cargo, its contribution must be considered critical. The MIM appears to be living up to its promise, allowing ground-breaking research to be conducted reliably in zero-G. ■

Spinoza the Robot Sees the Light

Robots are finally beginning to see things Jim Little's way. Little, an associate professor of Computer Science at UBC and CICSR member, specializes in computational vision and aritificial intelligence, and is concentrating on the development of near real-time vision systems for robots. With the help of Spinoza, a mobile robot, Little is working to construct vision systems that will allow robots to see the world much in the way we see it.

Real-time Vision a Challenge

The challenge is to enable robots to see in real-time. It is one thing for robots to take pictures and analyze them, says Little, but it is another thing for them to see and respond to visual information on the fly. Building human aspects of vision in computational form is another challenge, and Little is collaborating with researchers in UBC's Department of Electrical and Computer Engineering to give robots the ability to see the way humans do, using motion and shape as visual cues.

Spinoza, for example, can motor around, recognize where it is, and process information about relative distances, which allows it to locate itself in a room. It can push objects around, and at some point will have a hand or carrying case. Other systems in Little's lab enable

Jim Little and Spinoza

Spinoza to see movements, including one that couples the robot's stereo cameras with an arm so it can recognize objects and pick them up.

Potential Industrial Uses

Robots with real-time vision potentially have many industrial applications. Robots with vision could be used to manage materials in warehouses, to work on assembly lines, and even to act as office assistants, carrying things from one office to another.

Another possible use is in health and home care: robots may be able to assist the aged and infirm who need help in the home. Little envisions a sort of robot assistant that helps people prepare meals, fetch things around the house, and generally extend people's physical capabilities. Little is also beginning to consider ways the same vision systems might be used to help blind people navigate and become more mobile.

Networked Robots

"We're only just beginning, but the systems we've developed are very capable, and that's exciting," says Little. "We're just learning to use teams of robots, but in the next few years we're going to look at how they can communicate in a networked way."

And if robots can see, Little thinks we can find ways to communicate with them by gesture rather than by sound.

Little and his colleagues at UBC have formed what they call the Dynamo Group to develop ideas, realize algorithms and test them within an embodied machine. The group is currently building a prototype stereo vision system that will be a self-contained add-on for robots. ■

CENTRE FOR INTEGRATED COMPUTER SYSTEMS RESEARCH

The UBC Centre for Integrated Computer Systems Research (CICSR) is an interdepartmental research organization made up of computer-related research faculty members in the Departments of Computer Science, Electrical and Computer Engineering and Mechanical Engineering. Currently there are more than 70 CICSR researchers who direct over 300 graduate students and collaborate with dozens of industrial firms in areas such as robotics, artificial intelligence, communications, VLSI design, imaging, and industrial automation.

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