



McGill
C e n t r e f o r

Intelligent Machines

Volume 9, Number 11, November, 1995

Newsletter

A new member of the DIESTRO Family

As some fellow CIMites already know, the Angeles group has been working on a new class of robotic manipulators over the last six years, known as *isotropic*. So far, three manipulators of this type have been manufactured at CIM, namely, DIESTRO, REDIESTRO 1 and the C3 arm. Recently, McGill and Concordia Universities teamed up with the Canadair Division of Bombardier Incorporation in a joint project to develop a new member of this class of manipulators: REDIESTRO 2. The leaders of the groups working on this project are R.V. Patel of Concordia and J. Angeles of McGill.

The goal of this project is to develop a highly dextrous dual-arm robotic manipulation environment that can be used for hardware and software testing and training of personnel. The first robot that will be acting as one of the arms was designed and manufactured from scratch at McGill. It was originally given the name REDIESTRO, an acronym standing for REDundant, Dextrous, Isotropic Enhanced, Seven Turning-pair RObot. In order to distinguish this robot from the new one, which is currently under development, it has been renamed REDIESTRO 1. The second arm, REDIESTRO 2, will be an improved version of REDIESTRO 1 (see the figure).

The two main features of this robot are redundancy and isotropy. A redundant manipulator is a manipulator that has more degrees of freedom than necessary to perform a specific task, that is, redundancy depends on the task dimensions. For example, a three-link planar manipulator is redundant if its task is only to position the end-effector in a plane. The same manipulator will not be redundant if its task is to position *and* orient the end-effector in the same plane. On the one hand

redundancy gives extra degree of freedom and the ability to avoid singularities. On the other hand, a redundant robot is more challenging to control, as it admits infinitely many solutions to the inverse kinematics problem.

A robot is isotropic if, for a specific configuration, the associated Jacobian matrix has all its singular values identical and non zero. In this case, there is a large singularity-free region around the isotropic configuration, which yields accurate sensing and control, and hence, an enhanced overall performance.

This project is funded by NSERC through a collaborative R & D Grant. It involves the development and implementation of state-of-the-art methodologies in a number of areas in robotics – path planning, collision avoidance, redundancy resolution force and position control, object contact, hardware and software development for real-time control, etc.

The CIM team, consisting of Professor Angeles as the group leader, Ferhan Bulca, Noga Arenson, and Mordechai Arenson, is responsible for designing and manufacturing REDIESTRO 2, while the Concordia team will work on the control. We started working on this project in mid-August. Since then, we have redesigned REDIESTRO 2 to accommodate the requirements of the Concordia and Bombardier teams. In the initial stage, we used an optimization program, developed by Farzam Ranjbaran at CIM, in order to find an optimal set of Hartenberg-Denavit (HD) parameters of the manipulator that fulfill the isotropy condition plus additional functionality constraints. The optimization program finds a set of HD parameters for a given objective function; then, the skeleton rendering of the robot can be visualized and examined using the Robotic Visualization System (RVS), a piece of software developed by John Darcovich while at CIM (John is now at CAE Electronics Ltd., Saint-

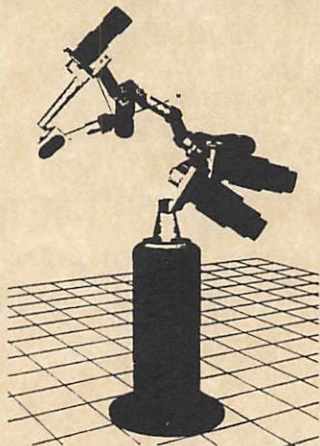
Laurent, Quebec). RVS provides a very useful visual tool to determine the feasibility of the design.

One of the options for the architecture of REDIESTRO 2 is manufacturing the mirror image of REDIESTRO 1, since the two robots will be working together. Our purpose was to have a general algorithm to produce the mirror image rather than finding a mirror image for each case. We derived the equations for the reflection and coded in MATLAB. Our program is now functional and very useful for finding the mirror images of different designs that are under consideration for the final product.

Additionally, we are developing the tools for the static and dynamic analysis of REDIESTRO 2. This will help us in the selection of the actuators. We are using MOBILE for this purpose, which is an object-oriented programming package for the modeling of multi-body systems. It is based on the object-oriented programming language C++ and developed by Dr. Andr s Kecskem thy. MOBILE is a very powerful tool that can also import AUTOCAD drawings and provides user interaction with click-and-drag features for on-line kinematics, statics and dynamics. It is also fully compatible with INVENTOR.

We have nine months to finish our part in the project and we are running on schedule. There is still plenty of work to be done and we enjoy what we are doing when things are going well; when this is not the case, which also happens once in a while here at CIM, we try to look like we are still enjoying the stress! This is a wonderful experience for all of us since it is a combination of theory and practice and also involves interaction with people from industry.

Submitted by Noga Arenson & Ferhan Bulca



A last letter from an old Associate Editor, Paul Mackenzie

So what does an associate editor for the CIM Newsletter do anyway? Well, since that is one of the great unanswered questions of our time, you'll have to ask my replacements/heirs/upgrades: Michael "Inspector Gadget" Daum and Nick "The Voice of Reason" Roy will be taking over my role as CIM Newsletter associate editors as of this month. I'm sure they will provide plenty of weird, wacky, and perhaps even informative stuff for you to read. At least you can breathe a sigh of relief that those crazy Top 10 lists are gone, although don't be surprised if you see the odd "Guest List" appear!

As for me, I have heeded the call to join le Centre de Recherche Informatique de Montreal (CRIM) to aid in the never-ending quest to pillage the land of the north of its vast treasure trove of softwood forests. I'll be involved in a project to create some kind of virtual reality system that will be used to simulate some high-tech honky-dory lumber labotomizer in order to better train the operators to terminate trees with extreme prejudice. And so, as I make the transition from robot-dude to robot-graphics-dude, from English to French, and from University Ave to McGill College, I shall carry with me fond memories of my days at CIM, and I shall look forward to eating twice as much as my new co-workers.

Editor's note: CIM will miss all the help Paul has given us over the years, as well as his personal and humorous view of the world. Thanks very much, Paul, for all your help.

Holiday party update


Thank-you to all who offered to help with the organization & entertainment for the '95 CIM Holiday Party. This anticipated event will take place on Monday Dec. 4, starting at 6 pm, at La Cabane Grecque, 102 Prince Arthur. The dinner menu will consist of soup, entr e, main course (eight choices), dessert & coffee. There is also a children's menu for about \$2.00. Entertainment will be provided and Santa will drop in again for the children. All this for \$10.00 per adult. CIM will

cover the surplus costs (an additional \$3.00 p.p.) as well as some bottles of wine.

Please sign up by email to <kathleen> or <jmb> ASAP so that we can confirm numbers and provide Santa with a list of the children before the Holiday shopping rush. You may pay when you sign up before Nov. 24 or on the day of the party. We're hoping for a great turnout again, so please mark your calendars & come out to join us !!!




NEWS AND EVENTS


 As most of you know, Principal Shapiro visited CIM on October 31. After a brief tour of the CIM labs, the principal met with the CIM faculty for approximately 50 minutes to discuss topics such as: the future of Centres at McGill, etc.

Most CIMites exhibited true CIM spirit by coming in early that morning to be available for the principal's tour. Thank you for your participation and cooperation during this important visit!


Hats off to ...

 Manuel Hernandez-Cruz submitted his Masters thesis entitled "*Modeling, Sensitivity Analysis and Control Design for a Tendon Transmission*". He has decided to remain at CIM and is working on his Ph.D. with Vincent Hayward. Congratulations!


Welcome to...

 Marcello Pelillo was born in Taranto, Italy, and graduated with a degree in Computer Science at the University of Bari, Italy, on March 1989. After spending a year at the IBM Research Center in Rome, he became Assistant Professor at the University of Bari, Italy, in 1991. In March 1995 he moved to the University of Venice "Ca' Foscari", and in June-August 1995 he has been a Visiting Professor at the Department of Computer Science of

the University of York, UK. His main research interests are in the areas of Neural Networks, Pattern Recognition, and Computer Vision.

 Farrokh Janabi-Sharifi received his B.S. and M.A.Sc degrees, both in mechanical engineering, from the Middle East Technical University, Turkey, and the University of Toronto, respectively. He received his Ph.D. degree from the University of Waterloo in 1995 in electrical & computer engineering. Since then, he has been an NSERC postdoctoral fellow at CIM. His research interests include dynamics, systems modeling and control, AI, neural networks, robot motion planning and control, and in particular visual relative pose based control of manipulators. He has published more than 20 technical papers in these areas. He is also the co-author of a book entitled "*An Introduction to Oil Hydraulics: Design & Control*". He has received several awards and certificates of recognition. During the last few years, he has been active within several committees of the IEEE Robotics & Automation Society.

Good-bye to...

 After finishing his thesis on "*Singular Stewart-Gough Platforms*" under the supervision of Prof. Zsombor-Murray, Dominik Hartmann is moving back home to Switzerland. He said that after enjoying an extended vacation in Canada (mountain climbing in the N.W. Territories), real life is catching up to him & he has to look for a job, most likely somewhere in Europe. Looking back over the time he spent at CIM, he can't believe that it went by so quickly. "It was a very interesting and motivating research environment and I enjoyed working with all the great people at the Centre very much. The time I have spent in Canada was a very good experience and I hope to come back many times. About Montreal: great city, but, there are really NO mountains!!" Good luck, Dominik!

CIM in the community

Currently a team from CIM is volunteering as mentors for Vincent Massey High School in Montreal. The school is entered in the Canada

First Robotics Competition. The goal of the competition is to build a remote control mobile robot which can collect balls and return them to their own goal while also defending against other competitor's robots. What is more, they have just one month to design, build, and test their entry. The CIM team are acting as engineering consultants to the high school. Already the high school team has visited the Centre twice and we discussed and presented mobile robot designs and ball pick up mechanisms. We also plan to help them via e-mail and to visit their school to lend a hand with construction.

The CIM team is made up of: *Oliver Astley, Manuel Cruz, Prof. Dudek, Ahmed Helmy, Anna Lin, Bin Mu, Romney Ka-Ho Ng, & Dan Rey*

If you would like to lend a bit, not a lot, of time, please e-mail oliver@cim.

Save the Children-Canada cards

Save the Children-Canada is an international development organization guided by volunteers dedicated to the attainment of the objectives of the United Nations Declaration of the Rights of the Child and to the implementation of the United Nations Convention on the Rights of the Child.

Each year volunteers across the country sell Christmas Cards to raise money for Save the Children-Canada community development projects at home and around the world. Funds raised from these cards help Save the Children-Canada to work with the most needy communities around the world, whether it be clean water projects in Kenya or Street Kids programs in Haiti.

If are interested in purchasing a box of Save the Children Christmas Cards, or in seeing a brochure of the available cards, or if you have any questions about Save the Children-Canada in general, please contact Don Bui (bui@cim) or (398-2186 in rm. 416).

Submitted by Don Bui, Save the Children-Canada McGill Branch

Articles & ideas are welcome. Please send them by e-mail to the editor. Deadline for publication is the 7th of every month.

Editor: Janet Burghardt (e-mail: jmb@cim.mcgill.ca)

Associate Editors: Michael Daum <mdaum>, Nicholas Roy <nickr>, Kathleen VanderNoot <kathleen>

CIM Safety Committee update

As most of you already know (with the exception of new CIMites and those of you who forgot!), CIM has a safety committee that meets approximately twice a year. The members of this committee are: **Profs. Hannah Michalska and Martin Buehler, and Iyad Abdul-Baki.** Their responsibilities include checking CIM labs and other areas for possible dangers and making recommendations to supervisors and administrative staff on ways to improve safety. They also act as resource people for safety concerns.

We have decided it would be helpful if we asked someone working in each of the labs to take responsibility for safety in those labs. **Oliver Astley** has agreed to be in charge of safety in 418 and 416, **Carlos Martinez-Mascarua** will take care of 435, and **Gilbert Soucy** will take care of 444 (411 is covered by Martin and Iyad.) We believe they will be more likely to spot potential trouble areas sooner because they are there so much of the time.

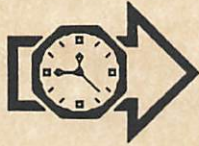
If you have any safety concerns or see anything you think should be changed, please send me a message or feel free to talk directly with one of the above-mentioned people. Of course, all CIMites are involved in making CIM a safe and pleasant place to work and to study, and we hope that by having someone nearby whom you can consult when you have concerns will make things even easier for you. For your information, we have included a copy of safety procedures at the end of this newsletter. Have a nice (and safe!) day.

Fire drill procedures

The fire drill that was held last week was a dry run, i.e. it gave the Building Emergency Monitors a chance to discover where the hazards lie. At CIM we were lucky it was only a drill ... we broke all records in clearing the floor, the slowest group ever!

There was a fire door problem which has now been remedied and which forced people to exit via the Macdonald Building. The big danger however, was the lack of cooperation on the part of very studious students who just could not tear themselves away from their research!

For your information the *CIM Emergency Monitors* are Jan & Kathleen, and the *Sweepers* are Janet, Jennifer, Ahmed & Marc. The procedure to follow when you hear the fire alarm is to drop what you're doing immediately and leave the building using the nearest exit. The Sweepers check their assigned areas and then report to the Monitors when their areas are cleared. The Monitors are the last to leave and they report any problems to the Building Director, who in turn reports to the Fire Chief.



Overheard on the Psychiatric Hotline...

RING.....RING.....CLICK.....:
"Welcome to the Psychiatric Hotline."

"If you are obsessive-compulsive, please press 1 repeatedly."

"If you are codependent, please ask someone to press 2."

"If you have multiple personalities, please press 3, 4, 5 and 6."

"If you are paranoid-delusional, we know who you are and what you want. Just stay on the line so we can trace the call."

"If you are schizophrenic, listen carefully and a little voice will tell you which number to press."

"If you are manic-depressive, it doesn't matter which number you press. No one will answer."

Submitted from the Web by Paul Mackenzie

EMERGENCY PROCEDURES

FIRE

1. Shout 'FIRE', determine if anyone is in immediate danger, attempt to rescue, **do not endanger yourself.**
2. **Pull the nearest fire alarm.**
3. Use fire extinguishers for fighting small fires only. Don't attempt to fight a major fire on your own. Use only CO₂, halon, or dry chemical fire extinguishers for electrical fires.
4. **Get everyone out of the lab. Close but do not lock door.**
5. Report to the porter's office at 8403 or call the emergency tel. no.: 3000.

SAFETY REGULATIONS

GENERAL

1. Smoking, eating, drinking and storage of food are NOT permitted in labs.
2. Work places must be kept clean and freed of unnecessary material and equipment.
3. **Exits and passageways must be kept clear at all times.**
4. Be familiar with the locations and operation of safety and emergency facilities such as the fire extinguishers, first aid kit, fire alarm pull stations, telephone and emergency exits.
5. Long hair must be tied back when working with moving machinery. **Use safety glasses when working with lasers, sprays, chemicals and machinery that can generate projectiles.**
6. Work only with materials when you know their flammability, reactivity, toxicity, and emergency procedures. Obtain proper material safety data sheets (MSDS) from Safety Office (loc. 4563).
7. Sharp objects should be placed in a rigid container before disposal.
8. Do not work alone with potentially dangerous equipment.

ELECTRICAL SAFETY

1. All electrical equipment should be grounded with a 3-pronged plug.
2. Major wiring should be done by, or under the approval of, a licensed electrician.
3. Any electrical equipment that has been wetted should be disconnected at the main breaker before being handled. Familiarize yourself with the location of such devices.
4. **Electrical equipment with frayed wires should be repaired before use.**
5. Discharge all electrical potential before commencing repair work on any equipment.
6. Minimize the use of extension cords and avoid placing them across areas of pedestrian traffic.