NSERC
2010
Undergraduate Student
Research Award

For further information:
http://www.nserc-crsng.gc.ca/Students-Etudiants/UG-PC/USRA-BRPC_eng.asp

Scholarships are valued as follows (amount shown includes $4500 from NSERC):

Students who have completed Level 1: $5625
Students who have completed Level 2: $7300
Students who have completed Level 3: $8100
Students who have completed Level 4 or 5: $8500

The **Department of Computing and Software** is accepting applications for the following projects. Applications must be received in the CAS Departmental Office (ITB/202) no later than Friday, February 5, 2010. Applications must include Part 1 of Form 202 (Application for an Undergraduate Student Research Award), available on the NSERC website, and official transcripts. The form must be completed electronically by logging into the NSERC website, then printed and signed prior to submission to the departmental office. Please also include a brief separate statement indicating which project(s) you are applying for.

Project #1 (looking for 2 students):
Library Development for a Mechanized Mathematics System
Supervisors: J. Carette and W. Farmer

Project # 2:
Combinatorial Optimization: Theory and Algorithms
Supervisor: A. Deza

Project # 3:
Extending Xmonad for Multiple X11 Displays
Supervisor: W. Kahl

Project #4:
Applications of 3D Graph Transformation in GraTraVis
Supervisor: W. Kahl

Project# 5:
Design, implement and test tools to assist in the scheduling and resource allocation in Level 1 Engineering.
Supervisor: S. Smith

Project # 6:
FPGA Based Implementation of Verifiably Correct Safety Critical Systems
Supervisor: M. Lawford

Department of Computing and Software
NSERC USRA Project Descriptions
Summer 2010

Project # 1:

Project title: Library Development for a Mechanized Mathematics System

Supervisors: Jacques Carette and William Farmer

The mission of mechanized mathematics is to develop software systems that support the process people use to create, explore, connect, and apply mathematics. MathScheme is a long-range project being pursued at McMaster University that seeks to develop the next generation of a mechanized mathematics system. MathScheme is developing an implementation of a new language for expressing mathematics. The language is intended to serve as the logical basis for the development of an experimental library of mathematical knowledge. We are looking for a student who can contribute to the development of the library by using the new MathScheme language to specify and implement simple data structures and model-building tools from mathematics. These data structures and tools will be used to carefully build up mathematical knowledge in the library.

Required qualifications:

1. Good programming skills; knowledge of OCaml or other ML programming languages is a plus.

2. Good background in mathematics, particularly in logic and discrete mathematics.

Project # 2:

Project Title: Combinatorial Optimization: Theory and Algorithms

Supervisor: A. Deza

Combinatorial optimization focuses on problems arising from discrete structures, such as graphs and polyhedra. These problems are formulated with discrete, mainly integer or 0/1-valued, variables. Discrete optimization exploits the combinatorial properties that enable us to develop powerful algorithms that are able to tackle large-scale problems intractable by general purpose algorithms. The project deals with geometric aspects of optimization.

The task of the student concerns bridging theoretical and computational approaches in order to design high-performance algorithms.

Required qualifications:
Good computer sciences/software skills
Good mathematical skills, in particular discrete mathematics.

Project # 3:

Project Title: Extending Xmonad for Multiple X11 Displays

Supervisor: W. Kahl

Large multi-monitor displays open up new possibilities for intuitive interaction with discrete structures, such as software, theories, or even just relations and graphs. However, such displays also pose particular implementation challenges due to the fact that the monitors may be driven by separate computers connected only via a network.

Making the resulting system appear conceptually as a single display space can be achieved with different technical solutions and different trade-offs.

The tiling window manager Xmonad already has excellent support for multiple monitors connected to a single machine, that is, for multiple screens constituting a single Xinerama display.
This project will explore extensions to Xmonad that will allow it to operate across multiple X11 displays, that is, also on monitors connected to other machines.

The student taking on this project will need to acquire knowledge in several areas:
* programming in the functional programming language Haskell, the implementation language of Xmonad
* the X11 window system, and in particular
* window manager operation in X11, in particular ICCM and EWMH

The final target of this development is our large display wall consisting of twelve 30-inch monitors driven by six MacPro machines; testing will use one of our "small development stations" sporting four 30-inch displays, driven by two machines.
Previous experience with working on UNIX-like operating systems and with X11 user interfaces is highly desirable (and can be gained for example via working in Linux for the rest of the term).

Haskell: http://haskell.org/
Xmonad: http://xmonad.org/
http://en.wikipedia.org/wiki/Xmonad
X11: http://en.wikipedia.org/wiki/X_Window_System

Project # 4:

Project Title: Applications of 3D Graph Transformation in GraTraVis

Supervisor: W. Kahl

The generic graph transformation, visualisation, and editing framework GraTraVis already supports programming of custom graph transformation mechanisms, and of custom visualisations in Cairo for 2D and in OpenGL for 3D graphical representation of graph models.

This project will add different new graph model instances to show off and improve these capabilities.
Candidates include:

* L-systems for plant models
http://en.wikipedia.org/wiki/L-systems

* Systems Biological Graphical Notation
http://sbgn.org/

* 3D support for browsing of dependency graphs.

GraTraVis is programmed in the pure functional programming language Haskell:

Haskell: http://haskell.org/

Project #5:

Project title: Design, implement and test tools to assist in the scheduling and resource allocation in Level 1 Engineering.

Supervisor: S. Smith

Design, implement and test tools to assist in the scheduling and resource allocation in Level 1 Engineering. Potential tools include implementation of the algorithm to assign Level 1 students to Level 2 programs, scheduling of summer school classes, scheduling of teaching assistants and room booking management. Proper software engineering methodologies and tool use will be emphasized.

Qualifications:

An ability to program.

Project # 6:

FPGA Based Implementation of Verifiably Correct Safety Critical Systems

Supervisor: M. Lawford

This project involves investigation of the design and implementation of safety critical systems for the nuclear industry using FPGA based platforms. The focus will be upon construction of pre-verified functional blocks that can be used to implement verifiably correct systems.

The candidate should have experience with FPGAs, embedded systems design and knowledge of Verilog and/or VHDL. Experience with related CAD tools is considered an asset.