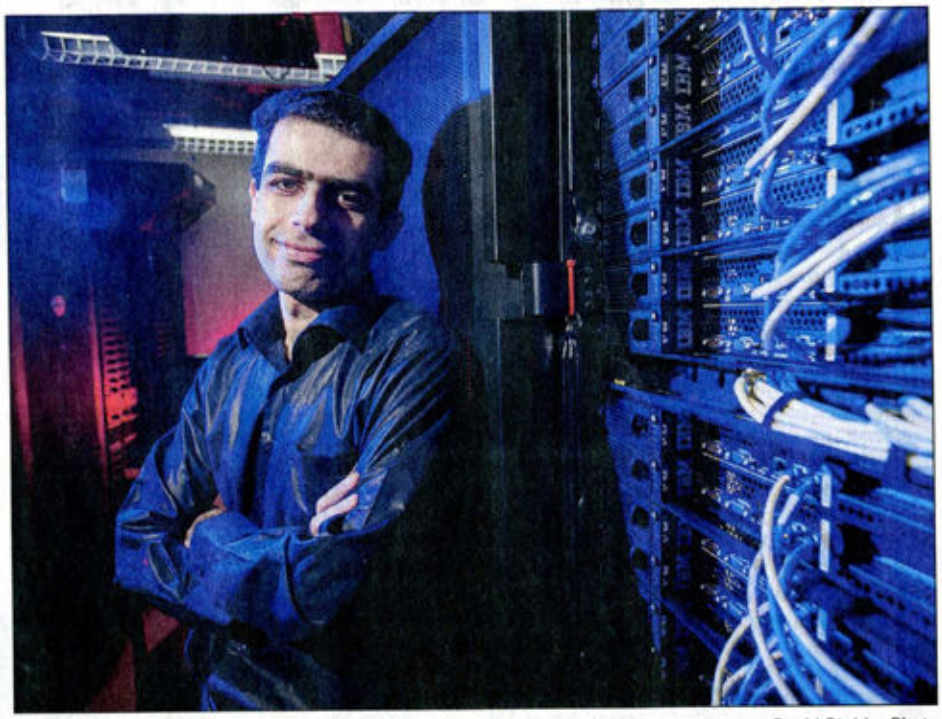
YOUNG INNOVATORS

Student takes math to heart

THOMAS ONION
FOR THE STARPHOENIX



David Stobbe Photo

Saeed Torabi uses math and supercomputers to simulate heart rhythms.

As a child growing up in Iran, math problems really got Saeed Torabi's heart pumping. As a PhD student, he is using his love of math to help build a computer simulation of a beating heart.

Simulated hearts exist already, but Torabi's work at the University of Saskatchewan aims to make them lifelike enough to have a practical use in labs and hospitals.

"Medical researchers could use these really fast simulations to design drugs or determine optimal placement of pacemakers," said Torabi's supervisor, U of S computer science professor Raymond Spiteri.

"Doctors and other health practitioners could also be trained on virtual hearts, or see how the effects of procedures unfold in front of their eyes."

Using supercomputers on campus, Torabi solves complex equations that are mathematical models of a heart. Electrical currents make our hearts contract and push blood through our bodies. He uses equations to simulate these currents and finds the most efficient way to model a pulsing human heart.

By solving these equations, Torabi determines the voltage at every point of the heart, at any time during a heartbeat.

Equations that model the heart already exist, but Torabi analyzes them to explain why one method of solving might be faster or more accurate.

So far his research on single cell models of the heart has led to new methods of solving equations that are up to 270 times faster than existing methods. Torabi is now working on more complex equations that model the whole heart. Using 2-D models, he is achieving results that are three times faster than the common methods. He is now working on 3-D models.

"Our final goal is to simulate a heartbeat, in a heartbeat's time," Torabi said.

Once a simulation this advanced is completed, doctors will be able to turn on their computers and open up a lifelike virtual heart, beating and ready for their tests.

With today's technology, the calculations are so complex that supercomputers are needed. Torabi said the early-stage work can be frustrating.

"Our biggest calculations can take two months," he said, adding it can take weeks to know whether the computations will work out.

The simulation could make a major difference in people's lives. Ischemic heart disease — a disease characterized by a reduced blood supply to the heart — is the leading cause of death worldwide. In 2008, it killed more than seven million people, 15 per cent of all deaths globally.

The project's potential to improve the quality of virtual simulations is being recognized. Torabi's work is supported through grants received by Spiteri's lab from the Natural Sciences and Engineering Research Council and the research organization MITACS.

Spiteri's team is collaborating with the University of Oxford's Cancer, Heart, and Soft Tissue Environment (CHASTE) group. CHASTE is its biological simulation package, which includes models for organs like the heart.

When the U of S team finds faster ways to simulate the heart, it writes computer code or "patches," which are used to improve CHASTE.

"The primary goal of our project is to have our methods be part of the software package that would be the first in the world to reach real-time simulation," Spiteri said.

Torabi stresses that math is everywhere, from the structure of buildings to the pulses through our veins. He is happy to use math in a project that could help people.

"I would be very happy to see mathematics save human lives. Also, it would help show that mathematics is a practical and useful knowledge," he said.

Thomas Onion is a graduate student intern in the U of S Office of Research Communications.