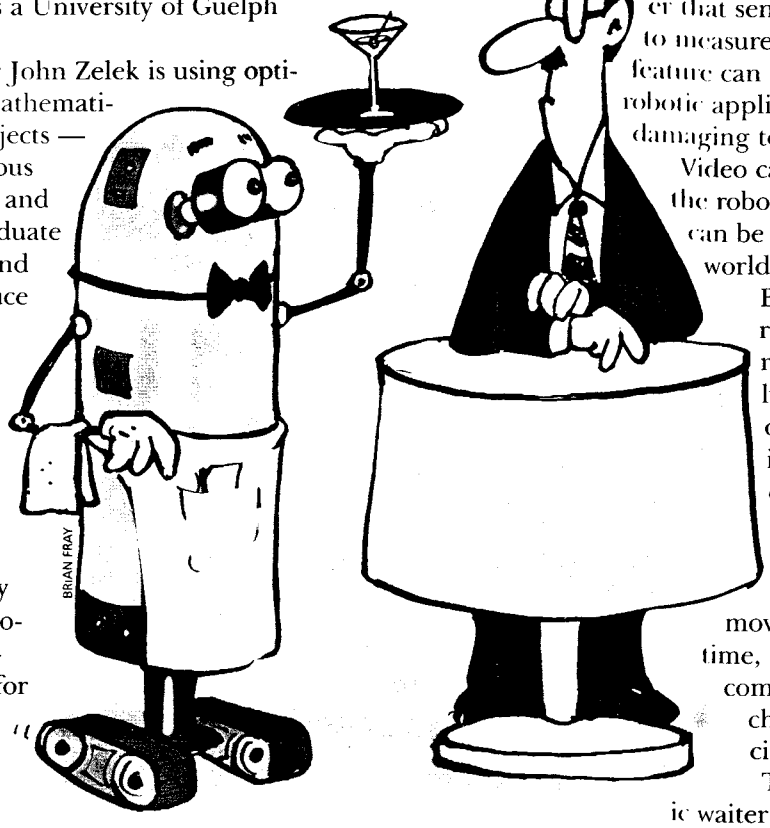
Shaken, not spilled

New robotic waiter stands to take orders

BY CHRISTINA CLARK

A robot engineered to serve cocktails — without spilling a drop — is the design prototype for a legion of droids that could perform all kinds of tasks too dangerous, mundane or inaccessible for humans, says a University of Guelph researcher.

Engineering professor John Zelek is using optical flow technology — mathematical models of moving objects — to program an autonomous robot for navigation. He and his research team — graduate student Rekha Kanwar and undergraduates Neil Bruce and Luk St-Onge — are using a robot mounted with a computer and video cameras that can steer through crowded rooms.



The researchers say the spill-free delivery of drinks is a good everyday innocuous test for the prototype, which, once complete, could be adapted for other applications. For example, "seeing" robots could be used in remote locations such as outer space and in tedious or hazardous environments such as nuclear power plants or chemical spill sites, as well as for intelligent wheelchairs for the physically disabled.

"If the technology can be used to serve cocktails, then it can be transferred to a variety of other uses," says Zelek.

"Seeing" robots could be used in remote locations and in tedious or hazardous environments

To make the robot work effectively, the team is first adapting it to indoor environmental conditions — it must be able to see at eye level and manoeuvre around moving and stationary obstacles. To this end, sonars that emit sound signals (much like the natural navigation system that guides bats in the dark) are mounted on the robot. The emitted sounds hit objects and bounce back to the robot, which picks up the signal and measures the distance from the object based on travel time. It then adjusts its "walking" pattern accordingly.

The problem with seeing like a bat is that indoors, sounds can bounce around haphazardly and generate misleading information. That's why the robot is also equipped with a laser range finder that sends out a beam of laser light to measure distances from objects. This feature can be used only for industrial robotic applications because laser light is damaging to human eyes.

Video cameras are also mounted on the robot. Everything the robot "sees" can be viewed from anywhere in the world via the Internet.

Because objects in the environment move around, the robot's path must be constantly recomputed. That's where optical flow technology comes in, to keep track of moving objects that the robot "sees." The algorithm (mathematical model) on which the technology is based computes movements of objects in real time, so that path planning can be computed to keep up with changing environmental circumstances.

The challenge with the robotic waiter is processing all the information it collects. Right now, the technology is limited by the computer hardware that's required to make the algorithms run as quickly as possible. The same computer must receive and process all the information and compute the algorithms to plan the robot's navigation.

"It can take a long time to process information from the video cameras, bumper sensors and sonars," says Zelek. "This information must be processed quickly enough that the robot's path can be continuously planned and adapted to the changing environment."

Optical flow technology is also being used by Zelek's team to track the movements of pigs (see story on page 35).

This research is sponsored by the Natural Sciences and Engineering Research Council.

Pig Brother is watching

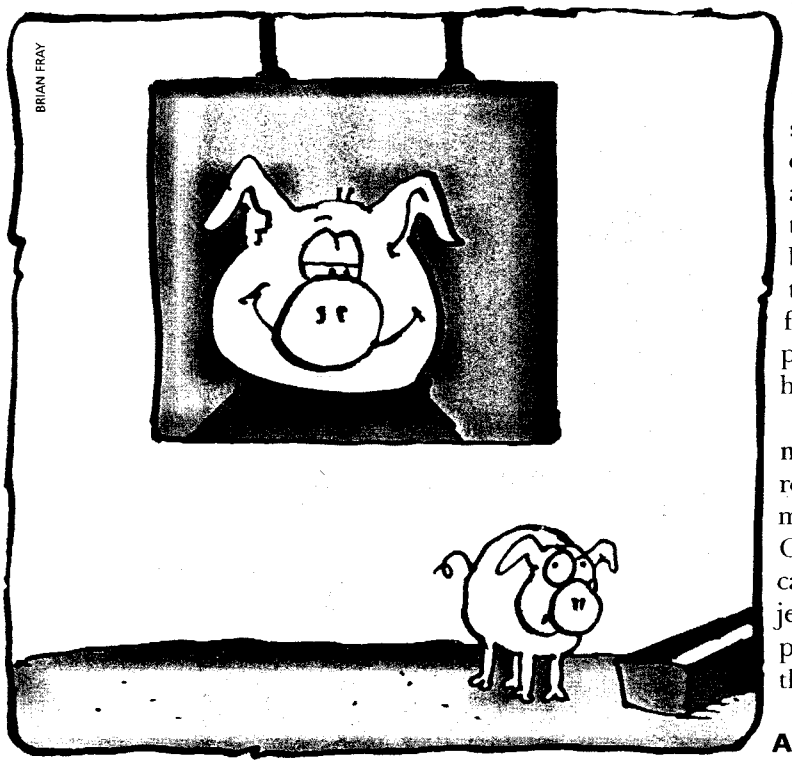
Monitoring technology helps track animal health

BY MURRAY TONG

Pigs could face an Orwellian future with a new monitor that simplifies the task of tracking their health and well-being.

U of G engineering professor John Zelek has created a non-invasive automated pig monitor, a real-time software application that observes the range and frequency of movement of individual pigs.

"A lack of motion generally indicates a lack of welfare," says Zelek. With that in mind, he created a computer software program that can instantly warn producers or behaviourists about behavioural or health-related irregularities in the herd. Other tracking systems simplify the environment by placing artificial markers on the subjects, making them easier to track, but he's a pioneer in applying non-invasive monitoring technology to pig production.



Zelek had originally planned to develop an interactive robot waiter, but he put that project on hold when interest was expressed in the design of an inexpensive stationary tracking device.

KEEPING IT SIMPLE

He found the simplest solution to be the most effective. He mounted an inexpensive video camera over a pigpen, plugged the image into a Pentium 2 processor and created a computer program to monitor movement of individual animals.

To track the pigs individually, Zelek used what's called "simple segmentation" (also known as "blob tracking"). This technique uses a tracking window to define an area around an object's centre of mass, such as a pig's body. By setting up multiple windows, the computer can follow the movements of several pigs at the same time. Zelek says it's the easiest and fastest way to grab the position of a moving pig, but there are still some bugs to work out. For example, the monitor tends to lose track of its target if the pig's body twists too much or if pigs squeeze next to each other. In addition, although the monitor can track an animal once it's been identified, it can't do the identification itself. To fix that, Zelek will add a pig recognition module to his program.

A selling point of his pig monitor is that it works in real time, analysing information as it's recorded. Other monitoring systems can only record their subjects and must be tediously played back later to extract the required data.

A GLOBAL AUDIENCE

Zelek says his tracker can be modified and developed to observe other animals on a farm setting, and data can even be transmitted around the world for animal studies. This capability is shown by Zelek's own office camera, which provides the world with a 24-hour view of U of G's University Centre parking lot via his Web page at www.eos.uoguelph.ca/webfiles/zelek/.

John Zelek created the pig monitor, a software application that observes, in real time, the movement of pigs.

Zelek still wants to return to work on his robot waiter, but his eventual goal is to apply this technology to a wheelchair guidance system. This would involve a robot that could synthesize information from a collection of cameras on a wheelchair and navigate the occupant.

His research was supported by the Natural Sciences and Engineering Research Council.