Part 5

Human Centred Robotics
Session Summary

James Trevelyan  
Chair

Department of Mechanical & Materials Engineering, University of Western Australia

Visitors to Australia often like to ask local people about food that is truly Australian. It is a hard question to answer: people from over 160 countries now live in Australia and most of them have brought their culinary tastes with them. However, there is one particular delicacy enjoyed by aboriginal Australians: the wichety grub. This creature is a white caterpillar about 6 to 10 cm long often found in dead and decaying wood if you know where to look for them. It bears a remarkably accurate resemblance to the creature depicted in figure 1 of Allison Okamura’s paper entitled Uniting Haptic Exploration and Display. In fact one can only truly appreciate the wichety grub with both the sense of taste and touch, bringing us to the world of haptics which two papers in this session explore.

Allison Okamura’s paper describes a series of experiments in which a small robot equipped with a touch sensing finger is used to explore features on a smooth surface. The paper is particularly valuable because of an extensive reference list: there are many references and comparisons to earlier work which make this a particularly useful paper for researchers in this field. She also takes us through a formal definition of surface features and methods that can be used to explore them. She then goes on to explain how the shape of the feature can be extracted from feature points discovered from exploration. Finally she describes how the same small manipulator can be converted into a haptic rendering and display device to display the feature.

Features on the surface that can be explored with this device are described in terms of differential geometry. Given the radius of curvature of the finger, and the path traced by the finger as it traverses the surface, one can compute differential geometric properties of the surface. This process is limited: if the surface has the feature with a negative radius of curvature less than that of the finger tip there will be small unobservable regions. These aspects are clearly explained in the paper.

The author points out that there is much more to do in this field. While she has demonstrated that it is possible to generate realistic haptic models automatically she points out that this work is really only a starting point. Haptics has many advantages in situations where other kinds of sensing are not feasible, for example, in underwater situations where vision is impractical due to turbidity. She suggests that rolling fingertips need to be developed to reduce friction problems where sliding is impractical.

Oussama Khatib presents an elegant paper that brings robot control, task planning, posture control, corporative manipulation and obstacle avoidance together to provide a computationally efficient method for interacting with a virtual world full of complex objects using a Phantom haptic manipulator. The paper is elegant because it shows how other methods developed by the author over several years can be neatly combined to solve this problem. The paper can only be properly appreciated...
if what has the chance to see the author’s video which he showed at the conference meeting.

The author explains that the key problem to solve is to make the computation feasible for typical computers available today. He does this for systems with up to 500 degrees of freedom: the systems can interact and collide with each other, have articulated joints, and users can feel all forces as if they were actually present in the artificial world.

The final paper of the session takes us to a different subject: how to bring together the cognitive strengths of human beings and autonomous robots. The aim is to solve the typical problems that make the robots unable to operate without occasional help from the human masters. The authors introduce a concept that they label as “collaborative control”. They define this in terms of a human and a robot working as partners to achieve common goals. Whenever the robot needs assistance it sends a message to the human based on its knowledge of the human’s expertise. The robot knows that a novice human will not be able to reliably answer all the questions it might ask. Therefore, the robot treats the human as just another source of information alongside its many senses. It weights the information from the human appropriately. If the human does not answer the question, either because he or she is too busy or because the question is too difficult, the robot will give up after a while and do its best to solve the problem that it confronts without the additional information.

These ideas are explored in a hypothetical situation: a rock finding robot exploring a planet, looking for green rocks. The vision system of the robot cannot distinguish different kinds of rocks but it can find green things. Therefore, when it finds a green thing it asks the human operator “is this a green rock?”.

The authors have implemented this system using a hand-held organizer for the human interface: they address the problems of limited screen resolution and the need for simple menu driven responses.

During the discussion following the paper presentation many possibilities were explored. Like the other papers, this one created a great deal of interest because it offers an effective work-around for many of the problems facing today’s generation of autonomous vehicles. A member of the audience pointed out that many control systems used for process plant automation interact with plant operators using computer-generated displays and text messages. It is quite possible that some of the techniques could provide a valuable source of ideas for the robotics community.

The author opened the presentation by asking the audience “what kind of conversation would a robot like to have with human?” He suggested that perhaps the robot would like to ask for help every now and again, particularly when confronted with difficult perceptual problems. “What you think this is? Is it a real cat? Is it safe to drive over it?”

The unifying theme of this session is the interactions that are possible between robots and human beings: a theme that was revisited in many other papers in this conference. Robotics science is coming to terms with the need for human beings and robots to interact usefully and safely. While human-computer interaction (HCI)
has been carefully studied for many years, it is clear that the field of human-robot interaction (HRI – a new acronym?) is wide open and is only just beginning to be explored. These three papers provide a valuable starting point for anyone interested in further work in this area.