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Finding Connected Components in Map-Reduce in Logarithmic Rounds

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Abstract: This paper discusses the motivation behind the Royal Society of New Zealand funded project "New Zealand Robotic Olympics: Quickest, Strongest, Smartest". The paper introduces successful robotic contests that are incorporated into the curriculum of mechatronics engineering programmes at Massey University and the University of Waikato identifying their role in motivating study in an open ended manner. The paper also identifies several international robotic competitions and shows how the "New Zealand Robotic Olympics" complements these international efforts.

Keywords Robotics, Competition, Student Motivation, Project Work.

INTRODUCTION

Throughout the world engineering programmes having been facing challenges to enrollments. New Zealand to some extent has been immune to these effects especially with the addition of a significant number of overseas students. Over time even our engineering schools will start to see the effect observed world wide of decreasing engineering enrollments while the total number of tertiary students have been increasing [1]. There are many reasons for this trend but one problem has been the public perception of the profession, particularly the challenging aspects of the work coupled with the relatively modest remuneration. Science and technology in general suffer from this poor perception. In order to assist in overcoming thesemisconceptions the Royal Society of New Zealand provides special funding to promote science and technology [2].

This paper discusses the motivation behind the Royal Society Science and Technology funded project "New Zealand Robotic Olympics: Quickest,

Strongest, Smartest". The New Zealand Robotic Olympics will be the first in a series of annual competitions that will raise the public awareness of the role of science and technology in enhancing our lifestyle, environment and productivity. Example competitions include: Solar Vehicle (the fastest solar powered toy car), Intelligent Pathfinder (the smartest robot that can navigate an unknown course), Robot Football (the strongest and smartest robot that can outwit and outscore the opponent), and an Open Category (an exhibition and demonstration of innovative robotics).

The solar vehicle race will highlight the importanceof renewable energy and the role that high technology can have in conservation. It will not require any onboard intelligence on the robot, so will be the simplest robot to design and construct.

The intelligent pathfinder and robot football competition will show the need for human intelligence in machine control: the most powerful, strongest and most expensive solution will not necessarily win, but creativity,

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innovation and ingenuity will be essential for success. These

competitions require onboard intelligence and will be more challenging, suitable for tertiary students if the complete system is designed, or suitable for secondary students if robot kit-sets and off the shelf components are used.

The open category contest will showcase original and innovative robotic solutions from businesses, industry and universities.

MECHATRONICS CURRICULA

There are currently a number of institutions in New Zealand that have incorporated robotics into their curricula. Among them are Massey University and the University of Waikato. They have introduced mechatronics engineering programmes that have incorporated competitions as part of the project design and implementation process. Competitions have the desirable property of setting a hard deadline to the implementation of the project as well as providing a forum for exhibiting project work. It is also a great opportunity for feedback in both absolute performance of the robot as well as the design process and methodology used.

University of Waikato

At the University of Waikato there is an annual robotic competition in which the students design and build a mechatron using the RoboLab software and Lego Mindstorm components for the hardware. This rapid prototyping environment is most suitable for the competition as the students have a limited time to design and build the robot, typically less than three weeks. The competition event itself changes from year to year, so that novel and creative designs have a greater chance of success rather than designs from previous years, rewarding students that have designed and built a new robot.

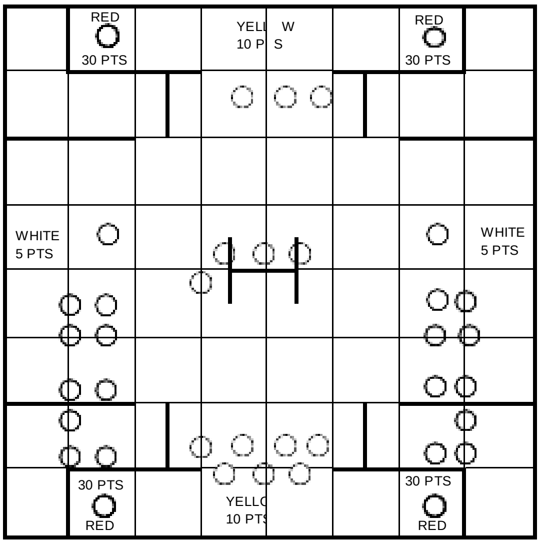

Figure 1. Puck Collection Competition

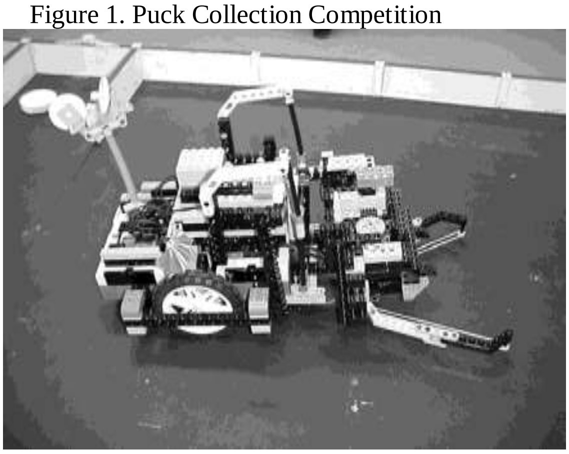

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Figure 2. Runner up in year 2000

The 2002 competition was a puck collection and disposal event (figure 1) in which two competingrobots collected as many pucks as possible, disposingthem in the goal position at the centre of the field.

Example mechatrons from past and current competitions are shown in figures 2 and 3.

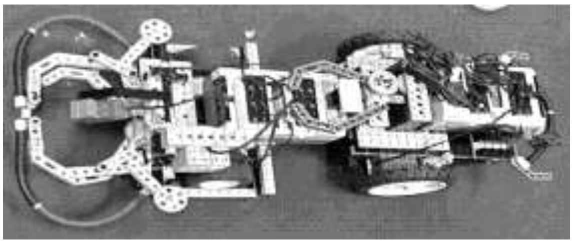


Figure 3. Collaborative Robots

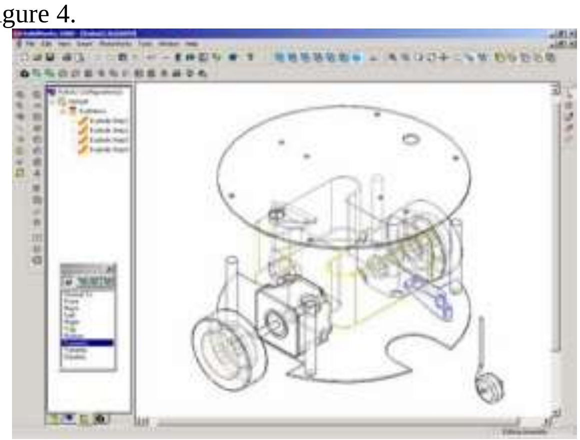
The creativity of the designs can be seen from the collaborative robots shown in figure 3. This robot cansplit in two and allowed one robot to collect the pucks while the other disrupted the opponent robot.

Massey University

At Massey University several papers introduce a competitive element to the design andimplementation process. The final year mechatronics paper which requires students to design and implement a mechatronic system as well as the second year digital and analogue design project.

The application for the mechatronics project design and implementation paper changes from year to year and in 2001 the application was a lawn mowing mechatron. This system is designed and fabricated at the prototype level. The fully operational robotic lawn mover is not implemented (though technically it is easily possible) due to practical safety reasons (in particular, due to safety concerns related to the cutting mechanism)

The first phase of this project is the CAD design of the mechatron as shown in the SolidWorks screen shot in figure 4.



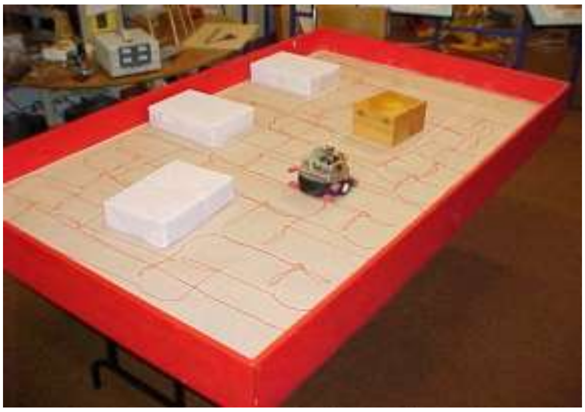


Figure 4. SolidWorks CAD Model of Lawn Mower Mobile Robot

This phase allows students to model the mechanical design of the system and then simulate the system to ensure that there are no mechanical restrictions to the movement of the robot. The design itself can be sent to a machine shop for fabrication, but normally, the students will fabricate the parts themselves.

Figure 5 shows a completed mobile robot, that is a scaled version of a real lawn-mowing robot. The students design the electronic circuitry for controllingthe robot, the micro-controller interfacing to the actuator and sensor systems, in this case the stepper motors and the infrared sensors.

Having designed and implemented their mechatrons, the students compete to test their system's maneuverability in avoiding obstacles and intelligence in mapping the environment [3]. The relative performance of the robots can be seen from the path traced by the robot (figure 6). More student mechatronics design projects (and their video clips) at Massey University can be found at the site www.massey.ac.nz/~wlxu.

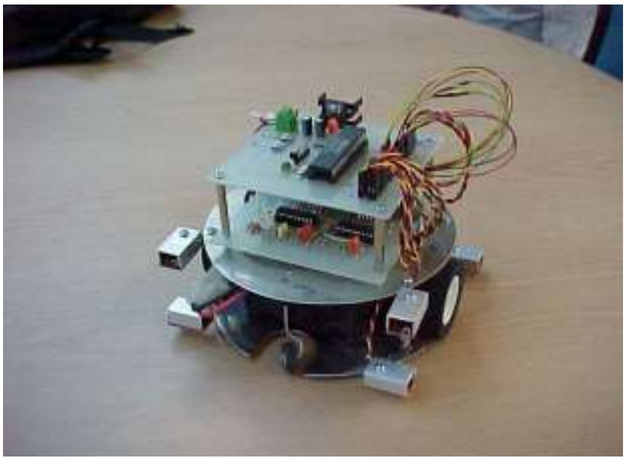


Figure 5. Lawn mower robot

Figure 6. Executing path plan

Another good example of the robotics related studies at Massey University is the second year digital and analogue design project. It was introduced so that the traditional lecture and laboratory drill and practice of the basic electronic concepts would be given a realistic design context in which students can attach meaning [4].

Additionally the project introduced a competitive element in which different project groups would compete with each other to produce the best design.

It involves designing a gamekeeper module (figure 7)reading and responding to an infrared signal from a duck (figure 8).

The ducks send out one of two signals. The gamekeeper responds differently depending on the signal, the "friendly" ducks are left alone by the gamekeeper, while the "unfriendly" ducks are terminated by the gamekeeper with a shoot signal that it generates.

Figure 7. Student's gamekeeper turntable

Figure 8. A Target Duck

The competition is run, by surrounding the gamekeeper with friendly and unfriendly ducks and the winner is the gamekeeper that can terminate the most unfriendly ducks without harming any friendly ones in the shortest possible time. This project consists of many challenging design and implementation elements of multidisciplinary nature including analogue and digital electronics, communications, motor control, etc.

Another good example of mass-participation robotics design and competition at Massey University is the annual first year engineering and technology students' robotics contest. It includes six events such as curving path following (figure 9), steep surface climbing, and others [5].

The students are provided with a basic motor and gearbox and given a free rein on chassis and wheel design.

Figure 9. RoboSpiral contest

Summary

Both the Massey University and the University of Waikato experience have shown that robotic competitions provide significant motivation for students to excel in the project design and implementations. It provides an opportunity forstudents to exhibit their work and receive feedback from members of the public, business, industry and academics as well as their peers.

INTERNATIONAL COMPETITIONS

International robotic competitions have been established for well over 20 years, including the international micro-mouse competitions, flying robot competitions and more recently robot soccer [6, 7] (see figure 10) and robofesta competitions [8].

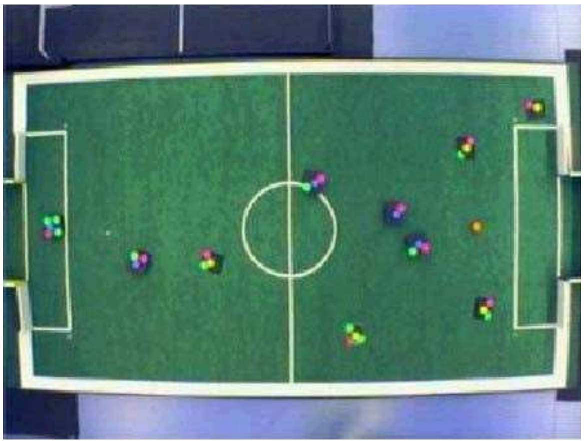


Figure 10. RoboCup soccer robots

Many of these competitions were initiated as specialist competitions for robotics researchers, but as technology has developed and commercial robots have become available they have filtered down to tertiary and even secondary/primary school competitions. This is evidenced by the micro-mouse competitions in the UK annually organized by the Institution of Electrical Engineers, and in Singapore where students regularly compete in the Singapore Robotics Games.

Another trend has been to add robotic components to human or computer-based games, such as chess, checkers or Trax. See figure 11 for a prototype Trax playing robot [9].

Figure 11. Trax playing robot

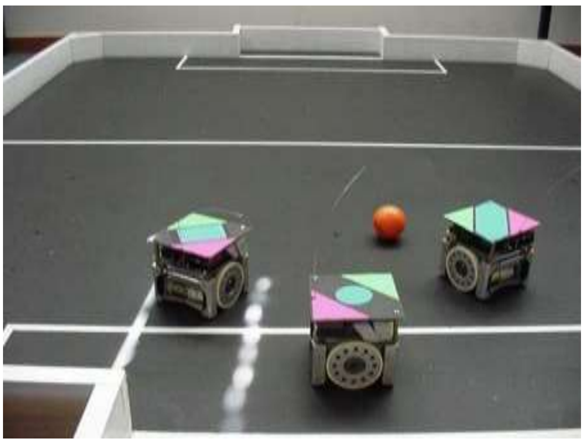


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Figure 12. Biped walking robot

The Singapore Robotic Games is a national robotic competition that is open to international participants [10]. Originally envisioned in 1992 as a competition for robotics researchers, it was quickly expanded to include participants from tertiary and secondary schools.

Currently there are 14 different robotic events ranging from the pole-balancing robot, wall-climbing robot to walking robots (figure 12). The current trend is to make available standard kit-sets for robot soccer for secondary schools thus encouraging them to enter the robotic soccer contest along with the tertiary institution teams.

As robotics competitions filter down to secondaryand primary schools, young students are exposed to technology that is challenging yet extremely motivating. Abstract mathematical concepts can be brought to life in robotics applications as illustratedin the use of the robot turtle and the LOGO programming language. Competitions such as micro- mouse and robot soccer are ideal for illustrating geometric concepts as well as calculus (velocities and accelerations in the system) as well as, at a more advanced level the dynamics of control systems. All of these concepts can be studied in theory and illustrated in simulation, but robotics applications give students a real and immediate experience of the concepts that can aid understanding.

EW ZEALAND ROBOTICOLYMPICS

Motivation

It is planned that the New Zealand Robotic Olympics will be held every year in different locations around the country. They will be suitable for a range of people, in particular school and tertiary students as well as the general public.

Figure 13. Mirosot robot soccer

Cheap robot starter kits and guides will be made available for novices to kick start development, but individuals will be free to use their creativity to design their own novel solutions.

The competition organising committee will include academics and engineers from around the country, from business, industry, tertiary and research institutions. This will also enhance the link between the competitors and the businesses, industries and academia that will support the event in the future. By providing a community presence with this competition, engineers will be able to help the members of the public overcome their misconceptions about the field, the practitioners and the profession.

While international robotics competitions such as RoboCup [6] and Mirosot [7] (figure 13) were designed as research test beds that provide challenging environments for the latest theory and practice in intelligent robotics, they do notsignificantly impact the members of the public thatare not already interested in technology. The New Zealand Robotic Olympics aims to capture the interest and participation of students in primary and secondary schools whose perceptions to science and engineering are still being formed. We believe the positive experience of building a robot and competing in a local and then national event willenergise these students and improve their attitudes towards science and engineering study.

The competition events may seem too challenging for novice students, but with robot kit-sets and suitable teacher/tutor support, it is expected that the average primary school student will be able to compete in the solar vehicle competition, while high school students will compete in the intelligent pathfinder competition. Undergraduates and postgraduates as well as members of the public will compete in the robot football and open category competitions. While the robot kit sets provide a platform for a positivetechnology experience, it is expected that more creative and innovative participants will extend and augment these robot designs.

Target Audience

The participants in the competition will be primary, secondary and tertiary students as well as members of the public, who are interested in science and engineering. However the target audience of the activity will also be the general public that are not necessarily technically aware. That is, the spectator event will allow the activity to influence more that the active participants in the Robotic Olympics. The Olympics will take place at public

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venues, such as a shopping centre or regional science centre, which will facilitate members of the public access to the event. People who have not necessarily had a positive experience of technology will be able to see students and members of the public of all ages demonstrate their robotic creations in a fun and competitive way.

Impact

The large national participation in an entertaining, competitive event will generate mass media publicity that will expose ordinary members of the public to science and engineering. The event will help overcome the misconceptions some members of the community have about what science and technologyis and the role it has in the work place and everyday life. It will achieve this by showing that engineering and technology is interesting and exciting and can be developed and used by the public. The general public will see that robotics and automation is not about replacing people, but about giving them more effective means to improve the quality of their lives and the productivity of their work.

The exposure to science and engineering will mean that members of the general public will be more likely to appreciate technology in their daily lives changing a historical negative attitude into a positive one. This should lead to more active participation from all sections of society in the high value added, high tech economy.

The success of the Robotic Olympics will be measured by its long-term sustainability. It is the aim that the Olympics will run annually, eventually in a self-financing manner. The funding will have to be sought from innovative New Zealand and international companies and organisations.

CONCLUSIONS

We have highlighted some of the motivations behind the Royal Society of New Zealand's Science and Technology Promotion funded "New Zealand Robotic Olympics: Quickest, Strongest, Smartest" that is planned to be held next year. We have shown that robotic competitions, held as part of engineering degree programmes, have provided students with the motivation to complete their design and development to the required deadlines and the opportunity to gain feedback from both industry and academia.

We hope that the same enthusiasm will be transferred to a general robotic competition suitable for primary and secondary students and members of the general public.

With this paper we would like to invite the engineering community of New Zealand to join forces in organizing and making a success the proposed Robotics Olympics. We will be happy if this invitation finds response from engineers, academics, technologists, school teachers and the general public.

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