The 18th

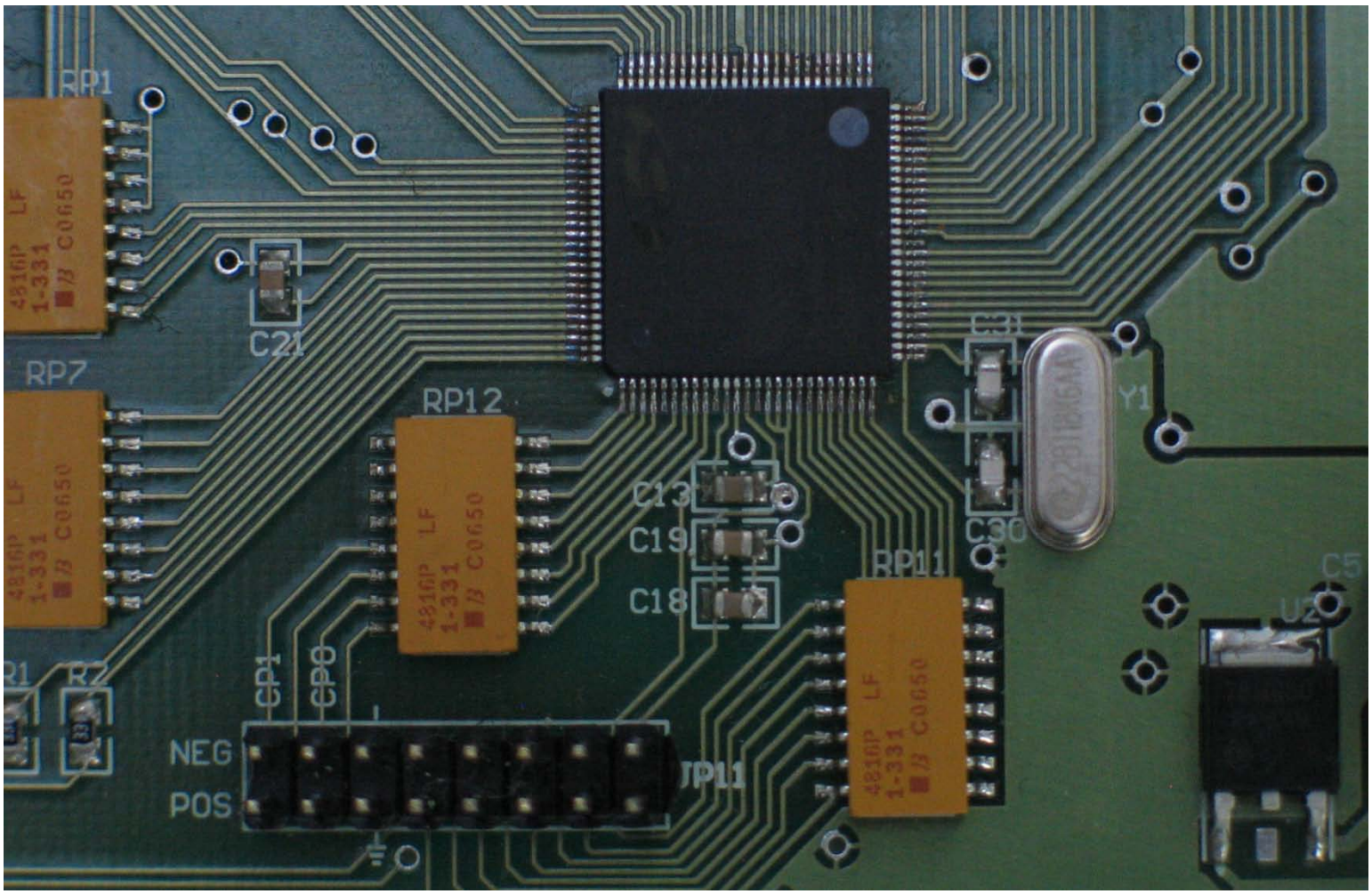
Electronics New Zealand Conference

ENZCon 2011

Massey University
Palmerston North

21-22 November 2011

Conference Programme
&
Digest of Abstracts



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Foreword and Welcome

Welcome to the eighteenth Electronics New Zealand Conference. This year ENZCon is being held in Palmerston North, hosted by the School of Engineering and Advanced Technology, at Massey University.

Electronics is a common thread in all the 26 papers to be presented but they encompass many areas ranging from signal processing to component modelling to artificial intelligence to audio waveguides. It is always pleasing to see the large number of student papers presented at this forum which is an important platform for the cultivation of local research.

I wish to thank all those who have contributed papers – clearly you are the core of any conference. I'm particularly grateful to the reviewers and have been really impressed with the level of feedback that many included with their reviews.

I also want to acknowledge the work of Lisa Dunn with the website, Gayle Leader and Trish O'Grady for efficiently organizing the venue and catering and particularly Donald Bailey and Gourab Sen Gupta for mentoring and guidance.

Lastly it is with great pleasure I welcome the stalwarts of ENZCon – well known as Mentors and informally as Graybeards. You are retired but have gone to the trouble and expense to attend. Collectively you are responsible for the existence of the institution and philosophy known as ENZCon and it is with trepidation that I have stepped into your shoes.

We hope you have a stimulating and rewarding two days at ENZCon.

Ken Mercer

Convener, ENZCon '11

Monday 21 November

Registration

9:00 Registration

Opening

9:30 Conference opening and Welcome

Keynote Address:

Chair: Ken Mercer

9:40 Projects, Product Development and Commercialisation

Professor Emeritus Bob Hodgson
Massey University, Palmerston North

This address will include reflections on the nature of the numerous engineering projects that have engaged the author for at least the past 55 years. A current engineering project, underway for about ten years, involves the development of an automated, intelligent microscope initially applied to the counting of pollen on microscope slides. The address will concentrate on the process that, starting from a broad specification has led to the design and construction of a series of machines. The first machine was built to investigate the feasibility of a theoretical approach, the second to refine the design. The Series 1 and Series 2 machines were two iterations in the product design cycle that led to the development of the Series 3 machines. Seven Series 3 machines are now in use in palynology laboratories around the world and more are being made for supply to enthusiastic customers. This address will describe and explain how a small team working at Massey University and led by the author, has made the hazardous journey from a conceptual design to both a manufactured and marketed product and a soon to be established start up company.

Break

10:30 Tea / Coffee

Session M1 Mechatronics

Chair: Dale Carnegie

10:50 Design of a Biomimetic Robotic Arm

S. A. Mullan, C. Hollitt

With humanoid robots becoming more and more prominent there is greater desire to construct a human-like robotic system. The inspiration in building a biomimetic robotic arm comes from using the morphology behind human anatomy and motion as a building block.This paper focuses on the construction behind making a fully biomimetic robotic arm and the arms response to control.

The platform has been designed with a structure that imitates the human anatomy, using the features of the human structure to infuence the design of the robot.

The arms response to step and ramp inputs was evaluated to determine whether the arm can be made to move smoothly, an important consideration for a device which was required to appear human-like.

11:10 Two-Tier Wireless Robotic System for Urban Search and Rescue

Brendon Rhys Le Comte, Gourab Sen Gupta

Urban search and rescue is a dangerous task. However, it is incredibly important in a world where the cities are getting larger. Robots can be designed and developed to help minimize the risks associated with this task as well as improving the likelihood of success for any urban search and rescue operation. Massey University is currently working on a prototype system that will prove the concept of a tether-less system that utilizes smaller deployable robots for maintaining a communications link. This prototype will eventually be incorporated into the three-tiered robotic system being developed by Victoria University of Wellington. This paper outlines the overall research goals at Massey University. The structure of the overall system and a description of how each section will work is covered. A description of both function and architecture is covered for both tiers of the system as well as specific implementation of the lower tier robot.

11:30 Embedded Hardware Design For An Autonomous Electric Vehicle

Henry Jenkins, Simon Richards, Zachary Taylor, Wim Looman, Andrew Bainbridge-Smith

This report details the design and production of a hardware platform to for an autonomous go-kart. The sys- tem includes seven printed circuit boards (PCBs). Five of the PCBs communicate via a CAN bus to collect data and control other circuitry, while the other two PCBs control actuators for steering and brake control. The system is based around Atmel AT91SAM7XC micro controllers along with various other electronics. The PCBs built for this system are four layers so were manufactured in America by Advanced Circuits, then populated and tested at the University of Canterbury.

11:50 Development of a Marker Following System for use in the Mariokart System

Zachary Taylor, Simon Richards, Wim Looman, Henry Jenkins, Andrew Bainbridge-Smith

An autonomous go-kart system, nicknamed Mariokart was being developed. It required a simple algorithm to demonstrate its abilities and test its systems. To meet this need an algorithm was developed to follow the path of a marker. Three computer vision techniques colour detection, SURF and chessboard detection were evaluated to see if they could be used to locate the marker. SURF performed slowly and only at very short ranges, colour detection was found to be too sensitive to lighting changes but otherwise a viable option. Chessboard detection was found to meet all the needs of the system with the exception of having a reasonably short range. Once the method of marker detection was in place a method for allowing the kart to follow the same route as the marker was implemented. This utilized the karts on board sensors to estimate its location. The system was tested but never mounted to the Mariokart due to delays in the development of systems it required to interface with the kart.

12:10 Safety by Design for the Mariokart System

Simon Richards, Wim Looman, Zachary Taylor, Henry Jenkins, Andrew Bainbridge-Smith

An electric go-kart is out?tted with a drive- by-wire system in the ?rst phase of development of an autonomous vehicle. The safety aspects of the design are evaluated and analysed using typical project management techniques. A model of the distributed software required is developed and proven and the place of modelling in software engineering is discussed.

Break

12:30 Lunch Break and Trade Show

Session M2 Signal Processing

Chair: Donald Bailey

13:30 Design of Variable Bandpass Filters Using First Order Allpass Transformation And Coefficient Decimation

S. J. Darak, A. P. Vinod, E. M-K. Lai

In this paper, the design of a computationally efficient variable bandpass digital filter is presented. The center frequency and bandwidth of this filter can be changed online without updating the filter coefficients. The warped filters, obtained by replacing each unit delay of a digital filter with an allpass filter, are widely used for various audio processing applications. However, warped filters fail to provide variable bandwidth bandpass responses for a given center frequency using first order allpass transformation. To overcome this drawback, our design is accomplished by combining warped filter with the coefficient decimation technique. The design example shows that the proposed variable digital filter is simple to design and offers a total gate count reduction of 36% and 65% over the warped filters compared to the designs presented in [3] and [1] respectively.

13:50 Signal Processing Techniques for Language Identification Based on the Pitch Contour

Stephen D. Bier, Catherine I. Watson, Margaret Maclagany, Jeanette King, Ray Harlowx, Peter Keegan

In this paper we present the signal processing techniques used in two different language identification tasks, a perception based task and an automated task. The two languages studied were English and Maori, and the language identification is done on the "melody" of the speech, i.e. the suprasegmental features rather than on explicit sound recognition. We argue that for language identification based on suprasegmental features it is more useful to perform these studies on explicit prosodic features such as pitch and loudness. New stimuli based on complex harmonic sinusoidal synthesis are presented, these stimuli have been successfully used in a perceptual based language identification task, showing that only pitch is required to identify the two languages. A method of encoding and analysing the pitch contour with DCT coefficients is presented and able to show significant differences between the c0 and c3 coefficients for read excerpts of Māori and English. Finally we show that the DCT coefficients of the pitch contour can be used in an automatic language identification task to distinguish between English and M¯ aori with a classification rate of 71%.

14:10 An Artificial Neural Network to Detect Audio Sequences

N. J. Hartley, S. J. Weddell

An audio classification system has been developed in Matlab for the classification of broadcast television audio into five categories: Advertisement, News Item, News Story, Sports and Weather Forecast. The simplified classification problem of advertisement detection is also considered. The software has been developed with the aim to provide a theoretical basis for an embedded hardware implementation. Static, dynamic and recurrent artificial neural network architectures are focused upon as a means of realising the classification software. The artificial neural network architecture proposed as most applicable to the real-time audio classification problem is the Focused Time Delay Multi-layer Feed-forward architecture, pre-trained with dynamic back-propagation. Other architectures, including static multi-layered networks and the recurrent Echo State network have also been investigated under different noise conditions.

14:30 Hyperspectral Video for Forensic Applications

R. Dunn, M. Andrews

Hyperspectral Imaging is a technique where material properties and quantities are determined using interactions between light and matter. Its non-contact and non-destructive nature ensures it has numerous applications in forensic science. Many of these applications require a video-rate hyperspectral system, although, processing this volume of data is demanding and difficult to perform in real-time. A novel method is presented for reducing the complexity of current hyperspectral imaging techniques in the context of a hyperspectral video crime scene

analysis tool. Specifically, the essential but time-consuming phase of dimension reduction is achieved using a new on-line estimate of the principal components and exploits temporal redundancy in sequential hyperspectral volumes. This new algorithm is shown to provide a significant reduction in complexity (> 10×) in processing hyperspectral video when coupled with Abundance Guided Endmember Selection - a new endmember identifcation and extraction algorithm developed for hyperspectral video applications. A theoretical frame-rate of over 20fps for a scene with 5×10^6 pixels and 224 bands can be achieved when implemented on an nVidia Tesla C2070.

14:50 Implementing a Guitar Effects Processing Unit (GePU) using Arduino

Guy Davis, Andrew Gilman

Guitar effects add substance to the original sound of the guitar. This paper is about implementing these effects on an Arduino Uno, a cheap electronics development board with a micro-controller to digitally modify the guitar signal, and to create an effects unit which is both cheap and simple to implement new effects on. Building on an implementation from Kyle McDonald, we have expanded on his ideas, and implemented multiple effects on the one unit. Using the built-in Successive Approximation Analog-to-Digital Converter on the Arduino, we digitized the guitar signal, then processed it and output it by using Pulse-Width Modulation technique. Sampling of the signal was done using an interrupt triggered by an internal timer, which gave us a sampling rate of 15.6 kHz with 8-bits of resolution. Of the implemented effects, none were using above 20% of the available processing time. The sound quality of the effects was comparably not as good as analog effects, but for the price of less than 1 analog effects unit, we have the possibility for many more effects.

Break

15:10 Tea / Coffee

Session M3 Applications

Chair: Colin Fox

15:30 Comparison of software and hybrid based implementation of gait algorithm

Matthew Richardson and Neel Pandey

Biometric identification using gait recognition has become a popular research topic. Implementation of a real-time system for a gait based person identification algorithm is proposed in this study. The implementation is based on standalone software and hybrid based solution which enables feature matching deployed on an FPGA or one or more networked PCs. In the Hybrid mode, the feature matching algorithm that uses Dynamic Time Warping (DTW) technique is implemented on an Altera DE2 board. Based on the relative comparison of processing speed, at least a 16 fold improvement can be achieved when matching algorithm was implemented using FPGA compared to stand-alone mode. The hybrid system provides a platform for future deployment of the algorithm in hardware and subsequent parallel execution of feature matching on the FPGA.

15:50 Vibration Analysis on New Undamaged Bearings

H.J. Lawrence, T.C.A Molteno

This paper discusses signal processing methods used in the analysis of bearing vibrations. Vibration analysis is usually a comparative process where a bearing’s condition is determined by comparing its current condition with its condition when new. Current work involves instead asking the question “what properties does a new and undamaged bearing have?". And looking at variations between different new bearings of the same batch, used in an identical set up, under (as near as possible) identical conditions.

16:10 A Comparison of Pick-Based Strategies for Robotic Bass Playing

R.G Vindriis, D.A Carnegie, A. Kapur

The Faculty of Engineering at Victoria University of Wellington has constructed a robotic bass guitar player, Bassbot. A critical feature of such a robot is the plucking mechanism. Three mechanisms were made, two using stepper motors of differing sizes and one using two pull type solenoids. These were compared based on metrics of speed and consistency. There was trade-offs between the systems, with the most consistent being the slowest and the fastest system being the least consistent. To expand the abilities of the robot, a height adjusting cam was added to one of the stepper motors to allow dynamic playing.

16:30 Determining Acoustical Directionality in an Impedance Tube Using Multiple Fixed Microphones

Kyle Pennington, Jonathan Scott, Kerry Bodman

Acoustic impedance of a port or object is a valuable piece of knowledge describing how well sound is transmitted or reflected. The commonly used slotted-line method is labourious and time consuming, requiring manual movement to find the maxima and minima at each frequency. This paper outlines a technique to computationally determine the magnitude and phase of the constituent travelling waves from the standing plane sound wave measurements in an impedance tube. Measured magnitude and phase data from multiple fixed microphones carefully spaced along the length of the impedance tube is numerically fitted to incident and reflected wave models, which can then be used to calculate the complex acoustic impedance at each frequency of interest.

Conference Dinner

18:30 Halikarnas Restaurant & Bar, 15 Fitzherbert Avenue

Tuesday 22 November

Session T1 Electronics

Chair: Gourab Sen Gupta

9:10 A Low Power 4th Order Low Pass Gm-C Filter in 130nm CMOS

Ananiah Durai, S. M. Rezaul Hasan

A Low Voltage, Low Power 4^{th} order Gm-C Elliptic filter is proposed in this paper. For supply voltage of 1.4V, the Operational Transconductance Amplifier is designed to dissipate low Power of 1.4mW. The two stage fully differential Operational Transconductance Amplifier is designed in 130nm CMOS technology for high linearity and large Output Voltage swing. The Filter is designed using Mentor Graphics tools and the simulation for an input voltage of 150mV (PP), a Total Harmonic Distortion of less than -60dB is achieved.

9:30 Third-Order Nulling Effect in Darlington Transistors

Toby Balsom, Jonathan Scott, William Redman-White

In this paper we present the first proof that a Darlington transistor has an inherent nulling effect in its third-order intermodulation distortion, similar to the well known third-order null seen in single BJT amplifiers. It is proven mathematically and by measurement. The results suggest the null actually becomes feasible as a source of distortion reduction in a Darlington BJT amplifier.

9:50 The Energy Efficiency of 8-bit Low-power Microcontrollers

Mark H. Jones, Jonathan B. Scott

We have measured the energy cost of processing, sleeping, non-volatile memory writes and ADC measurements of six 8-bit microprocessors from three manufacturers. These measurements compare the chips directly to one another and reveal ideal operating points which can be used to reduce energy consumption.

10:10 Decomposition method for AES Mix Column and Inv Mix Column VLSI architecture optimization

Nabihah Ahmad, S.M. Rezaul Hasan

This paper presents an efficient integrated Mix Column and Inverse (Inv) Mix Column architecture for Advanced Encryption System (AES) using decomposition method to optimize the chip area and path delay. This development is suitable for compact 8-bit AES cipher. The evaluation of the proposed design is based in terms of total area of number of Exclusive OR (XOR) gates and critical path delay. The hardware cost of the proposed design is about 190 logic gates equivalent to1140 transistors with shorter critical path of 6 XOR gate results in reduction in area compared favourably with other existing design including direct implementation.

Break

10:30 Tea / Coffee

Session T2 Sensors and Modelling

Chair: Tim Molteno

10:50 FPGA-based Electrical Impedance Tomography

Patrick Suggate, Tim Molteno, Colin Fox

We are building a compiler to help map large computations into FPGAs because we are also developing hardware to perform Electrical Impedance Tomography (EIT) in real-time. The EIT inverse problem is non-linear and severely ill-posed and the sampling algorithms that calculate good solutions have a high computational cost. These algorithms require performing many forward-map solves and this is the calculation that is being mapped into dedicated hardware. We expect that the FPGA implementation will be significantly faster, and use much less power, when compared to implementations that use only general- purpose processors. This is because the raw compute-throughput of the hardware will be very high, and code-analysis of our compiled computation shows that the whole computation will fit within just the static RAMs inside a moderate-sized FPGA, therefore eliminating any memory-access I/O bottle-necks created by having to access external RAMs. Analysis has also shown that about 90% of all operations can be of the form of fused multiply-and-add operations and, by using a floating-point/fixed-point hybrid multiply-and-add functional unit, can be mapped efficiently into Xilinx FPGAs. The compiler is then needed to schedule our computation across an array hundreds of parallel functional-units, and efficiently utilising the available buses and static RAMs, to maximise hardware utilisation and, therefore, solve-rate.

11:10 Ultrasonic Testing System for Characterising Acoustic Properties of Materials

Brett Ryan, Gideon Gouws

The electronic circuits, transducer characteristics, data acquisition and measurement methods for a pulse echo ultrasonic testing system have been developed and tested. The system can measure the acoustic impedance of a material with an uncertainty down to 0.59%. It has been used to measure the ultrasonic velocity of materials and give an indication of attenuation in materials. Circuits have been designed to allow system flexibility for future experimenters, allowing transmission and pitch catch test configurations to be used. Circuit operation has been verified to operate over a frequency range of 500kHz - 40MHz allowing transducers of a wide range of frequencies to be used. Data acquisition software has been developed to provide automated data collection for analysis using MATLAB or similar data processing

software. Measurements of the acoustic impedance of PVA tissue phantoms produced by directional solidification were taken which verified the anisotropic structure of the tissue phantoms.

11:30 A Combined Optical, Thermal and Electrical Performance Model of a Building Integrated Photovoltaic/Thermal Concentrator (BIPVTC)

T N Anderson, R Künnemeyer, M Duke, J K Carson

The electrical output of concentrating photovoltaic devices is significantly affected by the temperature of the photovoltaic cells. The ability to actively cool photovoltaic cells under concentrated radiation allows their electrical efficiency to be maintained particularly during periods of high solar radiation when concentration offers the maximum benefit. In this study, the design of a novel photovoltaic/thermal solar concentrator for building integration (BIPVTC) is discussed. The optical, thermal and electrical performance of the collector was theoretically modelled and validated with experimental data. The results show that BIPVTC offers improved electrical yields from both concentrating radiation onto the photovoltaic cells and also by actively cooling them.

11:50 Modeling of surge protection circuits for the study of transient propagation in power conversion interfaces

Sisira James, Nihal Kularatna, Alistair Steyn-Ross, Rainer Künnemeyer

As predicted by the International Technology Roadmap for Semiconductors, VLSI devices are currently progressing towards feature sizes around 22 nm, with sub 1 V DC power supply requirements and equivalent noise voltages close to the DC rail values. This scenario makes state of the art systems seriously vulnerable to lightning and other power transients. In a research project to predict the propagation of transients within the power conversion interfaces, accurate models for surge protection devices were required. This paper highlights the basis for model development of the transient voltage surge suppressor systems and associated experimental techniques using a lightning surge simulator to confirm the validity of the models. MATLAB based simulation used to test the models is also highlighted.

12:10 Simulation of Vehicle to Vehicle Communication using OPNET

Ning Sun, Fakhrul Alam, Suhaimi Abd Latif

Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication have been identified as significant elements of the Intelligent Transportation System (ITS). They are based on Vehicular ad-hoc Network (VANET), a special form of Mobile ad- hoc network (MANET). They also provide communications between nearby vehicles or with fixed equipment in order to improve road safety. The recently finalised IEEE 802.11p is probably the most promising technology for V2V and V2I communication. In this paper, we study the QoS performance of two of the most important access categories (ACs) of 802.11p Enhanced Distributed Channel Access (EDCA) mechanism. We investigate the impact of packet size, and vehicle traffic flow on these categories through OPNET simulation.

Break

12:30 Lunch

12:50 ENZCon Inc AGM

Session T3 Software

Chair: Adrian Dorrington

13:30 Development of a hierarchical hybrid navigation system with Microsoft Robotics Developer Studio

Buddika Kasun Talwatta, Dale A. Carnegie

A fundamental requirement of an indoor mobile robot is to know its position within its operating environment which can be accomplished by employing various navigation techniques. Such a

technique has been designed at Victoria University utilizing a reactive and a deliberative control to enable desired movement of a robotic platform to a specified goal. This paper presents the development of this hierarchical hybrid navigation system using Microsoft Robotics Developer Studio (MRDS) for an indoor mobile robotic system. Relying upon software concepts of modularity and abstraction, a software framework was developed.

13:50 Software Engineering Practices in the Mariokart System

Wim Looman, Simon Richards, Zachary Taylor, Henry Jenkins, Andrew Bainbridge-Smith

This report details a variety of software engineering practices followed today in the world of traditional software development. It then explores why these should be adopted by all engineers, and how they can help embedded development speciVcally. This is all explored in the context of an autonomous go-kart system developed at the University of Canterbury

14:10 Parallelism of an MCU on an FPGA

Rose Pearson, Joshua Jordan, Mathew Falloon, Stuart Duncan, Tristan Read, Yanosh Irani, Steve Weddell

A parallel, scalable and efficient hardware system that can be used in a variety of applications was implemented using VHSIC hardware description language (VHDL) to program a Field Programmable Gate Array (FPGA). This system provides a template for further research and development by providing useful tools such as: a two pass compiler, two parallel Microcontroller Units (MCU) that can compute instructions in parallel, and a communications buffer that allows efficiencies of programs to be recorded for N processors. It was found from testing on a Spartan-3 FT256 board that this parallel system closely modelled Amdahl's law of parallel computing; stating that as the percentage of code that is made parallel increases, the speed-up time increases exponentially.

Break

14:30 Tea / Coffee

Closing

14:50 Awards

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The screenshot to the left shows a Electromechanical system containing a DC motor, worm gear, Hall effect sensor, speed controller, and a motor servo-amplifier (top), the associated SimElectronics model (left), and a portion of the speed controller model (bottom). The coloured blocks in the model correspond to the components in the electromechanical system.

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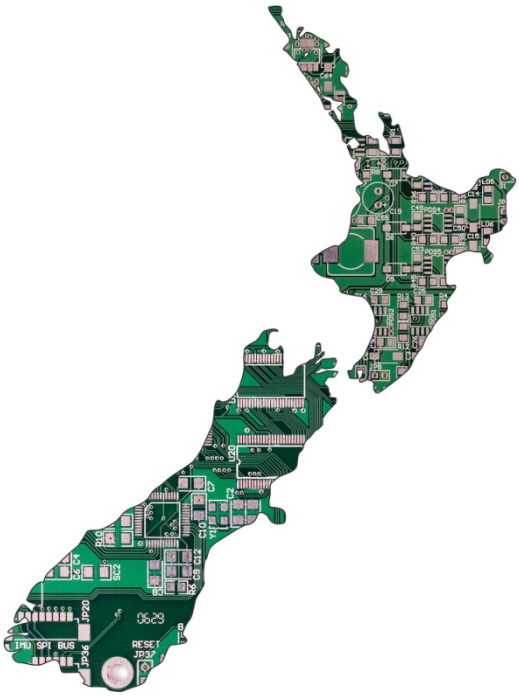

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