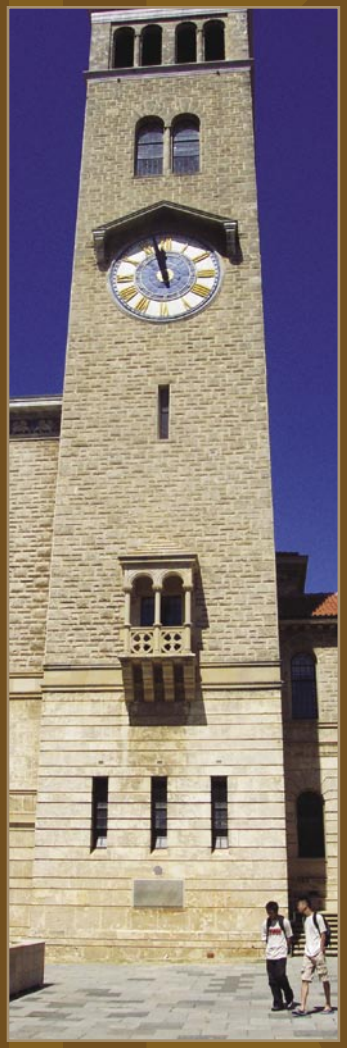

Centre for Intelligent Information Processing Systems
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Centre for Intelligent Information Processing Systems

Annual Report 2003

School of Electrical, Electronic and Computer Engineering

THE UNIVERSITY OF WESTERN AUSTRALIA

The University of Western Australia

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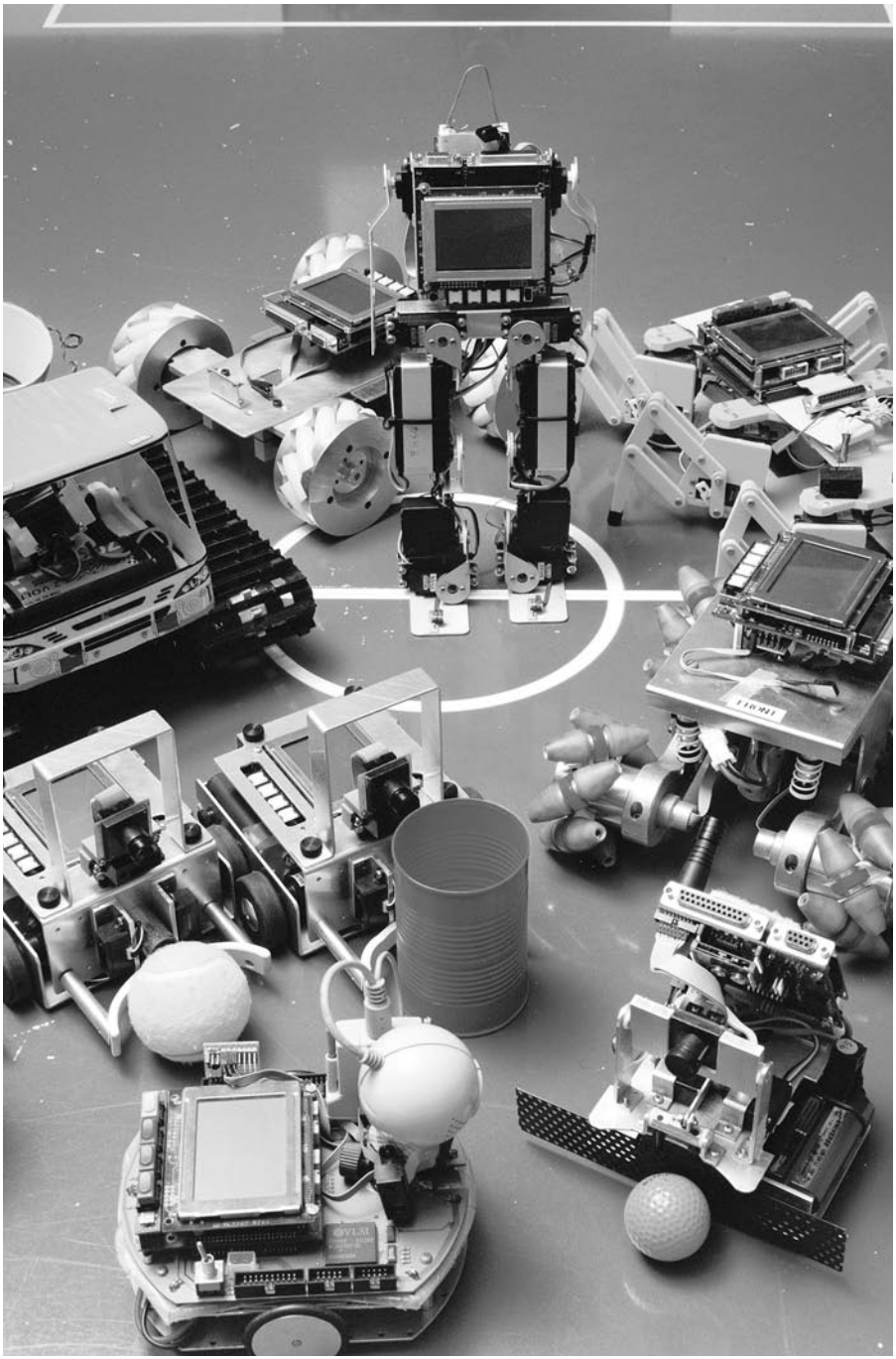


DIRECTOR'S REPORT

Having been a CIIPS member for seven years, I became the Centre's new director at the start of the year. A number of changes in the Centre's structure and management had become necessary, in order to reflect the new lab structure and to consolidate the Centre's financial situation.

CIIPS is now structured as a group of research labs, with increased responsibilities and individual budgets for each lab. The labs divisions follow the existing areas of research strength in CIIPS. These are:

Hardware Design Lab (A/Prof. J. Morris)

FPGA Development, Parallel System Development

Information and Software Engineering Research Group (A/Prof. G. Bundell, T. Woodings)

Real-time distributed systems design methodologies, Petri-net modelling, Software quality and metrics

Integrated Sensory Intelligent Systems Lab (A/Prof. A. Zaknich)

Adaptive Self-Learning Systems, Intelligent Signal Processing, Audio and Underwater Applications

Mobile Robot Lab (A/Prof. T. Bräunl)

Intelligent Autonomous Mobile Robots, Image Processing Systems, Simulation

Signals and Information Processing Lab (Dr. R. Togneri)

Speech signal processing, Spoken Language Systems, Pattern recognition

Systems and Biomedical Engineering Lab (Dr. T. Fernando)

Electronic Medical Systems, Signal Processing Systems

The management and administration approach for CIIPS was also changed, giving all members more responsibility. The three key principles implemented in 2003 are:

1. **Open Management**

   An "open management" philosophy has been established in CIIPS, which gives every CIIPS member access to all administrative documents, including all budgetary and financial information.

2. **Participation**

   All major decisions are decided by the group following inclusive discussions.

3. **Sharing of Responsibility**

   Every CIIPS lab has its own individual budget and spending authority, giving much more responsibility and flexibility to CIIPS members.

During the year 2003, the Centre welcomed returning members Dr "Chandra" Chandrasekhar, now an Adjunct Senior Research Fellow, who is an expert in medical image processing, and Dr John Morris, now Adjunct Associate Professor, who brings a vast research background in reconfigurable computer architectures. Another CIIPS adjunct member, Dr Tony Zaknich, had his position renewed and was promoted to Adjunct Associate Professor.

The Centre is off to a new start and will hopefully continue to grow in 2004. While biomedical and nano-technologies have taken some of the lime light from information processing, and - more importantly - significant government funding, IT is as important as ever. A strong CIIPS will play an important role in the IT education of all engineers at UWA and will be a significant partner for research in academia and industry.

Thomas Bräunl

Director
Centre for Intelligent Information Processing Systems

INTRODUCTION TO THE CENTRE

The Centre for Intelligent Information Processing Systems (CIIPS) was established as a Category A Centre within the then Department of Electrical and Electronic Engineering at The University of Western Australia in November 1991. Formerly existing as the Digital Signal Processing Research Group within the Department, it has developed into a multidisciplinary research centre which brings together researchers from engineering, science, mathematics and medicine.

The Centre combines an active teaching programme with pure and applied research to provide an environment in which innovative theoretical developments can be rapidly turned into technologies that provide solutions to a range of real-world problems.

The Centre is active in the areas of artificial neural networks, biomedical engineering, control, digital signal processing, image processing, mobile robots, parallel and reconfigurable computing, pattern recognition, software engineering, and spoken language systems.

Strong and successful collaboration between the Centre and industry is a key element in its operation. Joint research and development projects with a number of Australian companies have been undertaken, as well as contract research for industry, government and other bodies.

Over the past five years, the Centre has attracted grants and contracts totalling more than $2.0 million from the Australian Research Council ($665,000), the Defence Science and Technology Organisation ($110,000), and other bodies.

EQUIPMENT

The Centre is well equipped for the research that it undertakes. It has a network of UNIX workstations and Personal Computers, which includes colour graphics workstations from SUN Microsystems and from Silicon Graphics. Various forms of data acquisition, including speech and image capture, are supported by a variety of peripherals. Sophisticated equipment for the support of hardware design and testing is also available, in particular, software and hardware for the design and programming of field programmable gate arrays. The Centre also provides about 20 autonomous mobile robot syststems in its Mobile Robot Lab.

A number of systems have been developed and constructed for research and teaching purposes, including a reconfigurable parallel computing system using field programmable logic.

CAPABILITIES

The capabilities of the Centre encompass both hardware and software development. Special-purpose devices and circuits can be designed and constructed. Sophisticated software for signal and image processing and pattern recognition can be developed, using adaptive filtering, artificial neural networks and other digital signal processing techniques.

The Centre is well-placed to do pure research, applied research, research and development and contract research.

MEMBERS OF THE CENTRE

ACADEMIC STAFF

School of Electrical, Electronic and Computer Engineering

Associate Professor Thomas Bräunl, MS, PhD, MIEEE

Associate Professor Gary Bundell, BE, MEngSc, PhD, MIEAust, CPEng, MIEEE, MIEE, CEng

Dr Tyrone Fernando, BE(Hons), PhD

Dr Roberto Togneri, BE(Hons), PhD, MIEEE

Mr Terry Woodings, BSc, DipComp, FACS, FQSA

Adjunct Appointments

Dr Ramachandran Chandrasekhar, BE PhD W.Aust., MAppScTor., MIEEE

Mr Keith Godfrey, BE UWA

Dr John Morris, BSc(Hons), PhD

Associate Professor Anthony Zaknich, PhD UWA, MEScUWA, BE UWA, BSc USA, BA USA, SMIEEE, MAES

School of Computer Science and Software Engineering

Dr Gareth Lee, BSc(Hons), PhD, MIEEE

School of Mathematics and Statistics

Dr Mike Alder, BSc(Hons), ARCS, PhD, MEngSc, MIEEE

ADMINISTRATIVE STAFF

Ms Sandra Passamani

VISITORS

Mr Norman Apel, Uni Ilmenau/DaimlerChrysler Ulm, Germany

Mr Christoph Braunschädel, FH Koblenz, Germany

Mr Jia Lei Du, University of Stuttgart, Germany

Mr Andreas Koestler, Uni. Giessen, Germany

Miss Charlene Orange, Univ. Rouen, France

Mr Antonio Pickel, FH Koblenz, Germany

Mr Pierre Polotec, Uni. Rouen, France

Mr Jung Hyun Ryong, Chonnam National University, Indonesia

Mr Stefan Schmitt, FH Koblenz, Germany

Dr Xin Xu, Wuhan University, Hubei, P.R.China

Mr Weiqun Zheng, Computer Science, UWA

Mr Jochen Zimmermann, FH Koblenz, Germany

POSTGRADUATE STUDENTS

Doctor of Philosophy

Mr Adrian Boeing

Mr Frederick Chee

Ms Fiona Evans

Mr Thomas Hanselmann

Mr Yves Hwang

Mr Jordan Kosek

Mr Philippe Leclercq

Mr Martin Masek

Mr Alistair Sutherland

Mr Terry Woodings

Mr James Young

Mr Fangwei Zhao

Master of Engineering

Mr Ivan Mendez Zapata

Mr Erik Raberg

Master of Engineering Science

Mr Sze Man Kwok

Mr Siddharth Parekh

UNDERGRADUATE STUDENTS

Jeff Allen

Jarrod Bassan

Reshampreet K Chail

Michelle Chan

Oscar Chan

Sai Mun (Simon) Chan

Fa Ching (Fabian) Chang

Kaming Chang

Greg Cheong

Jason Cheong

Li Li Chong

Ritika Chopra

Jia-Bin (Jacinda) Chou

Kwan Ching, Charles Chua

Melina Chung

Gregory Cresp

Michael Crouch

Anushka Desilva

Thuc Chien Duong

Matthew Fleming

Justin Chee Jueen Foo

Hadwin Hoi-Wang Fung

Fahed Ghazali

Craig Gianoli

Stephen Hanham

Claire Harrison

Bradley Harvey

Shun Leung (Andrew) Ip

Brenton Jack

Colm Kiely

Hui Min Kow

Sally, Yi Ling Lay

Tze Wei Lee

David Leech

Vickie Leung

Michael Lew

Eric Thian Yew Ling

David Luong

Thomas Lynch

Naveen Mahadeva

Terenyi Mahoney

Brett Miller

Mahsa Mooranian

Travis Moore

Michael Musca

Efendi Namdin

Ramaishwaran Natkunanathan

Leslie Ng

Tien Nguyen

Chong Sean Ong

Rich Chi Ooi

Kien Pang

Vinay Patel

Mark Pepper

Guang Sha Qiu

Christoper Rispoli

Sarfaraz Samnakay

Jonathon Seah

Wan Jeam Seet

Manjit Singh

Ritwik Singh

Charles Stan-Bishop

Anthony Tan

Keng Chong Tan

Yu Ling (Doreen) Tan

Aik Ming Toh

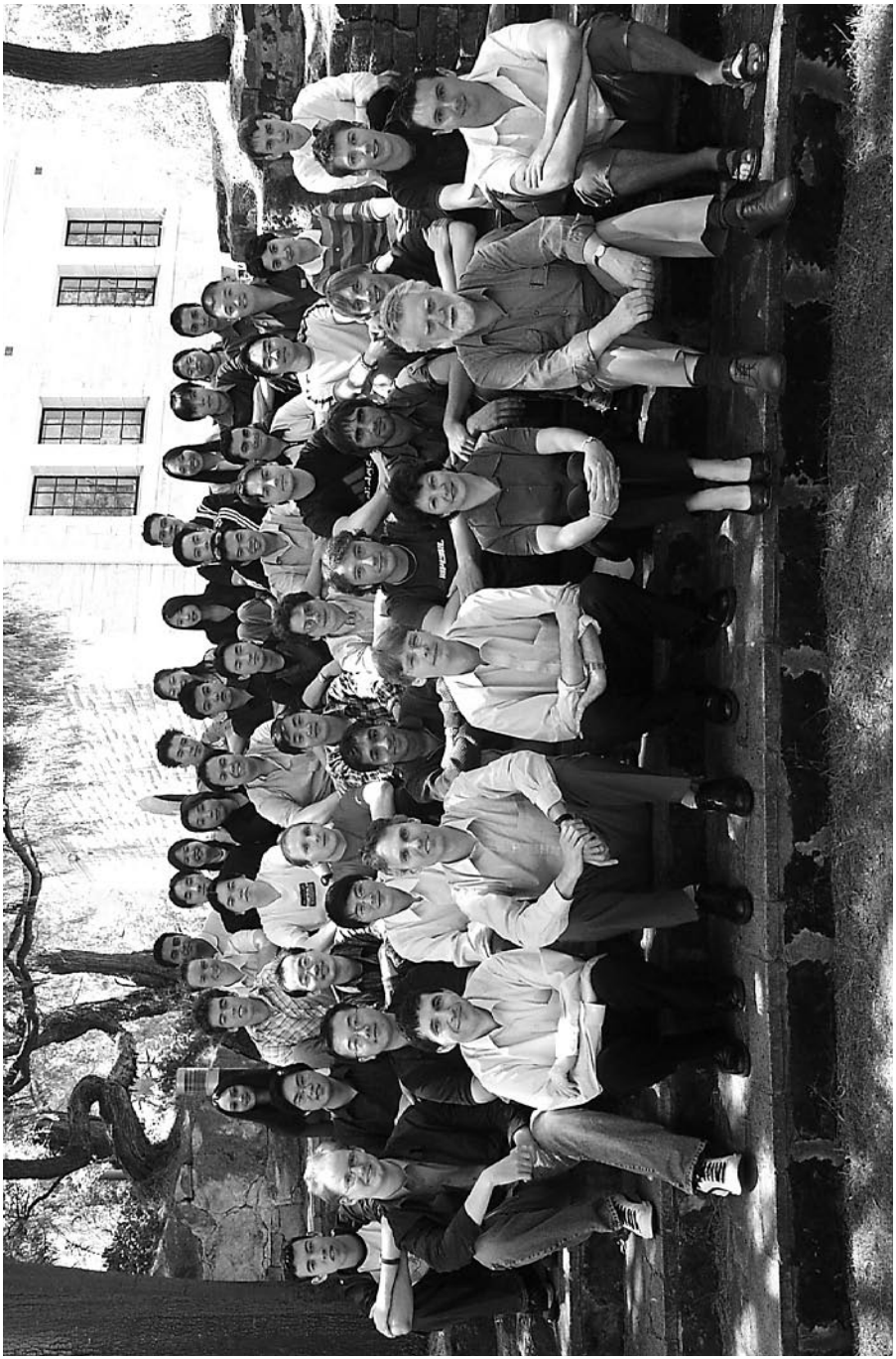
Alex Uloth

Pradeep Vatvani

Matthew Wright

Sheir Min (Glen) Yeo

William Yeung



MEMBERS OF THE CENTRE

6th row, left to right:	Ritwik Singh, Sally Lay, Eric Ling, Kim Duong, Vickie Leung, Michael Lew, Melina Chung, Doreen Tan
5th row, left to right:	David Leech, Wan Jeam Seet, Glen Yeo, Hadwin Fung, Jason Cheong, Kien Pang, Oscar Chan
4th row, left to right:	Anushka de Silva, Christopher Rispoli, Fabian Chang, Greg Cheong, Jonathan Sean, Bruce Wang, Pradeep Vatvani, William Yeung
3th row, left to right:	Stephen Hanham, Aik Ming Toh, Frederick Chee, Martin Masek, James Young, Thomas Hanselmann, Jordan Kosek, Yves Hwang, Mahsa Mooranian, Michael Crouch
2nd row, left to right:	Colm Kiely, Kaming Chang, Xin Xu, Siddharth Parekh, Norman Apel, Andreas Koestler, Adrian Boeing, Mark Pepper
Front row, left to right:	Roberto Togneri, Thomas Bräunl, Gary Bundell, Sandra Passamani, Terry Woodings, Craig Gianoli

RESEARCH ACTIVITIES

1. HARDWARE DESIGN LAB (ASSOCIATE PROFESSOR J. MORRIS)

Sonny Tham completed his thesis work on the Achilles cross-bar switch with extensive experiments demonstrating its superior bandwidth compared to fast Ethernet running actual programs. Sonny also compared two parallel program models (message-passing using the popular standard MPI and Cilk's dataflow model) and demonstrated that Cilk can outperform MPI under a variety of conditions.

Targetting real-time stereo vision for applications such as collision avoidance and face recognition, many stereo correspondence algorithms were compared using some objective metrics (rather than the subjective standards all too often applied by the vision research community). Fortuitously, one of the simplest algorithms (correlation with a sum-of-absolute-differences cost function) turns out to perform as well as considerably more complex ones under a wide range of conditions. VHDL models have been simulated and synthesized to demonstrate the real-time 3D environment maps are obtainable in real-time using FPGA devices.

2. INFORMATION AND SOFTWARE ENGINEERING RESEARCH GROUP (ASSOCIATE PROFESSOR G.A. BUNDELL)

Distributed information and software and engineering projects in the area of benchmarking distributed object infrastructures was further extended in the last year with updated technology comparison projects on CORBA, Jini and .NET technologies over a range of platforms and client/server configurations.

A new area of development this year has been in technology evaluations of various mobile information appliance platforms, ranging from 3G cellular handsets to enhanced PDAs. Detailed work focused on performance assessment of various types of hardware and software emulation environments. This work benefited from equipment loaned by the Motorola Software Centre and joint supervision and assessment of final year student projects.

Postgraduate research in automated software generation from UML specifications was carried further and work linking component design information to earlier work on software component testing was initiated. A key area of on-going interest is application of design patterns to the development of high-performance mobile information devices.

Other research undertaken in the software engineering area was a continuation of an investigation into software project and process metrics and their effectiveness. Industry case studies were explored to further develop estimation toolkits that project managers can use to determine the suitability of various metrics for use in software project monitoring and control.

3. INTEGRATED SENSORY INTELLIGENT SYSTEMS LAB (ASSOCIATE PROFESSOR A. ZAKNICH)

Significant project completions in the area of Intelligent Signal Processing (ISP) have been achieved this year. Firstly, the book, "Neural networks For intelligent signal processing, World Scientific Publishing, Series on Advanced Biology and Logic-Based Intelligence, Vol. 4, January 27th 2003", has been published. This new book has significant novel research content drawn from over a decade of work as well as sufficient tutorial material making it suitable as a textbook in the area of artificial neural networks for Masters and final year courses. Research has significantly progressed in the area of adaptive sub-space filtering models and their application to underwater acoustic signal processing applications, including signal detection and channel modelling. As a natural continuation of this lead a book publishing contract has been secured for the completion of another book, Principles of adaptive filters and self-learning systems, Springer-Verlag, Series on Advanced Textbooks in Control and Signal Processing." Two PhD theses have been completed and submitted for examination as follows:

1. Approximate dynamic programming with Adaptive Critics and the Algebraic Perceptron as a fast neural network related to Support Vector Machines, Thomas Hanselmann, 1998-2003.

2. Equalization of nonlinear communications channels with practical large margin classifiers, James Young, 1999-2003.

The first thesis represents a very valuable contribution to the area of both dynamic programming as well as the further development of a neural network called the Adaptive Perceptron. This network, along with others, was further modified and applied to the problem of nonlinear communication channel equalisation in the second thesis. It is expected that all this research work will significantly contribute to ongoing work related to underwater acoustic communications problems.

4. MOBILE ROBOT LAB (ASSOCIATE PROFESSOR T. BRÄUNL)

The year 2003 was a busy year for the Mobile Robot Lab with robot demonstrations at the AMiRE Symposium in Brisbane, the FIRA robot soccer world cup in Vienna, and the completion of the textbook "Embedded Robotics – Mobile Robot Design and Applications with Embedded Systems".

A group of four students (Boeing, Du, Pickel, and Zimmermann) joined the director at the Symposium on Autonomous Minirobots for Research and Edutainment (AMiRE 2003) in Brisbane. Besides research paper presentations, the highlights were robot demonstrations. We were able to show biped robots Andy Droid and Rock Steady, and give a demonstration of cooperative cube clustering by a group of driving robots.

Bassan, Schmitt and Petitt trained the 2003 robot soccer team and implemented a new behavior-based software architecture. Bassan took the robot team to Vienna and achieved a third place in the autonomous FIRA RoboSot league.

The new textbook on "Embedded Robotics" reflects our research work done over the last ten years in embedded systems used for constructing mobile robot systems. Originally planned for publication "around the year 2000", it took until mid-2003 for completion. The book is structured in three parts, dealing with Embedded Systems (hardware and software design, actuators, sensors, PID control, multitasking), Mobile Robots (driving, balancing, walking, and flying robots), and Robot Applications (Mapping, Robot Soccer, Genetic Algorithms, Neural Networks, Behavior-Based Systems, and Simulation). It can be used as a textbook for courses in Computer Science, Computer Engineering, IT, or Mechatronics, as well as a guide for robot hobbyists and researchers.

The simulation system "EyeSim" has been extensively used for a number of student projects, especially those involving genetic algorithms that would be impractical to apply to real robots directly. For 2004, a simulator revision has been planned, to allow it to run under Linux and Windows.

Boeing has extended his biped simulation system to incorporate virtual sensors. The first sensor implemented is a model of the inclinometer used in several of our real robots. Spline patterns that govern the robot's periodic movements are being evolved using genetic algorithms. With the additional sensor feedback, modifying the spline pattern depending on the local floor angle, we were able to evolve walking patterns that enable a biped robot to navigate hilly terrain.

We anticipate augmenting our model with all sensors used on a real robot and updating our model to even closer reflect real robot behavior. This will then allow us to more easily apply the simulation findings by transferring them back to real robots.

5. SIGNALS AND INFORMATION PROCESSING LAB (DR R. TOGNERI)

In 2003 a range of final-year projects covering speech/music processing and recognition, image and pattern recognition and information processing were run. Successful first-class honours projects included:

(1) Implementation of a flute instrument using digital waveguide physical modelling. High quality reproduction of various notes was achieved.

(2) Handwritten digit recognition using both neural network and dynamic template approaches. The neural network approaches yielded the best performance due to the complexity of the dynamic template models.

(3) Lip contour recognition of both the outer and inner lip regions for possible use in multi-model speech recognition. A combination of features was selected for both the outer and inner lip contour models and used to perform simple vowel recognition.

(4) Integration of higher-order language models for lattice rescoring which demonstrated that tri-gram models achieve the best performance on the ATIS rescoring task.

A part-time PhD project was also successful in reimplementation of the 2002 final-year project on speech enhancement using spectral subtraction and Wiener filtering. The proposed PhD work will investigate enhancement of speech in the presence of non-stationary noise.

Collaboration between the SIP Group at CIIPS and the Signal Processing Laboratory headed by Professor Sven Nordholm from WATRI was established resulting in the submission of joint journal and ICASSP conference papers. Both papers dealt with the enhancement of noisy babble speech by Blind Signal Separation (BSS) post-processed by an Active Noise Cancellation (ANC) stage. The involvement of the SIP Group was to establish the efficacy of this approach for robust recognition of connected digit speech trained upon clean data and tested on the enhanced data. Joint supervision of a PhD project on enhancement of speech for robust recognition has also commenced.

The latter half of 2003 also saw the arrival of Dr. Xin Xu from Wuhan University, China as a CIIPS Visiting Scholar who will be visiting initially for 6 months. Dr Xu's research will concentrate on aspects of speech enhancement and speech recognition.

6. SYSTEMS AND BIOMEDICAL ENGINEERING LAB (DR T. FERNANDO)

The following projects were undertaken in the area of Systems and Biomedical Engineering within CIIPS. The projects were carried out by students enrolled in PhD and also final year Engineering students.

Two-Dimensional Systems Theory and Applications

Systems that process two-dimensional (2-D) signals, eg. image intensity, are 2-D systems. Such systems have wide applications in manufacturing, telecommunications, defence and IT. The stability test of 2-D systems and super-resolution spectral estimation of 2-D signals are two of the most important problems that limit further development of 2-D systems. This project aims at developing efficient stability test and super-resolution spectral estimation algorithms for 2-D systems and signals.

Robust Control and Filtering For Uncertain Systems

Feedback control systems are widely used in manufacturing, mining, automobile and military hardware applications. It plays a key role for maintaining efficiency, reliability and profitability. In response to these demands, control systems are being required to deliver more accurate and better overall performance in the face of difficult and changing operating conditions. The main aim of the research undertaken in this project is to develop feedback control system design and filtering methodologies which take into account both robustness against uncertainties as well as the presence of stochastic white noise disturbances. The intention is to provide a unifying framework for robust control and filter design theory and applying this theory to practical applications.

Design of Reduced-Order Observers to Estimate States and Unknown Inputs of Nonlinear Systems

This project addresses the problem of designing an asymptotic observer to estimate both the states and the unknown inputs of nonlinear systems. This project has numerous applications in the areas of fault-detection and control, secure communications and conditions monitoring systems. By adopting the generalized state-space model, it is shown that it is possible to simultaneously estimate both states and unknown inputs and that the error converges asymptotically to zeros with any prescribed rate.

Reduced Order Observers Theory

This project solves the problem of designing reduced-order observers to estimate a linear functional of the state vector of complex, large-scale systems. The project will attempt to answer some fundamental questions such as: Given

a complex, large-scale system: (i) what is the minimum order of the observer? (ii) Can the minimum order be pre-determined? And (iii) Can the minimum-order observer be systematically designed?. This project has many applications in the areas of fault-detection and control, secure communications and in-process monitoring.

Closed Loop Control of Blood Carbon Dioxide and Oxygen Tension

Majority of the critically ill patients require the assistance of a mechanical ventilator to maintain arterial carbon dioxide and oxygen tension within clinically acceptable levels. A mechanical ventilator can alter breath parameters in order to maintain a patient in a clinically stable state. Breath parameters that can alter arterial carbon dioxide tension are tidal volume and respiratory rate whereas oxygen tension can be altered by positive end expiratory pressure and oxygen fraction in inspired air. In a mechanical ventilator all these four breath parameters can be altered manually or from an external computer. Developing a closed loop system to regulate blood gas tensions can relieve the clinical staff from routine repetitive tasks associated with ventilator management. However there are no commercially available sensors that can measure arterial carbon dioxide and oxygen tension continuously, estimation of these parameters using other measurable signals are necessary to facilitate automation. This project deals with arterial carbon dioxide and oxygen tension estimation and the application of expert system and modern control techniques to regulate blood gases within clinically acceptable levels.

Blood Glucose Regulation in Diabetics

The Diabetes Control and Complications Trial conducted by the National Institute of Diabetes and Digestive and Kidney Diseases showed that keeping blood sugar levels as close to normal as possible, leads to a substantial decrease in long-term complications of diabetes. The goal of diabetes treatment is to control blood glucose to levels that are as near normal as possible, in order to reduce the risk of disease complications. The aim of this project is to:

(1) Develop an automatic closed-loop control system that is capable of measuring patient's blood sugar level and prescribing an appropriate insulin dosage to control blood sugar level in patients.

(2) Investigate and demonstrate the viability of constructing an automated closed-loop blood sugar level control system using off-the-shelf components.

(3) Demonstrate the viability of utilising Interstitial fluid blood sugar measurement (rather than using whole blood) with intravenous insulin infusion to automatically control blood sugar level.

Pain Management of Postoperative Patients - Patient Controlled Analgesia

Patient Controlled Analgesia refers to a way of pain management by self administrating administering drugs. Pain is subjective and a feedback system to manage pain should incorporate pain intensity felt by the patient. Current method of pain management is through a bolus infusion of analgesic when pain is felt by the patient with no consideration to the intensity of pain being felt. This project aims at developing closed loop system for pain management based on the intensity of the pain being felt and also using methodology to optimize the amount analgesic being delivered.

GRANTS AND CONTRACTS

The Centre was in receipt of the following grants and contracts during 2003.

Evolving a Controller for Bipedal Locomotion,

UWA Research Grant, Perth $14,000

Atmospheric Fire Studies,

Dept. Environmental Protection, Perth $30,000

Visiting fellow/FAU Collaboration,

Friedrich-Alexander-University, Germany . . . . . Euro €15,000

TEACHING ACTIVITIES

DOCTOR OF PHILOSOPHY

The Centre had twelve postgraduate students working towards their doctorate in 2003.

MASTER OF ENGINEERING SCIENCE DEGREE

The Centre had three students enrolled for the Master of Engineering Science degree in 2003.

MASTER OF ENGINEERING IN IIPS DEGREE

The Centre offers a programme for the degree of Master of Engineering by Coursework and Dissertation in Intelligent Information Processing Systems. The course was designed to provide an advanced coverage of the theory and development of intelligent information processing systems. One student was enrolled in the course in 2003.

CIIPS PUBLICATIONS 2003

BOOKS

1. BRÄUNL, T.

   Embedded Robotics - Mobile Robot Design and Applications with Embedded Systems

   Springer-Verlag, Heidelberg Berlin, 2003, pp. (XIV, 434)

2. BRÄUNL, T. WITH CONTRIBUTIONS BY S. FEYRER, W. RAPF, M. REINHARDT

   Parallel Image Processing (Chinese)

   Revised edition, in Chinese, Reinhardt, Xi'an Jiaotong University Press in cooperation with Springer-Verlag, Xi'an China, 2003

3. TOGNERI, R., DE SILVA C.

   Fundamentals of Information Theory and Coding

   Chapman and Hall, 2003

4. ZAKNICH, A.

   Neural Networks for Intelligent Signal Processing

   World Scientific Publishing Co, Singapore, 2003, pp.(468)

BOOK CONTRIBUTIONS

1. BOEING, A., BRÄUNL, T

   Evolving Splines: Evolution of Locomotion Controllers for Legged Robots

   in: Tzyh-Jong Tarn, Shan-Ben Chen and Changjiu Zhou (Eds.), Robotic Welding, Intelligence and Automation, Lecture Notes in Control and Information Sciences, Springer Verlag, 2003, pp. (14)

2. MORRIS, J., LAM, C.P., BUNDELL, G.A., LEE, G., PARKER, K.

   Setting a Framework for Trusted Component Trading

   Component-Based Software Quality. Methods and Techniques, 2003, Lecture Notes in Computer Science, Vol.2693, pp.128-158

JOURNAL ARTICLES

1. CHEE F., FERNANDO T.L., SAVKIN A.V.

   Expert PID Control System For Blood Glucose Control In Critically-Ill Patients

   IEEE Transactions on Information Technology in Biomedicine, Vol. 7, No. 4, pp. 419-424, 2003.

2. CHEE F., FERNANDO T. AND VAN HEERDEN P.V.

   Closed-Loop Glucose Control in Critically Ill Patents Using Continuous Glucose Monitoring System (CGMS) in Real Time

   IEEE Transactions on Information Technology in Biomedicine Vol. 7, No. 1, pp. 43-53, 2003.

3. FERNANDO, T., TRINH, H. AND NAHAVANDI, S.

   Lower Bounds For Stability Margin Of N-Dimensional Discrete Systems

   International Journal of Computers & Electrical Engineering, Vol. 29, pp.861-871, 2003.

4. PETITT, P., BRÄUNL, T.

   A Framework for Cognitive Agents

   Journal of the Institute of Control, Automa-tion and Systems Engineers (ICASE), Korea, vol. 1, no. 2, June 2003, pp. (8)

5. TOGNERI., R., DENG., L.

   Joint State and Parameter Estimation for a Target-Directed Nonlinear Dynamic System Model

   IEEE Transactions on Signal Processing, Vol.51, No 12, pp.3061-3070, December 2003.

6. ZAKNICH, A.

   A Practical Sub-Space Adaptive Filter

   Neural Networks, Elsevier, Vol.16, No.5/6, pp.833-839, 2003

7. ZAKNICH, A.

   An Integrated Sensory-intelligent System for Underwater Acoustic Signal-processing Applications.

   IEEE Journal of Oceanic Engineering, Vol.28, No.4, pp.750-759, 2003

PATENTS

1. BRÄUNL, T., FRANKE, U.

   Verfahren und Vorrichtung zur videobasierten Beobachtung und Vermessung der seitli-chen Umgebung eines Fahrzeugs, Schutzrechtsanmeldung 102 44 148.0-32, submitted 23. Sep. 2003, DC Akte P1 12799/DE/1, in cooperation with DaimlerChrysler Research Esslingen/ Ulm, March 2003, Submitted as international patent in Europe, Japan, and USA, 23. Sep. 2003

CONFERENCE PAPERS

1. BASSAN, J., PETITT, J., BRÄUNL, T.

   CIIPS Glory: A Visual Servoing Approach within a Behaviour Based Framework for Soccer Robots,

   FIRA Robot World Congress 2003, Wien, Vienna, Austria, Oct. 2003, pp.(6)

2. BOEING, A., BRÄUNL, T.

   Evolving a Controller for Bipedal Locomotion,

   Proceedings of the 2nd International Symposium on Autonomous Minirobots for Research and Edutainment, AMiRE 2003, Brisbane, Feb. 2003, pp. 43-52 (10)

3. CHANDRASEKHAR, R., KWOK, S.M., ATTIKIOUZEL, Y.

   Automatic Evaluation of Mammographic Adequacy and Quality on the Mediolateral Oblique View

   Digital Mammography, IWDM 2002, 6th International Workshop on Digital Mammography, Bremen, Germany, June 2002, pp.182-186

4. DU, J., BRÄUNL, T.

   Collaborative Cube Clustering with Local Image Processing,

   Proceedings of the 2nd International Symposium on Autonomous Minirobots for Research and Edutainment, AMiRE 2003, Brisbane, Feb. 2003, pp.247-248 (2)

5. GRÖBNER, M., WILKE, P., BÜTTCHER, S.:

   A Standard Framework for Timetabling Problems

   1Published in "Selected Papers from the 4th International Conference on the Practice and Theory of Automated Timetabling (PATAT 2002)", Springer Lecture Notes in Computer Science, Vol. 2740, Juli 2003, Edmund Burke and Patrick De Causmaecker (Eds.), pp.24-38

6. MASEK, M., KWOK, S.M., DESILVA, C.J.S., ATTIKIOUZEL, Y.

   Classification of Mammographic Density Using Histogram Distance Measures

   World Congress on Medical Physics and Biomedical Engineering, IFMBE Proceedings, Sydney Australia, August 2003

7. TRINH, H. FERNANDO, T. AND PATHIRANA, P.N.

   A Reduced-Order Linear Functional Observer For Linear Stochastic Systems

   Applied Simulation and Modelling ASM 2003.

8. ZAKNICH, A.

   An adaptive sub-space Filter Model

   The International Joint Conference on Neural Networks, Piscataway, NJ, USA, IEEE Proceedings of the International Joint Conference on Neural Networks, Vol.2., July 2003, pp.1464-1468

CONFERENCE PROGRAM COMMITTEES AND CHAIRS:

Associate Professor T. Bräunl

- MASCOTS 2003, Orlando FL, Steering Committee
- Australian Conference on Robotics and Automation (ACRA), Brisbane AUS, Program Committee
- Euromicro Workshop on Parallel and Distributed Processing (PDP), Genova Italy, Program Committee
- Autonomous Minirobots for Research and Edutainment, Brisbane AUS, Program Committee
- FIRA HuroSot, Human Robot Soccer Championship, Vienna Austria, Chairman
- Workshop on Massively Parallel Processing (WMPP), Nice France, Program Committee
- International Robot Olympiad, IROC, Daejeon Korea, Program Committee

ABSTRACTS OF FINAL YEAR PROJECT REPORTS

JEFF ALLEN

Autonomous take off of a remote controlled aircraft

The concept of autonomous flight is not new. Modern jet liners are capable of flying on autopilot for many hours – and the world's militaries have been operating unmanned aerial vehicles in recent years. Flight is inherently dangerous, and this is reflected in the high costs of these low-tolerance autonomous systems, rendering them unsuitable for commercial applications. There exist opportunities for the extension of unmanned aerial vehicle technology to the commercial sector, in particular to the field of aerial imaging and surveillance. Current operations of this type require significant expense, in particular the purchase or hire of aircraft, and the additional costs of pilots, fuel and maintenance. Unmanned aerial vehicles do not require a pilot, making them smaller, lighter, and more fuel-efficient when compared to traditional piloted aircraft. As such they are an ideal solution for activities such as pipeline and crop-inspection, mineral exploration, topography, weather research and coast surveillance.

The purpose of this project is to design and implement a low-cost unmanned aerial vehicle, using the airframe of a standard remote-control aircraft, the EyeBot (Motorola 68332) micro-controller and an array of sensors. This paper focuses on the design & integration of additional sensors for the University of Western Australia's unmanned aerial vehicle; necessary so as to provide a basis upon which an autonomous take-off routine may be established. In particular, focus has been directed towards the design and integration of altitude, airspeed, pitch and roll indicators. An altitude indicator was developed in 2002; the design was subject to relatively severe electrical noise. This noise has been reduced through hardware filtering. A prototype airspeed indicator has been developed and tested, utilising a Pitot-tube measurement system coupled with a Honeywell low-differential pressure transducer. Attitude measurement problems have plagued the UWA autonomous flight project since its conception; it has been shown that these can be solved using an inclinometer & piezo-electrical gyroscope. A secondary objective of this thesis was the implementation of an emergency retrieval system. A preliminary feasibility study conducted with regards to a parachute retrieval system produced unfavourable results, and the further design of such a system is not recommended.

RESHAM CHAIL

Autonomous plane

The foundation of Unmanned Aerial Vehicles (UAVs) lies in defence research. However, as UAV technology matures, its applications and commercial viability broadens. UAV applications can be viewed as a more economic alternative to the conventional methods of manned aircrafts.

This thesis investigates the development of a Navigation and Control System for an Autonomous Model Aircraft. The Navigation and Control System allows the aircraft to execute a set of well-defined instructions without human intervention.

The objectives of this project are twofold: waypoint navigation and lateral control. The incorporation of appropriate sensors was fundamental to the achievement of these objectives.

The design and development of a basic waypoint navigation algorithm was successfully completed. A lateral control system has been proposed, though the implementation of this system remains unproven. The results from this research provide a basis for future work in the development of an Autonomous Flight system.

MICHELLE CHAN

Lip contour feature extraction for audio-visual speech recognition

Much speech information is contained in the movements of the lips and other facial features. Automatic lip reading systems aim to extract this information and provide assistance to audio speech recognition systems in order to improve their accuracy. This thesis investigates various techniques used to perform accurate lip contour extraction and recognition. The lip recognition process can be divided into three stages, colour image processing, lip contour extraction and feature-based recognition. The techniques investigated in the image processing stage were Chromatic Extraction, Chromatic Curve Map, Red Exclusion and Fuzzy Clustering. Active Shape Models were used for the lip contour and recognition was performed using a simple nearest-neighbour classification method. The Chromatic Curve Map technique was found to give the most accurate results for the outer contour. For the inner contour, the best

results were obtained using Chromatic Extraction. Both of these techniques made use of the red and green values of the colour spectrum. The use of Active Shape Models for modelling the outer contour was found to be e_ective, with an accuracy of 90.79%. It was less e_ective in extracting the inner contour, giving an accuracy of only 63.96%. The highest level of recognition achieved for the outer contour was 82.50% and for the inner contour, 66.67%. A combined contour recognition rate of 85.83% was also obtained.

OSCAR CHAN

Natural Language Modelling

Speech recognition is the process of converting a spoken utterance into a textual transcription. When dealing with continuous speech, language models can be used to apply constraints on word ordering. This helps the speech recogniser to discriminate between acoustically similar words. A commonly used form of statistical language model is the n-gram. These describe the structure of natural language by assigning probabilities to words based on a limited amount of the observed history.

We investigated the performance of n-gram language models for various values of n, and found trigrams to produce the best results. The n-grams were developed and integrated into a speech recogniser using the Hidden Markov Toolkit, which was trained and tested on the Air Travel Information Service (ATIS) task. Data sparsity was identified as a major problem, as it restricted the accurate construction of higher order n-grams.

KAMING CHANG

Functional Observer

Feedback systems are commonly used in the control engineering. Observers are used to monitor the behavior of such a system. This is to improve the final outcomes and the experimental results.

In the real world applications where functional observer applies, there are many uncertainties involve in the system. There are state variables that can be measured accurately and directly. For the rest of the state variables where they are impossible to measure directly, then an estimation of such variables is made. In order to make estimation, there are many constraints and conditions that must be satisfied before the design of an observer can take place.

Multivariable systems are commonly found in control systems. Previously, reduce-order observer is an approach to solve this kind of systems. As the order of the variables increase, this technique becomes inefficient and complicated. This is the main advantage and benefit that functional observer brings into the solving procedures. This thesis will illustrate the necessary and sufficient conditions for the stability of such an observer.

GREG CHEONG

Benchmarking Pipeline Performance for JXTA2.0

Peer-to-Peer computing has the power to improve the utilisation of networks by removing dependency on centralised points, eliminating the need for costly infrastructure by enabling direct communication among clients, increase network scalability and enable resource aggregation.

JXTA is a set of open source protocols that have been developed to build Peer-to-Peer application with. The protocols define the manner in which peers are created and how they interact with each other. JXTA is unique in that it provides a set of protocols that can be used to design more than one Peer-to-

Peer application. JXTA is best defined as a Message-Orientated Middleware. Message-Orientated Middleware are characterised as being event driven and latency hiding.

The purpose of this project was to examine the data throughput and message throughput performance JXTA. This performance evaluation was executed by examining the initial base line performance of JXTA peers. Base line performance was measured by testing Data and Message throughput of the JXTA peers and pipes.

The second component of this project was to develop the design of a Peer-to-Peer application simulation that the JXTA middleware can be assess upon.

The results of Data Throughput found that the latency involved differs for the type of pipe used. Secure reliable messaging in JXTA have large timing overheads compared to the unreliable message passing.

Message Throughput of a peer did not perform at a sustainable level when the sending rate was increased above 546.44 messages per second. Sending rates of 819.66, 1092.89 and 1366.11 messages per second experienced a degraded message-receiving rate and the majority of messages sent were lost.

LI LI CHONG

Pulse oximeter: design and implementation of pulse rate monitoring system

This project is to design a low powered pulse oximeter that will provide an accurate reading of ones pulse rate and oxygen saturation level in blood. This pulse oximeter will be easy to use and have a digital readout on the graphics LCD. Moreover, the designed pulse rate monitoring system also shows a warning message such as "Your pulse rate is too high" or "Your pulse rate is too low" when the measured pulse rate is out of the normal range of 50 to 85 BPM.

The pulse oximeter will measure the pulse rate and oxygen saturation level from a finger using LED and photodiode sensor.

Pulse oximeter exists today, so this design is not the first pulse oximeter to be built. However, by building and understanding the structure of the pulse oximeter system will thereafter be able to modify for detecting other gases in blood.

This thesis examined the pulse rate monitoring system, as part of the pulse oximeter system.

In additional, the pulse oximeter system is modified to measure the level of glycohemoglobin in blood according to Beer's Law. Using LED light sources at two wavelengths, 430nm and 575nm, the percent of glycohemoglobin in the blood is able to calculate.

RITIKA CHOPRA

Qantifying the Value of Software Products based on end user needs

Since software is developed to produce a valuable result for the organisation funding the project, the software produced must satisfy customers. To achieve this, the software practitioner must deliver value to their customers. Hence, the main objective of this thesis is to "quantify the value of software products based on end user needs." Wherein, the focus is on the end user, who is in essence the final customer of the software. The University of Western Australia (UWA) Handbook 2003 Web Site will be used as a case study to demonstrate how software practitioners can deliver value to end users using the House of Quality (HoQ) Matrix. The HoQ Matrix is one of the best known instruments of Quality Function Deployment (QFD), an approach that was developed in

Japan in the mid 60s and has since been used successfully by many large software organizations, such as Digital, AT&T, Hewlett Packard, IBM, and Texas Instruments.

CHARLES CHUA KWAN CHING

Modelling and control of insulin delivery in diabetes treatment

Diabetes is an elevation of blood sugar resulting from the body's inability to make or properly use insulin. There are mainly two types of diabetes i.e. Type 1 and Type 2. The first known record of diabetes dates back to 1552 B.C. However it was only since the 1940s that numerous breakthroughs in diabetes took place. It was during this time that blood glucose meters and insulin pumps were developed.

An insulin pump is an insulin-delivering device about the size of a deck of cards that can be worn on a belt or kept in a pocket. It connects to narrow, flexible plastic tubing that ends with a needle inserted just under the skin. Users set the pump to give a steady trickle or basal amount of insulin continuously throughout the day. Pumps release bolus doses of insulin (several units at a time) at meals and at times when blood glucose is too high, based on programming done by the user. The insulin pump has then been one of the main focuses in medical engineering to assist early stage diabetics.

In this project, we split the construction of the insulin pump into the main insulin pump algorithm and the display device (i.e. user interface). The typical user interface with buttons and text LCD will be further enhanced by replacing a graphics LCD and with touch-screen ability.

This dissertation deals primarily with the hardware development of the display device. The hardware development includes the circuit design, component selection, PCB fabrication and implementation. The software aspect of this project assists in the testing of the hardware as well as develops a fundamental display source code for the integration of a more sophisticated and user friendly insulin pump.

MELINA CHUNG

Development of a voice-based user authentication system

This project involves developing a voice based user authentication system, or more commonly referred to as a speaker verification system. Two speaker

verification systems are implemented: a text dependent system and a text prompted system. The project aims to implement these systems in real time using the Hidden Markov Toolkit. Each of the systems' performance are examined to see if the real time implementation can achieve a high positive verification rate that was achieved using database recordings.

GREG CRESP

Recognition systems for handwritten digits

The topic of handwritten digit recognition -- automatically extracting the digit contained in a given image, is one of great interest. It is interesting both as a stepping stone in the investigation of general handwriting recognition systems, and as an end in itself. There are many different approaches possible to creating such recognition systems. However, comparison between different systems, as they are presented in literature, can be difficult, due to the different conditions under which they have been trained and tested.

Two broad types of classifiers are structural and statistical classifiers. Structural classifiers operate by assuming a large amount of structural knowledge about the digits, whereas statistical classifiers achieve this knowledge from statistical examination of a large training set. There are different advantages to both approaches.

This thesis provides an overview of some of the structural and statistical classification schemes performed in literature. It then examines the implementation of several different statistical classifiers using a neural network approach and performs a comparison between their performance under controlled conditions. In addition, a structural classifier using the novel Shape Context approach is designed and implemented, and its performance compared to that of the statistical classifiers.

Of the classifiers implemented, the most successful, a neural network classifier using an edge detection feature, correctly recognises 97% of the test data presented to it. In contrast, the Shape Context classifier is less reliable, but presents other advantages, such as requiring less training data and being more robust to deformed digits.

MICHAEL CROUCH

Build your own spoken language system

This project is designed to develop a limited but working spoken language system. It examines the performance of a customised speech recognition

system. The system was created using the Hidden Markov Model Toolkit and tested using tools that come with this toolkit. Two different systems were created, a speaker dependent system and a speaker independent system. Both were created using the same methodology. They were both examined for their accuracy in performing speech recognition. The speaker independent system was also used to evaluate a method of adaptation. An accuracy of 95% was achieved for the speaker dependent system and 83% and 56% for the speaker independent system. Adaptation was examined and it was found that the adaptation technique used was able to increase the overall performance of the system. It was able to increase the accuracy from the previous 56% to 66%. The vocabulary used in the system and the amount of training data used has also been examined and conclusions about these two areas have been made.

THUC CHIEN DUONG

Linux on the iPAQ

Currently, in the modern business environment, information technology managers are required to implement an increasingly mobile, and real time network for users and their workforce. However, in order to implement a real time network, embedded hardware and device specific configurations of a real time operating system must be developed.

The use of Linux as the real time operating system for an embedded device is investigated. The Familiar Project is one of the major developments in this field; its current release is a preliminary beta version 0.7.2. Its performance in several real time benchmarks is measured, in order to determine its viability as the operating system of choice for an embedded device. This project utilizes an HP iPAQ 3970 as the embedded device for the test environment, with its improved X-Scale processor, and the benchmarks are executed on the Linux operating system that has been installed.

It will be shown in this thesis that the current release of the Linux operating system is far too unstable to be considered a viable solution for a real time operating system. Additionally, it will be shown that the newer processor used for testing poses some compatibility issues with more stable versions of the operating system. Whilst the Familiar release can be considered usable for soft real time applications, its use as a mainstream real time operating system must be investigated further; development is still proceeding, and as such, future tests of its compatibility with the embedded architecture will likely provide improved results.

HADWIN FUNG

Quality of Service (QoS) Enhancements In CORBA

Middleware is an established technology that can hide the complexity and heterogeneity of the underlying distributed environment to support faster and cheaper development. Common Object Request Broker (CORBA) is one such example of a middleware. More applications are now requiring the need for Quality of Service (QoS) support, which is the ability of the system to guarantee its level of performance.

In order to make CORBA more effective, QoS support in CORBA is important. In combination with Reflective Middleware (RM) technology, CORBA can provide more benefits and can help address QoS concerns. Reflective middleware is an extension of the middleware technology, allowing system components to query themselves and bring about self-reconfiguration where necessary. The self-reconfigurations are done through interfaces called QoS enhancements under CORBA.

This project investigates the effectiveness of QoS enhancements in CORBA to support reflective middleware. More specifically, the objectives for the project are: (i) investigate the effectiveness of several QoS enhancements to determine whether they in fact provide better QoS as claimed. (ii) generalise when should each enhancement be used. (iii) determine the cost of implementing enhancements.

To conduct the investigation, a testbed was implemented to conduct benchmark analysis. Operations of each QoS enhancements were studied and an analysis of their performances in providing QoS support was presented. QoS enhancements I successfully implemented include: thread-per-connection, timeout, Asychnonous Message Invocation (AMI) and buffer size property.

Results conclude that QoS enhancement in general do provide better QoS. The benefits gained from the QoS improvements outweighed the cost of implementing the QoS enhancement. However the performance in many cases, disagreed with the theories. The source of discrepancy was identified to be a bottleneck at the network level. Relating this result to RM, it is suggested that the source of a bottleneck should first be identified before any re-configuration is applied in order to achieve the optimal configuration to provide best QoS support.

CRAIG GIANOLI

Driver Assist Video System.

The DAVS is a WAGR designed system that provides train drivers with a real time video display of the platform area along the side of the train whilst it is in station. This is required for operational safety reasons to allow the driver to ensure that passengers on the platform are clear of the train and that the train doors are properly shut before departing the station. Determining when the doors are clear to be closed is a problem that has traditionally required additional staff. The DAVS was designed to permit driver dispatch of the trains thus lowering staffing costs whilst maintaining a high level of commuter safety. The requirement is for a system to provide clear high contrast images of the platformtrain interface on an in cab LCD monitor for all lighting and weather conditions and all stopping locations along a station. Due to the nature of the RF emission, if the train comes to rest in a null, a poor signal will be received resulting in a noisy picture or in extreme cases complete loss of picture. The extreme lighting conditions also pose a problem as the intrascene luminance range is greater than that supported by the cameras.

STEPHEN HANHAM

Evolution of a Locomotion Controller for a Real Biped Robot

The design of a control system for legged locomotion in robots is both a complex and time-consuming process. It often requires detailed knowledge and understanding of a robots underlying kinematics. An automated approach utilising software simulations is therefore highly desirable. This would free the engineer from labour intensive methods and allow rapid prototyping, all with minimal risk to the hardware. Ideally, such an approach would be applicable to a range of robot morphologies.

This paper presents a semi-automated approach towards evolving locomotion controllers for robots. A spline based locomotion controller is chosen as it is both simple to implement and lends itself towards being evolved. The controller is evolved in software by using mechanical simulation of the intended robot as feedback. The evolved controller is trialled on the real robot to verify the accuracy of the simulation and provide a measure of success of the walking gait evolved.

CLARE HARRISON

Autonomous Plane

The Autonomous Plane Project at UWA was initiated in 2000 in the quest to develop autonomous flight control systems for fixed wing aircraft. Since its inception, this project has used an array of flight sensors, all interfacing to an onboard processor, in the development of navigation and guidance routines. Logging flight data has always been a priority for post-flight analysis and since 2002 a Compaq iPAQ PDA has been used to collect and store log data between flights.

This Honours project, entitled "Ground Station Data Display for an Autonomous Aircraft", had the principle objective of developing the iPAQ as a full featured ground station for use with the aircraft of the UWA Autonomous Plane team. To achieve this, new applications were written for the iPAQ. This thesis presents the design considerations and method of implementation chosen to develop these applications.

The new iPAQ software was designed for ease-of-use and as such, the program functions are activated via graphical user interfaces (GUIs). One advantage of utilizing a PDA is the touch screen available and the GUIs developed allow user input through point-and-click methods. The graphical user interfaces were created using widgets from the Fast Light Tool Kit (FLTK), a cross-platform C++ GUI toolkit.

For the iPAQ to be effective as an aircraft base station, the required functionality was two-fold. To allow control of the aircraft's flight path from the ground station, a GUI has been developed that supports the generation of a flight path by pointing to waypoint icons with the iPAQ's stylus. A GUI has also been created to provide graphical presentation of real time flight telemetry.

Real time monitoring of the plane's flight status improves risk management of the aircraft, providing an indicator to the plane's stability under autonomous control. Flight telemetry made available to the ground crew reveals the effectiveness of both the onboard electronics and the flight program used for navigation and control.

COLM KIELY

Autonomous Exploration of Three-dimensional Terrain by a Tracked Robot

A system for autonomous exploration of rolling three-dimension terrain by a tracked robot is presented. A system for localisation of the robot through odometry, using a shaft encoder and a compass is presented. Sensor noise

reduction is achieved through the use of a Kalman Filter and a system is developed to extract heading information from a two coil compass as the robot undergoes pitch and roll changes over the terrain. The localisation system is not tested, due to hardware failures. A state-machine based system for autonomous navigation of the terrain is presented.

SALLY YI LING LAY

Developing a Generalised Estimation Method (GEM) tool to Estimate Multimedia Projects

Software nowadays is one of the most expensive components of all computer-based systems. The expensive costs are the reason why it is essential to have a reliable estimation tool. As developing a new and reliable estimation tool for multimedia projects, provides managers with a more accurate prediction of development efforts for their project, for example the budget and duration. But, estimation tools will never be completely accurate, as there are too many uncontrollable variables, for example human, technical, and environment, that can effect the final estimation. Although so, as technology costs get driven downwards through economies of scale, the possibility to develop such an estimation tool moves upwards, hence in trying to develop an estimation tool today could mean tomorrow or in the near future we could eventually produce an accurate estimation of projects.

This Final Year Project Thesis has three objectives. The first is to understand the importance of developing an estimation tool for multimedia projects. The second is to examine the Generalised Estimation Method (GEM) approach for multimedia projects, and to use this approach to develop a GEM Tool. The third is to evaluate the predicting accuracy level and usability of the GEM Tool.

The evaluations of the GEM Tool in this Final Year Project suggest that the tool is user-friendly and is useful for estimating development effort in multimedia projects.

TZE WEI LEE

Development of a pulse oximeter for measuring oxygen saturation level in arterial blood

Pulse oximetry is a simple, non-invasive method of monitoring the oxygen saturation of arterial capillary blood. The pulse oximeter is a convenient, cost-effective way to monitor the patient's oxygenation status and determine

changes before they are clinically apparent. It is important to know how oximeters work in order to maximize their performance and avoid errors in the interpretation of results.

This thesis outlines the development of a pulse oximeter, a non-invasive device that tells you the percentage of oxygen circulating in the blood, by measuring the oxygen saturation, SpO2 of the hemoglobin. This system aims to measure the saturation blood level from the index finger by making use of LEDs and photodetectors where the percentage saturation can be displayed on a digital LCD screen.

Pulse oximetry is based on the presence of a pulsatile signal generated by arterial blood, which is relatively independent of non-pulsatile arterial blood, venous and capillary blood and other tissues and the fact that oxyhaemoglobin [HbO2] and deoxyhaemoglobin [RHb] have different absorption spectra.

Pulse oximeter uses two light-emitting LEDs that emit light at the 660nm (red) and the 940nm (infrared) wavelengths to produce light through the finger. As light passes through the finger, light energy is absorbed by arterial and venous blood, tissues and variable pulsations of the blood. The oxygen saturation level in blood can be calculated by examining the attenuation of light which passes through the blood. Matched photodetectors, which is positioned perpendicularly to the light emitting LEDs, are used to detect the light energy and the ratio of the wavelengths (red: infrared) are calculated. The signal is then processed based on the Beer's Law which relates the intensity and wavelength of the incident light to the concentration, molar and absorption coefficient of haemoglobin derivatives. The implemented pulse oximeter is then modified to measure glycohaemoglobin level in blood.

DAVID J. LEECH

Arterial Carbon Dioxide Estimatior: Input Control

Among the most vital physiological processes the body performs are delivering oxygen (O2) to, and eliminating carbon dioxide (CO-2) from, the tissues. Patients whose breathing mechanisms have been compromised rely on an autonomous system to perform life-critical ventilation. Safe and effective control of an artificial ventilator is requires precise feedback to update breathing characteristics and provide a comfortable and consistent air supply. The quality of the feedback information is heavily reliant on an accurate measurement of arterial carbon dioxide tension. End tidal carbon dioxide is commonly used for estimation of the tension of arterial carbon dioxide but this has proven to be inaccurate and unreliable. The motivation for this project was to physically

realise an arterial carbon dioxide tension estimator that capitalises on these deficiencies. In essence, this equates to an optimum combination of intelligence, flexibility and accuracy. This led to the conceptualisation, design and implementation of a microcontrolled estimator with advanced computational power and expansive memory capacity.

The scheme implemented is a prototype for an ambulatory estimator powered by a Motorola microcontroller. The principle of operation is that the outputs of a continuous end tidal carbon dioxide measurement source are input to the device. Internally, the data is converted into a plot of the Single Breath Test for Carbon Dioxide and operated on by an enhanced algorithm to produce accurate arterial carbon dioxide tension estimation.

VICKIE LEUNG

A speaker-dependent Cantonese base syllable recognition system using HTK

Speech recognition strategies and methodologies have undergone substantial research and development in the last two decades. However, little work in this area has been done for Cantonese. In the past ten years, speech recognition techniques have also been applied to Chinese spoken language trying to solve the problem of inputting Chinese characters into computer systems. Inputting Cantonese on the keyboard, however, is counter-intuitive as the Cantonese language is not alphabetical and existing methods are very complicated and slow, which makes Voice Dictation a much better option.

The key objective for this project is to investigate and produce a speaker dependent Hidden Markov Model (HMM) – based speech recognition system prototype for Cantonese base-syllables using the HTK program running in Linux, as well as to test and evaluate its performance. A further investigation on Cantonese phonetic structure and why the performance levels of Cantonese recognition systems have been habitually lower than comparative Mandarin systems will also be conducted.

This dissertation will provide a background discussion including comprehensive research on Cantonese Speech Recognition (CSR) systems, Cantonese phonetics and other relevant topics. A theoretical framework will be given describing the main algorithms adopted as well as a detailed methodology outlining the design issues and the steps taken. Next, the results from the three main experiments conducted will be discussed and analyzed and finally, a summary and conclusion of any findings will be presented.

MICHAEL SONG TSEN LEW

An Information Extraction System for Annual Reports

Previous research in the field of information extraction has focused on using financial news articles from the Internet, this project investigates the use of template recognition, a form of information extraction on electronic annual reports.

The information extracted from these annual reports is based on metrics needed for financial ratio analysis, a field within financial accounting. Financial ratio analysis uses ratios to condense large amounts of values contained within annual reports into a useful measure. These measurements can then be used to critically evaluate a company's past operations.

Studies have shown that shareholders find annual reports difficult to comprehend and would not use simplified annual reports if supplied by companies. This project investigates and presents results of template recognition in annual reports, with financial ratios used as the basis of the information extracted.

ERIC LING

Design Patterns for Mobile Applications

There is an ever increasing growth of the mobile device market, which emphasises the importance of software design of mobile applications. This project provides an in depth examination of design issues concerning mobile applications. There are important considerations in the design of applications for mobile applications due to the differences in the devices capability in contrast to non-pervasive computing. The main issues are intermittent network connectivity, connection, data and application security, and memory resource limitations. This thesis is concerned with the development of design patterns to address these issues. The first approach taken is to customise generic design patterns for the mobile application environment. The second approach abstracts design patterns from common solutions to specific mobile applications. A combination of the two approaches is used to construct and generate the design patterns. These design patterns are described in Unified Modelling Language (UML) Diagrams abstractly. Further UML diagrams of example implementations are used to demonstrate the use of the design pattern. Justification of the designs is provided by proposed metrics and probability modelling. This thesis provides a background of the mobile application environment, as well as an explanation of design patterns and their importance in software design and development. Following that is an outline of the approach taken and the methodology employed to develop the design patterns. The design patterns for

mobile applications are then discussed and analysed along with UML descriptions in the following chapters. Finally, concluding and summary remarks will be presented along with recommendations for future work.

DAVID LUONG

Optical character recognition

This paper describes the design and implementation of two Optical Recognition Systems. The Optical Recognition Systems use the calculation of moments and the use of Neural Networks in order to classify letters. The networks were both trained and a performance evaluation was carried out on them with ideal letters and those that had been affected with noise. Both systems achieved high levels of accuracy and the Neural Network system was able to classify characters even under moderate amounts of noise. This paper demonstrates the fundamentals of Optical Character Recognition Systems which can be applied to further developments of the field.

TOM LYNCH

Evaluating Variants of the Spectral Subtraction Method for Speech Enhancement

Speech is our primary mode of communication, and more and more often conversations are being carried out under conditions of noise that impact upon the intelligibility and aesthetic character of what is said. Concomitantly it is becoming increasingly important to devise ways of diminishing the detrimental background noise so often present. This human need, along with research interest in applications that rely on speech input of a certain quality, such as automated word recognisers, motivates the study of speech enhancement techniques.

Spectral subtraction methods form one subclass of the wide range of speech enhancement techniques actively being researched. They are transform-based methods that employ a subtraction of estimated noise power in the frequency domain to modify the spectrum of a noisy speech signal so that it is closer to that of the original speech. The outcome following resynthesis is an enhanced speech signal with reduced background noise.

The particular interest in spectral subtraction methods stems from the fact that they are less computationally expensive than other speech enhancement techniques, and simple to implement. This project compares three variants of the spectral subtraction method, namely conventional spectral subtraction,

multiband spectral subtraction, and nonlinear spectral subtraction. Their performance as enhancement algorithms and their suitability for practical application is assessed. Experiments were performed using a range of experimental data including samples of real-world, nonstationary noise.

MAHSA MOORANIAN

Design of a cough-meter for TB infectivity Assessment, suitable for Deployment in Rural Village Population

A portable cough-meter has been built to monitor the coughing episodes of Mycobacterium Tuberculosis (TB). This device is made up of an intelligent cough-activated circuit (Cough-detector) and HCS12 microcontroller (MC9S12DP256 MCU). The cough sound is acquired by using a sensitive miniature Electret microphone located on the circuit. The signal processing and quantitative analysis of cough sound are carried out in the time domain by using the microcontroller.

The detector circuit is made up of five components. An operational amplifier and multi-feedback band-pass filter are used to enhance signal gain and to reject low and high components of signal (the cough sound level is bounded between normal speaking and shouting). A Schmitt trigger is also added for efficient distinction between cough sound and noise in order to ensure that the circuit actually captures the right signal. The voltage regulator (full wave rectifier) is attached to produce a DC pulse proportional to the sound level picked up by the microphone. A transistor switch is then applied to light up the LED when the sound is actually detected for indicating the presence of cough.

Five software components are used to configure Analogue to Digital (ATD) converter and Enhance Capture Timer (ECT) modules on the chip. These components enable the microcontroller to count the number of coughs, determine the intensity and duration of each along with the frequency and energy. The circuit is connected to the chip at three points: first from voltage regulator to ATD part and then from the LED to the ECT module.

The circuit accuracy in distinctly capturing coughs was found to be about 1 millisecond within 15cm distance from the mouth (in a noisy environment) and no sound/noise was detected more than one meter distance from the microphone. Radio and TV sounds were not recognized from any distance and seem to have no effect on the way circuit detected cough-related sounds. The

device was able to precisely count the number of coughs, record their intensities and produce an estimate value for duration, frequency and energy of each cough. However the minor set back was the failure to obtain time and date stamp for each cough as the Real Time Clock code and main program could not be run simultaneously.

CHONG SEAN ONG

Comparison of Parallel Asynchronous and Synchronous Algorithms in Cilk

Parallel processing is a useful technique for speeding up the process of problem solving. However, in order for the computers to work together, some form of coordination is required between the workstations.

There are two main methods that can achieve this coordination. The parallel algorithm may contain synchronisation points or the processors may operate asynchronously. Synchronisation points or 'barriers' can potentially lead to idle time due to bottlenecks during the message passing phase. The asynchronous program can alleviate the problem through the removal of synchronisation points. However, it may yield incorrect solutions or can take a long time to solve problems due to processors computing using incomplete information. However, it will be shown that the asynchronous algorithm will execute more quickly as well as produce comparable or better results.

The superiority of asynchronous algorithms is demonstrated in two applications. The first application, a temperature distribution problem is used to show that computing asynchronously will lead to higher speedup values despite calculating using incomplete information. The algorithms will be tested under different conditions to simulate real-world situations.

The second application, genetic algorithms, is used find an optimal tour for the travelling salesman problem (TSP). The parallel asynchronous algorithm mimics real-life natural selection through the use of the island model. The purpose of this application is to demonstrate that the asynchronous program will produce superior tours than the synchronous approach.

The algorithms were all implemented using Cilk, a multithreaded parallel programming language.

KIEN PANG

Implementing and evaluating a generic mobile information device emulator

Mobile application development is fast becoming a highly profitable commercial opportunity, where expectations of highly robust and useful mobile applications have risen over the years. This is due to the fast improving mobile device capabilities and the demand for more multipurpose devices to replace single purpose devices. To enable worldwide developers to build mobile applications for both personal and commercial use, phone manufacturers and third party suppliers have continuously provided developers with tools and support, the mobile emulators being one of those important tools. This project takes an in depth look at the uses of a mobile device emulator by both obtaining performance analysis and supportability of emulators that are commercially or freely available out in the market. It covers some areas to improve the effectiveness of using the emulators and to obtain further knowledge and understanding on mobile application development process. These were accomplished by both benchmarking on emulators and comparing its performances with actual mobile devices, as well as research on additional features that emulators support. Results showed that there are performance differences depending on the emulators used, and there are certainly limitations on what can be done on mobile device emulators. These results will not only guide existing mobile application developers on the usage on emulators but will also benefit those who are new to the mobile world.

MARK PEPPER

Autonomous navigation of a tracked robot in hazardous terrain

The use of autonomous robots has increased rapidly over the past few years due to the increase in computing power and the expansion of international robotics competitions. An autonomous driving system was developed for a small tracked mobile robot powered by an EyeBot controller. A behaviour-based system was defined and implemented to navigate the robot over hazardous terrain towards a specific target. The system merges the driving suggestions of all behaviours, and is expandable to include new behaviours. Testing on a man-made hazardous terrain was conducted and the successful operation of the driving system verified.

CHRISTOPHER RISPOLI

Arterial carbon dioxide estimator:data processing

The continual advancement and progression of technology in the biomedical industry is resulting in new techniques and methods for the diagnosis, monitoring and treatment of a patient's health. As we evolve as a population, these technologies are playing more of an integral role in not only reducing the suffering of a patient but also the time involved for the medical staff in attending to the plethora of patients in hospitals and general practices.

The motivation for this project was to physically develop a noninvasive procedure to provide a quick an accurate reading of arterial carbon dioxide tension – vital diagnostic information for the diagnosis of disease and monitoring of a patients organ function.

The complete system involves the integration of numerous components to provide a scalable and portable arrangement with the technology to update any algorithms implemented in the software or easily update any outdated or damaged components. The complete engineered system is to be computer controlled (via a microcontroller) to allow for the functionality mentioned above.

Intelligent software is responsible for interfacing all components to the powerful microcontroller, designed in such a way to allow for the software to easily be tailored if new algorithms or components are to be incorporated into the system.

JONATHON SEAH

Performance of Java 2, Micro Edition (J2ME) on Mobile Devices

Wireless devices such as cellular phones have undergone tremendous growth over the past few years. As this market matures, users will demand more applications from their devices and developers will bring new innovative applications for wireless devices. From the emergence of this market, the Java technology has been enabled for wireless devices. This technology is provided by Sun Microsystems in the form of the Java 2, Micro Edition (J2ME) platform. J2ME is a platform targeted for applications running on small devices such as mobile phones and PDAs.

This research is to evaluate the functionality and performance issues with Java on mobile devices. The measurement of performance is through the development of benchmark applications. The target devices used in this research is the Nokia 7250 and the iPAQ H3850. Analysing the results obtained from the benchmark applications, there were significant observations about the Nokia 7250 device and emulator and iPAQ.

Apart from developing benchmark applications, this research topic involved in the development of a real-world application called the Transaction Management System (TMS) which incorporates J2ME and J2EE (Java 2, Enterprise Edition). By combining these two platforms in the form of a client-server application, this will demonstrate the potential of having Java on wireless devices. This application will provide a better performance benchmark of J2ME on mobile devices. As J2ME is a new technology, the full potential of this platform has yet to be seen.

WAN JEAM SEET

Performance analysis of the .NET platform in distributed computing

Creating a viable architecture that facilitates remote component-based interactions is one of the greatest challenges in distributed computing today. Differences in operating systems, object models, and programming languages across organisational boundaries makes the task of developing flexible, scalable, and robust distributed systems a difficult one. Whilst integration is a key, performance is also essential. Users often demand both functionality and efficiency.

This is indeed the goal of Microsoft's .NET platform, which is a standards-based architecture that provides a specially adapted toolset and runtime environment. It is designed to enable the deployment of highly distributed applications reaching far beyond tightly-coupled client/server environments. The .NET platform is, however, a relatively new and unproven technology. At present, formal analysis of the .NET architecture against the above criteria has rarely been carried out.

This project takes a balanced approach in analysing the performance of the .NET platform. A performance benchmarking component is combined with a business analysis to provide for a comprehensive evaluation of the .NET technology. Performance comparisons with other distributed architectures such as CORBA and J2EE are also included in this project.

Results show that .NET exhibits linear load scalability, deterministic response times, sustainable throughput, and server-side scalability (up to the limit tested). Object leaks occurring at high server loads, however, were identified.

.NET is also outperformed by CORBA in terms of response time, and is found to have several shortcomings when business factors are taken into consideration. Overall, this shows that although positive performance characteristics were observed, there are still many areas which need be improved upon. The results provided in this project can be used in future performance analyses in order to determine the relative improvement factors made in subsequent versions of .NET.

RITWIK SINGH

Medical Device Communications

Healthcare, particularly at the point-of-care, is beginning to become overwhelmed by the voluminous amounts of data produced by the medical devices that essentially aid in the life-preserving process that is healthcare. One would assume then that medical device communications would be at the forefront of the medical device industry, leading the adoption of information technology rather than following it. Unfortunately, this is not the case and the effects are starting to be felt. The IEEE has developed the medical information bus with the promise to standardise medical device communications the world over. But until the standard gains industry approval, the wider engineering community can only contribute to such efforts by demonstrating their viability and suitability. This dissertation addresses the problems created by the lack of standardisation in medical device communications through a practical demonstration of the concepts of the ensuing standards by facilitating the intercommunications between medical devices and information systems.

Based on a formal design methodology, a communication system is proposed that will facilitate the intercommunications between a test-bed infusion device and a custom built medical information system. The system will be defined by a physical interface and a logical interface. The physical interface includes design considerations such whether to transfer data from the medical device via a serial or infra-red link. On the other hand, the logical interface specifies, for instance, how the data, once captured from the medical device, will be processed, stored and displayed.

ANTHONY TAN

Behaviour based robot simulation

For robotic agents, a behaviour of significant interest is that of pathfinding, the traversal from a given point to a destination goal. This is not a novel research area with several existing methods for path planning. Such methods

generally treat the problem as a mathematical optimisation with a particular representation of CSpace, applying a heuristic to determine a path. While effective, many of these techniques are complex, resource intensive and do not lend themselves to implementation on a constrained robotic agent. This paper presents an alternative solution for a mobile robot based upon viewing the problem as a series of unconnected environmental responses that can be derived by observation of human responses to the situation. A behaviour-based controller can then be composed by mimicking these responses in a neural network controller with appropriate training data. While the sample implementation does not display noticeable pathfinding ability, the network controller appears to be able to learn an underlying pattern in the training data suggesting that there at least some fundamental pattern governing the approach.

KENG CHONG TAN

Arterial carbon dioxide tension estimation

Carbon dioxide ( ) sensors have numerous biomedical applications, based on the fact that assimilation and respiration are fundamental processes intimately associated with life itself.

Measurement of the partial pressure of carbon dioxide ( ) in the arterial blood is used to assess the adequacy of modern lung ventilators such as the Mandatory Minute Ventilation (MMV) that interacts with the patient to provide a preset minimum minute volume. To help assist the clinician to set the number of volume breaths per minute, is determined and feed backed to the computer or clinician to control the number of delivered breaths per minute. Therefore, MMV is a very useful device that is able to increase or decrease the number of volume control breaths in a given time.

Therefore, the project aims to investigate non-invasive means to provide a continuous estimate of which is based on instantaneous, correlated measurements of ventilatory flow, airway pressure and end-tidal carbon dioxide ( ).

The most common and accurate method to determine end-tidal carbon dioxide ( ) is using Infrared principles as carbon dioxide molecules absorb Infrared at 4.26_m wavelength. With an appropriate casing design and calibration of the detector, end-tidal will be determined for every breath and this signal will feed to a micro-controller where other factors such as airway pressure and ventilatory flow rate will be calculated to give a good approximation of the partial pressure of carbon dioxide ( ) in the arterial blood

DOREEN TAN

Build your own spoken language system

This work describes a speech recognition system for Hokkien digits. Hokkien is a Chinese dialect which has eight distinctive tones. This is a software language systems engineering project which will involve developing a limited but working spoken language system using the state-of-the-art Hidden Markov Model Toolkit (HTK) software (http://htk.eng.cam.ac.uk). In this project, digits in Hokkien Language and English Language, recorded in Wav files, are being used. Speech signals of 2 males and 2 females are used in the testing. The samples are recorded in pulse code modulation (PCM), with a sampling frequency of 22.050 kHz, 8-bits and mono.

A range of factors are analysed in the experiment. The tradeoffs between speaker-dependent and speaker-independent were analyzed. The best performer is speaker-dependent which created a 100% accuracy system using isolated digits. As for speaker-independent, it produces a result of average 70% for speech recognition system with silence model, and a result of 40 % for normal speech recognition system.

AIK MING. TOH

Music synthesis

Recent developments in physical modeling synthesis have captured the popularity and potential of music synthesis applications. Physical modelling by digital waveguide techniques offers distinct advantages over past developed techniques such as additive, frequency modulation and wavetable synthesis. Digital waveguide techniques have reached a high level of development with respect to wind instrument. It offers accurate and efficient implementation of time-domain models which include tone holes and flared bells. Applications of digital waveguide modeling include soundcards, electronic musical instrument, digital and analog synthesizer.

This thesis provides a literature review on various synthesis methodologies with their features and limitations in music synthesis applications. Research and theoretical frameworks has been outlined in the project for digital waveguide modeling on flute. The thesis also discusses the fundamental theory and design requirements for various components of the digital flute model.

The primary objective of this project was to implement a digital flute model based on digital waveguide modeling using the software MATLAB™. The

algorithms focused on the production of synthesized tones in relation to the real acoustic tones. Issues such as controllability, scalability, realism and expressivity have been adopted in the project.

The algorithms that were developed generated remarkable similar tones compared to the acoustic flute tones. Both objective and subjective measures have been performed to evaluate the quality and performance of the tone production. The mean opinion score, MOS showed a promising result in the quality and realism of the synthesized tones

ALEX ULOTH

Robot soccer

This paper provides an indepth look at the history of the robotic soccer competition and the design of software modules for use in soccer robots. This involves the investigation of possible improvements in planning of teams of robots which leads to specific developments in the field of localization and the use of a global coordiante system. A technique for localization is developed using infra red range detectors and a compass to produce a radar like effect. This is designed and tested on a simulator and on real robots and results are summarized and presented.. This paper provides a firm basis for future work in localization and the use of a global coordinate system across a range of situations.

PRADEEP M VATVANI

The development of a cost estimation tool for multimedia projects

Over the past two decades, there have been numerous advances made in the I.T. industry, so much so that the software engineering is emerging as an engineering discipline in its own right. Despite, these advances, however, the software crisis persists. The software crisis is perhaps best defined as the inability of organizations to properly apply software metrics to improve their software development process.

In an attempt to tackle this crisis, academics and practitioners have developed numerous tools that, if used correctly, will enable project managers to estimate a project's likely cost, duration and development effort required. COCOMO II, function and use-case points, PERT and SLIM are examples of such tools.

A key handicap of the current tools is that they do not provide adequate mechanisms to re-estimate a project during development. To achieve this,

there is a need for definite points in the software development cycle where a project's attributes (i.e. cost, duration or schedule, and required effort) can be re-estimated. Re-estimation of a project's attributes is essential due to the occurrence of numerous events that may have occurred once the development process has begun. One such event is requirements or scope creep. Requirements creep occurs when changes to the functional requirements of a project are made once development has commenced.

A potential point at which re-estimation could be carried out was suggested by Lee. In her thesis, a methodology was developed that successfully identified the intermediate point of numerous software projects [1]. The primary aim of this paper will be to develop a new methodology, based on Multiple Regression that will provide more accurate estimates of a project's intermediate point.

Initial applications of the Regression Method indicate that the method is very sensitive to any change that may occur in the pattern in which work is carried out. Due to the fact that the data used to assess the Regression Method originated from an organisation that does not use a structured development process, the Regression Method performed poorly. However the theoretical foundations of the Regression Method were comprehensively analysed and numerous suggestions were made to make the Regression Method more robust and accurate.

MATTHEW WRIGHT

Sub-band speech recognition

This project presents the results of an investigation into the performance of the modified speech recognition technique referred to here as 'Sub-band Based Speech Recognition'. This technique is designed to improve the performance of speech recognition systems when the sample data is corrupted by additive noise. It attempts to achieve this by processing frequency bands separately from one another, which is expected to provide better resilience to additive noise when the corrupting noise sample is band-limited by allowing other frequency bands to return a correct result. There is also an expectation that the performance of the sub-band system will improve by allowing the speech models to achieve better statistical matches to sample data as less information is processed. While the results obtained did not suggest that sub-band based recognition is able to improve system performance over the traditional full band system, there are several possible explanations for these disappointing results that suggest that sub-band based recognition should be looked at more closely."