Centre for Intelligent Information Processing Systems

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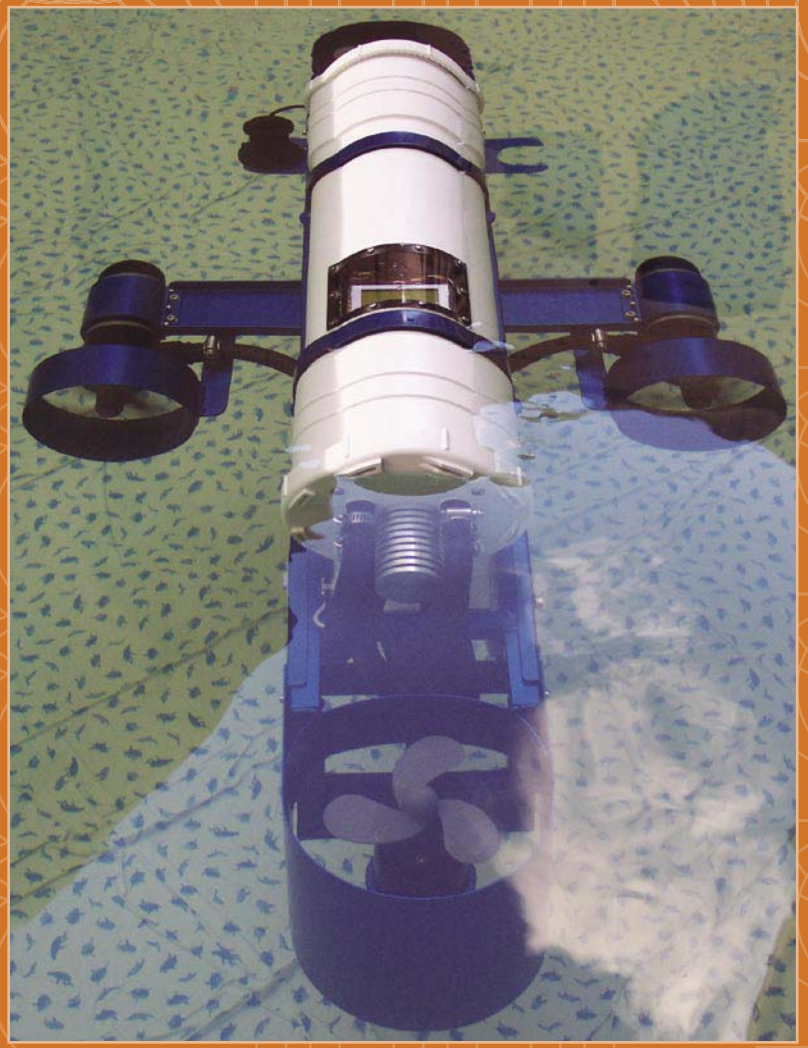
Centre for Intelligent Information Processing Systems

Annual Report 2004



School of Electrical, Electronic and Computer Engineering

THE UNIVERSITY OF WESTERN AUSTRALIA

The University of Western Australia

CONTENTS

DIRECTOR'S REPORT

During 2004, CIIPS (Centre for Intelligent Information Processing Systems) has further consolidated its financial situation and its position in the university. CIIPS was able to attract a number of research contracts and sponsorship from local and international companies. We hope this will be the beginning of an extended interaction and we will continue to do joint research with industry participation.

On the research and education side, we have maintained close ties with several European universities. In 2004, we have hosted exchange students from Paris and Rouen in France, and from Ilmenau, Koblenz, and Giessen in Germany. We have found these exchange visits to be beneficial not only to the visitors, but also for the academics in the Centre, they are working with. We will continue with the exchange programme and are looking forward to meet the students who have already arranged a visit for 2005.

A major undertaking for 2005 will be the conduction of the Autonomous Underwater Vehicle (AUV) Competition, which will take place in Perth for the inaugural year. During this year, we have already been busy with numerous preparations for the competition of both real and simulated AUVs.

While the nationwide downturn of IT students did not stop at UWA, we hope that the student numbers will increase again in the following years, as industry's demand for IT Engineers is likely to become stronger. 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 systems 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, Dipl.-Inform., MS, PhD, Habil., MIEEE, MDHV

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, MAppScTov, MIEEE

Associate Professor Anthony Zaknich, BE, MESc, PhD, BSc, BA, SMIEEE, MAES

Associate Professor John Morris, BSc(Hons), PhD

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

Mrs Sandra Snook

VISITORS

Mr Frederic Battistelli, Univ. Paris

Prof Anthony Constantinides, Imperial College, UK.

Mr Nicholas Duplat, Univ. Rouen

Mr Andreas Koestler, Uni. Giessen, Germany

Miss Annika Kuhl, TU Ilmenau

Mr David Legardinier, Univ. Rouen, France

Miss Azelle Sery, Univ, Paris, France

Mr Christian Schmitz, FH Koblenz, Germany

Dr Xin Xu, Wuhan University, China

POSTGRADUATE STUDENTS

Doctor of Philosophy

Mr Adrian Boeing

Mr Oscar Chan

Mr Dariush Farrokhi

Mr Serajul Haque

Mr Yves Hwang

Mr Jordan Kosek

Mr Peyman Kouchakpour

Mr Sze Man Kwok

Mr Philippe Leclercq

Mr Alistair Sutherland

Mr Aik Ming Toh

Mr Terry Woodings

Mr Weiqun Zheng

Master of Engineering

Miss Mahsa Mooranian

Master of Engineering Science

Mr Siddharth Parekh

UNDERGRADUATE STUDENTS

Nikhil Aggarwal

Neil Andrews

Winston Cheng

Jacinda Chou

Melisa Ciputra

Alex Craven

Udena Sahan Elangasinghe

Daniel Elkington

Neil Finney

Takashi Fujita

Mark Gillon

Julian Goh

Louis Gonzalez

Philip Greenhalgh

Patrick Ho

Elaine Hopwood

Janine Hussey

Richard Jarvis

Brian Kealley

Chien-Ee Kho

David John Knezevic

Linda Kurniawan

Yong - Long Lai

John Larcombe

Ga Rick Lee

Chin Teong Lim

Daniel Lim

Aaron Low

Minh Nguyen

Steven Nguyen

Toan Nguyen

Nicholas Pelly

Nora Pribadi

Elliott Ross

Yodi Bernardi Salim

Daniel John Stefanelli

Sunjaya

Justin Tan

Shuen-Hen Tim Tang

Lim Chin Teong

Shee-Leong Tham

Nay Chi Tun

Andre Arianto Umbul

Marcus Wan

Rafik Waters

Chris Williams

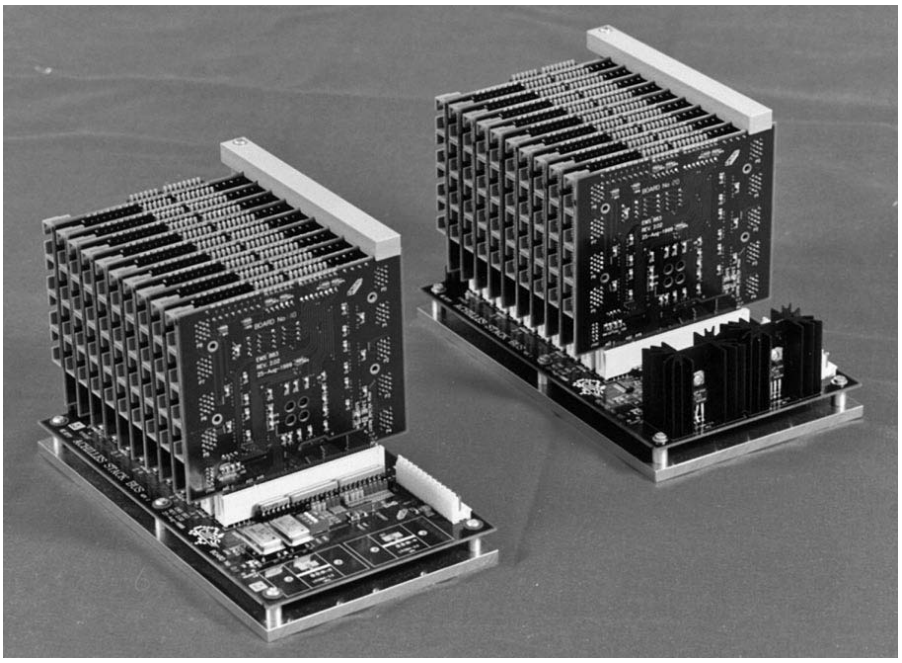
Edward Wistorohardjo

GROUP PHOTO

5th row, left to right:	Annika Kuhl, Martin Masek, Frederick Chee, Minh Nguyen, Christian Schmitz
4th row, left to right:	Louis Gonzalez, Elliott Ross, Serajul Haque, Weiqun Zheng, Daniel Lim
3th row, left to right:	Simon Kwok, Daniel Elkington, Aik Ming Toh, Neil Fenney, Steven Nguyen, Sahan Elangasinghe
2nd row, left to right:	Nick Pelley, Oscar Chan, Julian Goh, Winston Cheng, Marcus Wan, Phil Greenhalgh
Front row, left to right:	Roberto Togneri, Chin Teung, Edward Wistorohardjo, Neil Andrews, Thomas Bräunl, Sandra Snook, Evan Broadway

RESEARCH ACTIVITIES

1. Hardware Design Lab (Associate Professor J. Morris)



The Hardware Design Lab works on hardware and software of concurrent systems, reconfigurable hardware, and fast interconnect networks.

In collaboration with groups in Seoul, Auckland, Harbin and Computer Science, designs have produced for implementation of real-time stereo vision systems in programmable hardware. This work has been extended to examine optical configurations which mimic those discovered by evolution millions of years ago! These configurations provide better accuracy in depth measurement - a critical factor for several real-time applications such as collision avoidance.

Comparison of Cilk and MPI as support systems for parallel programming on Networks of Workstations has led to several simple strategies (implementable in both systems) which lead to improved performance.

2. Information and Software Engineering Research Group (Associate Professor G.A. Bundell, Mr T. Woodings)

The aim of the Group is to engage in research into the engineering of large-scale information and software systems. This means the development of tools and methodologies to aid the design of these systems; performance analysis, measurement and benchmarking of these systems; and evaluation of the organizational and environmental context in which these systems need to operate. As such, it is very much a multi-disciplinary endeavour that requires an understanding of the underlying information and communications technology, robust engineering design principles and practices, and extensive knowledge of current and potential applications.

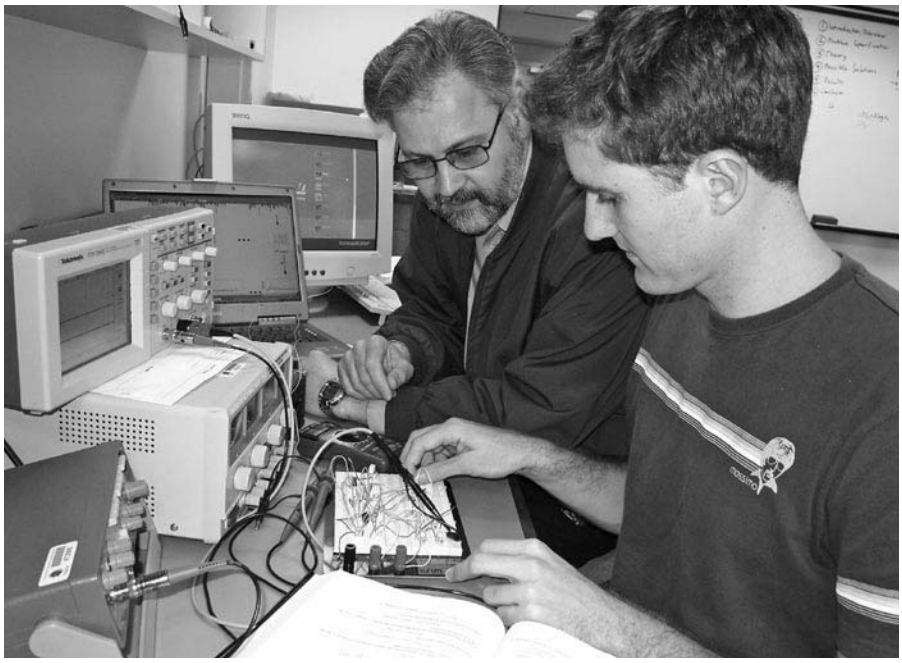
Distributed information and software and engineering projects in the area of benchmarking distributed object infrastructures was further extended in the last year with updated technology comparison projects on CORBA, Jini and .NET technologies over a range of platforms and client/server configurations.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

An ongoing area of development 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. An industry sponsored project into a low-cost inertial navigation system for mining applications was also initiated.

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 progressed. An active 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)



The lab's activities are related to the philosophy, theory and applications of intelligent signal processing; including learning theory; self-learning systems; artificial neural networks; adaptive systems; time-frequency filters and signal analysis; time delay spectrometry; adaptive space-time frequency signal processing; audio and Hi-Fi, and underwater acoustic communications systems.

The main projects over 2004 were torpedo spoofing and submarine inertial navigation guidance systems for Raytheon Australia.

This work involved developing a unique torpedo sound model for the realistic emulation of torpedo manoeuvres in the underwater environment. The navigation system identified submarine absolute underwater positions by one way acoustic communications from surface buoys fitted with GPS. There was also another continuation of the Aluminium Hydrate Characterisation system contract for Alcoa of Australia.

A new design concept for an underwater acoustic communication system based on a swept carrier and Time Delay Spectrometry (TDS) has been conceived.

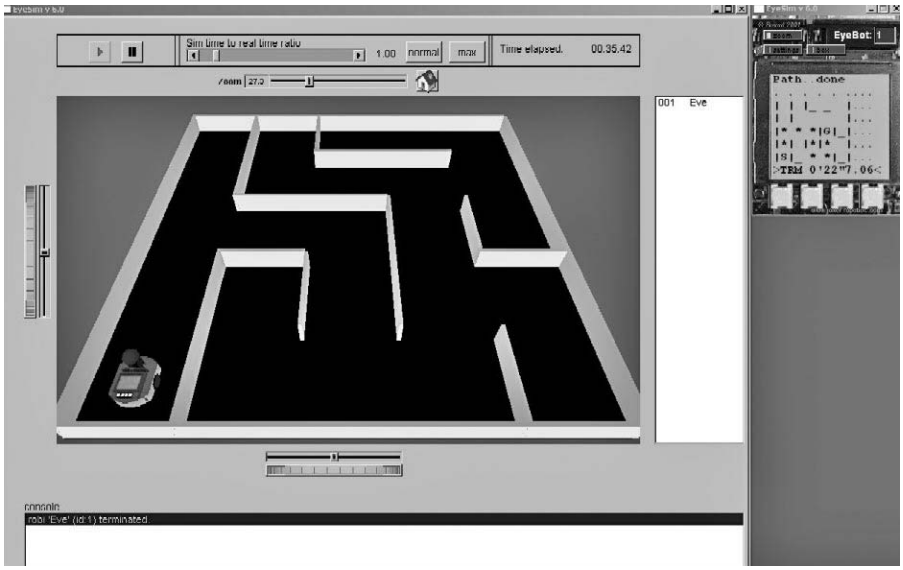
4. Mobile Robot Lab (Associate Professor T. Bräunl)

The Mobile Robot Lab has been established in 1998 and is dedicated to the research on intelligent autonomous mobile systems. Using embedded systems, over 30 mobile robots have been designed in the lab, while the development of simulation systems also plays a major role in the lab's research efforts. Details can be found at: http://robotics.ee.uwa.edu.au

2004 saw the construction of an Autonomous Underwater Vehicle (AUV) from scratch. A group of three students worked on this large project, later joined by a fourth mid-year student. "Project Mako" is a major achievement, given the limited funds available and the extremely short timeframe of less than one year from concept to realisation. The autonomous submarine has been tested in Claremont public pool and attracted a number of visitors during UWA Expo and the Perth CommIT fair. The AUV has been designed to meet the guidelines for the North American AUVSI competition, however, we are currently preparing a similar AUV event for the Australasian region for December 2005. A number of competition tasks are being developed at the moment.

Mako comprises four independent boating motors, a velocimeter, four echo sounders, leak sensors, digital compass and digital camera. Mako is controlled by an "EyeBot" embedded controller plus an independent mini-PC running Linux and operating as an intelligent vision subsystem.

The second major project that started in 2004 is the development of a submarine simulation system that will be the basis for the simulation AUV competition, planned to be co-hosted with the real AUV competition in Perth in December 2005. Development of the "SubSim" has been sponsored by a research grant from Raytheon. The first version of the system is expected to be operational in early 2005 and will be freely available from our website. We hope that a large number of robotics groups will develop submarine control programs to accomplish the competition tasks and submit their software designs.



The simulation system "EyeSim" has been completely revised, resulting in the release of versions 6.0 and 6.1. EyeSim now also runs under Windows and has a greatly improved user interface and graphics display. Research on error models has allowed us to build improved sensor and actuator models. These result in more realistic robot behavior and can be used to test the robustness of robot application programs in more realistic simulations.

Grants

The Mobile Robot Lab has received Grants, Donations, and Research Contracts from:

- Raytheon Australia
- Xilinx Corporation
- DSPComm Research
- Sherwood Overseas

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

The Signals and Information Processing Lab works in the area of spoken language systems and also in related areas of signals and information processing: speech/music synthesis, software tools for speech, textual data and language processing, audio-visual speech and pattern recognition.

In 2004 a range of final-year projects were undertaken in the area of signal processing, speech recognition, image processing and information processing. Successful first-class honours projects included:

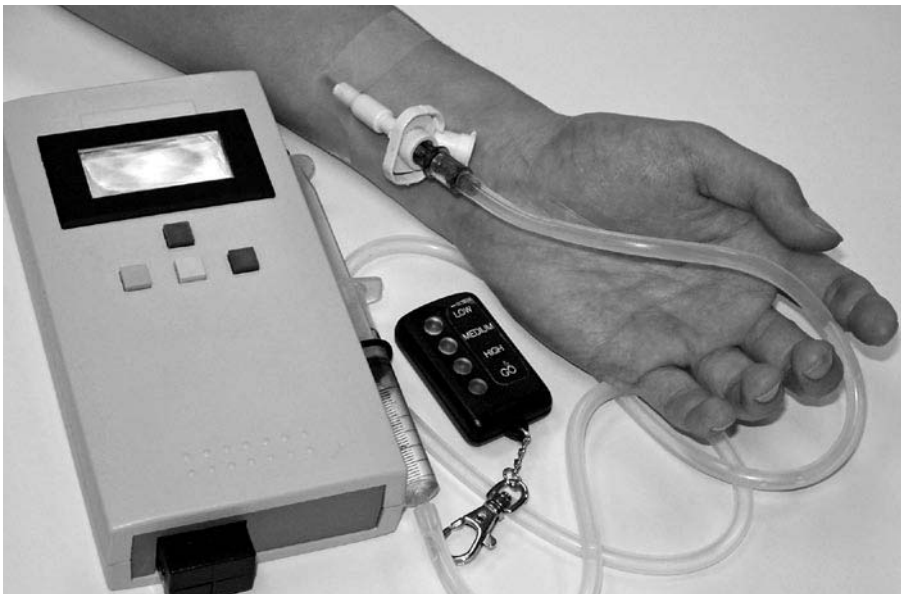
1. Application of Blind Source Signal (BSS) separation to both needle and surface EMG biomedical signals.
2. A commercial in confidence project with JRB Engineering Pty Ltd. involving advanced mathematical modelling of a complex electronic system.

Three full-time PhD projects also commenced in 2004. Aik Ming Toh commenced his PhD research in March on "Feature Extraction for Speech Recognition in Hostile Environments" with co-supervision from the Signal Processing Lab at WATRI. Oscar Chan commenced his PhD research in March on "The Use of Prosody for Robust Speech Recognition" which was presented at the local Symposium on Speech and Language Technology on the 15th October 2004. Serajul Haque commenced his studies in September 2004 and intends investigating perceptual-based features for robust speech recognition.

The collaboration between WATRI and the SIP Group at CIIPS continued with the successful publication of a journal paper and ICASSP conference paper. Further collaboration by joint supervision of a PhD candidate from WATRI investigating speech recognition of enhanced speech is expected to continue into 2005. Collaboration between the SIP Group and Professor Li Deng from Microsoft Research, Redmond, USA also resulted in the successful publication of an ICSLP conference paper on the use of the Hidden Dynamic Model for formant tracking. This work is expected to be expanded and published as a journal paper in 2005.

Dr. Xin Xu from Wuhan University, China was a CIIPS Visiting Scholar to the SIP Group between September 2003 and March 2004. Dr. Xu's research involved signal processing for perceptual based speech enhancement.

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.

CIIPS PUBLICATIONS 2004

JOURNAL ARTICLES

1. BRÄUNL, T.

   Institute Presentation - Mobile Robot Lab

   International Journal Of Advanced Robotic Systems, ARS, Vol. 1, No. 4, December 2004, pp. 308-312 (5)

2. KWOK, S.M., CHANDRASEKHAR, R., ATTIKIOUZEL, Y. AND RICKARD, M.T.

   Automatic Pectoral Muscle Segmentation on Mediolateral Oblique View Mammograms

   IEEE Transactions on Medical Imaging, Vol.23, No. 9, pp. 1129-1140.

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

   Design of Reduced-order Functional Observers for Linear Systems with Unknown Inputs

   Asian Journal of Control, Vol. 6, No. 4, pp. 521-527, December 2004

INTERNATIONAL CONFERENCE PAPERS

1. BOEING, A., HANHAM, S. AND BRÄUNL, T.

   Evolving Autonomous Biped Control from Simulation to Reality

   International Conference on Autonomous Robots and Agents, ICARA 2004, Dec. 2004, Palmerston North, New Zealand, pp. 440-445(6).

2. BRÄUNL, T., BOEING, A., GONZALES, L., KOESTLER, A., NGUYEN, M. AND PETITT,

   The Autonomous Underwater Vehicle Initiative - Project Mako

   2004 IEEE Conference on Robotics, Automation, and Mechatronics (IEEE-RAM), Dec. 2004, Singapore, pp. 446-451(6).

3. HANSELMANN, H., NOAKES, L., ZAKNICH, A. AND SAVKIN, A.

   A Hybrid Dynamical System with Robust Switching Control by Action Dependent Heuristic Dynamic Programming

   IEEE International Joint Conference on Neural Networks (IJCNN), Budapest, Hungary, 25-29th July 2004.

4. KOESTLER, A. AND BRÄUNL, T.

   Mobile Robot Simulation with Realistic Error Models

   International Confer-ence on Autonomous Robots and Agents, ICARA 2004, Dec. 2004, Palmerston North, New Zealand, pp. 46-51(6).

5. KWOK, S.M., CHANDRASEKHAR, R. AND ATTIKIOUZEL, Y.

   Automatic Assessment of Mammographic Positioning on the Mediolateral Oblique View

   IEEE International Conference on Image Processing, ICIP2004, 24-27 October 2004, Singapore, pp. 151-154.

6. LOW, S.Y., NORDHOLM, S. AND TOGNERI, R.

   Convolutive Blind Signal Separation With Post-Processing

   IEEE Transactions on Speech and Audio Processing, Vol. 12, No. 5, September 2004, pp. 539-548.

7. LOW, S.Y., TOGNERI, R. AND NORDHOLM, S.

   Spatio-Temporal Processing for Distant Speech Recognition

   Proceedings of ICASSP 2004, May 2004, Vol. 1, pp. 1001-1004.

8. MORRIS, J., AND LECLERCQ, P.

   Stereovision for Collision Avoidance

   Image and Vision Computing Proceedings, 21-23 November 2004, Akaroa, New Zealand, pp. 137-142.

9. TOGNERI, R. AND DENG, L.

Use of Neural Network Mapping and Extended Kalman Filter to Recover Vocal Tract Resonances

Proceedings of ICSLP 2004, October 2004, Oct 4-8, 2004, Jeju Island, Korea, No.WeB1201o.4, pp. 1201-1204.

10. YI J.S., KIM, J.S., LI, L.P., MORRIS, J., LEE, G. AND LECLERCQ, P.

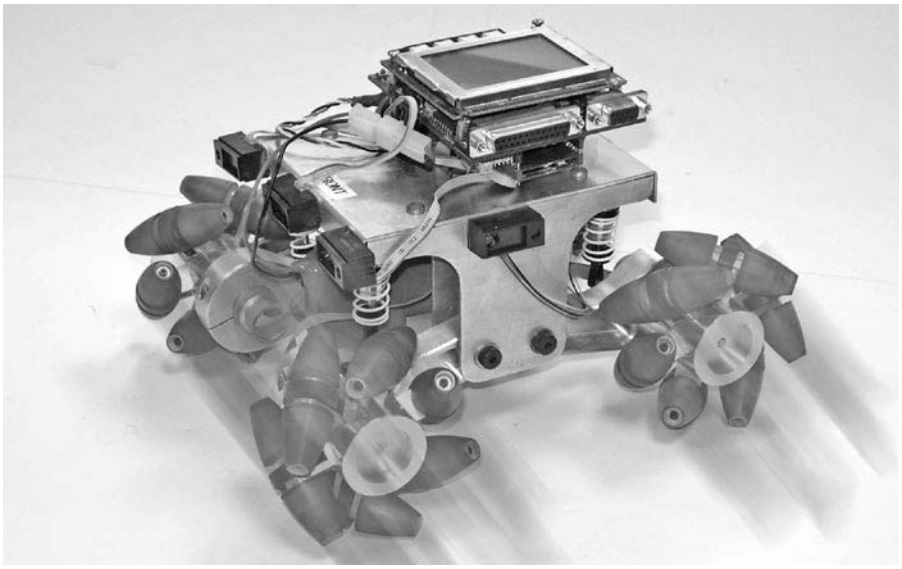
Real-Time Three Dimensional Vision

Advances in Computer Systems Architecture, 9th Asia-Pacific Conference Proceedings, ACSAC2004, 7-9 September, Beijing, China, pp. 309-320.

11. ZAKNICH, A.

A Loudspeaker Response Model using Tuneable Approximate Piecewise Linear Regression

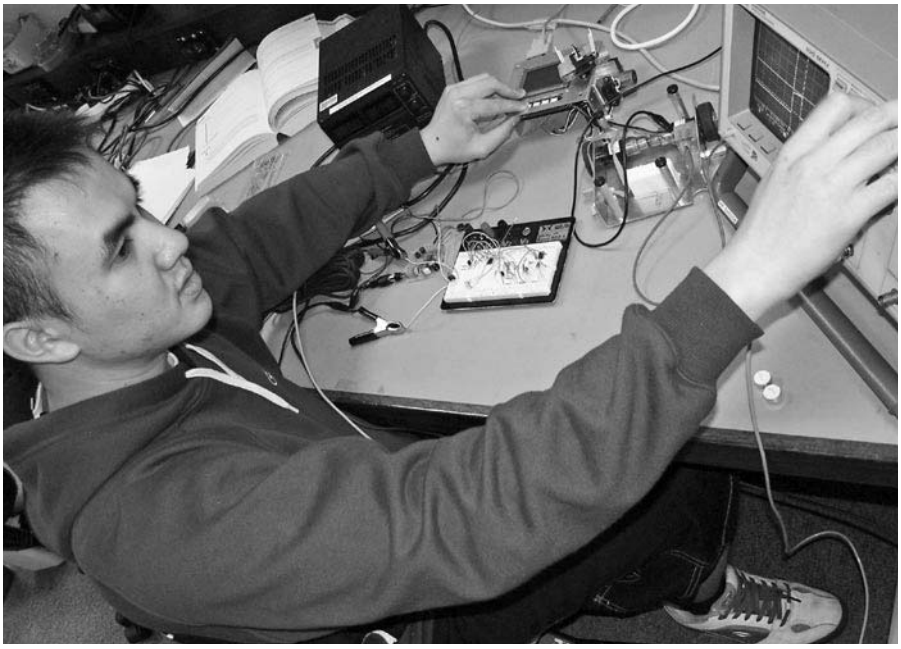
IEEE International Joint Conference on Neural Networks (IJCNN), Budapest, Hungary, 25-29th July 2004.



CONFERENCE PROGRAM COMMITTEES AND CHAIRS

Associate Professor T. Bräunl

- MASCOTS 2004, Volendam, Netherlands, Program Committee and Steering Committee
- Fourth Workshop on Massively Parallel Processing (WMPP), Santa Fe NM, Program Committee
- IEEE Robotics, Automation, and Mechatronics, Singapore, Program Committee, Session Chair
- The 2nd International Conference on Autonomous Robots and Agents (ICARA 2004), Palmerston North, New Zealand, Program Committee, Session Chair



ABSTRACTS OF FINAL YEAR PROJECT REPORTS

NEIL ANDREWS

Motor Control & Actuation of Omni-Directional Vehicles

Omni-directional vehicles (omni-robots) possess three degrees of freedom and are therefore more maneuverable than conventional wheeled vehicles. This is due to the nature of Mecanum wheels, which have free rollers, set at 45° to the axis of the wheel, instead of conventional tread. These rollers allow sliding motions in any direction; however, this sliding limits the accuracy of dead-reckoning as a method of odometry. Autonomous omni-robots have many potential industrial and commercial applications if they can be accurately and reliably controlled. The aim of this work is to implement velocity and position control solely using encoder feedback to create smooth trajectories and reliable odometry for any omni robot.

A software structure was designed to accommodate ramp-input velocity control and parabolic-trajectory position control using PID feedback. Hardware gains, determined experimentally through the average-of-trials method, were incorporated to allow for discrepancies between the actual velocity of the omni-robots and the velocity as given by the encoder feedback readings.

Smooth trajectories were generated for both velocity and position control, but the odometry is not reliably accurate for all motions. This study shows that dead-reckoning alone cannot provide accurate, reliable odometry for omni-robots. However, if used in a sensor fusion system, this control structure can form an integral part of the motor control of omni-robots.

MELISA CIPUTRA

Face Recognition Using Eigenfaces

Face recognition is a rapidly developing area with many possible applications including everything from crowd surveillance to smart buildings. This thesis has investigated the robustness of the eigenfaces and eigeneyes approach for face recognition by using images that incorporate the multiple sources of variation that are likely to affect the recognition system. These variations include head orientation, facial expression, scaling, illumination, time delay between acquisition of images (duplicate), and partial occlusion.

Although the accuracy of experiments conducted was limited to the number and diversity of the testing images, few results have been found regarding the importance of different features. Head orientation of more than 45%, partial

occlusion, and slight scaling substantially depressed recognition accuracy, while recognizing duplicate images was most difficult. The substantial higher performance, after preprocessing images with varied illumination, suggest that the challenge for a robust recognition system lies in normalizing the input images to resemble their training sets counterpart.

The results of reconstruction error also suggest that eigenfaces approach can be used to distinguish non-faces from faces although discriminating non-faces from illuminated or occluded images is still relatively difficult.

Eigeneyes technique was found to be less sensitive than eigenfaces approach when recognizing images that suffer from scaling and partial occlusion. This gives insight to the use the combination of eigenfaces and eigenfeatures for system improvement.

NEIL FINNEY

A Vehicle Positioning System for the Mining Industry

This report details the achievements in developing a platform orientation estimation system for large mining vehicles based on the inertial measurement concept. This is a subsystem of a solution designed to locate the bucket of an excavator to within 10 centimeters. Inertial sensing for civilian applications has recently become viable, as lower cost versions of the transducers used in advanced military applications come onto the market. Unfortunately, the limited performance of these transducers and a lack of detailed modelling data poses a major challenge to their successful implementation. This project reports on the evaluation of the performance attainable by combining low cost sensors with optimum filtering techniques. I will present the design of the electronic systems as well as the software systems, and show how they can be used to measure platform orientation with a predicted uncertainty of 1.8 degrees. This does not meet the required angle uncertainty. However, a scale factor model for the inertial sensors is proposed, which gives a predicted angle uncertainty of 0.28°. This meets the target requirements for an uncertainty of 10 centimeters at the excavator bucket.

TAKASHI FUJITA

Semi-Automatic Tracking of the Diaphragm Contour in Fluoroscopic Image Sequences

Contour tracking of the diaphragm has important clinical implications regarding the noninvasive assessment of diaphragmatic function. One such method of

assessment is the estimation of the volume displaced by diaphragm motion, V di, by analysing fluoroscopic image sequences of the diaphragm. Previously, manual methods were used to carry out V di analysis, including the necessary step to identify diaphragm contours—namely by tracing them onto transparent paper over a TV monitor. More recently, a computerised approach was developed by Shen (2002), in which segmentation was performed on-screen using a mouse, and the subsequent analysis performed entirely by computer. This approach, like the manual method, suffers from the fact that the segmentation process is labour intensive and highly subjective. There is hence the need for a more accurate, objective, labour saving solution to this step. In this thesis, a computerised, semi-automatic approach to diaphragm contour tracking in digitised fluoroscopic sequences is presented. A semi-automatic approach implies one that combines the power of computational methods with the interaction of an expert operator, to achieve fast and accurate contour tracking. A model of the diaphragm contour based on a priori knowledge of its general shape and dynamic behaviour was developed, implemented on computer, then integrated with a specialised, front-end GUI to perform tracking. The developed system was tested on several fluoroscopic sequences, and verification of results by our clinical collaborators have confirmed the validity and feasibility of this approach, and its potential value in a clinical setting.

MARK GILLON

Isolated Speech Recognition of the Japanese Alphabet

Speech recognition is the process of converting an acoustic signal to a set of words. Isolated word recognition is a form of speech recognition where the speaker pauses between the words that are spoken. The major advantage of this type of speech recognition is that there is no confusability about where one word ends and the next word starts. In this project we have implemented an isolated speech recognition system for the Japanese alphabet.

The implementation was carried out using Hidden Markov Models. Voice data was recorded from a number of native Japanese speakers and the author. This data was then used to train the Markov models and to test and evaluate the system. Tests were aimed at identifying sets of confusable characters, the effect of the speaker's physical state, gender and regional dialect on recognition rates.

The speaker dependent system achieved a recognition rate of 83%. Evaluation of this system showed a number of things. Firstly, that there are several confusable characters in the Japanese alphabet which largely effect the recognition

rate. Secondly, it was found that the physical state of the speaker also effects the recognition rate of the system. Finally, it was found that the recognition of words spoken with isolated characters is far more accurate than words spoken without pauses between the characters.

The recognition rate for the speaker independent system was not high enough to be used in a practical system. This is due to the insufficient amount of training data. From the evaluation carried out, results showed that regional dialect of the speaker has a larger effect on recognition rate than the speaker's gender.

Overall, the evaluation of the systems showed that with a sufficient amount of training data, HMMs are a practical way of building an isolated speech recognition system for the Japanese alphabet.

JULIAN PAO-YI GOH

Head-Up Display for use in the Formula SAE Competition

Normally for a driver to access information, they have to look away from the road and onto the dashboard. This is not safe for the driver and in racing conditions, it can disrupt the driver's concentration and reduce his confidence and performance. A head-up display presents an image directly into the user's field of view. This allows a driver to receive vital information while paying full undivided attention to the road.

This project documents the research, design and testing of a head-up display for the UWA Motorsport team. This student-run organisation represents the University of Western Australia in the international automotive racing competition known as Formula SAE. The designed head-up display uses a colour LCD, a micro controller and Bluetooth modules that perform wireless data acquisition. An optical array is used to project the image from the display into the user's field of view. Software is used to interface with the hardware and to generate graphical dashboard representations.

The display presents the vital information in the peripheral vision of the driver. The LCD did not have the brightness necessary to create an image that stands out in the driver's the direct line of vision. Tests demonstrate that a circular bar graph similar to a pie chart is the most effective form of graphical display, especially when it is enhanced by suitable colours. Tests also determine the minimum pixel size required for an object to be detected under different viewing conditions.

It is envisaged that the head-up display may be completed for the 2005 international F-SAE competition. The development and testing of a head-up display brings UWA Motorsport closer to improving the driver's performance and safety.

LOUIS ANDREW GONZALEZ

Design, Modelling and Control of an Autonomous Underwater Vehicle

Autonomous underwater vehicles are currently being utilised for scientific, commercial and military underwater applications. These vehicles require autonomous guidance and control systems in order to perform underwater tasks. Modelling, system identification and control of these vehicles are still major active areas of research and development.

This thesis is concerned with the design and development of an AUV specifically intended for entry into international underwater vehicle competitions. The thesis consists of two phases; the first involves the design and construction of the vehicle while the second phase is concerned with the modelling and system identification of the vehicle, as well as the simulation of a control system.

The design and development of the vehicle consisted of implementing a mechanical and electrical system, as well as the integration of subsystems. The development of these systems has resulted in a low-speed, bottom-heavy, open-frame underwater vehicle named the Mako that exhibits high symmetry, modularity and stability.

The modelling of the Mako was then performed which involved the application of the dynamic model of an underwater vehicle and the consequent identification of the relevant parameters. The system identification of the vehicle parameters consisted of using onboard sensors to perform static and dynamic experiments. Least squares estimation was used to estimate the parameters from the experimental data obtained.

For the control system of the Mako, a PID tracking controller based on computed torque control was adopted. The controller was applied to the vehicle's dynamics and simulated using the parameters found in the system identification process. The results of the simulations demonstrate that this type of controller could indeed be successfully implemented on the vehicle.

The undertakings in this thesis have resulted in a functioning autonomous underwater vehicle that has undergone modelling, system identification and preliminary control analysis. The groundwork has indeed been laid for the Mako's entry into future underwater competitions.

PHIL GREENHALGH

Real-Time CORBA: A Performance Investigation

There are two continuing trends in today's technology environment. The first is towards diversification of electronic devices, and the second is toward functional integration and information sharing between those devices.

Feeding the second of these trends is research by a number of entities into middleware technology. Consequently, there are a number of software architectures and approaches to designing middleware, which provide different features and benefits. It is important to understand the features and performance differences between these diverse approaches to be able to design and implement effective middleware applications.

One such middleware architecture is CORBA, which is a specification that can be applied on a number of platforms and developed with a variety of languages. One feature of CORBA is its real-time specification, with support for deadline preservation and priority management. These features are vital for any application with hard real-time requirements, and it is important to understand how a particular CORBA implementation has interpreted the specifications and what effect this has on performance.

This thesis will focus on The ACE ORB (TAO), an implementation of the real-time CORBA specification by the Distributed Object Computing (DOC) group. An investigation into the design and performance of the ORB will be undertaken with a view to its future integration into a full-scale application. Through various experiments and comparisons with previous research, this thesis will show that although there are some configuration and performance issues, TAO represents an effective implementation of the CORBA standard that should perform well in full scale applications.

PATRICK HO

Telemetry

The University of Western Australia Motorsport team have been designing and competing in Formula SAE vehicles since 2001. In competitive racing, gathering performance data is critical to the tuning and optimisation of the vehicle. Telemetry provides a means of viewing and logging the data from the pits in real time through the use of a wireless connection. With this, vehicle performance can be continually monitored then later analysed and assessed.

Development can be split into the main areas of data transmission and the host software. The resulting final system, which uses Bluetooth modules and custom software, is well suited to the team's requirements and is flexible enough for other applications also.

ELAINE HOPWOOD

Size Estimation with Special Reference to Web-based Applications

Commercial-in-Confidence

JANINE HUSSEY

Dynamic Underwater Positioning; a Simulation using Least Squares Optimisation

Commercial-in-Confidence

CHIEN-EE KHO

Analysis of the Relationship between Value and Effort for Functional Requirements

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DAVID KNEZEVIC

Blind Source Separation for Signal Processing Applications

Blind Source Separation (BSS) is a statistical approach to separating individual signals from an observed mixture of a group of signals. BSS relies on only very weak assumptions on the signals and the mixing process (hence the "blind" descriptor) and this blindness enables the technique to be used in a wide variety of situations. Research in the field of Blind Source Separation has resulted in the development of a family of algorithms, known as Independent Component Analysis (ICA) algorithms, that can reliably and efficiently achieve blind separation of signals.

Within Blind Source Separation research there are two important problems that are generally considered: instantaneous BSS and convolutive BSS. The

difference between these two is based on the nature of the signal mixing process; in essence instantaneous BSS separates signals that are mixed without introducing time delays whereas convolutive BSS can achieve separation when time delays are involved.

In this thesis, the mathematical foundations of both instantaneous and convolutive BSS are developed. Once this mathematical framework has been established, the emphasis of the thesis moves to experimental results obtained with ICA techniques. The two primary applications of BSS addressed in this thesis are to acoustic signal mixtures (both instantaneous and convolutive) and to biomedical signal processing.

Biomedical applications of BSS are of particular importance to this thesis and, in particular, a novel application of BSS to electromyography (EMG) is proposed and examined. Experimental results demonstrate the effectiveness of BSS in achieving signal separation from EMG data which could potentially have important applications in clinical EMG testing.

LINDA KURNIAWAN

Automatic Handwritten Signature Verification

Signatures have always been the most accepted and widely-used means of personal identification, even more so than photographs and thumb prints. To this point there is only one noticeable signature verification tool, namely human observation. This is so far known as the most economical and efficient tool of verification. On the other hand, their reliability cannot be guaranteed. Thus it has become increasingly important to have a reliable means of signature verification system, one that may accurately authenticate the origin of a signature.

There exist a number of system solutions that may have reached an acceptable accuracy, yet none has been able to give an adequate efficiency in terms of cost and time. The system can be carried out using two different approaches: online and offline approach. This project uses the offline approach, which is used for verifying static signature images.

This thesis overviews the different stages that apply to most signature verification system, including a brief description for each stage. Also included are the different methods used in existing solutions, namely Neural Network (NN) and Hidden Markov Models (HMM).

A signature verification system with Neural Network approach was designed and implemented, followed by a number of experimentation on the parameters used for this system. The final solution achieved a 7.5% False Acceptance Rate and 13.33% False Rejection Rate based on the experiments with 130 signatures, consisting of 90 genuine signatures and 40 skilled forged signatures.

YONG-LONG LAI

Software Risk Management through Multi-Valued Logic

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AARON LOW

Recognition of Vowels via Acoustic Phonetic Features

Phoneticians and linguists commonly supplement their qualitative speech experiments with automated recognition systems. Most modern recognition systems use a hyper-dimensional codebook approach, for example mel-frequency cepstral coefficients to parameterise the speech signal. While effective, the results of this method of recognition do not transfer well to traditional phonetic ideas.

Formants are defined as the characteristic overtones of speech and are the major phonetic features used when phoneticians classify vowels on spectrograms. The vowel space is a two dimensional representation of vowels using formants. This idea can be used to create a novel automated recognition system for vowels based on formants.

The use of the vowel space for vowel recognition was evaluated by using three different classification techniques, jointly Gaussian, mixed Gaussian and a probabilistic neural network. Three different data sets served for training and testing these classifiers. Following the implementation further investigations were made into improving the initial classifier.

MINH NGUYEN

Design of an Active Acoustic Sensor System for an Autonomous Underwater Vehicle

Unstructured oceanic environments present great challenges to AUV navigation. However, with continual improvements in sensor technology, new methods of navigating hazardous underwater terrain are far more effective than ever before.

To date, much research has focused on maximising the functionality of AUVs at the expense of cost. In contrast, this thesis aims to develop an active acoustic sensor system that determines the distance an obstacle or landmark is from an AUV, while optimising cost efficiency. Although this has been accomplished successfully on land-based autonomous vehicles, these systems have not been implemented on AUVs. The focus is to design a system that consists of four distance sensors directed to the port, starboard, bow and downward side of the AUV.

The sensor system is custom-made using low cost components comprising the commercially available Navman Depth 2100 transducer and the LM1812 ultrasonic transceiver chip. The processing of sensor data will be accomplished by an Eyebot (Motorola 68332) microcontroller.

Outcomes of the project included the successful design of a prototype sensor for the active acoustic sensor system and successful testing and verification to demonstrate correct sensor functioning, which provides the basis for further research in sensor development for the University's AUV, called the Mako. Final comments include a proposal for a control system for the sensor application of wall-following, as well as recommendations for future improvements and research.

STEVEN NGUYEN

JXTA and Peer-to-peer Development Evaluation

The growth of peer-to-peer computing, most notably through file-sharing and instant messaging, has lead to an increase in development of peer-to-peer applications. JXTA is a set of open source protocols developed for implementing such applications. It is a recent development and is constantly improving with enhanced and new services to aid in creating peer-to-peer networks.

Performance evaluation of JXTA is necessary to better understand the limitations and benefits of using JXTA. This has been achieved using a Round Trip Time implementation of JXTA and analysing the resulting Round Trip times with increasing peers. By comparing the results of JXTA 2.2 with 2.1 we establish the improvements of 2.2 with respect to 2.1. Changing the number of peers on the network will allow a load testing performance evaluation of JXTA.

The manner in which JXTA handles advertisements has important implications for the security of a peer-to-peer network. The effect of stray advertisements and their potential misuse is also examined through an adaptation the Round Trip Time benchmark.

The principle results show the improvement in JXTA 2.2 over 2.1 with the single and dual peer tests. However, degradation in performance of JXTA 2.2 was found under additional loads. Tests of JXTA 2.2 over 2.1 when run between two peers, shows that JXTA 2.2 has a 14.51% improvement in the Round Trip test. However, when tested over five peers JXTA 2.2 has performed 47.1% slower than 2.1.

TOAN NGUYEN

Developing a Customizable Graphical User Interface in MATLAB

Although current image processing graphical user interfaces such as xv, Gimp and ImageMagick offer a working image processing application, it has limitations. IPGUI [1] developed by Neil Bastian in 2001, remedied some of these limitations by providing the simplicity, interactivity, versatility and intuitiveness being sort in applications. However all these applications fail to allow users to customize their own image processing graphical user interfaces. Users are restricted to a set number of functionalities and a standard look and feel.

The main objectives of this thesis were to create the system infrastructure, methodologies and development environment so users can create their own image processing graphical user interfaces. Instead of creating just another image processing GUI, the aim was to create the required infrastructure so users can create their own image processing graphical user interfaces, much like how users can create GUI objects in MATLAB. By taking an open architecture approach and extending the MATLAB Handle Graphics concept user will be able to add Image Processing Objects (IPO) to their GUIs with a

simple command line argument. The system will take care of all the technical programming so every day users with limited programming experiences will be able to create image processing graphical user interfaces with little fuss. Just like how GUIDE allows users to easily create GUIs, Image Processing Object Development Environment (IPODE) was developed to allow users to easily create their own IPOs.

NICHOLAS PELLY

Torpedo Spoofing

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YODI BERNARDI SALIM

Language Identification

Automatic language identification (LID) is the problem of identifying the language being spoken from a sample of speech. LID system is particularly designed to be speaker independent. The system consists of two phases: training phase and recognition phase.

There have been three recent approaches employed in language identification. The first approach is to model an entire language by a single stochastic model. The second approach is to train separate stochastic model for each phoneme. The last approach incorporates stochastic grammar in the model. This project particularly investigates the first approach that employs single model per language.

An extension to the original method was also implemented. This second system employs single model per word. In this system, each digit or word is modeled into one model. Both systems were implemented based on Hidden Markov Model by using HTK Toolkit.

These two systems were tested on digits case and typical telephone banking case, which involved English, Indonesian, and German language.

The result shows that for 'read-speech' test data, the extended approach that uses one model per word performed up to 20% better than the original approach. On the other hand, the original approach performed better for spontaneous speech test data.

DANIEL STEFANELLI

Real-time Digital RF Processing on a Locomotive Communication System

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SUNJAYA

Natural Language Call Routing

Natural Language Call Routing (NLCR) is a routing system that uses human natural language response as the input of the system routing system. With NLCR system caller is allowed to speak spontaneously in their own words in addressing their destination or problem. The system tries to conclude the keywords from the caller's request and route the call accordingly.

NLCR system has advantages compare to the Touch-Tone Interactive Voice Response (TTIVR) that is commonly use. Few methodologies have been implemented for NLCR system such as: Probabilistic Measurement, Multinominal Distribution and Vector-base Routing. This project focus in the development of the Vector-base routing scheme, which also include some additional idea from the other schemes.

There are some limitation and assumption that the system has to employ, as the project only uses the Corpus sample database that available for this project development. This project will develop the suitable database for the system base on the Corpus sample database given. The best database in this project has delivered the best result to fulfill the project objectives.

JUSTIN TAN

Automatic Quantification of Mammographic Parenchymal Density

Mammogram screening is a form of breast cancer detection prevention that is generally targeted at women with family histories relating to breast cancer or are above the age of 40. Medical research has linked women with high mammographic breast density to having higher risk of developing breast cancer later in life than women who do not have mammographically dense breasts. In recent times there has been a bid to aid physicians and radiologists in quantifying mammographic breast density by use of computer imaging techniques.

One of the problems with humans reading mammograms, is that there is inconsistency between and within readers due to the reading methods being subjective and qualitative. There are inter-personal variations in readings when different radiologists read mammograms because different radiologists have different opinions and look for different features. There is also the problem of intra-personal variances in readings when the same radiologist reads the same mammogram. This can be due to factors such as tiredness or lack of concentration. This is why there is a place for an automatic method of quantifying mammographic breast density. An automatic method that is quantitative and objective will yield repeatable results no matter who the user is.

The author proposes an automatic method to quantify mammographic breast density in this thesis using single level thresholding and a variation of the watershed transform to achieve automatic threshold selection.

The author achieves his goal of providing an automatic method for quantifying mammographic breast density in mammograms that is objective and quantitative, however, it is difficult for the author to measure the accuracy of his method due to a lack of radiographic knowledge or resources to obtain a detailed benchmark to compare accuracy of results.

SHUEN-HEN TIM TANG

A Speech Recognition system: Application to a Car Environment

Speech recognition is the comprehension of meaning from speech by machines. Speech has the potential to provide limitless interface to computers and machines if implemented. Its potential in control applications is especially exploitable. As it is a very natural form of communication, it can offer means of control unlike that of the hands.

Many forms of speech recognition have been implemented. These rely on a number of underlying phenomenon associated with speech, most with limited success. The most powerful modelling technique is Hidden Markov Models. These statistical models have proven the most success in speech recognition systems. It is their ability to utilise solid theories and algorithms that make them so robust in modelling speech. An algorithm for providing maximum likelihood estimates of model parameters is discussed in this paper, along with algorithms for recognising unknown speech inputs given an established model.

The Hidden Markov Toolkit offers the functionality of HMMs in that the algorithms utlised by HMMs are implemented as a software toolkit. With this

modelling tool, a number of experiments in creating a speech recognition system are explored. These outline the feasibility of improving a speech recognition system with techniques such as training data increase, silence modelling, and Gaussian mixtures.

LIM CHIN TEONG

Robot Soccer Using Local

Robot soccer is an exciting channel of research in the field of artificial intelligence and robotics. The complex problems that it poses are also present in many real life applications hence the growing interest. Organized international competition has helped to improve the quality and popularity of the work done for robot soccer.

In this project a robot soccer program based on local vision was developed for a single robot. Algorithms for vision and image processing were designed and implemented with the aim of helping to improve the performance of the University of Western Australia's CIIPS Glory soccer robots. Work was also done on the driving of the robot so that the soccer program would be more complete. With a more complete program, the performance of robot's local vision system could be tested and observed more realistically and thus more improvements can be made.

Although there were some areas of the robot soccer not fulfilled such as team work and good ball control, testing and simulations showed that the final program was able to perform all the basic and most important tasks of robot soccer such as finding the ball, going to the ball, and attacking as well as defending goals. The robot was also able to move around intelligently while performing those tasks and it also avoided collisions and did not get stalled.

NAY CHI TUN

Environmental Robustness For Speech Recognition

Performance of Automatic Speech Recognition (ASR) systems have reached a high level given that these systems are trained and tested in a controlled environment, however their performance degrade in adverse situations such as in the presence of background noise. Therefore, speech recognition in noisy environments remains a problem even for isolated word recognition with small vocabularies. In this project, we investigated and implemented algorithms which provide an environmental robustness to additive noise for a simple speaker-independent isolated-word recognition system.

Two algorithms that allow for noise in the recognition process are implemented in this project. They are Model Adaptation Method and Parallel Model Combination (PMC) Method. A statistical modelling method called Hidden Markov Model (HMM) modelling is used to represent speech and noise signals used in this project. A simple speaker-independent isolated-word recognition system is implemented using HTK (Toolkit for building HMMs). Then model adaptation and PMC algorithms are implemented and evaluated using HTK, MATLAB, C, and shell scripting. The use of environmental adaptation algorithms is proven to improve word recognition rate of ASR in noisy environments. In particular, model adaptation method performs better than PMC method for the testings in this project.

ANDRE ARIANTO UMBUL

ASE-3000 Control System: Design of "Backward Compatible" Electronics and Software

In producing oil and gas, Subsea Electronic Modules are used to measure, monitor and operate equipment located on the seabed. Starting late 2003, ASE-3000, the SEM currently used by Woodside for the Cossack / Wanaea field can no longer be supported by the suppliers as they are unable to source suitable components which are no longer being manufactured. The proposed replacements SEM, the iCon SEM uses different communication modulation and demodulation schemes for its data transmission. Therefore, as it is, the system requires the use of separate umbilical (the communication lines) for each system. To save cost of installing separate umbilical for the different communication protocols from ASE-3000 and iCon, Woodside is considering utilising Frequency Division Multiplexing that would allow the new iCon SEM and the old ASE-3000 SEM to run simultaneously on the same existing umbilical. After investigation of the system and various simulations in MATLAB and SIMULINK, it is shown that a reliable data transmission can be achieved when multiplexing the two different communication protocols on the same pair of wires. Economic benefit analysis shows that there is a significant costs saving in the multiplexed system over the non-multiplexed system.

MARCUS WAN TECK SUN

Visual Servoing

Visual Servoing plays an increasingly popular role in modern technology due to civilisation's growing interest in automation. Additionally, the steady growth in computer performance and price decline in electronics has sparked off much

research into the topic. The topic is presented in this thesis as a vehicle navigation problem where the main objective is to guide a miniature vehicle from a start point to an end point whilst avoiding collision with all existing obstacles, using only global vision as a sensor. The problem can be broken down into two major parts – obstacle detection and vehicle guidance. A study is conducted in the fields of Image Processing and Path Finding. To be precise, an investigation is carried out among image processing methods mainly in the areas of Noise Filtering, Edge Detection and Morphological Procedures. With regard to Path Finding, a set of vehicle mobilisation behaviour is defined and tests have also been carried out on existing path planning methods with slight variations to improve system performance as well as to keep in line with research objectives. Under appropriate configurations dependent on workspace conditions, results show a remarkable performance with the Eyebot while the erratic movements of the utilised radio-controlled car greatly hinder the accuracy of the visual servo system. All in all, results strongly indicate that for a visual servo system to be successful, it has to accomplish three things well – translate video images into useful information, generate efficient response actions and have complete control over the mobile unit.

CHRIS WILLIAMS

Physical Modelling of the Cello

Physical Modelling is the use of equations governing the sound production of an instrument to synthesize sound such that the musician has direct control over intuitive playing parameters. Increases in computational power have led to the physical modelling approach becoming more pervasive, at times replacing the well entrenched sampling synthesis methods.

In this dissertation, the physical modelling approach will be applied to the synthesis of the cello, using the efficient digital waveguide algorithm. Several methods for modelling the bow will be investigated, along with techniques for incorporating body resonances into the model.

Techniques for calibrating the model to a real instrument are discussed, including least squares design of loop filter coefficients from instrument measurements, and the design of warped finite impulse response (WFIR) filters from the measured impulse response of the instrument body.

Finally, the success of the model will be evaluated by surveying listeners, as well as determining the playability of the cello model over a range of bowing parameters.

EDWARD WISTOROHARDJO

User Interface and Sensing Systems for Autonomous Wheelchair

With the increase in the number of disabled people, many autonomous wheelchairs have been developed in recent years. All these wheelchairs serve as an aid to mobility for disabled people who find it difficult or impossible to drive a conventional wheelchair. In order to achieve this, various techniques and technologies have been used.

This year the School of Electrical, Electronic and Computer Engineering of the University of Western Australia has been working on an autonomous wheelchair that employs omni-directional driving concepts. This wheelchair uses Mecanum wheels that allow three degree-of-freedom movements which imply that any combinations of forward, sideways, and rotational movement are possible. In addition, the wheelchair is equipped with an on-board controller and several sensors for navigation and path planning purposes.

This thesis focuses on the user interface and sensing systems of the wheelchair. The user interface has three variations. The first variation is a simple 'menu-driven' interface which contains several driving routines that the wheelchair can perform. The second one allows the users to operate the wheelchair from distant via a remote control. The last variation is a Graphical User Interface which allows the users to control the movements of the wheelchair from a PC or laptop via a wireless or Bluetooth connection.

The sensing systems consist of shaft encoders which are used for position control and localization (finding the position of a vehicle at any time), and PSD sensors which are used in the navigation system for determining object distances.

The integration of the user interface and sensing systems will enable the wheelchair to navigate from one location to another with minimum control from the users.