ANNUAL REPORT 2006

School of Electrical, Electronic and Computer Engineering

THE UNIVERSITY OF WESTERN AUSTRALIA

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WESTERN AUSTRALIA

CONTENTS

DIRECTOR'S REPORT 2006

The year 2006 was another busy year for CIIPS with many and varied projects carried out as part of the Centre's active research programme.

The Centre also hosted a diverse group of international visitors and scholars in 2006 from Germany, Japan and Korea. The year 2006 also saw some changes and new faces at CIIPS and we welcome our new administrative secretary Ms Linda Barbour and congratulate Dr Terry Woodings on his successful PhD and appointment as an adjunct Associate Professor.

The Centre has also maintained its success at attracting a large cohort of final-year project students involved with projects covering a range of discipline areas in intelligent control, information systems and signal processing. This has been complemented by students from the MEICT and DEICT programme undertaking their dissertation component with CIIPS which is expected to strengthen over the coming years. In 2006 the Centre was also successful in securing a significant industry grant ($130,000) through the ISER Group.

Once again 2006 was an uncertain year in terms of undergraduate student numbers entering the discipline. The BE(IT) programme, which has been under annual review in response to decreasing enrolments, was renamed the BE(CE) programme to better reflect its emphasis. Due to efforts of the School's marketing current indications are for a turnaround in numbers across all the programmes offered by the School. Even so, there is expected still to be a drop in the number of final-year project students in 2008 which may affect the Centre.

Other challenges to be faced by the Centre over the coming year are consequences arising from the 2006 School review and the renewal of the Centre which is due at the end of 2007. Given the research strength and diversity enjoyed by the Centre it should be well placed to meet the coming challenges and adapt accordingly and ensure that CIIPS continues to play an important role in the IT education of all engineers at UWA and remains a significant partner for research in academia and industry.

Roberto Togneri

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.

Equipment

The Centre is well equipped for the research that it undertakes. It has a network of running Linux and Windows workstations. 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 FPGAs. The Centre also provides about 30 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 FPGAs and simulation systems for various areas ranging from embedded systems to mobile robot simulation.

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.

Contact Details

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MEMBERS OF THE CENTRE

Academic Staff at the
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, MIET, CEng

Dr Ramachandran Chandrasekhar,
BE, MAppSc, PhD, MIEEE

Dr Tyrone Fernando,
BE(Hons), PhD

Associate Professor John Morris,
BSc(Hons), PhD

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

Associate Professor Terry Woodings,
BSc, DipComp, PhD, FACS, FQSA

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

Academic Staff at the School of Mathematics and Statistics

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

Administrative Staff

Ms Linda Barbour

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Robotics; Image Processing; Concurrent Systems; Embedded Systems
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Bundell, Gary
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Woodings, Terry
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Zaknich, Anthony
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Visitors

Mr Tobias Bielohlawek
University of Kaiserslautern, Germany

Mr Michael Drtil
FH Koblenz, Germany

Mr Jan Haas
University of Kaiserslautern, Germany

Prof. Hiroyuki Harada
Hokkaido University, Japan

Dr Heiko Kalte
University Paderborn, Germany

A/Prof Jae Ha Yoo
Hankyong National University, Korea

POSTGRADUATE STUDENTS

Doctor of Philosophy

Ms Saufiah Abdul Rahim
Multi-Robot Scenarios (T.Bräunl)

Mr Adrian Boeing
Genetic Algorithms (T.Bräunl)

Mr Oscar Chan
Prosody for Language Modelling (R.Togneri)

Mr Chang Su Lee
A Framework for Adaptive Fuzzy Systems (T.Bräunl/A.Zaknich)

Mr Dariush Farrokhi
Speech Enhancement of Non-Stationary Noises (R.Togneri/A.Zaknich)

Mr Serajul Haque
Perceptual Features for Speech Recognition (R.Togneri/A.Zaknich)

Mr Yves Hwang
Automatic design synthesis framework in practice: an examination and evaluation (G.Bundell)

Mr Peyman Kouchakpour
Genetic Programming (A.Zaknich/T.Bräunl)

Mr Marco Kühne
Integration of Microphone Array Processing and Robust Speech Recognition (R.Togneri)

Mr Navid Nikraz
Functional Observers (T. Fernando)

Mr James Ng
Path Planning (T.Bräunl)

Mr Aik Ming Toh
Speech Recognition in Hostile Environments (R.Togneri)

Mr Azman Muhamed Yusof
Vision Tracking (T.Bräunl)

Mr Weiqun Zheng
Model-Based Software Component Testing (G.Bundell)

Master of Engineering

Mr Kamran Ahmed
Implementation of Secure Digital Rights Management System (G.Bundell)

Mr Stewart Johnson
'Risk management: The Selection of Appropriate Strategies for Software Projects' (T.Woodings)

Miss Mahsa Mooranian
My Crystal Diary (G.Bundell)

Perumalsamy Gurusamy
Liquid Level Control (T.Fernando)

Doctor of Engineering in Information and Communications Technology (DEICT)

Ms Sujatha Bulandra
Communicating Assumptions during the Requirements Engineering Process in Multi-site Organizations (T.Woodings)

PhDs completed

Alistair Sutherland
A torso driven walking algorithm for dynamically balanced variable speed biped robots (T.Bräunl)

Terry Woodings
Variation in Project Parameters as a Measure of Improvement in Software Process Control (G.Bundell)

UNDERGRADUATE STUDENTS

Rizal Shahiman ABDUL RAZAK	Mei Yee LEONG
Bernard BLACKHAM	Peng LIU
Dmytro BUGAYEV	Kasun LIYANAARACHCHI
Aaron CHA	Ling MIAO
David CHEN	Christophe NIELSEN
Chee Ken CHIA	Jason PANG
Lixin CHIN	Mark Yiannis PAZOLLI
Tse Hung CHO	Sena PRATAMA
Grace CHOO	Daniel PULLELLA
Christophe CHUNG	Mark RANKILOR
Neal CURRIGAN	Zhi Wen TAY
David ENGLISH	Tom WALKER
Aditya ISHAK	David WELLS
Brenton JACK	Wing Fong WONG
Matthew JOHNSTON	Benjamin WOODS
Idris LAZUARDI	

Some of the staff, students and visitors of CIIPS 2006.

GROUP PHOTO

4th row, left to right: Bernard Blackham, Lixin Chin, Aditya Ishak, Tom Walker, Chris Bobridge, Marco Kühne, Aik Ming Toh

3th row, left to right: Jae Ha Yoo, Linda Barbour, Roberto Togneri, Yves Hwang, Mahsa Mooranian, Oscar Chan, Serajul Haque

2nd row, left to right: Weiqun Zheng, Jason Peng, Christophe Chung, Mark Rankilor, David English, Grace Choo, Ling Miao

Front row, left to right: Dmytro Bugayev, Jonathan Chee Ken Chia, Justin Chak, Idris Lazuardi, Mark Pazolli, Daniel Pullella

RESEARCH ACTIVITIES

1. Biomedical Engineering and Medical Image Processing
(Dr R. Chandrasekhar)

R Chandrasekhar co-authored four chapters on mammographic image analysis in the monograph "Recent Advances in Breast Imaging, Mammography, and Computer-Aided Diagnosis of Breast Cancer" (Jasjit S Suri and Rangaraj M Rangayyan, editors, SPIE Press, 2006).

In July 2006, R Chandrasekhar presented a paper entitled "Speculations on the Mind of Nikola Tesla" at a one-day conference "Nikola Tesla: The Man who Lit the World" dedicated to the life and work of Nikola Tesla, organized by the Tesla Forum of WA, and held on 7 July 2006 at the Perth Convention Centre, timed to coincide with the sesquicentennial of Tesla's birth.

2. Hardware Design Lab (Associate Professor J. Morris)
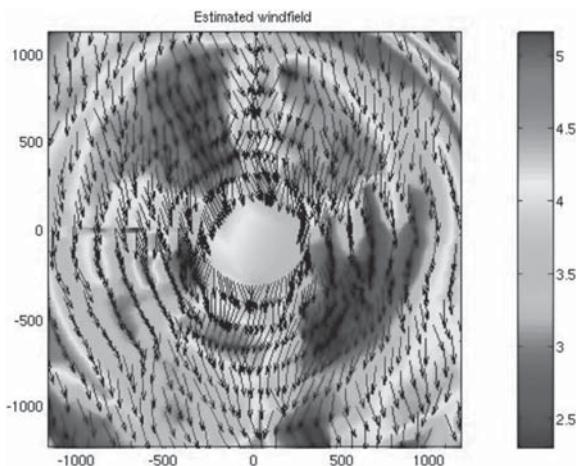
Analysis of Wind Fields for Environmental Protection.

Doppler LIDAR systems can be used to measure wind fields over an area of several square kilometres and thus provide valuable input for monitoring and predicting pollution dispersion, bushfire progression and meteorological studies. A new algorithm for extracting information from inherently ambiguous LIDAR scans was developed and tested. The group will be working on improved methods for processing LIDAR data obtained from scans collected in various parts of Western Australia.

3. Information and Software Engineering Research Group

(Associate Professor G.A. Bundell and Associate Professor Terry 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 with updated technology comparison projects on CORBA, Jini and .NET technologies over a range of platforms and client/server configurations. A specific focus has been in real-time CORBA, and future work will encompass OMG's real-time data distribution service.

Another 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 high integrity embedded systems for an automatic train control application was also initiated this year.

Postgraduate research in automated software generation from UML specifications was further developed and work linking component design information to earlier work on software component testing was progressed. A new postgraduate project on software architectures for Digital Rights Management was initiated.

Another thread of research, undertaken in the software engineering area, is concerned with software project and process metrics. This includes studies on the requirements engineering of systems with the allocation of priorities, when there are insufficient resources, based on the measurement of value and effort. Project risk is being studied with reference to assumptions made in the requirements definition process. Work is continuing on techniques for systematic process improvement based on a reduction in variation in the estimation of relevant project parameters.

4. 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.

In 2006 the development of DSP theory along with related hardware, software and algorithms for loudspeaker frequency response testing and equalisation has continued. Other projects, by PhD students, related to speech processing, fuzzy logic and genetic programming are also in progress.

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

The Mobile Robot Lab was 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

Associate Professor Bräunl spent his Sabbatical Leave during Semester 2 of 2006 at the Technical University München (TUM), Germany, cooperating on robotics projects, especially vision-based driver assistance systems for automotive applications. One of these projects involves a collision avoidance system solely based on monocular image processing without the need for additional sensors such as radar systems.

The major new robot development in the lab during 2006 was the re-construction of the omni-directional wheelchair robot, which was redesigned from scratch by mechatronics students Ben Woods and Mei Leong. The wheelchair was given a new frame and suspension system to give each individual wheel optimum traction. A chair and joystick control were integrated, as well as new electronic motor drivers and batteries. On the software side, the new driver assistance system implements significantly simplified driving modes for severely handicapped people, such as automatic wall following and automatic passing through narrow passageways such as door frames or lifts. The wheelchair has been designed using the Mecanum principle: a number of free rolling barrels along the surface of each wheel allow the vehicle to drive in any direction forward/backwards/sideways) and turn on the spot, very similar to a hovercraft.

The autonomous underwater project was continued during 2006 with improvements being made on both the large Mako and the smaller USAL

autonomous submarines. A processor board for sonar multiplexing has been completed for the Mako, while USAL uses infrared sensors. A new version of the SubSim simulation system incorporating a new physics engine has been completed and made available for download from the Lab's ftp server at the end of 2006.

Two new Pioneer AT robots for conducting outdoor experiments have been purchased by the School and set up by the Lab for the undergraduate unit "Robotics and Automation". The Pioneer robots have been equipped with digital cameras on pan & tilt units as well as simple GPS receivers and wheel encoders. The goal for using these robots for teaching is to make students aware of the problems associated with real machinery, to be able to work in a group effectively, and to gain new knowledge from studying new technology.

In 2006 the Mobile Robot Lab hosted the following visitors:

Prof. Hiroyuki HARADA, Hokkaido University, Japan

Dr. Heiko KALTE, University Paderborn, Germany

Michael DRTIL, FH Koblenz, Germany

Tobias BIELOHLAWEK, University Kaiserslautern, Germany

Jan HAAS, University Kaiserslautern, Germany

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

Research Activities

In 2006 various final-year projects were undertaken in the area of signal processing, speech recognition, and information processing. First-class honours projects of special note include:

1. Demonstrating that keyword spotting is a viable alternative to continuous word recognition and understanding in interactive voice response systems

2. Some interesting and novel methods for speech enhancement using wavelet denoising

3. The use of higher-order cepstral features for robust speaker recognition in additive noise conditions

The Masters project commenced in 2005 by candidate Marco Kühne on "Wavelet Features for Phoneme Recognition" was concluded with a paper presented at INTERSPEECH 2006. From July 2006 Marco upgraded to PhD studies and commenced work on new research in "Integration of Microphone Array Processing and Robust Speech Recognition" which has already resulted in a submission of a conference paper for ICASSP 2007.

Successful conference publications arising from PhD research included two papers for INTERSPEECH 2006, three papers for SST 2006 and one paper for EUSIPCP2006. Research which was submitted for review in 2004/2005 also resulted in this work being published as two journal article publications.

In 2006 the NICTA sponsored LaMP (Last Meter Problem) project with WATRI was in its second year with Roberto Togneri being responsible for leading the Automatic Speech Recognition (ASR) sub-group. Collaboration with WATRI continued through the LaMP project and joint supervision of post-graduate students.

Visitors

Dr. Jae Ha Yoo commenced his visit with the SIP Group in February 2006. His main area of interest is in Echo Cancellation and Dr Yoo gave an EECE School Seminar presentation "Lattice adaptive filter - problems and reasons, and its practical modification for the network echo canceller" on July 11, 2006 on his work.

7. Systems and Biomedical Engineering Lab (Dr T. Fernando)
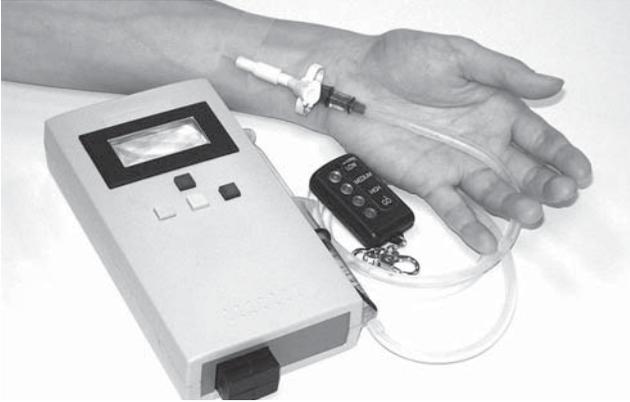
The Systems and Biomedical Engineering Lab works on a number of projects on electronic medical systems and general signal processing systems.

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

Functional Observers

The design of minimum order linear functional observers has been an open problem for the past four decades. One of the key research contributions in this group has been in presenting a solution to this long outstanding problem.

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.

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

A majority of 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.

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.

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 2006

Book

1. BRÄUNL, T.

   Embedded Robotics - Mobile Robot Design and Applications with Embedded Systems,

   Second Edition, Springer-Verlag, Heidelberg Berlin, 2006, pp. (XIV, 458)

Book Chapters

1. KWOK, S.M., CHANDRASEKHAR, R., ATTIKIOUZEL, Y., RICKARD, M.T.

   Automatic Pectoral Muscle Segmentation on Mediolateral Oblique View Mammograms

   In: Jasjit S. Suri, Rangaraj M. Rangayyan (Ed.), Recent Advances in Breast Imaging, Mammography and Computer-Aided Diagnosis of Breast Cancer, Washington, SPIE, pp.613-638, 2006

2. CHANDRASEKHAR, R., ATTIKIOUZEL, Y.

   A Simple Method for Automatically Locating the Nipple on Mammograms

   In: Jasjit S. Suri, Rangaraj M. Rangayyan (Ed.), Recent Advances in Breast Imaging, Mammography and Computer-Aided Diagnosis of Breast Cancer, Washington, SPIE, pp.701-722, 2006

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

   Automatic Assessment of Mammogram Adequacy and Quality

   In: Jasjit S. Suri, Rangaraj M. Rangayyan (Ed.), Recent Advances in Breast Imaging, Mammography and Computer-Aided Diagnosis of Breast Cancer, Washington, SPIE, pp.833-846, 2006

4. SURI, J.S., CHANDRASEKHAR, R., et al

   The Current Status and Likely Future of Breast Imaging CAD

   In: Jasjit S. Suri, Rangaraj M. Rangayyan (Ed.), Recent Advances in Breast Imaging, Mammography and Computer-Aided Diagnosis of Breast Cancer, Washington, SPIE, pp.901-961, 2006

Journal Articles

1. BRÄUNL, T., BOEING, A., GONZALEZ, L., KOESSLER, A., NGUYEN, M.

   Design, Modelling and Simulation of an Autonomous Underwater Vehicle

   Int. J. Vehicle Autonomous Systems, Vol. 4, Issue 2/3/4, 2006, pp. 106-121.

2. BRÄUNL, T., KOESSLER, A., WAGGERSHAUSER, A.

   Fault-tolerant Robot Programming through Simulation with Realistic Sensor Models

   Int. J. Advanced Robotic Systems, Vol. 3, No. 2, 2006, pp. 99-106.

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

   Partial-State Observers for Nonlinear Systems

   IEEE Trans. On Automatic Control, Vol. 51, No. 11, November 2006, pp. 1808-1812.

4. FERNANDO, T., TRINH, H.

   Design of Linear Function Observers for Time-Delay Systems of the Neutral-Type

   Int. J. Information and Systems Sciences, Vol. 2, No. 3, 2006, pp.398-420.

5. TOGNERI, R., DENG, L.

   A State-Space Model with Neural-Network Prediction for Recovering Vocal Tract Resonances in Fluent Speech from Mel-Cepstral Coefficients

   Speech Communication, Vol. 48, No. 8, August 2006, pp. 971-988.

6. DAVIS, S. NORDHOLM, S., TOGNERI, R.

   Statistical Voice Activity Detection Using Low Variance Spectrum Estimation and an Adaptive Threshold

   IEEE Transactions on Speech and Audio Processing, Vol. 14, No. 2, March 2006, pp. 412-424.

Conference Papers

1. LEE, C.S., BRÄUNL, T., ZAKNICH, A.

   A Rough-Fuzzy Controller for Autonomous Mobile Robot Navigation.

   Proc. IEEE 12'06, September 4-6, 2006, London, U.K.

2. FERNANDO, T., TRINH, H.

   Design of Reduced-Order State/Unknown Input Observers: A Descriptor System Approach

   Proc. 2006 IEEE Int. Conf. on Control Applications, 4-6 October 2006, Munich, Germany, pp. 1759-1762.

3. FERNANDO, T., TRINH, H.

   Design of Reduced-Order Observers for Neutral Time-Delay Systems

   Proc. 2006 IEEE Int. Conf. on Control Applications, 4-6 October 2006, Munich. Germany, pp. 3218-3221.

4. TRINH, H., FERNANDO, T.

   Design of a Common Observer for Two Linear Systems with Unknown Inputs

   Proc. TENCON 2006, 14-17 November 2006, Hong Kong.

5. KÜHNE, M., TOGNERI, R.

   Automatic English Stop Consonants Classification using Wavelet Analysis and Hidden Markov Models

   Proceedings of INTERSPEECH 2006 - ICSLP, September 2006, Pittsburgh, USA, pp 637-640

6. CHAN, O., TOGNERI, R.

   Prosodic Features for a Maximum Entropy Language Model

   Proceedings of INTERSPEECH2006 - ICSLP, September 2006, Pittsburgh, USA, pp 1858-1861

7. DAVIS, A., NORDHOLM, S., LOW, S.-Y., TOGNERI, R.

   A Multi-Decision Sub-band Voice Activity Detector

   Proceedings of EUSIPCO2006, September 2006, Florence, Italy

8. HAQUE, S., TOGNERI, R., ZAKNICH, A.

   Zero-Crossings with Adaptation for Automatic Speech Recognition

   Proceedings of SST2006, December 2006, Auckland, New Zealand.

9. TOGNERI, R., TOH, A.M., NORDHOLM, S.

   Evaluation and Modification of Cepstral Moment Normalization for Speech Recognition in Additive Babble Ensemble

   Proceedings of SST2006, December 2006, Auckland, New Zealand.

10. TOH, A.M., TOGNERI, R. , NORDHOLM, S.

    Combining MLLR Adaptation and Feature Extraction for Robust Speech Recognition in Reverberant Environments

    Proceedings of SST2006, December 2006, Auckland, New Zealand.

CONFERENCE PROGRAM COMMITTEES AND CHAIRS

ASSOCIATE PROFESSOR T. BRÄUNL

- Steering Committee, MASCOTS 2006, 11-14 September 2006, Santa Clara, CA

- Advisory Board, European Conference on Parallel Processing (Euro-Par), 29 August – 1 September, 2006 Dresden

- Program Committee, International Conference on Autonomous Robots and Agents (ICARA), 12-14 December 2006, Palmerston North, NZ

- Program Committee, IEEE Robotics, Automation, and Mechatronics (RAM), 7-9 June 2006, Bangkok

- Program Committee, IASTED International Conference on Robotics and Applications (RA), August 14-16 2006, Honolulu

- Program Committee, 18th International Conference on Pattern Recognition (ICPR), 20-24 August 2006, Hong Kong

- Program Committee, 2006 IEEE Pacific-Rim Symposium on Image and Video Technology (PSIVT), 11-13 December 2006, Hsinchu, Taiwan

- Program Committee, Intl. Symposium on Practical Cognitive Agents and Robots (PCAR 2006), 27-28 November 2006, Perth, Australia

DR T. FERNANDO

- Co-Chairman, session on "Observers" at the IEEE International Conference on Control Applications, Munich, Germany, October 2006.

RESEARCH GRANTS/CONTRACTS

ASSOCIATE PROFESSOR G.A. BUNDELL

Development of a Robust Design and Testing Approach for an Embedded Mission Critical Supervisory Train Controller Algorithm, MRX Technologies, $130,000

ABSTRACTS OF POSTGRADUATE DISSERTATIONS

ALISTAIR JAMES SUTHERLAND

A torso driven walking algorithm for dynamically balanced variable speed biped robots

As a contribution toward the objective of developing useful walking machines, this dissertation considers solutions to some of the problems involved with bipedal robot development. The main area of focus involves control system design and implementation for dynamically balanced walking robots.

A new algorithm "Torso Driven Walking" is presented, which reduces the complexity of the control problem to that of balancing the robot's torso. All other aspects of the system are indirectly controlled by the changing robot state resulting from direct control of the robot's torso. The result is literally a "top-down" approach to control, where the control system actively balances the top-most component of the robot's body, leaving the control of the lower limbs to a passive "state-driven" system designed to ensure the robot always keeps at least one leg between the torso and the ground.

A series of low-cost robots and simulation systems have been constructed as experimental platforms for testing the proposed new control system. The robots have been designed to balance on "point" feet, and so the control system must be able to dynamically maintain balance, while moving at a variable velocity.

The Torso Driven Walking control system achieves a fully dynamic, variable speed walking behaviour that does not rely on maintaining a stable supporting polygon for balance. In addition, the system exhibits a high degree of tolerance for low frequency "bias" or "drift" errors. These measurement errors are commonly encountered when using sensors for detecting torso inclination.

TERRY WOODINGS

Variation in Project Parameters as a Measure of Improvement in Software Process Control

The primary tool for software process control is the project plan, with divergence from the schedule usually being the first indication that there are difficulties. Thus the estimation of the schedule, particularly the effort parameter, is a central element of software engineering management. Regrettably, estimation methods are poorly used within the software industry and accuracy is lacking when compared with other engineering disciplines. There are many reasons for this. However, the need to predict project effort remains, particularly in situations of tendering for contracts.

The broad objective of this research is the improvement of project control by means of better estimation. It focuses on the development of a practical approach by which software engineers may systematically improve their estimation processes in order to obtain a more effective framework for management. To improve project planning, managers need to have an understanding of the theory and practical techniques of estimation together with an appreciation of the sources of error and bias. The error in the prediction of a project parameter is investigated as the result of the variation in two distinct (estimation and actual development) processes. Improvement depends upon the understanding, control and then reduction of that variation.

A strategy for the systematic identification of the sources of greatest variation is developed - so that it may be reduced by appropriate software engineering practices. The key to the success of the approach is the statistical partitioning of the Mean Square Error (of the estimate) in order to identify the weakest area of project control. The concept is proven with a set of student projects, where the estimation error is significantly reduced. The conditions for its transfer to industry are discussed and a systematic reduction in error is demonstrated on five sets of commercial project data.

The thesis concludes with a discussion of the linking of the approach to current estimation methods. It should also have implications for the statistical process control of other projects involving small sample sizes and multiple correlated parameters.

ABSTRACTS OF FINAL YEAR PROJECT DISSERTATIONS

Rizal Shahiman ABDUL RAZAK
Level Control Using Programmable Logic Control (PLC)

The objective of this thesis was to develop and validate various control system models for Basic Process in 38 – 100 which is the representation of the fluid level control system in today's level control industries.

The process system was modelled using the knowledge of balance flow equation involved in the system and from there on the transfer function for the system is derived. Then a series of controller design proposed in the literature review were developed in conjunction with the process transfer function. Simulink is a software package that was used for modelling, simulating and analysing the dynamics of the design control systems.

The designed control systems were then evaluated by a series of performance analysis outlined in the thesis. This evaluation will provide a big picture of the comparisons between the different type of controllers; P-control, PI-control and PID-control designed by Direct Synthesis Method, Ziegler-Nichols Closed Loop Tuning Technique, Dale's Closed Loop Tuning Technique and First Order plus time Delay (FOPDT) Integrating Model. It was discovered that the PI-control designed by Ziegler-Nichols Closed Loop Tuning Technique is considered to be the best controller suitable for BPR38 – 100.

Bernard BLACKHAM
The Development of a Hardware Platform for Real-time Image Processing

In recent years, Field Programmable Gate Arrays (FPGAs) have begun to reach densities that allow large-scale parallel processing to be performed in programmable logic. The application of FPGAs to image processing allows operations to be performed orders of magnitude faster than on CPUs or DSPs. The ability to perform a given operation simultaneously on large sets of data removes the mundane repetitive tasks from CPUs, allowing them to perform more complicated control tasks.

This project investigates the application of FPGAs to an image-processing platform targeted at real-time imaging. A design is developed to optimise the flow of data through the processing units (a CPU and a FPGA), such that image data is not required to traverse the same path multiple times. The design also

allows for configurable pre-processing stages to be performed on the FPGA, freeing the CPU for more complicated control-oriented tasks. One key feature of this platform is the built-in support for two cameras, enabling research into hardware-based stereopsis.

Linux is used as the operating system on the device as it offers a solid, familiar platform for development with a feature-rich toolchain. The developed board is capable of streaming image data at 60 frames per second from two cameras, through a Spartan-3E FPGA for pre-processing, and to a 400~MHz PXA255 for analysis. It offers a host of real-world interfaces including motor drivers, position sensors and ADCs, along with USB and Ethernet connectivity.

The reliability of the design is analysed by ensuring signal integrity within the circuit. The hardware's performance is evaluated and optimised to maximise data throughput from end to end.

Dmytro BUGAYEV
Denoising of Speech Using Wavelets

Wavelet-based signal decomposition has recently been successfully applied to the denoising of corrupted signals with promising results.

The focus of this work was to refine this general approach and specifically tailor it to speech signals. The two most important factors that determine the performance of the denoising algorithm are the underlying mother wavelet function used to decompose the signal and the wavelet coefficient thresholding procedure that is applied in the wavelet domain to eliminate the noise. The focus of the project has been on the continuous wavelet transform. The two most significant outcomes of the work include a new adaptive coefficient thresholding procedure, which changes the threshold for high frequency signal components depending on the value of a scale-weighted coefficient sum function that is used to determine critical speech segments where the conventional procedure performs worst. More importantly, a novel evolutionary optimisation algorithm has been proposed and implemented which is essentially a recipe allowing for the optimisation of wavelets for the purpose of signal denoising. The effectiveness of both of these new measures has been investigated under a variety of scenarios with promising results. The proposed procedures have been found to be especially effective under moderate to severe noise conditions and outperform the standard thresholding technique by an equivalent SNR gain of up to 10dB.

Aaron CHA
Control and Simulation of an Autonomous Underwater Vehicle

This thesis describes the development of a small AUV (autonomous underwater vehicle) for the University of Western Australia. Project USAL is the second autonomous submarine constructed in the Mobile Robot Lab. The first phase of the project involved the modification a remotely operated underwater vehicle for autonomous underwater navigation tasks. The design incorporates an embedded controller which drives the servos at all times. The controller receives input from sensors as well as an infrared remote control or Bluetooth device. The second phase involved the development of a navigation control system using mathematical modelling, system identification and 3D simulation software. The control system required the implementation of numerous onboard sensors and real-time navigation and decision systems

David CHEN
Optimal H_∞ Insulin Injection Control in Diabetes Treatment

The theory of H_∞ optimal control has the feature of minimising the worst-case gain of an unknown disturbance input. When appropriately modified, the theory can be used to design a "switching" controller that can be applied to insulin injection for blood glucose regulation. By applying the Bergman's Minimal Model to define the blood glucose dynamics of the system, the "switching" controller is defined by a collection of basic insulin rates and a rule that switches the insulin rates from one value to another. The rule involves the solution of a "jump" Riccati differential equation and discrete-time dynamic programming equation. From the solution a corresponding controller can be designed.

Chee Ken CHIA
Musical Note Recognition

Neural networks are widely used in many applications because of its adaptive learning nature. It has been used in areas such as speech and pattern recognition, adaptive inverse controls, weather forecasting, and, in recent years, music recognition. One of the common applications in the area of music classification would be the conversion of wav files to visual musical scores.

This paper presents a single piano note recognition system based on a neural network model as classification which serves as the foundation of most music classification systems. The theories and design of the classification system will be addressed as well as its advantages. A history background of neural networks would is also included.

The neural network will be trained with sufficient piano notes and tested to examine the system's recognition accuracy. The results would be discussed and possible future work will be presented.

Lixin CHIN
FPGA Based Embedded Vision Systems

Embedded micro-controller systems are becoming increasingly popular in image processing applications. Imaging algorithms can consume large amounts of the processing time on a CPU, which also needs to handle other tasks such as I/O. A significant amount of research has been performed in recent years into the acceleration of image processing algorithms using reconfigurable hardware logic devices such as FPGAs (Field Programmable Gate Arrays). This project combines the two, presenting an embedded controller with an on-board FPGA for real-time image processing.

In addition, this project investigates the implementation of several imaging algorithms in hardware logic. FPGA implementations of algorithms for performing colour space conversion, image thresholding and object location are presented and analysed.

Finally, this project outlines the design and implementation of a new hardware divisor for performing 8-bit division. The error probability function of this division algorithm is fully characterised and contrasted against existing hardware division algorithms.

Tse Hung CHO
Driving Simulator

The aim of this project is to create a driving simulator of a vehicle. It will focus mainly on the steering wheel, gas and brake pedals of the vehicle in the simulation. This is exactly as in the real environment where the vehicle

in the simulation is controlled by the steering wheel, gas and brake pedal joystick. The purpose of this project is to develop a program that will allow the user to experience driving in a virtual driving environment. The program will be emulating a driving vehicle in a real situation. The simulator can be used to observe the behaviour of a driver. The simulator can provide a safe environment for the non-experienced driver to learn to drive safely.

This project will also look at some of the dynamic and kinematics of the vehicle. This involves mainly the study of the movement and motion of the vehicle in a real situation and then applies them to the simulator. These equations are provided and discussed in the later part of this dissertation.

This project also considers some of the projection viewing or how images are displayed in the virtual environment. It specifies how the image is projected and displayed into the viewing environment or area.

Grace CHOO
Localisation and control for an Autonomous Underwater Vehicle

Localisation and control have always been a problem for robotics and especially underwater vehicles. This is primarily due to limited means of communication available from land to submarines. Currently, there are three widely available means of wireless communication, they include: WiFi, Bluetooth and IR. Due to the water column between the vehicle and surface these signals are heavily attenuated.

This project proposes the use of a Kalman Filter as a localisation technique that blends information coming from various sensors on-board these vehicles. The Kalman Filter is an adaptive filter that takes into account the noise model of the measurements, the process and errors from previous predictions to optimally estimate the current state of a vehicle. It is a relatively robust filter that is widely used in industry.

By combining the localisation information from the Kalman Filter with an actuator control system derived from testing in the system identification process, some degree of autonomy can be achieved for underwater vehicles. The scope of this project is limited to providing the Mako AUV developed at the University of Western Australia enough autonomy to perform mapping an object detection within closed waters.

Christophe CHUNG

Speech Recognition System by Keyword Spotting

A keyword spotting system is a specialisation of a generic speech recognition system. Rather than attempting to recognise every word in the input utterance, as in the case of large vocabulary speech recognition systems, a keyword spotting system has the task of detecting a prescribed set of keywords from unconstrained speech.

The most common approach to keyword spotting involves the use of filler models to represent the non-keywords and background noises in the extraneous speech. In this project, the Hidden Markov Toolkit is used to build five keyword spotting systems based on three predominant filler model approaches. We investigate the relative keyword spotting performance and computational complexity of the different approaches in an effort to find a middle ground between high keyword spotting performance and low system complexity. We also implement and investigate the effects of likelihood ratio scoring, a modified scoring procedure, in an attempt to further improve the keyword spotting performance of the systems.

The task is the detection of 22 keywords in unconstrained speech. We have demonstrated that a set of context-independent monophone filler models provides the best trade-off between high keyword spotting performance and low computational complexity. This system achieved an average keyword spotting performance of 81.06% Figure of Merit (FOM), between 2.79% and 27.03% FOM better than any other approach. We have also shown that likelihood ratio scoring is beneficial to keyword spotting performance for all systems, yielding significant improvements in keyword spotting performance of up to 74.30% FOM.

Neal CURRIGAN

Node Based Navigation and Localisation for Autonomous Mobile Robots

Navigation and localisation can be considered the two most pertinent issues facing the design of any autonomous mobile robot. In short, they refer to the processes of determining where a robot needs to go, and where it currently is, respectively. This paper describes a node-based navigation and localisation strategy for the application of an autonomous robotic tour-guide in a structured office environment, where detailed map information is known.

Use of the A* algorithm is proposed for global path planning. In this way, we are able to take advantage of known environment data by strategic node placement. Using available range sensors, corridor following is achieved through a position centering control system. Localisation is accomplished by detection of periodic geometric variations in the environment using range sensors. In combination with a position estimate from odometric data, the robot can determine necessary coordinate updates from proximity to available localisation nodes. A test robot, along with a corresponding simulation environment is used to obtain experimental results in verification of the effectiveness of this technique.

David ENGLISH
FPGA Based Embedded Stereo Vision Algorithms

With improvements in technology, especially microprocessors and Field Programmable Gate Arrays (FPGA), it is possible to bring rapidly increasing levels of intelligence to autonomous robots and other embedded systems. The University of Western Australia and other research groups have need for a robotics control platform which offers traditional features such as motor and servo control alongside modern features such as fast processors, large memory, FPGAs, Bluetooth networking for control and self-organisation, as well as high speed USB interfaces for expansion. Such a platform needs to be small form factor, low power consumption and cost effective in small to medium quantities.

This project, working in a team of three, focuses on the design and verification of a new hardware platform that aims to meet all of the goals outlined, as well as accompanying software and FPGA logic designs to make the features accessible from user space under a standard embedded Linux operating system. Individually, research was also undertaken into stereo vision, with the aim of proposing an algorithm which can be made to fit this specific hardware platform, while maximising quality and performance where possible.

Significant effort has been put not only into the design of the systems presented, but also verification. Extensive testing of the timing critical components on the PCB was undertaken, and results with accompanying analysis of maximum stable speed is presented where relevant. On the logic design side, a software tool to assist in bridging the gap between traditional test bench code and VHDL designs is presented. This framework allows the rapid application of many automated test cases to logic simulations at both the behavioural and timing levels. The stereo vision research code presented includes a powerful visualisation and analysis system to assist in testing algorithms for validity and comparing against expected results.

Aditya ISHAK
Digital Rights Management for an Online Music Store

With the widespread use of Internet and digital technologies; digital music, images and books can be distributed instantaneously across the Internet to the end-users. Whereas in the traditional analogue media the content was bounded to a medium (i.e. a tape or a disc), the 'digitization' of the information resulted in the digital content which was 'released' from its medium. Combined with the Internet, the digitization of music has opened new avenues of music exploitation.

To protect commercial digital intellectual property and avoid digital piracy, a system is needed to prevent unauthorized access to digital content and to manage content usage rights. Enter Digital Rights Management (DRM). The aim of the project is to research and design a possible Digital Rights Management scheme for an online music store through in-depth analysis regarding the requirements, specifications and modules for the digital rights management system.

The second part of this thesis will discuss both the online music store server design and end-user media player design. In this part, the specific detail of software architecture of the design is presented. Lastly, the thesis closes with the possible modes of operation of the music store and a discussion regarding the possible avenues of attack and sources of weakness of the DRM scheme.

Brenton JACK
Wireless and Real-Time Operations in a Retail Warehouse Environment

This thesis investigates the modelling and analysis of workflow in a paper-based warehouse to justify the implementation of wireless and real-time technologies.

Redesign of any business operation is a major undertaking. This project introduces methods by which a business will be able to begin investigation into the implementation of real-time and wireless systems in their warehouse.

Through simple examples of process and workflow modelling, it will be demonstrated that the paper-based warehouse is highly inefficient and that real-time and wireless technologies have the potential to greatly improve warehouse operation.

This project provides a sound basis for paper-based retail warehouses to consider improving their work practices and reap the benefits of new technology.

Matthew JOHNSTON
Eye Gaze for Computer Interaction

This thesis investigates the development of a video based eye tracking system designed with the purpose of computer interaction. The system uses a normal "webcam" type video camera and an attached computer for real time processing.

Software to determine face and eye position within a set of video frames has been developed, using various computer vision processing techniques. An approach to gaze determination from an iris image is described, and the accuracy of this method quantified. The individual components of this system have been tested successfully, however resolution constraints prevent the integrated system from working as a whole.

Idris LAZUARDI
Physical Modelling of the Classical Guitar

In the past, there have been two different general methods for synthesis of musical instruments. One approach is to look at the spectrum of a real instrument and try to recreate it. Another popular approach is to use a sample of the instrument, such as Wavetable synthesis and samplers. These two methods create sounds without any consideration on how the sound is actually produced by the instrument.

With physical modelling, sound is not created directly. Instead, the process that produces the sound (described by models and equations) is created and controlled, hence creating a high quality sound. This approach is only possible due to the increase in computing power.

In creating a classical guitar sound by physical modelling, one has to model the vibration of the string and body of the guitar. Techniques to calibrate the guitar model are also discussed, which includes warping the measured impulse response of the body.

The success of this project is determined by a survey to a group of listeners. The different types of model will be presented and the listeners will be required to give a score to evaluate the quality of the simulated sound.

Mei Yee LEONG
Active User Omni-Directional Wheelchair

The University of Western Australia Centre for Intelligent Processing Systems (CIIPS) has been developing an Omni-Directional Wheelchair since 2004. The Omni-Directional Wheelchair is driven on Mecanum wheels, which allows for three degrees of freedom mobility – allowing the chair to be driven in longitudinal, latitudinal and angular velocities. Each Mecanum wheel consists of a central hub, on which the free rollers are mounted on 45° to the wheel axis. The omni-directional wheelchair's extra mobility is of great benefit to handicapped users as navigation is more intuitive and more convenient compared to a traditional wheelchair. Navigational software was implemented to aid handicapped users with fine motor control handicap. Fine motor control handicaps may hinder joystick navigation in confined built environments - thus the software implements obstacle avoidance and aids navigation through narrow spaces and doorways, using the six infra-red sensors to manoeuvre in unknown environments semi-autonomously. A chair was designed and mounted onto the omni-directional base such that future testing of the omni-directional wheelchair by test subjects would be possible.

Peng LIU
Functional Observers

Modern control theory involves state space analysis in time domain as opposed to classic control theory, which is done in frequency domain. However, the usual controller design still involves feedback control. In the case of modern control, this is often state feedback and is where problems arise. It is common for a system to have states that are immeasurable or simply too great a cost for it to be economically viable. Therefore, the need arises for a method to estimate the states accurately and efficiently. The introduction of the state observer was able to provide the necessary estimates accurately, and there have been continuous research to improve its performance and applicability.

This dissertation examines the effectiveness of a particular type of observer known as functional observers, where functions of the state vector are estimated instead of the entire state vector. Comparisons are made between the functional observer, full-order and reduced order observers, to determine its advantages and disadvantages in key areas of performance such as stability, simplicity in design and implementation, and the order of the observer. The approach taken to achieve this is by examining current research in observer design and applying them to a specific real life example to see which performs better. The result obtained from the examinations showed that functional observers, despite having a lower order, still perform as well as other types

of observers in terms of response and quickness in approaching asymptotic stability. The significance of this result is that functional observers could be widely employed to improve control systems due to the nature of feedback control, where functions of state vectors are used as control signals.

Kasun LIYANAARACHCHI
Vision Guided Path Following

Waypoint navigation and path following were traditionally considered separate problems and their combination was rarely attempted. This thesis implements a Path Following Algorithm that enables a mobile robot to follow a footpath and reach allocated waypoints while avoiding obstacles.

The algorithm consists of three sequentially dependent constituents; Image Segmentation, the Path Direction Algorithm and the Navigation Algorithm. Image Segmentation involves extracting regions of path from images taken by the robot's camera, using differences in region colour. The Path Direction Algorithm is responsible for the extraction of path edges from the segmented image. The path edges enable the retrieval of the path direction relative to the robot heading. The Navigation Algorithm collects information about the path direction, the location of waypoints and the location of obstacles. It then makes navigation commands based on the priority of this information, allowing the robot to reach allocated waypoints while staying on the footpath and avoiding obstacles.

Ling MIAO
Benchmarking Mobile Device Frameworks

There has been a growing acceptance within society of mobile devices: they provide a convenient way to integrate and aggregate information which is useful in people's daily lives. Due to this, there has been a growing interest in technologies that maximise the usability of these mobile devices and firms such as Microsoft and Sun Microsystems have developed mobile technologies which seek to accomplish this goal. With the release of the Microsoft .NET Framework and the Java 2 platform, mobile frameworks with corresponding development tools have allowed for greater leverage in the areas of designing, developing and deploying mobile applications. The major frameworks concerned in this project are the Microsoft .NET Compact Framework under Visual Studio 2005, the Personal Java Framework under Creme 3.27 and Java 2 Micro Edition with Creme 4.0.

This project undertakes a comprehensive comparison between two mobile device frameworks: .NET Compact Framework and Personal Java through a series of performance analysis and benchmarks. As both of these platforms require a host device, a Personal Digital Assistant (PDA) with a scalable mobile processor and well featured operating system was selected to run the benchmarks.

To examine the underlying methodology and logic behind the performance of each framework, benchmarking applications were developed and implemented. These results, along with further research, would be useful in providing evidence which could be used in the selection of a suitable mobile device framework for application development.

Christophe NIELSEN
Digital Watermarking of Audio

The purpose of this final year project was to implement and test a digital audio watermarking technique. The two aims of this project were to implement the PN Spread Spectrum (or PNSS) technique of digital audio watermarking, and to rate the PNSS technique's robustness while undergoing both processing operations and simulated attacks. Many tests were performed on the watermarking technique to test its inaudibility under normal conditions and to test its robustness to a range of attacks and audio manipulations. The tests performed were informal listening tests and attacks using AWGN, Colored Noise, D/A – A/D conversions, resampling, coding, multiple watermarking and audio conversions. The informal listening test showed that the PN Spread Spectrum technique does create inaudible watermark and further tests showed that this watermarking scheme is robust to attacks involving AWGN, multiple watermarking and Resampling. The tests also showed that the watermark can be removed using attacks involving Colored Noise, Coding, D/A – A/D Conversions.

Jason PANG
**The Execution and Evaluation of an SNMP-Based
Agent Monitoring System**

Many organisations have a high reliance on automated systems. These systems provide a service which aids those organisations in achieving their goals. However, if these systems fail and become unavailable, the adverse impact sustained by organisations can be substantial. Consequently, a need for systems to be monitored is prevalent in order to minimise the impact of system failures. Motorola Enterprise Solutions ("the client") is an organisation which

has expressed their need for such a system. Their security network system is currently operating in countries such as Hong Kong and Austria. As their system consists of multiple remote servers placed in geographically secluded locations, the problem lies in monitoring each server's condition persistently. The purpose of this project was to create a network management system capable of receiving information about the condition of each remote server (agent) in the form of messages. A structured software development process was adopted and included the design, implementation, and evaluation of the system. To design and implement the system, the client's requirements were captured and documented. The system was built on Microsoft's .NET programming platform and based on the Simple Network Management Protocol (SNMP), in accordance with the client's main requirements. Using methods such as trap-directed trapping, the system was successfully created and complied with the documented requirements. Subsequent to implementation, the performance of the system and thus its suitability for deployment was sought. An environment consisting of two personal computers were used to evaluate the performance of the system. Each computer was SNMP-enabled and included Microsoft's .NET 2.0 framework. Key performance indicators were measured against two changing loads - message size and agent load. The results were compared to the client's minimum requirements and indicated that the system should perform well within the live environment. The message size was found to have a negligible effect on the performance of the system. Although the number of agents had a larger impact, this load was also considered insignificant when compared to the client's requirements. As the system could not be tested to the required agent load, techniques based on extrapolation were undertaken to estimate the values at these higher loads. The estimated values further indicated that the performance of the system was more than adequate. The overall conclusion was that the system is suitable for deployment.

Mark Yiannis PAZOLLI
Architectures for a Hardware Classifier

This research presents the designs for two fixed-point hardware classifiers: one based around the vector quantization algorithm and another based around the neural tree network algorithm. The research then simulates the performance of these hardware classifiers in software for the speaker recognition problem. The research shows that the accuracy of the fixed-point hardware classifiers using only 7 or 8-bit precision approaches that of software implementing floating-point versions of the algorithms they are based upon. Furthermore, the research shows that for the speaker recognition problem the vector quantization algorithm classifies with significantly better accuracy (77.7% of feature vectors correctly classified) than the neural tree network algorithm (69.9% of feature

vectors correctly classified). And that the accuracy figure achieved using the vector quantization algorithm falls only slightly below the figure achieved using Gaussian mixture models (80.6% of feature vectors correctly classified), which some consider the most popular approach to software-based speaker recognition. Based upon this, the research recommends the architecture based around the vector quantization algorithm is the preferred architecture for a hardware classifier.

Sena PRATAMA

Representation of Vulnerability on Submarine Tactical Displays

Defence Science and Technology Organisation (DSTO) is currently developing prototypes of Tactical and Command displays. These prototypes will be used to convey to a submarine command team the situation of the submarine and promote command team confidence that their understanding of the situation is sound. One of these prototypes is the Command Tactical Display. A major part of displaying information to command is the need to be aware of the submarine's vulnerability, that is, factors that impact its safety. The submarine has a suite of sensors that can be used to determine its possible vulnerability. The aim of this project is to investigate and develop prototype(s) to display the submarine's vulnerability using simulated data from the submarine sensors, as layer/s on the Command Tactical Picture prototype. These display prototypes will be implemented and assessed by submarine operators and commanders.

Daniel PULLELLA

Speaker Identification Using Higher-Order Spectra

Human speech contains not only the literal message being spoken but also information pertaining to the identity of the speaker. Speaker identification relies on the development of features which accurately capture speaker discriminatory information. Existing techniques such as Mel-Frequency Cepstral Coefficients (MFCC) features typically utilise the cepstral domain to perform the feature extraction. Characteristically these cepstral features provide accurate speaker modeling under ideal conditions but show poor robustness to noise, and in particular to mismatched noise.

Higher order spectra result from a multi-dimensional frequency analysis of higher order statistical cumulants, and features extracted from these domains offer advantages to the speaker identification task including the suppression of some forms of noise and the preservation of phase information. This research

evaluates the use of both magnitude and phase based bispectral features in robust speaker identification. A practical identification system is constructed where independent short-utterance classification is performed under clean speech and noise-affected speech conditions. A newly defined bispectral magnitude feature is analysed in addition to a bispectral integrated phase based feature and a standard MFCC baseline feature. The results show that bispectral based features exhibit a large degree of resilience to mismatched noise, where the bispectral magnitude feature produces a recognition rate of 68.7%, in contrast to a rate of 10.7% by the MFCC feature, under mismatched AWGN with a 5dB SNR. The bispectral magnitude feature was also shown to outperform the bispectral integrated phase based feature by up to 20.9% in clean speech conditions and up to 24.5% in mismatched noise conditions, confirming the suitability of the bispectral magnitude as a domain for extracting robust speaker discriminatory features.

The main drawback in the use of bispectral features for short-utterance based identification is the resulting low clean speech recognition rates. Super features were produced by combining standard MFCC features with bispectral magnitude or bispectral integrated phase features. These super features produced clean speech recognition rates almost equal to those of plain MFCC features, showing a maximum clean speech recognition of 94.5%. Under mismatched noise the super features show an improvement of up to 33% over plain MFCC features, but more significantly the use of super features always increases the recognition rate compared to the standard MFCC features for SNRs below 40dB. This demonstrates the feasibility of combined Mel-Frequency Cepstral bispectral features for speaker identification in practical noise environments.

Mark RANKILOR
Object Detection and Mapping for an Autonomous Underwater Vehicle

Autonomous underwater vehicles are a rapidly developing area of technology for commercial use such as offshore surveying and mining operations, and for research use such as studying ocean patterns for climate and weather predictions. They are required not only to be able to perform tasks autonomously, but also think intelligently about the task being performed and adjust its actions accordingly.

One of the major areas that provides an AUV with the information required to perform this intelligent operation is vision processing. This thesis implements a modular vision system by providing capabilities to the University of Western Australia's AUV, mako, for detecting the existence and positions of objects within the vehicle's field of view.

An implementation of the vision processing system was designed by considering different methods, and the constraints, both environmental and internal to the AUV. A focus is taken on an upcoming Australian AUV competition which relies largely on image analysis.

The two main parts to the vision system are detection and positioning. These allow an AUV to find, and direct or align itself to a specific target or to map the existence of discovered objects. The detection system uses histogram analysis of images due to the very fast computational speed, with simplifying assumptions that still produce an accurate result.

The positioning system is an extension of detection, using basic properties of the image analysis to produce fast, reliable results. An evaluation of the performance of this implementation shows that it is a viable solution, and optimized to the operational constraints.

A complete modular software package was also put together to allow a simple interface to the vision system from the viewpoint of future design and extension. This allows easy addition of new functionality, extension of current algorithms and only learning of the interface is required to be able to use the vision system.

Finally, an algorithm was designed and simulated to perform a sweep over an entire pool floor, using PID controllers to maintain heading and depth. Along with the above vision system, this provides most of the necessary functionality to be able to detect and travel towards certain targets, and to scan a pool floor and locate, record and report the locations of pre-specified objects.

Zhi Wen TAY
Build Your Own Speech Recognizer

A 24 word speaker dependent isolated word recognition system and a speaker dependent 13 phrase connected word recognition system have been developed using Hidden Markov Models modelling. It has achieved 100% recognition for the isolated word recognition system and for the connected word recognition. It has shown that the accuracy for the connected word recognition deteriorated greatly with the increase of grammar due to perplexity. Increasing Gaussian mixture components for connected word recognition was also investigated and the accuracy was improved.

Data acquisition has proven to be a time consuming and tedious process of building a recognizer, even though his speaker dependent system has only 6 speakers; with 3 male and 3 female speakers. However it is an important issue to acquire a large substantial amount of data from several speakers, as more complex systems can be built on it.

The front-end parameterization uses Mel-Frequency Cepstral Coefficients, Baum Welch Re-estimation for training and the Viterbi algorithm for decoding.

A very basic speech recognizer has been built and it can be further enhanced or experimented with different parameterization techniques, algorithms and extension to speaker independent and adaptive systems is possible.

Tom WALKER
A Behaviour Based Framework for the Control of Autonomous Mobile Robots

Traditional robot control involves following a structure of perception, planning and then action. In the perception and planning phases a world model is built up and subsequently used to determine action. Behaviour based robotics departs from this organisation by removing the world model and employing a structure where the robot is controlled through a combination of parallel behavioural modules.

This project involved the design and implementation of a software framework for the development of behaviour based applications for use with Eyesim. Basic behaviours and a simple controller were developed to demonstrate the framework. Adaptive capabilities were implemented to extend the system and allow the robot to successfully react to changes in the environment.

The adaptive capabilities allow for improved navigation through environments of varying densities. The main adaptive controller was built around the Q-Learning algorithm. This controller was trained using carefully chosen training environments in order to optimise its performance. Q-Learning has been demonstrated to provide a marked improvement in performance.

David WELLS

Terrain Mapping with a Tracked Robot

The objective of this thesis was to perform and analyse a method of terrain mapping with a tracked robot. Many robots already have this functionality using different sensors and techniques for obtaining altitude measurements. The tracked robot achieves this using an inclinometer, for measuring the pitch of the robot and an optical encoder, for measuring the distance travelled.

Advanced robots have a vast array of very expensive sensors which provide accurate altitude readings relative to their application. These sensors include altimeters and GPS receivers. The tracked robot project investigated the feasibility and methodology for performing terrain mapping using an inclinometer and an encoder.

Using these sensors, altitude calculations proved to be sufficiently accurate and actually produced a better terrain map than what would be produced using more expensive devices mentioned above.

With the inclusion of altimeters or GPS receivers in larger scale robots, the applicability and area of operation for the robot were brought into question. Traditionally, these robots operate in a different environment to the small, enclosed, area in which the tracked robot was tested. The tracked robot's method proved to be more practical and accurate for this application.

The outcomes of this project demonstrated the worthiness of the finalised method for obtaining a terrain map. The result of this project produced a better way of performing terrain mapping, in small areas, compared to that of the methods used in more expensive robots. The cost effectiveness and simplicity of the tracked robot were key factors in determining the practicality of the mapping method.

Wing Fong WONG

Implementation of an Operating System for an Image Processing System

This project aims to implement an Operating System squarely aimed at a platform designed for image processing. The system that was available, an ML310, consisted of a Xilininx FPGA, plus a whole host of other peripherals.

But most of the other peripherals are superfluous and are not required or even desired in this platform. The main components of interest were the Vitex II FPGA, the DDR RAM, the compact flash controller, the UART and the expansion ports. One of the primary aims was to create a boot loader that would take a file from the compact flash card and write the content to memory. Secondly, once the boot loader was implemented, then it should be developed into a fully fledged kernel.

How the boot loader functioned depended largely on how the binaries were formatted and saved on the compact flash. Three alternate methods were available, these being Motorola's SREC, ELF format and flat binary file. The easiest to implement was the flat file format, but this method was prone to errors and corruption of data. The next easiest to implement was Motorola's SREC format. This particular format was human readable to some extent and has building error checking if implemented properly. But with SREC format, information about the executable is lost. The ELF format is a very comprehensive format. With detailed information about different sections of the executable it lends itself to relocation and other memory tricks. But with comprehensiveness comes complexity and ELF formats have considerably more cases to handle than, say, SREC format. From this it seems that the SREC format, from a simplicity point of view is the most suited. Although one would have to consider the ELF format once the project reaches a certain level of complexity.

Once we are able to load an executable into memory, we need to handle the execution. To make the step from boot load to a kernel requires the system to have some library of common functions to be called upon by applications that run on the system. One could just leave it as a boot loader and let the application contain within itself all the instructions necessary to drive the system, but for the sake of efficiency and storage considerations, it is useful to have basic input and output and other functions to be preloaded into memory and called by the applications. The available alternatives are to not preload functions into memory and let the applications handle all that, preload functions into memory and have applications link to them or load the functions as needed when the application is executed. It seems that a combination of all might be suited at some stage or another.

Benjamin WOODS
Omni-Directional Wheelchair

Since the beginning of 2004, the University of Western Australia's Centre for Intelligent Information Processing Systems (CIIPS) has been developing an omni-directional wheelchair. Omni-directional vehicles can turn and drive in any direction, including directly sideways.

Therefore, an omni-directional wheelchair allows the user to navigate through a confined environment with less difficulty than would otherwise be possible with a conventional wheelchair.

This paper presents many improvements that were made to the driving accuracy, human interface and comfort of the already existing omni-directional wheelchair found in the mobile robotics laboratory at the University of Western Australia. Specifically, alterations were made to the wheels, batteries, motor driver cards, joystick, control software, chassis and suspension system with the aim of improving the overall experience for the user. The results of this work are demonstrated and shown to be successful through initial testing.

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