Annual Report 2007

Centre for Intelligent Information Processing Systems

THE UNIVERSITY OF
WESTERN AUSTRALIA

CONTENTS

DIRECTOR'S REPORT 2007

In the year 2007, CIIPS directorship duties were shared between Roberto Togneri and Thomas Bräunl. In the first half of the year, Thomas Bräunl was on Sabbatical Leave at Technical University München, Germany, and Santa Clara University, California U.S.A. One positive effect of this Sabbatical has been the renewal of academic and industrial links. In 2007, CIIPS has had a number of international visitors, three alone from TU München with several more to come. With the help of a donation from BMW München, we are looking to start an automotive simulator project in 2008.

The Genesis project is now up and running and the School of Electrical, Electronic and Computer Engineering is sponsoring visits of our Genesis demonstrators, which will be free of charge to all interested High Schools in the Perth Metropolitan area. All new project details can be seen at http://genesis.ee.uwa.edu.au.

With the upcoming academic re-grouping in the School in 2008, we farewell some existing CIIPS members and welcome our new CIIPS members.

Roberto Togneri, Thomas Bräunl

Directors
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
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Associate Professor Thomas Bräunl,
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Ms Linda Barbour
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Visitors

Mr Johannes Brand
Technische Universität, München, Germany

Mr Simon Hawe
Technische Universität, München, Germany

Mr Shamsul Huda
University of Ballarat, Victoria, Australia

Mr Torsten Sommer
Technische Universität, München, Germany

Internships from India

Ms Shruti Bansal

Mr Kanay Jerath

CIIPS LABS

High Integrity Computer Systems Lab
(A/Prof. G. Bundell, A/Prof. T. Woodings)

High-performance, high-reliability and high-quality computer hardware and software systems design methodologies and management [3.02]

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

Adaptive Self-Learning Systems, Intelligent Signal Processing, Audio and Underwater Applications [3.15]

Robotics and Automation Lab
(A/Prof. T. Bräunl)

Intelligent Mobile Robots, Embedded Systems, Image Processing, Automotive Systems, Simulation [3.13]

Signals and Information Processing Lab
(Dr R. Togneri)

Speech signal processing, Spoken Language Systems, Pattern Recognition [3.06]

Systems and Biomedical Engineering Lab
(Dr T. Fernando)

Electronic Medical Systems, Signal Processing Systems [3.15]

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

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

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

Mr Navid Nikraz
Functional Observers (T. Fernando)

Mr James Ng
Path Planning (T.Bräunl)

Mr Daniel Pullella
Integrating Feature Selection and Missing Data Recognition for Robust
Speaker Identification (R.Togneri)

Mr Robertus Susanto-Lee
Application of Fuzzy Logic to Blood Glucose Control (T.Fernando)

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)

Doctor of Engineering (ICT)

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

Master of Engineering (Research)

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

Master of Engineering (ICT)

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

Perumalsamy Gurusamy
Liquid Level Control (T.Fernando)

Mr Stewart Johnson
Risk management: The Selection of Appropriate Strategies for Software Projects (T. Woodings)

Ms Suet May Khong
Measurement of the Software Testing and Repair Process (T.Woodings)

Mr Pal Simen Ruud
Automobile Simulation (T.Bräunl)

Chumith Chandana Ukwattage Don Suriwardana
Integration of PSP and TSP into Agile Methods (T.Woodings)

Edwin Soebijono
Application of the Work Transformation Model to the Software Process (T.Woodings)

Shi Wang
Version Control in the School's Content Management System (G.Bundell)

POSTGRADUATE DEGREES COMPLETED

PhD

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

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

Master of Engineering by Research

Miss Mahsa Mooranian
My Crystal Diary (MCD): an integrated software application for recording the observations and results of crystallographic experiments (G.Bundell)

PhDs Conferred 2007

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)

ME(ICT)s Conferred

Kamran Ahmed
Digital Rights Management (DRM) System for Media Objects (G.Bundell)

UNDERGRADUATE STUDENTS

Pejman Astani

Tom Baranski

Alexander Alan Benn

Chris Bobridge

Brent Chadwick

Justin Chak

Weijie Chang

William James Chin

Wei Jun Choh

Weizian (Alvin) Chung

David Nelson Allan Churn

Andrew Keith Corrigan

Karl Thomas Daws

Andrew Ross De Gruchy

David D'Souza

Gavin Hangchi

Matthew Harley

Jason Heeris

Rahul Khubchandani

Kian Kuchakpour

Ce Yin (Sean) Lee

Wai Loong (Stephen) Lee

Rob Lightfoot

Leroy Lum

Ian Lutz

Ewan MacLeod

Davyd Madeley

James Austin McAlpine

Ryan Bradley Mepham

Ben Murrihy

Husain Zoeb Sadiq

Jaskirat Singh

Hyun Joon Sung

Jason Tan

Lay Hooi Tan

Jayashree Valyutham

Chris Van De Ruit

Surendran Vijay Kumar

Some of the staff, students and visitors of CIIPS 2007.

GROUP PHOTO

4th row, left to right: Kian Kuchakpour, Stephen Lee, Ryan Mepham, Rahul Kubchandani, Davyd Madeley, Jason Heeris

3th row, left to right: Pal Ruud, Chang Su Lee, Andrew Corrigan, Daniel Pullella, Sujatha Bulandran, Serajul Haque, Edwin Soebijono

2nd row, left to right: Weiqun Zheng, Simon Hawe, Oscar Chan, Marco Kühne, Aik Ming Toh, Karl Daws

Front row, left to right: Tyrone Fernando, Gary Bundell, Terry Woodings, Thomas Bräunl, Roberto Togneri

RESEARCH ACTIVITIES

1. Information and Software Engineering Research Group
(Associate Professor G.A. Bundell and Associate Professor 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.

Two final year projects in home automation technologies were also supervised, most notably in computer vision systems for smart houses and the development of the SCADA software for the School's new IDEAL house project. Another final year project was supervised with Thales Australia, evaluating the OpenSplice real-time data distribution service, and another finalising work on technology evaluation of various mobile information appliance platforms.

The main contract research conducted has been in mission critical embedded systems for the resources industry – specifically in an automatic train control application for MRX Technologies. This has involved research into embedded systems development to the IEC 61508 standard, and an expansion of the group's research activities into high-integrity systems development is expected.

Postgraduate research (MEngSc) in automated software generation from UML specifications was largely completed this year and work linking component design information to earlier work on software component testing was continued (via a PhD) and is also nearing completion. A postgraduate project (MEICT) on architectures for Digital Rights Management was completed.

Another important 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. Postgraduate research (DEICT) in this area has been focussed on assumptions analysis and this was well advanced this year.

2. 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 2007 projects, by PhD students, related to speech processing, fuzzy logic and genetic programming continued, with 3 PhD students nearing the completion of their theses: "Perceptual Features for Speech Recognition", "A Framework of Adaptive T-S type Rough-Fuzzy Inference Systems" and "Population Variation in Canonical Treebased Genetic Programming".

3. ROBOTICS AND AUTOMATION LAB
(Associate Professor T. Bräunl)

The Robotics and Automation 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 1 of 2007 at Santa Clara University in Silicon Valley, California, cooperating on projects for embedded system hardware and software.

The Genesis high school interaction project has been relaunched with a number of new experiments, mostly based on Microchip's Basic-programmable PICAXE microcontroller. A partnership has been established between UWA's Genesis and Murdoch-based ASISTM project (Australian Schools Innovation in Science, Technology and Mathematics), which hopefully will allow us to reach even more high schools. Interested high schools can contact us from the Genesis web site and arrange for a school visit by our Genesis demonstrators or order teaching material and PCBs free of charge. http://genesis.ee.uwa.edu.au/

The Improv tool (image processing for robot vision) has been re-designed and is now based on the OpenCV platform, extended by an interactive graphics user interface. The system can run from a live camera or a recorded video sequence and allows the simple generation of image processing operations, from basic functions to complex motion and stereo operations, up to full automotive driver-assistance functionality.

In a feasibility study, a new scalable algorithm for automotive lane keeping has been developed that can run on a small PDA or mobile phone. This will allow the use of existing hardware for future driver-assistance functions, reducing the cost factor to software development.
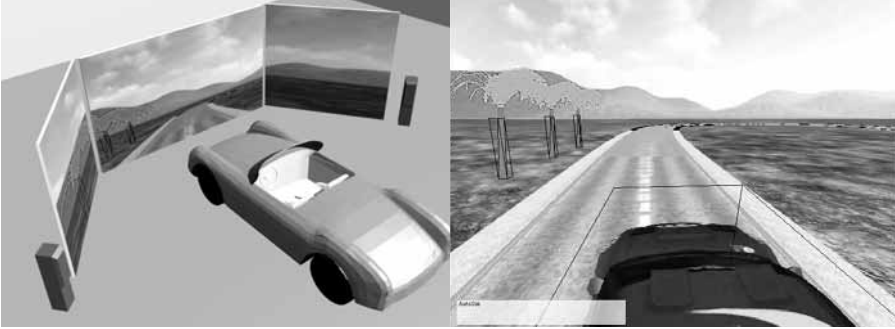
The development of a comprehensive, physics-engine based driving simulator has been started with the help of exchange students from TU München. This large-scale project will evolve over the next few years and will see the implementation of a car simulator built around a complete car chassis with three surrounding walls. On the modelling side, we plan to generate typical city scenes from Australia (Perth/Crawley), North America (Los Angeles), and Europe (München). This driving simulator will then be used to evaluate new driver-assistance systems - even before a prototype has been built.
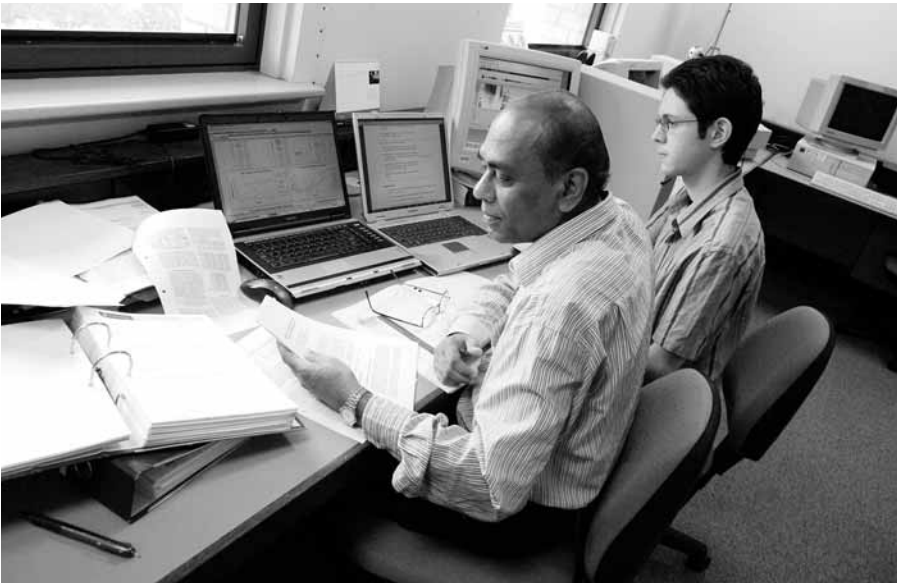
In 2007 the Robotics and Automation Lab hosted the following visitors:

- Simon HAWE, TU München, Germany
- Johannes BRAND, TU München, Germany
- Torsten SOMMER, TU München, Germany

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

Research Activities

In 2007 various third-year and final-year projects were undertaken in the area of speech recognition, speech signal processing and biomedical signal processing.

First-class honours projects of special note include:

1. Analysing, modelling and predicting pre- and post-stimulus EEG data and the responses between normal and clinical patients. This project was in joint collaboration with CCRN.

2. Progress on the next generation acoustic models by investigating different methodologies for the important VTR to MFCC feature mapping.

3. Investigations, implementation and evaluation of a scheme for the difficult task of single-channel source separation.

Technology deployment of speech recognition was successfully initiated in 2007 via the School's IDEAL House project. In semester one students carried out a feasibility study and then in semester two implemented the hardware and software for voice-activated control of a room environment. This was carried out by integrating the Nuance Dragon NaturallySpeaking engine with the room automation server system. Sponsorship from both VoicePerfect Systems and Nuance ensured access to the latest speech recognition technology and tools.

The continuing work on speech and speaker recognition in 2007 saw the start of a new PhD project by candidate Daniel Pullella on "Robust Speaker Identification". And in 2007 two PhD students (Oscar Chan and Aik Ming Toh) succeeded in completing their project and submitting their thesis for examination. The research being undertaken with the SIP lab resulted in conference publications at the key premier conferences in the area: 2 papers for ICASSP2007 and 3 papers for InterSpeech2007.

Visitors

Mr Shamsul Huda visited the SIP Lab as a visiting PhD student for two months May to June. Mr Huda was a PhD candidate at the University of Ballarat, Australia and visited the SIP Lab to collaborate further on his research into applications of evolutionary computing to the training of HMMs for speech recognition. Mr Huda gave an EECE School Seminar presentation "A hybrid training algorithm for Hidden Markov Models" on June 1, 2007 of his work.

5. 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

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.

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.

6. Meta-Education, Mathematical Software, and Human Consciousness
(Dr R. Chandrasekhar)

The term meta-education has been coined to refer to the processes by which we learn, do research, write reports and theses, etc. While the content varies with discipline, the processes of learning, researching, and writing remain substantially the same across disciplines. It is possible to analyze these processes and distil techniques which will enhance performance in each of them.

In 2007, Dr Chandrasekhar has been working on a series of books to assist students to achieve their full academic potential by applying tried and tested techniques for precisely this end.

CIIPS PUBLICATIONS 2007

Books

1. BRÄUNL, T.

   Embedded Robotics - Mobile Robot Design and Applications with Embedded Systems (Japanese Translation),

   Springer-Verlag, Tokyo, 2007, pp. (XV, 457)

2. FERNANDO, T. and CHEE, F.

   Closed-Loop Control of Blood Glucose,

   Lecture Notes in Control and Information Sciences, Springer, Heidelberg/ New York, 2007, pp. 157

Journal Articles

1. FERNANDO, T. and TRINH, H.

   Design of Reduced-Order State/Unknown Input Observers Based on a Descriptor System Approach,

   Asian Journal of Control, Chinese Automatic Control Society, Vol. 9, No. 4, December 2007, pp. 458-465

2. KOUCHAKPOUR, P., ZAKNICH, A. and BRÄUNL, T.

   Population Variation in Genetic Programming, Information Sciences,

   Informatics and Computer Science Intelligent Systems Applications, Elsevier, no. 177, no. 17, September 2007, pp. 3438-3452 (15).

3. NG, J. and BRÄUNL, T.

   Performance Comparison of Bug Navigation Algorithms,

   Journal of Intelligent and Robotic Systems, Springer-Verlag, no. 50, 2007, pp. 73-84 (12)

Conference Papers

1. ABDUL RAHIM, S. and BRÄUNL, T.

   Behavior-based System Using Neural Network for Robot Control

   ROVISP 2007, International Conference on Robotics, Vision, Information, and Signal Processing, Penang, Malaysia, November 28-30, 2007, pp (4)

2. BOEING, A. and BRÄUNL, T.

   Evaluation of real-time physics simulation systems,

   GRAPHITE 2007, 5th Inter-national Conference on Computer Graphics and Interactive Techniques, Perth, December 2007, pp. 281-288

3. BRÄUNL, T.

   Robotics Education using Embedded Systems and Simulations,

   AAAI 2007, Robots and Robot Venues: Resrouces for AI Education, Stanford, CA, Technical Report SS-07-09, March 2007, pp. 16-19 (4)

4. FARROKHI, D., TOGNERI, R. and ZAKNICH, A.

   Speech Enhancement of Non-stationary Noise Based on Controlled Forward Moving Average Proceedings 2007 International Symposium on Communications and Information Technologies,

   October 16-19, 2007, Darling Harbour, Sydney, Australia, pp 1551-1555.

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

   A Temporal Auditory Model with Adaptation for Automatic Speech Recognition

   Proceedings of ICASSP 2007, April 16-20, 2007 Honolulu, Hawaii, USA, Vol. IV, pp 1141-1144.

6. KÜHNE, M., TOGNERI, R. and NORDHOLM, S.

   Mel-Spectrographic Mask Estimation for Missing Data Speech Recognition Using Short-Time-Fourier-Transform Ratio Estimators

   Proceedings of ICASSP 2007, April 16-20, 2007 Honolulu, Hawaii, USA, Vol. IV, pp 405-408.

7. KÜHNE, M., TOGNERI, R. and NORDHOLM, S.

    Smooth Soft Mel-Spectrographic Masks Based on Blind Sparse Source

    Proceedings of Interspeech 2007, August 27-31, 2007, Antwerp, Belgium, pp 918-921.

8. LEE, C.S., ZAKNICH, A. and BRÄUNL, T.

    An Adaptive T-S type Rough-Fuzzy Inference System (ARFIS) for Pattern Classification,

    IEEE NAFIPS, San Diego, June 2007, pp. (6),
    Best-Five Student Paper Award

9. M. YUSOF, A. and BRÄUNL, T.

    Using Xilinx ML310 Development Board as Test and Development Platform for FPGA-based Embedded Vision System

    ROVISP 2007, International Conference on Robotics, Vision, Information, and Signal Processing, Penang, Malaysia, November 28-30, 2007, pp (4)

10. NG, J. and BRÄUNL, T.

    Robot Navigation with a Guide Track,

    The 4th International Conference on Computational Intelligence, Robotics and Autonomous Systerms (CIRAS 2007), Palmerston North, New Zealand, November 28-30, 2007, pp. (6)

11. TOGNERI, R. and LI, D.

    A Structured Speech Model Parameterized by Recursive Dynamics and Neural Networks

    Proceedings of Interspeech 2007, August 27-31, 2007, Antwerp, Belgium, pp 894-897.

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

    Feature and Distribution Normalization Schemes for Statistical Mismatch Reduction in Reverberant Speech Recognition

    Proceedings of Interspeech 2007, August 27-31, 2007, Antwerp, Belgium, pp 918-921.

13. ZHENG, W. and BUNDELL, G.A.

    A UML-Based Methodology for Software Component Testing

    Proceedings of IMECS 2007, March 21-23, 2007, Kowloon, Hong Kong, pp1177-1182.

14. ZHENG, W. and BUNDELL, G.A.

    Model-Based Software Component Testing: A UML-Based Approach

    6th IEEE/ACIS International Conference on Computer and Information Science (ICIS 2007), July 11-13, 2007, pp 891-898.

CONFERENCE PROGRAM COMMITTEES AND CHAIRS

ASSOCIATE PROFESSOR T. BRÄUNL

- MASCOTS, 24-26 Oct., Istanbul, Turkey

- AMIRE, 2-5 Oct., Buenos Aires, Argentina

- Euro-Par, 28-31 Aug., Rennes, France

- APESER, 5-7 Dec., Taiwan

- PSIVT, 17-19 Dec., Santiago, Chile

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

Supervisor: A/Professor T. Bräunl

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

Supervisor: A/Professor G. Bundell

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.

OSCAR CHAN

Prosodic Features for a Maximum Entropy Language Model

Supervisor: Dr R. Togneri

A statistical language model attempts to characterise the patterns present in natural language as a probability distribution defined over word sequences. Typically, they are trained using word co-occurrence statistics from a large sample of text. In some language modelling applications, such as automatic speech recognition (ASR), the availability of acoustic data provides an additional source of knowledge. This contains, amongst other things, the melodic and rhythmic aspects of speech referred to as prosody. Although prosody has been found to be an important factor in human speech recognition, its use in ASR has been limited.

The goal of this research is to investigate how prosodic information can be employed to improve the language modelling component of a continuous speech recognition system. Because prosodic features are largely suprasegmental, operating over units larger than the phonetic segment, the language model is an appropriate place to incorporate such information. The prosodic features and standard language model features are combined under the maximum entropy framework, which provides an elegant solution to modelling information obtained from multiple, differing knowledge sources. We derive features for the model based on perceptually transcribed Tones and Break Indices (ToBI) labels, and analyse their contribution to the word recognition task.

While ToBI has a solid foundation in linguistic theory, the need for human transcribers conflicts with the statistical model's requirement for a large quantity of training data. We therefore also examine the applicability of features which can be automatically extracted from the speech signal. We develop representations of an utterance's prosodic context using fundamental frequency, energy and duration features, which can be directly incorporated into the model without the need for manual labelling. Dimensionality reduction techniques are also explored with the aim of reducing the computational costs associated with training a maximum entropy model. Experiments on a prosodically transcribed corpus show that small but statistically significant reductions to perplexity and word error rates can be obtained by using both manually transcribed and automatically extracted features.

AIK MING TOH

Robust Feature Extraction for Speech Recognition in Hostile Environments

Supervisor: Dr R. Togneri

Speech recognition systems have improved in robustness in recent years with respect to both speaker and acoustical variability. Nevertheless, it is still a challenge to deploy speech recognition systems in real-world applications that are exposed to diverse and significant level of noise. Robustness and recognition accuracy are the essential criteria in determining the extent of a speech recognition system deployed in real-world application. This work involves development of techniques and extensions to extract robust features from speech and achieve substantial performance in speech recognition. Robustness and recognition accuracy are the top concern in this research. In this work, the robustness issue is approached using the front-end processing, in particular robust feature extraction.

The author proposes a unified framework for robust feature and presents a comprehensive evaluation on robustness in speech features. The framework addresses three distinct approaches: robust feature extraction, temporal information inclusion and normalization strategies. The author discusses the issue on robust feature selection primarily in the spectral and cepstral context. Several enhancement and extensions are explored for the purpose of robustness. This includes a computationally efficient approach proposed for moment normalization. In addition, a simple back-end approach is incorporated to improve recognition performance in reverberant environments.

Speech features in this work are evaluated in three distinct environments that occur in real-world scenarios. The thesis also discusses the effect of noise on speech feature and their parameters. The author has established that statistical properties play an important role in mismatches. The significance of the research is strengthened by the evaluation of robust approaches in more than one scenario and the comparison with the performance of the state-of-the-art features. The contributions and limitations of each robust feature in all three different environments are highlighted.

The novelty of the work lies in the diverse hostile environments which speech features are comprehensively evaluated for robustness. The author has obtained recognition accuracy of more than 98.5% for channel distortion. In addition, recognition accuracy greater than 90.0% has been maintained for reverberation time 0.4s and additive babble noise at SNR level of 10dB. The thesis delivers a comprehensive research on robust speech features for speech recognition in hostile environments supported by significant experimental results. Several observations, recommendations and relevant issues associated with robust speech features are presented.

MAHSA MOORANIAN

My Crystal Diary (MCD): an integrated software application for recording the observations and results of crystallographic experiments

Supervisor: A/Prof. G. Bundell

Recent technological advances in computer science have contributed to immense data generation in many critical areas of biology. These data can be used in intelligent information systems to better understand biological processes from the atomic details of biological molecules to the interaction of species in an ecosystem. This seminar presents My Crystal Diary (MCD), an integrated software application designed for use in an intelligent decision-support system for planning novel crystallographic experiments.

At the conceptual level, PostgreSQL database server is the information repository containing both the experimental data and general knowledge. At the practical level, Web-based interfaces developed in Plone provide remote access to the database by utilizing a Zope Web application server.

Opportunities exist to broaden MCD's scope by adding image and statistical analysis components when more resources become available. These enhancements could potentially transform MCD from an information storage system into an intelligent decision support system for developing effective techniques in the production of crystals.

KAMRAN AHMED

Digital Rights Management (DRM) System for Media Objects

Supervisor: A/Prof. G. Bundell

This research focuses on the development of a Digital Rights Management system for the protection of digital media objects. Digital media is prone to easy duplication and circulation leading to piracy and huge losses to the owners and distributors of digital media especially in the entertainment industry. The aim of DRM systems is to restrict piracy and enable adequate collection of revenues for the distribution of media. The software prototype developed in this project restricts such free access to digital media and demonstrates other DRM concepts.

ABSTRACTS OF FINAL YEAR PROJECT DISSERTATIONS

PEJMAN ASTANI

Aluminium Sulphate Process Automation and Control

Supervisor: Dr T. Fernando

Coogee Chemicals produces liquid and solid Aluminium Sulphate through a controlled reaction of alumina hydrate, water and sulphuric acid in a batch process. This document describes the batch control of the reaction ingredients (alumina, water and acid) to be implemented for the Process Control Upgrade.

This project is the first step in upgrading of the plant process control and control system hardware. The upgrade scope starts with weighing of the alumina hopper and ends with the addition of dilution water into the reactor for liquid Aluminium Sulphate.

This document examines the automation techniques and applies them to Aluminium Sulphate process automation upgrade. The implementation of control system is divided into stages. At first Aluminium Sulphate process is analysed. From the Analysis a functional description of what the control system contains is developed. This paper also looks at how the design is going to be implemented.

TOM BARANSKI

Driver Assistance Software for an Omni-Directional Wheelchair

Supervisor: A/Prof. T. Bräunl

Omni-Directional wheelchairs can move in any direction (such as sideways), as well as the usual directions. This allows finer movements that are not possible with conventional wheelchairs. Such fine movements can be utilized by software to aid the user in navigating the wheelchair through scenarios that would otherwise require the user to possess motor skills and reflexes they may not have. The Centre for Intelligent Information Processing Systems

(CIIPS) has developed an omni-directional wheelchair with software that takes advantage of these capabilities. It can follow walls, drive through doors and avoid collisions. However, the software is limited as it still requires a high level of interaction from the user, and it fails to cover several key scenarios. The ODW itself also needs to be examined.

This project extended the software to cover more scenarios and to provide more automation, with the aim of having varying levels of automation that can be selected by the user. This will make the wheelchair flexible for people with varying levels of disability (without having to customize the software for each individual).

The previous software has only been tested in simulation; this project verified the new software in simulation and inspected the available omni directional wheelchair to determine how the software would work on it. The flexibility of the wheelchair was then tested.

CHRIS BOBRIDGE

Neural-network Based Sonar Detection and Classification

Supervisor: A/Prof. A. Zaknich

A neural network classifier to detect artificially generated sinusoids in the presence of biological ocean noise was coded in Matlab and used to classify a testing data set of 666 one second samples of this noise. The classifier was constructed with a preprocessing filter to whiten the input to the following stages, a feature extractor to calculate the energy in a number of bins (sections of time and frequency), a feature reducer to decrease the amount of memory and complexity required in the system and finally a probabilistic neural network based classifier. This classifier worked at a base quality of approximately 60% of the ideal, with refinements due to increased training data and decreased frequency range increasing this to approximately 80% of the ideal case. These results indicate that Neural Networks are a promising option for use in sonar detection systems, but the high incidence of false positives at low signal to noise ratios means that further research should be carried out to minimize these false positives.

BRENT CHADWICK

IDEAL House SCADA Control System

Supervisor: A/Prof. G. Bundell

The IDEAL House is a collaboration of ever improving technologies for the advancement of human habitation. Vision systems, voice recognition and smart devices all operate independently to provide the inhabitants with improvements in different areas. The integration of these systems into a seamless single

system is what differentiates a "smart" home from an "ideal" home. Project development is focused on creating a modular, extensible supervisory control and data acquisition system, abbreviated to SCADA, to integrate the IDEAL House system technologies. The capabilities of the system extend to status monitoring; user defined function block logic, closed loop control and data logging. The IDEAL House SCADA control system is custom programmed software written in C# using the .NET framework of Visual Studio 2005. The system meets the principal design fundamentals as defined in the project scope and is fully functional within the IDEAL House. Users are now capable of externally generating custom runtime logic to be implemented in the house for their own experimental purposes. A framework for addition and integration of future technology into the IDEAL House has been established, and the SCADA control system will remain central to the IDEAL House developments for the foreseeable future.

JUSTIN CHAK

Functional Observers – An Application to the Glucose Regulation Problem

Supervisor: Dr T. Fernando

Ever since David Luenberger introduced the problem of observing the state vector of a deterministic linear time-invariant multi-variable system, there have been numerous studies on the design and optimisation of observers for reduced-order. Of particular interest is one type of observer, the functional observer. It is often the case that a feedback control strategy requires some linear combination of the states (for example, closed-loop pole allocation or a linear quadratic regulator), the very fact that the functional observer provides this linear function of states at much reduced order forms the motivation behind the research.

One of the problems of functional observers is the complexity in their design, proposed design methods seem to offer a trade-off between the observers' general applicability to a wide range of systems, degree of order reduction and simplicity. In this paper we attempt to take a non-linear 19th order insulin-glucose physiological model, linearise the system, apply a model reduction technique and design a state feedback controller which utilises Darouach's functional observer to supply the linear function of the states for feedback. A new result that relaxes the sufficient and necessary conditions for the existence of the Darouach observer is discussed. This result increases the range of systems to which this observer can be applied.

WEIJIE CHANG

Blood Pressure Control

Supervisor: Dr T. Fernando

Automatic control of blood pressure in post cardiac surgery patients is desirable for many reasons. These include better patient care, reducing the workload of healthcare staff and the cost of healthcare. Many studies have been reported on modelling and/or control of blood pressure in patients. Motivated by the need for simple and effective controllers for clinical applications, this study focuses on the ubiquitous and proven PID controllers and development of different types of control strategies for arterial blood pressure regulation.

Firstly, detailed and realistic physiological models are studied. A model that was developed by Slate et al., which gives us a dynamic response of the mean arterial pressure to Sodium Nitroprusside (SNP) was chosen for the design of our controller to evaluate its performance to regulate the infusion of Sodium Nitroprusside (SNP) for blood pressure control in post cardiac surgery patients.

With the realistic physiological model chosen, a proportional-integral derivative (PID) controller is then designed to meet certain performance criteria. The PID controller is to be tuned by different methods and the resulting controllers are tested on different patient model types, mainly the sensitive, nominal and the insensitive patient, for a blood pressure drop of 30 mmHg.

The performances of these PID controllers are compared and simulation results show that PID controller proves to be of acceptable performance to regulate arterial blood pressure. Simulations results also demonstrate that the PID controller tuned by Ziegler-Nichols method prove to meet the performance criteria better especially for the case of the majority group of patients, i.e. the nominal patients.

ANDREW KEITH CORRIGAN

Functional Observers and Covariance Control Systems

Supervisor: Dr T. Fernando

Covariance Control and Functional Observers are both developing areas of control system theory which to this point in time have not been applied together for the design of control systems. This research has for the first time presented applications of functional observer theory to the design of covariance controllers. Experiments were carried out comparing both the controller order and design methodologies of functional observer controllers and dynamic covariance controllers. The results of the experiments have revealed that functional observer controllers performed nearly identically to state feedback controllers, they had simpler design procedures and they offered order reduction above that possible using dynamic controllers in many system contexts. Aside from these covariance control related results, a new method for the design of unknown input functional observers was successfully used to design functional observers to implement covariance control.

DAVID D'SOUZA

Mapping of Vocal Tract Resonances to Speech Feature Vectors

Supervisor: Dr R. Togneri

The vocal tract resonances are dynamic variables that correspond to the frequencies that are most amplified by the oral cavity. These resonances form the basis of the recently proposed hidden VTR dynamic model. The model assumes that there is a functional mapping between the vocal tract resonances and the speech feature vectors. In this project we investigate the performance of various VTR to Acoustic mapping models, including an analytical all pole model as well as data driven approaches such as neural networks. We generally found that the data driven models were better able to fit the observed data. However, the all pole models were better able to represent the spectral peaks of voiced sounds. We also found that normalizing data and compensating for variability improved mapping performance.

GAVIN HANGCHI

Distributed Objects Architectures Performance Evaluation

Supervisor: A/Prof. G. Bundell

Development of distributed computing systems is complex. To be shielded from this complexity, application developers may utilise a middleware, which may provide some measure of abstraction from low-level implementation details. Popular examples of such middleware include CORBA and JMS. Recently, Data Distribution Service (DDS) has emerged as a new middleware standard for distributed computing using a data-centric publish/subscribe architecture. Publish/subscribe offers many advantages to the client/server model as used in previous standards.

In this project we produced a detailed quantitative and qualitative analysis of a DDS product called OpenSplice. This was accomplished by designing and implementing a benchmarking application in the OpenSplice environment. Specific areas of study were guided by Thales Australia, a user and developer of OpenSplice.

We found that OpenSplice offers extensive support for arbitrary data types and quality of service parameters. We also demonstrate on our experimental setup that the requirements of a system with typical data load to Thales Australia's specifications are easily satisfied by OpenSplice.

MATTHEW HARLEY

IDEAL House Vision Systems

Supervisor: A/Prof. G. Bundell

The use of computer vision systems in a smart house environment has been in development for years, but is still yet to reach widespread consumer adoption. Research in the area is focused on three main areas, being security, home automation and smart homes for the elderly. Using off-the-shelf camera technology and open source software, this project focuses on creating a flexible, expandable and modular vision processing architecture to provide real-time visual analysis and event triggering in the IDEAL house, which can be easily extended by future projects.

JASON HEERIS

Single Channel Blind Source Separation Using Independent Subspace Analysis

Supervisor: Dr R. Togneri

The problem of separating conceptually distinct sources of information in a single channel mixture signal, known as single channel blind source separation, was approached using the technique of independent subspace analysis, an extension of independent component analysis. A prototype system was implemented and tested in the numerical processing language Octave and showed reasonable success at separating simple test signals. The prototype failed to adequately separate mixtures of speech and noise, however, and its performance was severely degraded when adapted to operate on non-stationary signals. The inability to select an optimal level of detail to retain during processing coupled with the unsatisfactory non-stationary operation appear to be the main weaknesses of this technique, and further development should focus on improving these points.

RAHUL KHUBCHANDANI

Towards the Real-Time Classification of the P300 Pre-stimulus EEG

Supervisor: Dr R. Togneri

A recent development in electrophysiology has been the use of interactive recordings to examine the effect of a particular background electroencephalogram (EEG) pattern upon the averaged Event Related Potential (ERP). Whilst much work has been dedicated to identifying correlations between ERP features and post-stimulus EEG, this project investigates the relationship between the less explored pre-stimulus EEG and ERP effects. A number of different pattern recognition techniques are applied in this new neurophysiological paradigm, in the effort to obtain evidence of the pre-stimulus EEG patterns that may be characteristic of schizophrenia and/or the particular averaged ERPs observed.

KIAN KUCHAKPOUR

Automatic Generation of Hexahedral-Dominant Meshes for Image Registration and Surgery Simulation

Supervisor: Dr T. Fernando

A neuro-navigation system that accounts for brain shift can be constructed using a method called image registration that ultimately utilises a finite element analysis approach. Building a finite element model requires a mesh of the structure preferably comprising of hexahedral elements. However, automatically generating hexahedral elements for complex structures like the brain is a problem that is yet to be solved. This project looks at a new approach where a hexahedral dominant mesh is sought rather than a fully hexahedral mesh. A new algorithm for hexahedral dominant mesh generation is developed and a prototype generator that employs the algorithm is implemented in MATLAB. The requirements of the generator for it to be feasible to use for image registration is that it needs to be time efficient, robust and produce a good quality hexahedral dominant mesh. The prototype generator was tested on an ellipsoid and ellipsoid with holes. The generator fulfilled all the requirements except it did exhibit problems generating purely hexahedral dominant meshes. The meshes produced were hexahedral dominant with respect to volume but not with respect to the number of elements. However, it was shown that the parameters of the algorithm did have an effect on the percentage number of hexahedral elements and a few approaches were clearly outlined to fix this issue for any future work in this area. This work was quite unique in that it looked at ways to produce automatic meshes that are only hexahedral dominant and further, it lays the foundation work for creating a neuron-navigation system that accounts for brain shift based on image registration for brain surgery simulation.

CE YIN (SEAN) LEE

Performance Evaluation of Mobile Devices

Supervisor: A/Prof. G. Bundell

PDAs today continue to struggle to satisfy our increasing demand through advancements in technology. This is why this project will research into improving the performance of PDAs at hardware, software and also at a user-friendliness and convenience level. When considering enhancements for the PDA, we would obviously have to take into account the limitations involved with mobile devices such as size and battery life to assure the convenience that it should provide.

This project will also look into justifying the shortcomings within Motorola's 'SmartPhone' architectures and providing innovative solutions on how their recent SmartPhone technology can evolve into their next era of Microsoft Windows Mobile PDAs.

WAI LOONG (STEPHEN) LEE

Identification of Emotion in Speech

Supervisor: Dr R. Togneri

There are many obstacles in the way to designing a successful emotion in speech recognition system. This paper has addressed the obstacles related to reliability of the emotional corpus, and proposed experiments to test the theory in literature and to measure the effectiveness of certain methods in increasing system recognition accuracy rates. The methodology adopted in this paper has seen the design of the system from the stage of compiling the emotional utterance database to testing of the system. It must be said that compiling the database is considered half the task for this paper, owing to the elusive nature of naturally occurring emotional utterances. Through the use of elicitation techniques on 11 subjects, a database totaling just above 350 happy and irritated utterances was formed. Upon compilation of the database, a GMM-based emotion recognition system was created, on which the following experiments were performed: (a) testing of a purely-elicited emotional training database, and (b) testing of a self-referenced training database. Via these experiments, the final design of the system yielded a recognition accuracy rate of 75% an increase from the original system's accuracy rate of 69.1%. These results indicate that improvements in the quality of design of systems can be made, which lead to increases in recognition accuracy rates.

ROB LIGHTFOOT

Design of the Data Acquisition and Control system for a Hydrogen Fuel Cell Vehicle

Supervisor: Dr T. Fernando

The data acquisition, user interface, sensor and actuator system was designed and partially built for use in a hydrogen fuel cell vehicle. A controller area network was implemented, using microcontroller nodes connected by a single CAT5 cable. The network should be able to run at 8000 messages per second split between 20 nodes, with a max theoretical sampling rate of 400Hz. A sampling rate of 100Hz was used, allowing a low bus load so bad frames could be resent without any chance of disrupting the data flow.

The vehicle requires 15-20 nodes to be effective in reducing wiring and being able to reach all sensors and actuators. Everything from lights and windscreen wipers to the motor controller temperatures would be controlled by the CAN bus, so any power losses or other problems could be found easily in later analysis.

Microchip PIC's were used to control the nodes and a National Instruments PCI-CAN interface was used with Labview for the user interface. Labview will run on a mini computer and touch-screen mounted next to the driver. The Labview front panel utilizes tabs that allow the driver to quickly move through all the information available on the bus. Labview also continually logs all the data on the bus to a delimited text file so any failures can be analysed at a later date.

LEROY LUM

Performance Analysis of Cryptographic Algorithms

Supervisor: Dr R. Togneri

In the modern digital information age, the use of effective cryptography is a must. There are many uses for cryptography such as for the secure storage of sensitive data, secure transactions, user identification and digital rights management. There are many cryptographic algorithms available for both public-key and secret-key encryption but in particular the public-key Rivest, Shamir and Adleman (RSA) algorithm will be examined.

The aim is to implement different variants of RSA; standard RSA, RSA using the Quisquater-Couvreur method and MultiPrime RSA in the C programming language and to analyse the results. In theory the Quisquater-Couvreur method and MultiPrime RSA run faster than the standard RSA algorithm.

Also, a review of other cryptographic algorithms will be included and compared where possible.

IAN LUTZ

Tieline Wireless Listening Device Base Station

Supervisor: A/Professor A. Zaknich

Commercial and in confidence.

DAVYD MADELEY

Automatic Computer Classification of Solo Musical Instruments

Supervisor: Dr R. Togneri

Musical instrument recognition has many applications in Music Information Retrieval (MIR) systems. This project describes and implements a musical instrument recognition system capable of recognising six solo musical instruments causally and in near real-time, with an accuracy of 65%. Eight signal features were used to achieve this result including spectral features and Mel-Frequency Cepstral Coefficients. A feed-forward artificial neural network is used as the classifier.

For training and testing the classifier, a database of recordings for the six instruments was made that included both solo instruments and duets. The algorithm was able to classify unseen data played by the same musician and by different musicians. Surprisingly it locked onto a musician who trained on one instrument and tested on another. The algorithm also performed reasonably with a similar, but unseen, instrument and muted instruments. Duet performance was briefly analysed.

JAMES AUSTIN MCALPINE

Level Control Using a PLC

Supervisor: Dr T. Fernando

Level control is a commonly encountered problem in various types of industry. This project explores the use of a Programmable Logic Controller to implement an efficient and effective control system for the level of water in a water tank system. This is achieved through the application of control theory and through the testing of various control strategies. A Proportional-Integral-Derivative (PID) Controller is successfully implemented using a PLC. Various tuning methods are used to obtain parameters for the PID controller and effective level control is consequently achieved.

RYAN BRADLEY MEPHAM

Implementation of Speech Recognition

Supervisor: Dr R. Togneri

Automatic Speech recognition software has existed for about fifty years. Throughout the years there have been some promising applications of the software into the real world. For example there has been the development of transcription machines. Applications have been further extended to machines communicating with humans. Speech recognition software also has its applications with control systems. One of these applications includes the use of speech recognition software in the home environment. As with the first use of controlled electricity by Alexander Bell with the light bulb, the light source has again been thrust into spotlight with a speech recognition light switch. This would allow the user to have the ability to control a room from the same position.

BEN MURRIHY

Automatic Measurement of Defect Density of HgCdTe Wafers

Supervisor: Dr R. Togneri

HgCdTe semiconductors have great applicability in the realm of infrared detection. A way to automatically count the number and areas of defects on HgCdTe wafers could ease a very difficult and tedious manual process. The information gathered by such a system could be used to determine the quality

of semiconductor wafers and so evaluate different wafer production techniques or estimate yield of fabrication techniques. The images gathered are filtered in a variety of ways and then thresholded in order to segment the image into separate objects. These objects are counted and a histogram of their areas created: these are compared with each other and with a manually created version, for testing. Two types of defects are considered: Te precipitates and etch pit defects. Detecting objects successfully is much easier for the former as they are generally sparser and the surface is less textured. Overall the methods presented are adequate but fail a rigorous standard of accuracy when compared to a subjectively created reference image. Since the reference is but a subjective interpretation, it still allows that these techniques might be of reasonable accuracy.

Further investigation into this area could likely improve the techniques to quite accurate.

HUSAIN ZOEB SADIQ

Modelling and Control of Insulin Delivery in a Diabetes Treatment

Supervisor: Dr T. Fernando

In the development of equipment to administer insulin, it is essential to conceptualize how insulin helps to regulate blood glucose level. It is very important that the relationship of blood glucose and insulin is understood and use the understanding to develop a model which will represent the glucose regulatory system and implement it.

The paper will present a review of two approaches taken for the purpose of this study. The first approach would be the Ackerman Model i.e. a linear model and the second approach being a non-linear model. New ideas pertaining to control theory and PID controllers will be explored, covering concepts on feedback, process control and controller tunings relating to modelling of glucose regulatory system.

A number of permutations were considered in arriving at a successful model of glucose regulatory system using both approaches, A successful achievement was made when implementing a model of the system using PID controllers and functional observers.

JASON TAN

Bucket Wheel Reclaimer Automotion Upgrade
Supervisor: Dr T. Fernando

The stacker is well-known for its ability to deposit materials such as coal in pre-set patterns and a wide variety of configurations and throughputs. Increasingly, the extent of automatic control has grown. For example, a power plant or a transhipment terminal, the cost-efficiency of a stacker's operations determines the smooth functioning of its coal transport system. The need to move considerable tonnages in a short time - at least to avoid vessel demurrage - is to achieve fast reclaiming of the varied coal types carried. As reclaiming and stockpiling must very often be carried out simultaneously, the bucket wheel reclaimer has been selected as it operates in combination with the stacker or stacking out bridge.

The problem with the current reclaimer controller is an inconsistent reclaiming rate by the reclaimer due to a slow control system and as a consequence of the slow control system the reclaimer is subject to bogging.

The problems are directly attributable to poor speed reference control and integral windup. The system proposed by this undergraduate would have a much more accurate speed reference and very small integral term leading to fast response. Thus an improved PID controller is proposed that takes into account angular displacement of the boom and the slew speed of the reclaimer.

LAY HOOI TAN

Music Genre Classification
Supervisor: Dr R. Togneri

Music genre classification systems are systems that apply genre labels to songs by the content of the songs. This paper describes the development of two types of classification systems, the supervised and unsupervised systems.

The paper presents the theories and roles behind each component in both classification systems as well as detailed description of the how our chosen design was implemented. Our classification systems are made up of three main parts, the feature extractor, classifier and the decision making component. Mel-Frequency Cepstral Coefficients (MFCC) features and Gaussian Mixture Model (GMM) classifiers were used in both systems. The main purpose of the study is to conduct an objective comparison on the performance of the two systems in classifying genres. Hence, the same features and GMM parameters were used for the two of the experiments that were carried out in this study. Results have shown that the supervised classification system is able to achieve an overall accuracy rate up to 66.45%. They also indicated that the supervised classification system classifies songs according to genres that users perceived them to be. Results collected from the unsupervised system were unsuitable for the computation of an overall accuracy rate. However, the experiments have shown the potential of the unsupervised classification system to be an effective one.

JAYASHREE VALYUTHAM

Modelling and Control of Insulin Delivery in Diabetes Treatment

Supervisor: Dr T. Fernando

Diabetes mellitus is a chronic disease due to raised blood glucose concentrations. Poor blood glucose level control leads to several complications in the body. Tight regulation of blood glucose levels is necessary to avoid these complications. Current treatment methods are invasive, promotes discomfort and inconvenience to the diabetic individual. Motivated by the desire to improve the quality of life of a diabetic individual a solution was derived. A closed-loop control system that represents the blood glucose regulatory in a human body that doesn't require patient interference was represented.

The thesis is based on the theoretical design of a controller to deliver insulin within a closed-loop insulin delivery system. Suitable mathematical model that represents the dynamic of insulin and glucose in the human body is selected for this system. It is desired that the system exhibits optimum performance, despite the presence of uncertainties in the model.

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