Centre for Intelligent Information Processing Systems

Annual Report 2002

SCHOOL OF ELECTRICAL, ELECTRONIC AND COMPUTER ENGINEERING

THE UNIVERSITY OF WESTERN AUSTRALIA

CONTENTS

DIRECTOR'S REPORT

There have been a number of changes in the past year that will have an impact on the Centre for years to come.

In April, Professor Yianni Attikiouzel, the founder of the Centre, took up the position of Executive Dean of the Division of Science and Engineering at Murdoch University. More than a decade ago, Professor Attikiouzel foresaw the impact that intelligent computing would have on science and technology and set up the Centre so as to encourage multidisciplinary research and development activities that would apply intelligent computing techniques to a range of real-world problems. Under his leadership, the Centre grew in size and influence and developed some important research specialities, such as biomedical engineering and robotics.

When Professor Attikiouzel left, I took up the position of Acting Director for the remainder of 2002.

In August, most of the staff of the Australian Research Centre for Medical Engineering (ARCME) also moved to Murdoch. The two centres have worked closely together since the latter's inception, and this collaboration will continue for the remainder of the current round of funding of ARCME.

A further change occurred towards the end of the year, when planned upgrading of the clean room facilities in the Department of Electrical and Electronic Engineering made it necessary for the Centre to vacate the laboratories that it had occupied on the fourth floor of the Electrical and Electronic Engineering building since 1995. Alternative laboratory space was allocated to the Centre on the second and third floors of the building. By the end of the year, the relocation of the facilities was complete. The Centre now occupies five laboratories on the third floor and one on the second floor.

In 2003, Associate Professor Thomas Bräunl will be the Director of the Centre. Its activities will continue in the areas of biomedical engineering, control, parallel and distributed computing, robotics, signal and image processing, software engineering and spoken language systems. The continued existence of the Centre is an affirmation of the vision of its founder and a reflection of the growing importance of its research areas in education and industry.

Chris deSilva
Acting Director
Centre for Intelligent Information Processing Systems

The picture on the cover shows Adrian Boeing and Estelle Winterflood working with the robot Andy Droid.

INTRODUCTION TO THE CENTRE

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

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

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

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

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

EQUIPMENT

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

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

CAPABILITIES

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

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

MEMBERS OF THE CENTRE

ACADEMIC STAFF

Department of Electrical and Electronic Engineering

Professor Yianni Attikiouzel, AM, FTSE, BSc(Hons), PhD, FIEE, FIEEE, FIEAust

Associate Professor Thomas Braunl, MS, PhD, MIEEE

Dr Gary Bundell, BE, MEngSc, PhD, MIEAust, CPEng, MIEEE, MIEE, CEng

Dr Chris deSilva, BSc(Hons), DipEd, PhD, MIEEE

Dr Tyrone Fernando, BE(Hons), PhD

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

Associate Professor Peter Wilke, MS, PhD

Mr Terry Woodings, BSc, DipComp, FACS, FQSA

Department of Computer Science

Mr Peter Jones, BSc, MSc, MIEEE

Dr John Morris, BSc(Hons), PhD

Department of Mathematics

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

Department of Pathology

Professor J. Papadimitriou, OStJ, BA, MB, BS, MD, PhD, FRCP(UK), FRCP(Aust), FIB

RESEARCH STAFF

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

ADMINISTRATIVE STAFF

Ms Violetta Cetrullo (to April 2002)

Mrs Brenda Churchill (to September 2002)

Ms Sandra Passamani (from September 2002)

VISITORS

Mr Christoph Braunschädel, FH Koblenz, Germany

Mr Jia Lei Du, University of Stuttgart, Germany

Professor Peter Lawrence, University of British Columbia, Canada

Mr Antonio Pickel, FH Koblenz, Germany

Mr Peter Rowlands, The University of Western Australia, Australia

Mr Jung Hyun Ryong, Chonnam National University, Indonesia

Ms Alexandra Unkelbach, University of Kaiserslautern, Germany

Mr Axel Waggershauser, University of Kaiserslautern, Germany

Mr Stefan Weigand, University of Erlangen-Nurnberg, Germany

Dr Anthony Zaknich, The University of Western Australia, Australia

Mr Jochen Zimmermann, FH Koblenz, Germany

POSTGRADUATE STUDENTS

Doctor of Philosophy

Mr Ashbollah Aziz

Mr Frederick Chee

Ms Fiona Evans

Mr Bradley Finch

Mr Thomas Hanselmann

Mr Philippe Leclercq

Mr Martin Masek

Mr Pubudu Pathirana

Mr Alistair Sutherland

Mr Chok Kee Tham

Mr Terry Woodings

Mr James Young

Mr Fangwei Zhao

Master of Engineering

Mr Ivan Mendez Zapata

Mr Erik Råberg

Master of Engineering Science

Mr Sze Man Kwok

Mr Siddharth Parekh

UNDERGRADUATE STUDENTS

An Tong

Aw Chee

Binet Ian

Boeing Adrian

Chang Kenneth

Creasy Steven

Davey Catherine

Dickie Livia

Doan John

Fani Shervin

Fernandez Josh

Foo Chee Shian

Foo Jason

Franciscus Naden

Gunawardena Charith

Hanrahan Jeremy

Haryadi Alvin

Ho Chun Wei

Ho Kevin

Hwang Yves

Ip Sinmei

Jones Steven

Kalaimani Vikram

Khaw Kian Hin, Joseph

Koch Leon

La Brooy Luke

Laney Paul

Lee Ga Vin

Lee Jamieson

Lee Kin Hong

Lee Shirlyn

Lim Eric

Loo Meng Sun

Lucioli Alessandro

McManus Damon

Ng Tee Yen

Odhavji Seema

Patterson Hilary

Poh Katherine

Purdie Jonathan

Richardson Jennifer

Richardson Kayne

Rivera William

Siano Gaetano

Smith Courtney

Soo Alvin

Stamatiou Nicholas

Stan-Bishop Charles

Teo Han

Tey Jason

Thomson Jane

Toh Yi Er

Vaidiyakumar Prasannah

Venkitachalam Daniel

Versaci Damian

Wang Sin Li

Ward Matthew

Winterflood Estelle

Wong Timothy

Wong Wen-Fei, Frank

Yap Yin-Yue, Joanna

Yau Nicholas

Yeo Gareth

MEMBERS OF THE CENTRE

6th row, left to right: Charith Gunawardena, R.Chandrasekhar, Prasannah Vaidiyakumar, Alvin Soo.

5th row, left to right: Brenda Churchill, Fiona Evans, Frederick Chee, Kayne Richardson, Steven Jones, Anthony Zaknich, Chris deSilva, Simon Kwok, Yi Er Toh, William Rivera, Sin Li Wang, John Doan.

4th row, left to right: Martin Masek, Roberto Togneri, Alvin Haryadi, Chee Shian Foo, Han Yang Teo, Kin Hong Lee, Gareth Yeo, Tee Yen Ng, Chun Wei Ho, Hillary Patterson, Sinmei Ip.

3th row, left to right: Peter Wilke, Shervin Fani, Gaetano Siano, Damon McManus, Jason Foo, Jamieson Lee, Jon Purdie, Leon Koch, Paul Laney.

2nd row, left to right: Thomas Hanselmann, Yves Hwang, Joanna Yap, Naden Franciscus, Courtney Smith, Nicholas Stamatiou, Adrian Boeing, Meng Sun (Rodney) Loo, Timothy Wong, Vikram Kalaimani.

Front row, left to right: Tyrone Fernando, Christoph Braunschadel, Jia Lei Du, Erik Rayberg, Pantazis (Peter) Houlis, Yianni Attikiouzel, Thomas Braunl, Estelle Winterflood, Jason Tey, Eric Lim, Jennifer Richardson.

RESEARCH ACTIVITIES

ARTIFICIAL NEURAL NETWORKS

The Centre has been active in research on the theory and applications of artificial neural networks from its inception. It has developed new architectures and developed a range of applications, mainly in signal processing, image processing and pattern recognition.

In 2002, the Alumina Hydrate Characterisation expert system, a standard product quality evaluation system that uses artifical neural networks, was completed.

BIOMEDICAL ENGINEERING

The design of an automatic closed-loop system which uses subcutaneously measured glucose levels to control high blood sugar levels in patients rendered diabetic by critical illness was the focus of a project that was commenced in 2001. This project continued in 2002 and was complemented by a number of final year student projects.

Two final year student projects developed an infusion pump controller that could be used for patient controlled analgesia. The designs were sufficiently versatile for them to be usable in a range of different infusion applications, including blood sugar level correction and cancer treatment.

A number of projects were concerned with medical image processing. In particular, two postgraduate students developed algorithms for the automatic analysis of mammograms and ultrasound images of the prostrate gland. A final year student project was concerned with the quantification of the volume displaced by the motion of the diaphragm from measurements taken from lateral fluoroscopy images.

CONTROL

A final year student project investigated the robust stability of two-dimensional digital filters. A theoretical study of the design of various observers was completed and it was concluded that they were capable of state estimation. Another project investigated the use of impulse invariant transformations in the analysis of two-dimensional systems and filters.

DIGITAL SIGNAL PROCESSING

A final year student project designed a digital display for the UWA Motorsport 2002 racing car. The display was interfaced with various sensors to provide an information display for testing, tuning and dashboard instrumentation.

Another project investigated the use of a Programmable Logic Controller for controlling DC motors.

IMAGE PROCESSING AND PATTERN RECOGNITION

The recognition and counting of fish in video sequences taken underwater is the aim of a project commenced in 2001 and continued in 2002. Accurate estimation of numbers of fish is important for the management of fish stocks and fish farms. The project will develop image processing software that will count fish as they swim past a camera. This project is being carried out in collaboration with Dr Euan Harvey of the UWA Department of Botany and the CSIRO Division of Mathematics and Information Sciences.

A research project on the use of n-gram models for Information Extraction for the Named Entity Task was carried out under contract to the Defence Science and Technology Organization in Adelaide.

A final year student project investigated ways of making quantitative assessments of feature-based stereo matching algorithms. The algorithms were assessed using a perfect image pair generated using a ray-tracing program as well as image pairs contaminated with Gaussian noise. Various metrics were used for the evaluation of the algorithms.

MOBILE ROBOTS

The year 2002 was very productive in the Mobile Robot Lab with a number of new projects being accomplished.

A new simulation system for multiple driving robots in a common environment has been completed. The "EyeSim" system allows us to experiment with robot application programs under perfect conditions. We can simulate the cooperation of large numbers of robots or we can let a single robot learn over several days. The simulator includes all sensors of our EyeBot robots, including a generated synthetic image as it would be seen from the robot's on-board camera.

A behaviour-based system has been implemented using the EyeSim simulation system as a tool. A robot's task is now described as a set of behaviours, as opposed to a fixed program in conventional programming style. The important task of activating a particular behaviour and giving it control of the vehicle's drive system is being performed by a neural network. This neural network is not being trained in the classical sense. Instead, it is evolved over a number of robot generations, using genetic algorithms. The neural structure of the fittest robots is being recombined for the next generation, generating better and better adapted robot control structures for solving a given task.

The latest version of our "Improv" image processing tool now allows the separation of the graphical user interface and the actual image processing library. The system has been re-implemented in an object-oriented design. New image processing functions can be loaded into the system with dynamic libraries, not even requiring re-compilation of the complete package. We continue to use "Improv" for developing image processing routines off-line for a number of mobile robot applications.

A new biped walking robot has been developed, together with a new simulation system for legged robots. The new physical robot is using servos with five degrees of freedom per leg, plus one in each arm. It is a lightweight design and equipped with a variety of experimental sensors. The biped simulation system uses the "DynaMechs" package for the mechanical simulations and directly generates graphics output of the simulated creature. We use genetic algorithms to evolve periodic spline patterns, used to control individual joints of the walking robot. After several days of simulation and numerous generations of simulated robot populations, stable walking patterns occur.

At the moment, we are working on adding simulated sensors that match the physical robot's sensor equipment to our model. This will allow the robot to walk much more stably in flat or rougher terrain and also allow us to transfer the simulation results back to the physical robot.

A new robot has been constructed on the basis of a model snow truck. This all-terrain robot can go up and down slopes and over obstacles. It is equipped with an EyeBot controller and a number of sensors. We used it as a testbed for orientation sensors, which have been mounted on the robot and are actively monitored:

- accelerometer
- gyroscope
- inclinometer
- digital compass.

Through sensor fusion between several of these sensors, we can more accurately determine the robot's orientation. With this information, the robot can automatically adapt its driving speed to the surface it is on and even avoid driving towards unsafe terrain (e.g. too steep slopes or walls).

SOFTWARE ENGINEERING

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

A new area of development this year has been in the performance evaluation of Knowledge Management infrastructure and technologies. This work was done in collaboration with Honeywell Ltd who are seeking a major advance in information control and expertise sharing in their local organization.

Collaborative research was also performed with ADI Ltd in the area of performance evaluation of one of their commercial distributed information systems. This work reviewed the architectural design of the system modeled in UML, the correctness of mapping to implementation, and the performance of message handling throughout the system.

SPOKEN LANGUAGE SYSTEMS AND SIGNALS AND INFORMATION PROCESSING

In 2002 there were several projects involved with various aspects of spoken language technology, from speech enhancement to language modelling. Two projects investigated simple isolated and connected digit recognition for both English and Japanese. In both cases recognition rates in excess of 98% were obtained. It was confirmed that significant improvement is obtained when adapting models to new speakers and environments and when choosing the correct combination of models (e.g. including a short-pause for connected word recognition). One project dealt with the investigation of various speech enhancement algorithms for both robust speech recognition and higher intelligibility in the presence of additive noise. This was a very successful project providing a good foundation for comparing the different modelling approaches in future implementations. Two projects involved different aspects of language modelling and understanding. One project investigated the use of more advanced language modelling, including class-based modelling, for improving speech recognition decoding. It was established that a class-based approach provides the same level of performance as a word-based system but with a significant reduction in computational complexity. The second project investigated the problem of robust language understanding. The results of this research demonstrated that by the inclusion of appropriate modifications to standard parsing algorithms a very effective robust parsing strategy can be achieved. The novel extensions and results of this work are being considered for publication.

The work on the Hidden Dynamic Model (HDM) continued with investigations of optimal decoding strategies and more comprehensive evaluation. The results look promising with the HDM being able to detect the reference transcription in a 1000-best list where the baseline Hidden Markov Model fails to detect even one such case. The work on optimal decoding strategies is still continuing.

GRANTS AND CONTRACTS

The Centre was in receipt of the following grants and contracts during 2002.

Information Extraction for the Named Entity Task	DSTO, Adelaide	$50,000
Visiting fellow/FAU Collaboration	Friedrich-Alexander-University, Germany	DM360,000
Rail Flaw Detection System	Fairclough Corporation	$15,000

TEACHING ACTIVITIES

DOCTOR OF PHILOSOPHY

The Centre had thirteen postgraduate students working towards their doctorate in 2002.

MASTER OF ENGINEERING SCIENCE DEGREE

The Centre had two students enrolled for the Master of Engineering Science degree in 2002.

MASTER OF ENGINEERING IN IIPS DEGREE

The Centre offers a programme for the degree of Master of Engineering by Coursework and Dissertation in Intelligent Information Processing Systems. The course was designed to provide an advanced coverage of the theory and development of intelligent information processing systems. Two students were enrolled in the course in 2002.

CIIPS PUBLICATIONS 2002

JOURNAL ARTICLES

1. PETITT, J., BRÄUNL, T.

   Framework for Cognitive Agents,

   Journal of the Institute of Control, Automation and Systems Engineers (ICASE), Korea, November 2002

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

   Closed-loop Control of Blood Glucose Levels in Critically Ill Patients,

   Journal of Anaesthesia and Intensive Care, Australia, Vol.30, No.3, June 2002

3. FERNANDO, T., CADE, J., PACKER, J.

   Automatic Control of Arterial Carbon Dioxide Tension in Mechanically Ventilated Patients,

   Journal of IEEE Transactions on Information Technology in Biomedicine, United States, Vol.6, No.4, pp.269-276, 2002.

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

   Constrained pole placement for linear systems using low-order output feedback controllers,

   International Journal of Systems Science, United Kingdom, Vol.33, No.3, pp.165-173, 2002

INTERNATIONAL CONFERENCE PAPERS

1. BALTES, J., BRÄUNL, T.

   HuroSot - Laws of the Game,

   FIRA 1st Humanoid Robot Soccer Workshop (HuroSot), Daejeon, Korea, pp. 43-68 (26), January 2002.

2. BRÄUNL, T., SUTHERLAND, A., UNKELBACH, A.

   Dynamic Balancing of a Humanoid Robot,

   FIRA 1st Humanoid Robot Soccer Workshop (HuroSot), Daejeon, Korea, pp.19-23 (5), January 2002.

3. BRÄUNL, T., PETITT, J.

   Adaptive Local Control of a Group of Robots,

   2002 FIRA Robot World Congress, Seoul, Korea, pp.80-85 (6), May 2002.

4. SUTHERLAND, A., BRÄUNL, T.

   An Experimental Platform for Researching Robot Balance,

   2002 FIRA Robot World Congress, Seoul, Korea, pp. 14-19 (6), May 2002.

5. MASEK, M., DESILVA, C.J.S., ATTIKIOUZEL, Y.

   Comparison of Local Median with Modified Cross-Entropy for Pectoral Muscle Segmentation in Mammograms,

   Analysis of Biomedical Signals and Images 16th International URASIP Conference Biosignal 2002, Brno, Czech Republic, pp.320-322, May 2002.

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

   Image Retrieval Based on Histogram Comparison for Digital Mammography Workstations,

   International Congress on Biological and Medical Engineering 2002, Singapore, pp.1-2, December 2002.

7. ATTIKIOUZEL, Y., CHANDRASEKHAR, R.

   DSP in Mammography

   14th International Conference on Digital Signal Processing Proceedings Santorini, Greece, pp.29-34, July 2002.

8. CHANDRASEKHAR, R., HOULIS, P., ATTIKIOUZEL, Y.

   Unconventinoal Edge Detector: Preliminary Theoretical Investigation

   14th International Conference on Digital Signal Processing Proceedings Santorini, Greece, pp.457-460, July 2002.

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

   Adaption of the Daugman-Downing Texture Demodulation to Highlight Circumscribed Mass Lesions on Mammograms

   14th International Conference on Digital Signal Processing Proceedings Santorini, Greece, pp.457-460, July 2002.

10. SHEN, K., CHANDRASEKHAR, R., ATTIKIOUZEL, Y., SINGH, B., FINUCANE, K.E.

    Analysis of Digitized Lateral Fluoroscopy Images to Quantify the Volume Displaced by the Diaphragm

    24th Annual International Conference of the IEEE EMBS and the 2nd Joint EMBS/BMES Conference, Houston, Texas, USA, p.1047-1048, October 2002.

11. GROEBNER, M., WILKE, P.

    A General View on Timetabling Problems

    4th International Conference on the Practice and Theory of Automated Timetabling, Belgium, pp 221-227, August 2002.

12. BOEING, A., BRÄUNL, T.

    Evolving Splines: An alternative locomotion controller for a bipedal robot

    Seventh International Conference on Control, Automation, Robotics and Vision, ICARV 2002, Singapore, pp 1-5, December 2002.

13. CHEE, F., FERNANDO, T., VAN HEERDEN, P.V.

    Closed-loop Control of Blood Sugar Level Using CGMS(TM)

    2nd European Medical and Biological Engineering Conference, Vienna, Austria, pp. 314-315, December 2002.

14. CHEE, F., FERNANDO, T., VAN HEERDEN, P.V.

    Three-Point Regression Calibration for Real-Time Blood Sugar Level Estimation

    2nd European Medical and Biological Engineering Conference, Vienna, Austria, pp. 1166-1167, December 2002.

15. WONG, T.K.W.

    Data Fusion Applied to Medical Images: Integration of CT and MR Brain Images

    Conference on Biomedical Engineering, BME2002 Hong Kong, PRC, pp.17-21, April 2002.

16. WOODINGS, T. L.

    Limiting factors of estimation accuracy and project risk

    17th International Forum on COCOMO and Software Cost Modelling, University of Southern - Centre for Software Engineering, Los Angeles, California, USA, October, 2002.

17. WOODINGS, T. L.

Risk as Zero'th order change in Software Project Estimation

Read to the COCOMO-17 International Forum, University of Southern California, Los Angeles, California, USA, October, 2002.

18. MASEK, M., DESILVA, C.J.S., ATTIKIOUZEL, Y.

Automatic Breast Orientation in Mediolateral Oblique View Mammograms

Digital Mammography, IWDM 2002, 6th International Workshop on Digital Mammography, Springer-Verleg, Bremen, Germany, 2002.

NATIONAL CONFERENCE PAPERS

1. RANDOLPH, N., MORRIS, J., LEE, G.

A Generalised Spreadsheet Verification Methodology

Twenty-Fifth Australasian Computer Science Conference, ACSC 2002, Melbourne, Australia, pp 215-222, February 2002.

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

Determining Component Reliability Using a Testing Index

Twenty-Fifth Australasian Computer Science Conference, ACSC 2002, Melbourne, Australia, pp 167-176, February 2002.

3. WILKE, P., GROEBNER, M., OSTER, N.

A Hybrid Genetic Algorithm for School Timetabling

15th Australian Joint Conference on Artificial Intelligence, Canberra, Australia, pp 455-464, December 2002.

4. WOODINGS, T. L.

The Mechanical Improvement of Estimates during Projects

Australian Conference on Software Metrics, Melbourne, Australia, pp.4.1-4.12, November, 2002.

5. WOODINGS, T. L.

Where do the errors in Software Project Estimation come from?

Australian Conference on Software Metrics, Melbourne, Australia, pp.4.1-4.12, November, 2002.

SEMINAR TALKS

1. WOODINGS, T. L.

What is this thing called Quality? - Fad, fashion or style?

Read to the Department of Electrical & Electronic Engineering, University of WA, Perth, February, 2002.

2. WOODINGS, T. L.

Managing through Metrics - Core Values for iiNet Clients

Read to a staff seminar at iiNet, Perth, August, 2002.

3. WOODINGS, T. L.

Software Project Estimation - Assessing the Limits to Improvement

Read to the Inter-University Postgraduate Electrical Engineering Symposium, Murdoch University, Rockingham, October, 2002.

4. WOODINGS, T. L.

Pies and Source - CS, IS or SE? - Where should you get your graduates from?

Read to a meeting of the WA branch of the Australian Computer Society, Perth, October, 2002.

5. WOODINGS, T. L.

Multimedia and Software Engineering - A Fatal Attraction?

Read to the Development Unit in Instructional Technology, University of WA, Perth, December, 2001.

EDITED JOURNAL

ATTIKIOUZEL, Y. (ED.)

Australian Journal of Intelligent Information Processing Systems,

Perth, WA, Australia.

ABSTRACTS OF FINAL YEAR PROJECT REPORTS

TONG AN

Bipedal Walking Gait and Control in Robotics

Biped robots have higher mobility than conventional wheeled robots, especially when moving on rough terrain, steep stairs and in environments with obstacles. However, the biped robot inherently suffers from instability and always risks tipping over. The purpose of this thesis is to develop walking algorithms for use with mechanical bipeds to achieve stable balancing and walking.

In this thesis, a design methodology is described for building bipedal locomotion control architecture, inspired by the theoretical and experimental works to the actuator control in terms of self-organization and the observation of human walking behaviour. The proposed architecture is based on fuzzy logic and incorporates a pre-planned rhythm generator. This means the walking phase based controller is capable of adapting the pre-planned trajectory to the change of gait parameters and terrain feedback, which makes it so potentially useful.

This design methodology uses an intelligent control algorithm to incorporate expert understanding and experience on bipedal walking and mimics the operation of human decision making, which greatly reduces the complexity in bipedal gait generation and control scheme derivation, compared to previous approaches.

In this project, stable balancing and walking are achieved. A framework to systematically generate bipedal locomotion and control is developed and partially tested. A reconfigurable mechanical structure of the biped foot is designed and implemented. Terrain feedback and force control are made possible by the construction of foot pressure sensors. Various walking gaits such as turning, sideways walking, and kicking are produced. Goal directed behavior specified by remote control is accomplished. A path-planning algorithm for goal directed behavior specified by camera is proposed and tested. Future research methods are also proposed to improve upon the theories developed in this dissertation.

CHEE LEONG AW

Digital Display for UWA Motorsport 2002 motorcar

The digital display forms part of the UWA Motorsport 2002 motorcar. It is interfaced with various sensors onboard the motorcar to provide an information display for testing, tuning and dash display. The methodology used for the design of the display is the Total Design Method. The Total Design Method uses a systematic approach that breaks the project down into activities and aids in the identification of the important parts in each activity.

ADRIAN BOEING

Simulation of Biped Walking using Genetic Algorithms

Designing a control system for legged locomotion is a complex process. Human engineers can only produce and evaluate several configurations, although there may be numerous competing designs that should be investigated. Automating design of the control system allows the evaluation of thousands of competing designs, without requiring prior knowledge of the robot's walking mechanisms.

Development of an automated approach requires the implementation of a control system, a test platform, and an adaptive method for automated construction of the controller. Evolutionary algorithms provide a powerful method for automated problem solving. As with previous approaches, a genetic algorithm was successfully applied to the construction of locomotion controllers.

Two control systems were presented and evolved. Both control systems successfully generated locomotion controllers for bipedal robots. A detailed investigation of the spline control system was performed, and the extensibility of the controller investigated. The spline controller was applied to multiple robots with widely varying morphology and successfully demonstrated dynamic control for a number of legged robots.

KENNETH CHANG

Distributed Systems Modelling of Transport's Executive Licensing System

Models provide graphical representations that describe the problem to be solved and the system that is to be developed. The Unified Modeling Language (UML) has emerged in recent years as the standard modeling language to meet these ends. TRELIS is an integrated distributed executive licensing system developed by ADI for the Department of Transport, and the role of the transaction engine is to handle interactions between the client and the database. The TRELIS Transaction engine represents the perfect candidate for conducting modeling studies, because the component was developed and realized through clear modeling processes.

The initial focus of the project will be on the UML modeling of the interactions within the transaction engine. This will then be followed by how actual models are derived for the transaction engine including such areas as design patterns. Moreover a study will also be made to examine whether making any modifications would bring benefits to these original models and how areas such as performance can be improved by more faithfully following these models.

STEVEN CREASY

Upgrade the Eyebot Display Interface to a Colour LCD

This project has been undertaken to upgrade the eyebot controller. The eyebot is a small controller used in mobile robots, which are studied in the robot lab at the Centre for Intelligent Information Processing Systems (CIIPS). The CIIPS research group is based at the University of Western Australia in the Electrical and Electronic Engineering Department.

The eyebot controller currently uses a monochrome liquid crystal display. The upgrade involves replacing this display with a colour display. The project involves both hardware and software components.

The hardware component consists of obtaining a suitable display for the project and then connecting it to the eyebot. The software component involves programming the display from the eyebot and also providing a software interface, which is used to operate the LCD from the eyebot controller. This interface is to produce predominately the same functions as the current display with, of course, the colour addition.

CATHERINE DAVEY

Feature-Based Stereo Matching

This thesis provides a quantitative assessment of feature-based stereo matching algorithms. There are two broad categories of stereo algorithms; area-based and feature-based. Scharstein and Szeliski recently published a paper providing a quantitative comparison between area-based algorithms.

Algorithms were assessed on a perfect image pair that was generated using a ray-tracing program. The metrics used for evaluation were the percentage of pixels that were assigned the correct disparity value, and the mean absolute disparity error. The superior algorithms were also assessed for robustness by contaminating the images with white Gaussian noise.

First-derivative filters were approximately 10% more accurate than second-derivative filters, which suffered from sensitivity to small changes in intensity values. This suggests that first-derivative filters are preferable for feature-based algorithms. There were minimal performance gains in using floating-point numbers as opposed to binary numbers to represent edge maps. This result is particularly significant for hardware implementations, where resources are scarcer.

JOHN DOAN

Design and Implementation of a Portable Telepresence System

Telepresence is the immersion of a person's perspective to a remote location through the use of visual feedback from a camera stationed in that location. In order to create the illusion of immersion, the camera has to be able to orient itself according to the user's input.

When implemented properly, telepresence allows people to virtually exist in a remote environment as if they were there. With the addition of manipulators, the user can also interact with the remote environment. Thus, telepresence can allow people to virtually travel vast distances or work in hazardous environments from the relative convenience and safety of a control station.

Due to these features, telepresence is an area of great interest in the field of human to machine interfacing. However, it is not without its problems. Simulator sickness is a big problem when utilising telepresence, with many users experiencing symptoms such as nausea, disorientation and headaches as a result of using telepresence interfaces.

This dissertation discusses the process taken to produce a telepresence interface. It details the objectives achieved and the processes used in the project, from rudimentary design all the way to hardware and software implementation and final testing.

Future applications of the portable telepresence unit could include further studies into telepresence, remote piloting and simulator sickness.

JASON FOO

The Development of a Camera Driver for Soccer-Playing Robots

CIIPS Glory is a team of small-sized soccer-playing robots with localised vision and intelligence. In the past, the competitive performance of these robots was hindered by slow image processing, as it was only possible to acquire frames from the camera at a rate of 3.75Hz. To improve the frame rate, a FIFO buffer chip was added to the microcontroller board. However, software support for this had not yet been written.

The objective of this project was to develop a new camera driver that took advantage of the FIFO buffer chip, and analyse the extent to which this was able to improve the competitive performance of the CIIPS Glory robots. It was proposed that the new camera driver would be able to acquire frames at a rate of ~30Hz. As the sensor chip used by the camera was no longer being manufactured, it was also proposed that it would be possible for the driver to include support for two new camera sensor chips manufactured by OmniVision.

The findings of this project reveal that the limitations of the chosen hardware platform have been reached. After development, it was found that the camera driver could indeed acquire frames at a rate of 30 Hz, but only when no image processing was performed. Furthermore, periodic processing, such as closed-loop differential drive control, was found to conflict with frame acquisition; solving this problem was not possible in the time frame for this project. Finally, although the inclusion of support for the OmniVision cameras was successful, their higher spatial resolutions severely limited the frame rates that they could operate at.

YVES HWANG

Object Tracking for Robotic Agents with Genetic Programming

This thesis discusses the use of the Genetic Programming Paradigm to evolve solutions to the problem of robot object tracking. The performance of the Genetic Programming Paradigm will be compared to a traditional approach and the behaviour-based subsumption architecture as means of solutions for the object tracking problem. The results will be evaluated based on the speed and the robot's behaviour to achieve such task. The Genetic Programming Paradigm is seen as an intuitive evolutionary method and has demonstrated the capabilities to obtain a better solution.

SINMEI IP

An Investigation into Isolated and Connected Digit Recognition

The main objective of this project was to investigate speech recognition using Hidden Markov Models (HMM). The focus was on the structure and the performance of speech recognisers. The types of recognition examined were isolated word recognition and connected word recognition. Digit recognition was studied, as it is fundamental to many applications over the telephone and many interactive voice response systems.

The process of design and implementation of speech recognition systems was experienced through building simple systems using the Hidden Markov Model Toolkit (HTK). These systems were speaker independent with a digit vocabulary.

Factors that may affect the performance of a system, especially in HMM creation and training, were investigated. These factors include the structure of a HMM, splitting Gaussian mixtures into multiple components and the refinement of the model parameters using the Baum-Welch algorithm.

The isolated digit recogniser achieved the expected accuracy of 100 percent while the connected digit systems were able to obtain 98 percent. The number of states generally improved the accuracy of a system but the performance decreases after a certain number of states. Good performance is shown as the number of re-estimations increases until the model parameters converge, which then sees a drop in accuracy. Adding Gaussian mixtures refined the performance of the system, improving the recognition results.

STEVEN JONES

PCA: Patient Controlled Analgesia Design and Implementation of an Infusion Pump Controller and PCA Program

Infusion pumps provide a controlled continuous dose of medication by controlled driving of a syringe. Infusion pumps are widely used for continuous intravenous infusion in hospitals and nursing homes. In this project, an

infusion pump was modifed and upgraded to become computer controllable for future use in various CIIPS patient controlled analgesia (PCA) projects. This was done by replacing the mechanical controls on the pump with electronically controllable switches, and controlling all of these with a microcontroller. This microcontroller was programmed to interface with a PCA module, but may be reprogrammed in future to incorporate new modules as they are developed. An LCD and four buttons were mounted on the face of the final unit for user interface, and the whole package fabricated (including the infusion pump, controller, switches, LCD, buttons and batteries) into a compact and portable package. This unit was designed to give maximum flexibility for future modification, and so external connections to used ports were provided. In future, many CIIPS projects will be undertaken to develop new modules that perform different infusion applications (such as blood sugar level correction or cancer treatment) that will simply plug into this unit in place of the PCA module. The microcontroller program can be expanded to incorporate these new modules as they are developed, resulting in this unit being a portable, multi-purpose progammable infusion pump.

VIKRAM KALAIMANI

Impulse Invariant Transformations of 2D systems.

In the early stages of research into two dimensional systems we used finite differencing techniques to transform continuous time systems into equivalent discrete models. This thesis presents a simple impulse invariant transformation from the two dimensional (2D) discrete time state space model(s) to the two dimensional (2D) continuous time state space model. With the help of this transformation the well developed theorems and algorithms of the two dimensional discrete time systems can be used to carry out the analysis and design of two dimensional continuous time systems. More importantly this transformation can also be applied to hybrid 2D systems including the Fornasini Marchesini model. Thus we can study composite systems in any domain depending upon the application.

JOSEPH KHAW

Distributed Objects in Software Modelling

Developing distributed applications in real-time domains requires real-time guarantees in all underlying application, operating system and network components. Traditionally organisations have used customised or proprietary solutions to develop their distributed systems. Having to maintain and add new functional requirements to the existing system is a nightmare for developers. In building scalable, fault-tolerant and affordable distributed systems, commercial off the shelf solutions are the likely alternative.

Middleware is the key to developing distributed systems in a robust and scalable manner. One such middleware, CORBA, a standard for distributed architectures, provides scalable and affordable solutions, but lacks in providing quality of service (QoS) guarantees required by many real-time applications. The real-time CORBA standard addressed the limitations of the conventional CORBA standard.

This project investigates the performance of TAO, a real-time CORBA implementation; against other conventional CORBA implementations and competing distributed technologies. The focus of performance applies to standard transactional applications on low-end general-purpose operating system (GPOS) platforms. Unlike most previous research, the TAO tests are not being conducted on a high-performance endsystem, nor are the applications optimised and prioritised within the system. Therefore the application alone will not guarantee real-time performance, allowing the project to focus on the fundamental performance enhancements of TAO.

Results show that TAO performs better than the conventional ORB provided in J2SE at lower end tests. However, once the load is increased, results from TAO become more erratic and performance degrades to a point where J2SE outperforms TAO. This does not mean that the underlying J2SE architecture is more efficient than TAO. Differences in languages, services, object adapters and implementation have to be taken into account when considering the performance results.

JORDAN KOSEK

Design of a Telemedicine User Interface

The field of Telemedicine is changing the way physicians around the world practice healthcare. For remote regions, it is proving to be vital in providing residents with comprehensive health services where there were none. For larger institutions, Telemedicine provides the opportunity to share resources with other medical facilities. With an effective Telemedicine System in place, the need to transport healthcare workers, medical film, patients and their escorts can be eliminated.

Currently there is a medical application named "RadCad", designed by the ARCME group at The University of Western Australia that performs digital signal processing of medical brain scan images. The objective of this project

was to enable RadCad to become a 'Telemedicine' application. That is, to provide RadCad wih the type of Telemedicine application that has the features of dual-way audio link, text chat and of companion cursors. This will eliminate the need to transport healthcare practitioners or film, when conferring on examinations of brain scans.

The result is a Telemedicine application that can simultaneously transmit an audio and text conversation whilst positioning local and distant user mouse coordinates to give the local user a rich presence of the distant user. The audio link uses the most effective compression, GSM, which reduces the data bandwidth by almost a factor of five. It can be run on machines as low as a reasonably fast 486, or Pentium I, with Microsoft Windows 95 or later. The text chat and companion cursor features are also low in bandwidth consumption despite being run in separate Java Virtual machines and being Java in nature. Their computational use is irregular and non-CPU intensive; therefore the only remaining major performance factors depend on the load of the connected network.

Such an operating Telemedicine System could provide an invaluable opportunity for healthcare workers to learn from each other by mutually diagnosing brain scan images at any distance. Thus not only is the transport of film or healthcare practitioners greatly reduced, convenience gained and time saved, but new windows of educational opportunity present themselves now since healthcare workers can confer with anyone from anywhere around the world; some of whom would have otherwise been unreachable. Furthermore, this solution is viable economically, since even long distance conversations all occur for the cost of a local call, due to the IP nature of dialing. As the combination of further features that could be attached and integrated into such Telemedicine Systems, such as medical diagnosis tools and video imaging, become more common as technology evolves, so do the possibilities of such Telemedicine Systems to electronically provide a greater quality of care.

LUKE LA BROOY

Interfacing Compaq iPAQ PDA to Eyebot Controller

This project was to interface a Compaq iPAQ 3600 PDA to an Eyebot, which is a mobile robot. The main goal of the task being to use the processing power of the iPAQ for image processing with the Eyebot. The task had three main components:

1. Find a way to connect the iPAQ to a camera.
2. Develop a serial protocol to control the Eyebot from the iPAQ.
3. Develop application specific software to test the iPAQ Eyebot combination.

Since the camera provided was the one on the Eyebot, this meant that the images needed to be transmitted over the serial cable, in addition to the control signals. This significantly changes what is possible with the project and it becomes the following:

1. Find the best method method for image compression on the Eyebot.
2. Develop a serial protocol to transmit image and sensor data to the iPAQ and control commands to the Eyebot.
3. Develop application specific software to test the iPAQ Eyebot combination.

The need to transmit the images over the serial cable means that the emphasis on image processing must be reduced because of the limitations in frame rate, latency and resolution.

Even if the combination is not useful for image processing it does provide the user with visualisation and control possibilities via the iPAQ which were not previously available.

The project then became a demonstration that it was possible to connect the Eyebot to the iPAQ, and that the combination works. In other words, the images and sensor data can be transmitted to the iPAQ, and the control commands can be received on the Eyebot.

The concept of the iPAQ Eyebot combination was demonstrated successfully and the application did perform basic image processing, display sensor data and control the robot.

If the project is to be extended in the future then a camera must be found for the iPAQ, so that it is not as limited by the Eyebot. With the current setup it has been taken as far as it can go.

PAUL LANEY

Computer Aided Tomography

Computed Axial Tomography describes methods used to construct a sectional model of an object with data obtained from projections. This technology allows the detailed internal examination of a closed and opaque three-dimensional body. Applications for this form of modeling are widespread, however it is particularly suited to medical applications. Using tomographic imaging, a

detailed internal diagnostic examination can take place without destroying the body. Various techniques can be used to create sectional images. This project seeks to implement one of the methods for use in conjunction with the Renae-93 prototype.

GA VIN LEE

The Construction of a Useful Measurement Programme for Multimedia Development Organisations

The Multimedia industry is still immature, with markets, technologies and needs which are still rapidly evolving. For this reason, software process improvement in the field has not been a major concern of industrial or academic research so far. However, for effective process improvement to occur, a focus on software measurement is essential.

This project focused on the development of a set of measures that were directly applicable and useful to a large proportion of multimedia development organisations. A complete set of measures was developed for two major types of these organisations, spanning the dimensions of customer satisfaction, product quality, cost, timeliness, accuracy of requirements gathered and productivity.

The approach first involved a series of interviews with two multimedia industry organisations to determine possible measurement environments. Two archetype organisations, representing existing classes of organisations, were developed. Relevant goals were then selected for each archetype. Finally, GQM techniques were used to derive metrics from goals, to form a set of metrics for each archetype; and a measurement plan for each goal.

The measurement programme provided multimedia development organisations with an improved understanding of their processes and products. Used in conjunction with other initiatives, it serves as an effective catalyst for process improvement.

JAMIESON LEE

Self-control of Autonomous Soccer Playing Robots

In recent years, the concept of robots playing soccer has grown in popularity as a research topic due to advances in technology and the need for more challenging technological problems. Together with the public appeal of playing a popular worldwide sport, robot soccer brings together a number of disparate issues relating to robotics and artificial intelligence. In this project, a new system has been developed that allows the mobile robots that we have to autonomously play a modified game of soccer. The design and implementation of the software architecture used involved researching methods that have been used for the robots in the past, developing an overall control algorithm for the robots, addressing inherent problems that the robots faced, and optimising the program for better performance.

The soccer program that has been developed consists of five concurrent processes responsible for monitoring button presses, driving, vision, object detection and communications. A hierarchal structure of events is then used to determine exactly what the robots should do. In addition to the integration of new vision and driving routines, a wireless communications module and digital compass have been implemented to improve group play and position tracking. This, along with a new set of strategies for searching for and approaching the ball, has resulted in an overall improvement to the soccer playing abilities of the robots.

KIN HONG LEE

DC Motor Control Using PLC

The objective of this thesis is to identify the various control strategies that could be implemented in PLC for the purpose of DC motor control. The main focus would be on controller-oriented and objective-centered controllers and to identify it as a coherent framework for control system design in Programmable Logic Controllers. The objective-centered controller has always been used implicitly in many research works, but it is less emphasized and therefore tends not to be outstanding as an independent control design framework.

The objective-centered control framework complements the existing plant-centered and controller-centered controller design framework in terms of controlling complex processes. The essential idea of it is to decompose a complex task into simple manageable sub-tasks for which relatively easy controls exist. The control for the whole system is then achieved by combining all the controls for these sub-tasks. The advantages of this novel framework are: first, it lays down a simple framework in which to a acquire knowledge base for a given control task; second, it does not require a precise model of the plant for the control system design; third, it has the ability to model non-linear operation of the plant.

SHIRLYN LEE

Investigating the Intermediate Point of Multimedia Projects

"Software engineering is the term used to describe the collection of techniques concerned with applying an engineering approach to the construction of software products." (N.E. Fenton)

In the development of all multimedia products, it is important for organizations to be able to estimate the size, cost and duration of their projects. Additionally, for a healthy multimedia project, organisations must be able to detect any problems, early in the project lifecycle. This is done by monitoring the project, and performing re-estimations at well-defined intermediate points, to determine how much more work needs to be done. Several common estimation tools include COCOMOII, function points, PERT and SLIM. However, these tools do not provide a point of re-estimation. On the contrary, GEM (Generalized Estimation Method) is a tool which allows the organization to re-estimate at the end of each phase to obtain more accurate estimations.

This thesis presents several different approaches that were used in the attempt to find the intermediate point of a project, where this re-estimation can be made. The intermediate point is determined as the point when the early activities involved in a project changes to late activities, i.e., the division between two phases in the project lifecycle. Nonetheless, the chaotic manner of a multimedia development process makes the solution to such a problem non-trivial.

MENG SUN LOO

Automated GUI Testing

Software verification is considered the poor cousin of the whole software development process. However without software verification, there is no way to check for errors and reliability with in the software. With the size of software that is currently being developed, software verification has become an essential part of any software development process.

To elevate the problem in software development, the Component-Based Software Engineering development methodology has enabled software being developed component by component rather than in a monolithic fashion. This simplifies the software verification, where each module can be verified at the lowest level to ensure that the software is fault free.

With Component-Based Software Engineering, the components can be purchased from a third party developer. These components need to be independently verified by both the client and the developer to ensure the correctness of the component is maintained. Hence, the Software Certification Laboratory has developed the Test Pattern Verifier as a tool in providing a documented test script and an automated verification tool.

The Test Pattern Verifier was initially designed to test various non-graphical components. With the important place of the graphical user interface as a method of interaction between the software and the user, the Test Pattern Verifier is being verified along with the development of automated Graphical User Interface,the GUI Test Cases (GTC), libraries to help in verifying the graphical component in softwares.

DAMON MCMANUS

Data Collection Over the Internet

The internet is an ideal means of collecting data from people using questionnaires. The aim of this project was to construct a web-based questionnaire that will allow users to construct their own questionnaires, use them to collect data via the Internet and collate and analyze the responses.

This report details the creation and customization of a web-based survey for the Nurses at Edith Cowan University. The entire project was a collaborative effort between Gaetano Siano and myself, and supervised by Dr Christopher deSilva. It followed on from work done in 2001 by another student, Matthew Yow.

We have succeeded in creating a customizable web-based survey that can be administrated and allows the user to enter their data via the Internet. It has an easy to use interface that allows users doing the survey a very simple method to interact with the pages. It takes in all of the user's answers and adds them to a database for later viewing by the administrating nurses. The administration section can be used to view all of the user's results, displaying them as graphs or text, add new users to the survey, check the security logs, change or add new survey questions and add new administrators all via the internet. It has been fully tested from a debugging and security point of view but still requires some stress and performance testing on a machine that is more capable than its original development environment.

The application was completely written in the PERL programming language (v5.6.1) and made from free UNIX based programs. This was an advantage over previous versions of the project that chose to use Microsoft C# with Active Server Pages - a costly investment for any company. It is also designed to use a MySQL database to store all data that is needed. Finally it uses a number of available PERL modules to do some of the tasks required.

This project was run under ARCME (The Australian Research Center for Medical Engineering) and the final implementation of the design was finished on November 21st, 2002.

TEE YEN NG

Spline Based Path Generation and Tracking Control for Differential Drive Robots

For the purposes of robotic soccer, a fast, accurate and robust method for driving from location to location is necessary. While commonly a solution to this involves combinations of turning on the spot and straight line driving, driving in curves may offer an advantage in speed and flexibility. This thesis explores the use of spline curves in reaching this goal.

HILARY PATTERSON

Biologically-Inspired Texture Measures

There is no unified mathematical theory of texture. The aim of this project was to discover techniques for visual texture analysis that are based upon an understanding of texture perception. The study of vision is multidisciplinary, involving biology, psychology, computer science and engineering. However, the number of researchers that have worked on merging these approaches is relatively small.

One biologically-inspired model of vision is that of Caelli "An Adaptive Computational Model for Texture Segmentation", in IEEE Transactions on Systems, Man and Cybernetics, 1988. The work of Caelli was repeated, and then modified using Gabor filters for the spatial decomposition. The algorithm was tested with natural and medical image textures, as well as the original synthesized micro-patterns used by Caelli. The Gabor filters yielded better results with natural and medical image textures than the edge and bar filters used by Caelli.

Scale was examined briefly, by performing spatial decomposition with filters of multiple sizes. The results indicated there was a possibility that such measures could be scale invariant, but were not conclusive.

The directionality of textures was investigated using novel methods developed using rose diagrams of the Gabor filter responses. These directionality measures were applied to mammograms. The results suggest that the method achieves greatest success in detecting lesions in glandular tissue.

KATHERINE POH

The Application of the Generalised Estimation Method (GEM) Approach to Multimedia Projects.

In the software engineering industry, the topic of estimation has gained significant attention in literature, and yet, still remains to be one of the more difficult tasks in project management. The difficulty in producing accurate estimates is even more pronounced in the management of multimedia projects, due to the significantly less research undertaken in this area. Furthermore, the use of existing software estimation methods to predict development effort in multimedia projects is highly inappropriate, thus warranting the need for estimation models specifically designed for multimedia projects.

This Final Year Project Thesis presents an approach for developing an estimation model for multimedia projects, based on the Generalised Estimation Method (GEM). As the concept of GEM involves using proxies to generate effort estimates, it is essential that the proxies selected for use in GEM are suitable for this purpose. Thus, one of the early areas of focus in this Final Year Project involved using statistical techniques (mainly linear regression analysis) to identify the proxies suitable for estimating development effort in the various phases of multimedia projects. Following from that, the next area targeted in this Final Year Project was in developing the GEM estimation model for each phase of multimedia projects based on the proxies selected. The accuracy levels achieved with these estimation models were then evaluated to determine the usefulness of the GEM approach in predicting multimedia projects.

The findings from the analyses performed in this Final Year Project suggests that the concept of GEM is indeed useful for estimating development effort in multimedia projects. Although the GEM estimation models developed were specific to the multimedia organisation, DUIT Multimedia, the same approach described in this Final Year Project Thesis may be applied to any other organisation.

JENNIFER RICHARDSON

Parenchymal Texture Measures for Mammogram Analysis

Breast cancer is the leading form of cancer in Australian women, and can be detected using mammography. The variations in the appearance of the glandular tissue, or parenchyma, can be described by the term visual texture. The mammograms in the Mammographic Image Analysis Society database were classified in annotations to the database as dense, fatty-glandular or fatty. A subset of these mammograms were selected, and methods investigated in an attempt to classify images into these three classes.

Laws' texture energy measures were studied, and a number of inconsistencies and anomalies were discovered in his definitions. A similarity was noted between the texture of clouds and that of mammograms, and so cloud texture measures were investigated. It was found that the similarity was possibly only superficial, although more work would be required to confirm this. Histograms were produced, using pixels from the parenchymal region of the mammograms, and statistical moments applied to these histograms. Skewness proved to be the most promising of these measures, and is worthy of further investigation.

KAYNE RICHARDSON

Patient-Controlled Analgesia

As society develops and advances, we naturally try to eliminate all forms of suffering in our lives. Palliative care techniques may only reduce physical pain, but the increasing need for this type of care is intrinsic in improving upon the quality of life of our ageing population. Continuous intravenous infusion is a widely used means of reducing the pain experienced by patients in a myriad of circumstances. Furthermore, the expansion of these ideas can lead to actual treatments of incapacitating illnesses such as cancer and diabetes. No eloquence could ever quantify the possible increase in the quality of life that these patients could experience.

Technologies for these purposes exist, and the motivation of this project was to physically realize an infusion pump that capitalizes on their deficiencies. In essence this equates to an optimum combination of intelligence, portability, and expense. This leads to a principal imperative, whereby the intelligence of the infusion pump implemented would allow it to have the facility to be computer controlled. This would then lend itself to much greater examination of the procedure being undertaken, improved problem detection, and for greater functional power. The department would then have technology that it could easily modify, update, expand, or adapt, in particular to control algorithms for diabetes and cancer treatments.

The culmination of this project was the formulation of a fully engineered system that more than fulfilled the required specifications. The work undertaken integrated all facets from conceptualisation of a solution, exploration of a range of possibilities, design, analysis, troubleshooting and finally synthesis.

The scheme implemented is ambulatory, runs on rechargeable batteries, and is extremely accurate. It is controlled by a particularly powerful microcontroller, and has the capability to be easily developed further. The principle of operation is that a motor turns a long drive screw, which is attached to a holder into which the filled syringe is inserted. The motor turns the drive screw, which gradually depresses the plunger of the syringe until the syringe is emptied. Hence the designed pump is actually a syringe pump, with a control mechanism that allows for volumetric infusion.

WILLIAM RIVERA

Medical Data Fusion

Medical Data Fusion is the method of combining images from different diagnostic tools to obtain more accurate medical information. The imaging modalities of interest are Computerised Tomography (CT) scans and Magnetic Resonance (MR) scans. CT images provide accurate bone information whilst MR images provide detailed soft tissue information. By combining the complementary information from these sources, a new type of visualisation is achieved, which preserves the important details from the both modalities.

Medical data fusion is a two step process. The first step is the registration of the images. The images are transformed and aligned so that both images share a common dimensionality. The second step is the fusion of the images. This entails the selection of the important features from each of the modalities and combining them together.

A fully automatic registration process was achieved with accurate results in this project. All transformations required to match the images were determined by the computer. Registration was achieved in two steps: firstly, by moment-based registration and secondly, refined by means of optimisation of binary correlation. The registration process did not use landmark based control points, which made it very flexible with the image objects.

This project also studied various image fusion processes. A linear, single resolution fusion process was investigated together with multiresolution image fusion techniques. A Laplace Pyramid fusion method was found to be the best method of fusion because of its method of retaining most of the information content.

KAI SHEN

Interactive Computerised Functional Analysis of Lateral Fluoroscopy Images to Quantify the Volume Displaced by Motion of the Diaphragm

Methods have recently been developed for accurately measuring the volume displaced by motion of the diaphragm (DVdi) and the contribution of the diaphragm to inspired volume. These methods are labour intensive and slow. In this thesis, a more accurate and efficient computerised system for the acquisition, distortion correction, image registration, interactive segmentation and quantitative measurements of fluoroscopic images of the motion of the diaphragm is presented. This non-invasive technique will allow earlier and more accurate detection of abnormal diaphragm function and have a direct clinical application. To examine the validity of this system of acquisition analysis, I compared measurements obtained by interaction analysis with those obtained manually. Four calibration objects with known dimensions were imaged. Differences in length and area measurements obtained between the interactive method and direct physical measurements were $< 2.2\%$, indicating a high degree of accuracy. I also compared functional measurements in 4 subjects with those obtained manually by a second (blind) operator. Differences between these two methods was of a greater magnitude, and this was attributed in part to differences in segmentation between the two operators. In conclusion I have demonstrated the superior feasibility, objectivity, efficiency, and accuracy of this interactive method compared with what is possible with existing manual methods.

GAETANO SIANO

Biomedical Data Collection over the Internet

Questionnaires are an effective data collection tool used to assist people to gather data from a potentially large number of respondents. Through the use of questionnaires we can analyze the outcomes of the respondents and make informative and knowledgeable decisions. Traditionally these questionnaires have been administrated by either a paper-and-pencil method or by personal interview. With the emergence of the Internet there is now a new more efficient way of collecting data from respondents.

The current system of 'paper-and-pencil' or 'personal interview' lacks the technical sophistication in collecting, distributing and analyzing the data provided. The intention of the project is to design and implement a Web Based Questionnaire to overcome these limitations imposed by conventional methods.

My project deals with the design of web-based nurse questionnaire survey for use in medical applications. In the medical field, physicians would be able to monitor the progress of their treatment and gather the medical condition of patients by conducting multiple questionnaires over time. This is a group project supervised by Dr Chris deSilva and to be undertaken by myself and partner Damon McManus.

The project is composed of two complementary parts - the questionnaire itself which records patient's responses to questions, and the administration section which is used to collate, analyze and process these results.

It is hoped that this web based questionnaire will be come part of the system used by the Nurses at Edith Cowan University to evaluate a patient's medical condition.

COURTNEY SMITH

Vision Support System for a Tracked Vehicle

The utilisation of autonomous mobile robots is becoming increasingly popular in hazardous or remote environments. The navigation of harsh unstructured terrain offers a vast number of technical challenges. The primary objective of this thesis was the development of a suitable hardware and software base that could be expanded to create a completely autonomous tracked vehicle capable of intelligently navigating terrain of which it has no prior knowledge.

Processing routines were developed for key devices, specifically the inclinometer and gyroscope sensors. Tests conducted in controlled environments and on the mobile robot identified a number of problems with each particular sensor – many of which were resolved during the course of this project. The development of an advanced remote control system for semi-autonomous operation was also investigated.

NICHOLAS STAMATIOU

Terrain Driving System for Tracked Vehicle

The use of autonomous mobile robots in the exploration and traversal of harsh and non-structured environments has become the focus of an increasing volume of research due to the vast technical challenges it offers. In view of these challenges, the applications of such technology include the exploration of planetary surfaces, operations in hostile environments, civilian protection and in the handling of dangerous materials. The primary objective that governed the thesis was to attach, install and integrate all the necessary hardware and equipment to a given structural model for the purposes of creating a fully autonomous tracked vehicle. Building on this basic hardware framework, the software development process described deals primarily with the formulation of slope-negotiation routines and the integration of various sensory components.

HAN YANG EDWIN TEO

Robust Stability of 2D Digital Filters

Feedback control theory uses linear state feedback to control the behavior of a dynamical process. In practice, not all states are available for feedback due to physical or economical reasons, this results in the need to reconstruct or estimate this much needed information using only the system input and output. An observer or estimator provides an elegant and practical solution to such deficiency.

In this thesis, a theoretical study has been done on the design of Full Order Observer, Reduced Order Observer, Reduced Order Linear Functional Observer, Unknown Input Observer and Optimal Observer. The principal results have shown that the various classes of observer studied exhibit the necessary and sufficient tracking properties of an estimator.

The Reduced Order Observer is able to estimate only the unavailable states, thus reducing the order of observer to reduce the constructional cost. The reduced Order Linear Functional Observer is able to further the reduction. The unknown Input Observer is able to reconstruct the states without the knowledge of the inputs. Lastly, the Optimal Observer provides an observer solution with balanced performance.

These results suggested the idea of state estimation is workable in theory. But there may exist other practical issues, which may worth investigating.

JASON TEY

JMS Messaging Protocol Performance

This final year project is conducted in conjunction with a software project called TRELIS currently running at ADI-limited. Being a massively distributed system, TRELIS utilizes many new technologies in its implementation. The area being investigated in this project is the messaging system and methods used to distribute information into external systems. This investigation is necessary and beneficial since TRELIS is a commercial information system still currently under development. Commercial projects such as this often utilize state-of-the art technologies to remain 'top of the market' and because they are under deadlines quite often, solutions to problems are usually 'what works well at the time' and little performance evaluation is conducted to improve distributed performance issues. TRELIS is unofficially the largest software project in the southern hemisphere and with over five thousand classes, its not hard to see why system and messaging performance is an important area of the system that requires investigation.

The work conducted toward this dissertation explores TRELIS and its underlying distributed architecture. More specifically, a conceptual model or slice of the architecture has been examined to observe any benefits or concerns related to the arrangement of software modules, and any performance issues of the technology used. The intended goal of this project is to provide a better understanding of the messaging system within TRELIS that distributes information and data management services to external organizations. The findings shall provide results-based support and possible suggestions for change, but keeping in mind that being a commercial system, realization of any suggested changes may or may not be feasible.

YIER TOH

Visualization of 3D Biomedical Volume Images

Volume rendering is a technique used for the visualization of 3-D data sets. It has many applications in scientific and biomedical image processing but it remains a very computationally expensive task. In this thesis, we present a more efficient method for volume rendering. This method uses a unique slit light source for illumination. The advantages of this technique are that it is computationally efficient, produces high reality images with real shadows and shading, allows for easy parallelization and is flexible enough to be implemented on different computer systems. The rendering method was implemented using Java and a graphical user interface was added for increased usability.

PRASANNAH VAIDIYAKUMAR

Review on Blood Glucose Monitoring Techniques

During the last 30 years numerous attempts have been made to develop glucose sensors, and new major breakthroughs have been announced repeatedly. However, up until now no glucose sensor has been available that can be used by diabetic patients in daily life conditions. Glucose sensors employing the transdermal, microdialysis or open tissue microperfusion techniques are currently under clinical development and may also become available in the near future. The types of glucose sensors referred to so far are not truly non-invasive, but normally minimally invasive. They measure the glucose concentration in the interstitial fluid of the skin or the subcutis. Non-invasive optical glucose sensors are designed to monitor glucose changes in the blood by directing light through a specific region of the body. They measure the characteristics of the reflected light that are changed as the result of an interaction with glucose. However, none of the attempts with optical glucose sensors have resulted thus far in the development of a sensor that allows monitoring of glucose with sufficient accuracy and precision within the clinically relevant glucose range in daily life conditions. This thesis proposes the various techniques available today in blood glucose monitoring that are minimally invasive and non-invasive.

SIN LI WANG

Speech Enhancement for Communications and Recognition (Japanese)

The Japanese Speech Recognition (JSR) systems for the recognition of Japanese digits have been built and evaluated. The JSR systems built comprise speaker dependent, speaker independent, gender dependent and speaker adaptive speech recognition systems on isolated digit and connected digit tasks. Methods for building JSR systems were explored and further refinement of models was conducted. The recognition performance achieved good results.

ESTELLE WINTERFLOOD

Control Algorithm for Bipedal Locomotion

Robots have historically been used for industrial purposes. However they are becoming increasingly available for the average household, for entertainment and for useful purposes. To maneuver within an environment designed for people it is reasonable to expect some of these robots will be bipeds, able to climb stairs and step over objects. Furthermore, bipeds offer an anthropomorphic form that is familiar and exhibits our accomplishment of a difficult balancing task.

This project focuses on the software control of a small biped robot. An open-loop control algorithm was implemented based on pre-planned walking sequences, allowing the biped to walk for varying distances depending on the stability of the gait. This control algorithm was improved by incorporating a number of step parameters which modified the gait. Walking was achieved in the forwards direction, along with side-stepping.

Work was done towards developing a closed-loop control algorithm to allow locomotion. Sensor readings were processed to remove noise and obtain useful information. A PID controller was implemented which allowed the biped to remain standing when the floor angle is modified.

TIM WONG

Autonomous Plane – Sensor Readings and Data Logging

Aircraft are used commercially and scientifically for surveillance and gathering data. This can be dangerous and expensive. It is for these situations where an autonomous plane can be useful. An autonomous plane has advantages over its piloted counterpart. Since the plane would be unmanned, it would mean that there is no risk of endangering human lives. Certain situations require data to be gathered from hazardous locations. It would be much safer to use an unmanned aircraft to gather data from these hazardous locations.

For an autonomous plane to succeed, it requires the use of accurate and reliable sensors for flight control and navigation. Inaccuracies in the readings obtained from the sensors can lead to a disastrous result.

This thesis investigates the Magellan GPS 315, the Vector 2X Digital Compass and the Seika N3 Inclinometer to determine their feasibility for use in the autonomous plane project. It is essential that adequate and thorough testing be done on each sensor to ensure that they are accurate and reliable. The sensors need to be tested in the conditions that would be experienced in flight to get a more accurate outlook on the sensors' functionality. This requires the readings obtained during flight to be analyzed for accuracy and reliability. Data logging provides the means to gather data from the test flights to assess the feasibility of each sensor.

JOANNA YAP

Distributed Software Engineering

The increasing complexity of real-time computer systems has meant that the development of formal methods for the verification of these systems has become essential.

Formal verification of real-time computer systems is necessary because the failure of a real-time computer system to correctly execute its operations within its time constraints could result in the loss of human lives. To this end, the real-time research community has developed several formal methods with which to verify the correctness of a system. The focus of this project is on the formal verification method of Real-Time Logic.

Although much research has been done in the real-time area to develop and extend Real-Time Logic for a variety of systems such as Distributed systems and hybrid systems, a verification tool which uses Real-Time Logic to verify systems did not exist.

Therefore the objective of this project was to develop a real-time tool which would verify a real-time system using the formal method of Real-Time Logic. The real-time tool is intended to be an educational tool which would seek to further the understanding of a Real-Time Logic student.

NICK YAU

Knowledge Management and its future for Honeywell

Knowledge has become the key economic resource and the dominant – and perhaps even the only – source of competitive advantage, as stated by Peter Drucker, and from this development Knowledge Management has evolved. Knowledge Management is the set of management activities that have been developed for the specific purpose of growing, extracting, leveraging and valuing the knowledge assets of the organisation for the purpose of maximizing shareholder value. Previous efforts by Honeywell Pacific have been unsuccessful in determining a Knowledge Management solution that will create value for Honeywell Pacific and this project was to assess Honeywell Pacific from a bottom-up approach to determine the best Knowledge Management solution.

From the results of a business survey, the most beneficial solution to improve Knowledge Management practices at Honeywell Pacific was to improve the reuse of project documentation. To improve the reuse of project documentation, four Knowledge Management packages were examined. The packages examined were Microsoft Sharepoint, Lotus K-Station, Xerox Docushare and ZY Lab and from these four packages, Microsoft Sharepoint was tested to further prove its functionality and gain user acceptance.

Microsoft Sharepoint was configured to categorise project execution documentation by the phase and step of the GPM Methodology, to replicate the structure of the current Project Execution web site. Tests were performed to test Microsoft Sharepoint's functionality and from the tests the main concern was that caution needed to be taken when assigning user roles to specific folders and documents, otherwise the package's functionality met what was required. Tests were also performed by Honeywell Project Managers to gather feedback on the user-friendliness and benefit of Sharepoint. From these tests there was positive feedback about how user-friendly and beneficial Microsoft Sharepoint will be if it was officially implemented.

From the results of this project, Honeywell Pacific should implement Sharepoint and then measure the Return on Investment from the implementation.

GARETH YEO

Speech Enhancement

The presence of noise in speech signals can result in appreciable degradation in both the quality and intelligibility. For example, background acoustic noise can corrupt voice signals in communication systems, interfering with message interpretation and understanding. This in turn impedes other applications such as speech coding, speech recognition and speaker identification. Speech enhancement techniques are concerned with algorithms that mitigate these unwanted noise effects and thus improve signal quality. The results of speech enhancement have important practical applications in systems such as mobile telephony, air-traffic radio control and voice relay networks.

This thesis is concerned with the study and implementation of four speech enhancement algorithms: Spectral Subtraction, Wiener Filtering, Kalman Filtering and Filtering. It investigates the quantitative and qualitative performances of each of these algorithms using a wide mixture of data sets and test conditions. The objective of this thesis is to compare the relative performances of these algorithms in removing noise from contaminated speech signals. A discussion of the limitations and possible improvements for all four techniques is also provided.