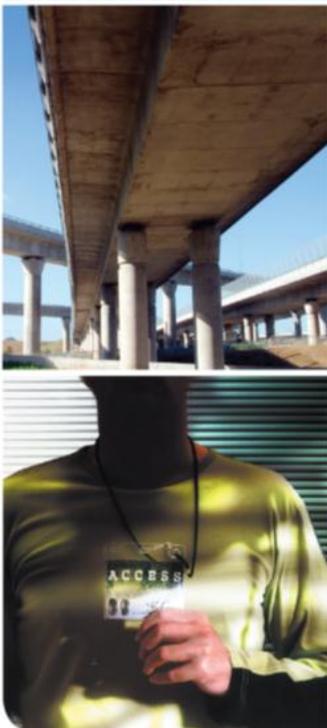
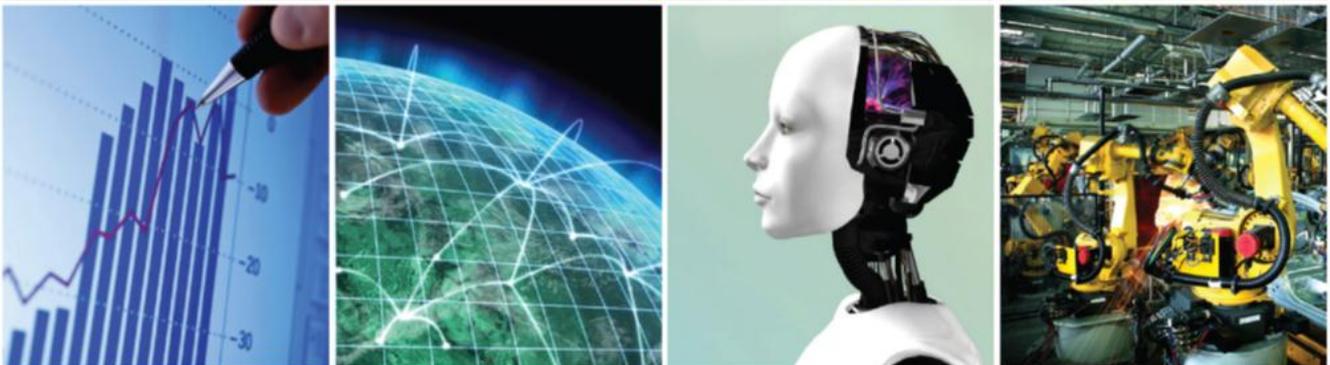


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RESEARCH: INSPIRING PEOPLE

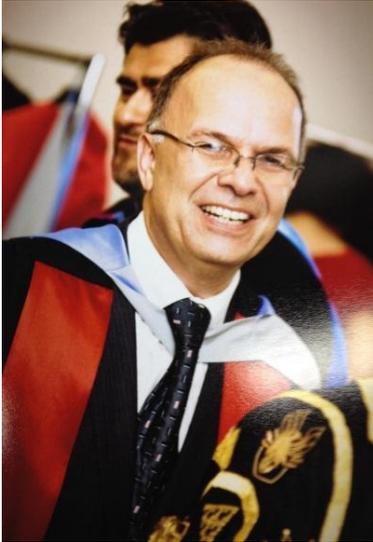


School of Computing,
Engineering and Mathematics

Postgraduate
Forum 2012

BOOK OF ABSTRACTS

Foreword



It is with much pleasure that I welcome you to the inaugural Research Futures Post Graduate Forum 2012 for the School of Computing, Engineering and Mathematics.

This forum provides a superb opportunity for all post graduate students to present their research, irrespective of their stage in the research process and to engage in rich discussions about their ideas with fellow students and academics in a supportive research focused environment.

The School of Computing, Engineering and Mathematics has an outstanding research reputation both nationally and internationally. This forum is designed to foster and encourage the next generation of researchers who, with the help of dedicated academic staff, will be pushing back the boundaries of current knowledge and making a significant impact on how the world works and our understanding of it.

Please enjoy the Post Graduate Forum 2012 and the many possibilities it has to offer.

Professor Simeon Simoff

Dean, School of Computing, Engineering and Mathematics

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Secure cloud computing – exploiting threats, prevention, defence and performance evaluation over crypto cloud

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Purpose

Cloud computing is vowing to change the way people use computer in everyday life for study, work and other means of life by providing cost-effective and scalable solutions, which makes it a preferable choice for IT industry as well as for educational institutions.

According to some survey, security remains a major issue for adapting cloud computing model, therefore, some sectors are moving slowly to adopt this technology. Providing consistent security and privacy solutions for Cloud computing environment is a challenge. Due to the conceptual development of Cloud architecture and multi tenancy system, new security vulnerabilities arise with promising security platform and APIs. Sharing of infrastructure, platform and services in the public cloud environment there are threat profiles for side-channels, covert channels attacks and also poses questions how to deal with abuse and nefarious use of the cloud computing, insecure APIs, malicious insiders, account and service hijacking.

Private, public and inter-cloud security models and threats needs to be identified and solutions needs to be evaluated. Currently we have symmetric and asymmetric encryption system with PKI infrastructure to provide authentication, verification and linked or layered trust. We are also utilizing digital signature and hash computation for identification and establishment of trust among users. Hence, it is required to evaluate the usability and performance of public key infrastructure provisioning secure access and services in Cloud model. Therefore, this research aims to work on security issues of cloud computing to provide sustainable cloud solutions in order to maintain adequate trust among the Cloud users and systems.

Method

Current research progress of the major players and their product and limitations are being evaluated. Security concerns are identified and being listed for improvement. In the next stage, possibility of new protocol or secure platform will be evaluated based on the previous findings. Then, in the next stage, outline of the solution will be proposed and designed comparing with conventional techniques. Then, in the next stage, possible implementation or theoretical solution will be build and will be tested against the list of concerned security issues with Cloud computing.

Study of niobium and indium segregation on surface and near-surface chemistry of titanium dioxide (TiO₂)

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Purpose

The purpose of this PhD research project is to understand the effect of segregation on the surface and near-surface composition of titanium dioxide, TiO₂, doped with niobium, indium as well as co-doped with both these ions. The ultimate aim is to assess the effect of segregation on the formation of chemically-induced electric fields. Knowledge of such effect is essential in order to modify the flat band potential that is required for light-induced charge separation. The project has resulted in the formation of solid solutions of Nb-doped TiO₂ and In-doped TiO₂, their basic characterisation and the determination of the segregation-induced concentration gradients. The studies investigated the effect of the gas phase composition (oxygen activity) on segregation-induced enrichment of the surface and near-surface layers. The presentation will include a brief overview the project and consider the importance of the obtained results in the formation of photoelectrodes for photoelectrochemical generation of solar hydrogen.

Methods

Secondary ion mass spectrometry (SIMS) is the key analysis technique utilised in this work. It is a unique surface sensitive technique capable of providing concentration depth profiles with high detection limits from the surface to the bulk with 2-5nm depth resolution. SIMS analysis may be used for the determination of diffusion- and segregation-induced depth profiles in the surface and near surface regions. SIMS is especially useful in the determination the effect of processing conditions on surface properties of oxide semiconductors, such as TiO₂. Additional methods utilised as part of this project include, XRD, PIXE, RBS and SEM.

Results

The results include the diffusion-induced concentration gradients (obtained from SIMS analysis). These data have been used for the determination of the bulk diffusion coefficient of In³⁺ in the lattice of rutile (TiO₂) at p(O₂) = 21kPa and in the temperature range 1173 K - 1573 K. The results also include the segregation-induced concentration profiles of niobium and indium in TiO₂ annealed in the gas phase of controlled oxygen activity.

Conclusion

The results show that the phenomenon of segregation may be used as a technology for imposition of controlled surface composition of oxide solid solutions, such as Nb- and In-doped TiO₂.

Analysis and Design Outlier Detection with High Dimensionality Data Set

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Purpose

Fraud is one of the most significant areas in Internet, Online Shopping, E-Commerce, Credit Card, Telecommunication, health care, insurance claims, and Computer Intrusion. The growing of using the online shopping is coming up day by day. For that reason, the fraud is growing too because it's difficult to know if the publisher is thief or no.

The empirical aspect of the research is on the review of the existing fraud detection strategies for dataset analysis, a review of different type of frauds, and to identify appropriate technique in a domain specific context, such as Fraud dataset analysis.

On the other hand, the conceptual aspect of the research is on the analysis and selection of an appropriate technique (like Neural Network) to suit fraud data, and on the developing improved methodologies and techniques and extended to general applications using appropriate datasets.

Methods

We built two algorithms using R, is a software environment for statistical computing and graphics, to find an outlier for fraud and they gave the same result for a same dataset. We are trying to minimize dataset without changing the meaning for it.

- 1st algorithm: A point p in a data set is an outlier with respect to the parameters k and l , if no more than k points in the data set are at a distance l or less from p .
- 2nd algorithm: Given a k and n , a point p is an outlier if the distance to its k th nearest neighbour is smaller than the corresponding values for no more than $n-1$ other points.

In addition, principal component analysis PCA is a multivariate method which can identify redundancy or correlation among a set of measurements or variables for the purpose of data reduction. This powerful exploratory tool provides insightful graphical summaries with ability to include additional information as well. In this case, we also created an algorithm for PCA method.

The research methodology is organized as follows:

- Collect an appropriate large dataset.
- Analyze and select appropriate techniques to suit Fraud dataset using R software and Java programming language by using outlier statistical method
- Developing improved methodologies and techniques extended to general application by creating a framework for fraud detection

Results and Conclusion

For all these algorithms, same output had shown to find outliers in a small data set but we are worry for using a large amount of data set. For the next step, we are looking for a large data set to apply these algorithms with it. If doesn't give us a right answer, the Compressed Sampling method with is a good approach for finding sparse solutions to underdetermined linear systems.

Numerical modelling of geosynthetic reinforced pile-supported embankments

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Purpose

Embankments are widely used in many infrastructure development projects in order to elevate the ground surface for construction. Due to the unavailability of proper land for construction, many projects are currently being undertaken on soft grounds which were previously considered unsuitable. Construction on soft soil is a challenging task due to the undesirable characteristics of soft soil such as low bearing capacity, insufficient shear strength and high compressibility and therefore, requires special attention on stability and settlements. Geosynthetic reinforced and pile-supported (GRPS) embankments provide a reliable solution for the problem of embankment construction on soft foundation soil. The advantages of using this system are; the embankment can be constructed in a single stage without prolonged waiting periods hence, suitable for fast-track construction, the total and differential settlements of the embankment are significantly reduced as well as the lateral displacements, pile spacing can be increased and the pile cap width can be reduced compared to a conventional pile-supported embankment and this method can be used reliably in any unpredictable ground conditions irrespective of the sub soil properties. The purpose of this study is to perform numerical modelling of a GRPS embankment using finite element method to determine the best way of modelling it in two dimensional plane strain condition.

Methods

Finite element modelling is carried out using ABAQUS/Standard software. A GRPS embankment case study found in literature with field measurements during construction was selected for modelling. Three dimensional numerical modelling was carried out first in order to verify the model. Once the model is verified, two dimensional models were prepared using different two dimensional idealizations for piles. The geosynthetic reinforcement was also modelled using two different types of elements (i.e., plain strain elements and truss elements) for comparison purposes. Then the results obtained from the two dimensional models were compared with both three dimensional model results and field measurements in order to select the best two dimensional idealization.

Results

The stress transferred to the piles and foundation soil, lateral displacements, development of settlements at the base of the embankment on both foundation soil and piles and the generation and dissipation of excess pore water pressures during and after construction for both two-dimensional and three-dimensional models were compared.

Conclusion

According to the results, it is clear that the three-dimensional model gives the closest results to the actual field measurements. On the other hand, out of all the two-dimensional idealizations adopted, the equivalent area method yields the closest results to the three-dimensional model results and field measurements. Furthermore, using truss elements for the geosynthetic layer does not make any significant change to the settlements or excess pore pressure distribution but, the tension in the geosynthetic layer is much closer to the three dimensional model results when truss elements are used. Therefore, the equivalent area method used with the truss element for the geosynthetic reinforcement layer can be considered as the most appropriate two-dimensional idealization method.

Regional flood frequency analysis in Australia: application of artificial neural networks

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Purpose

Consideration of potential for flood risk is required for the planning, design and construction of water infrastructure. Design flood estimation can ideally be made by analysing recorded streamflow data. However, there are many rivers in Australia where recorded streamflow data is limited or completely unavailable (ungauged catchments). In the past, different regional flood frequency analysis (RFFA) methods have been proposed for Australia. These methods include the Rational Method, the Index Flood Method and the Quantile Regression Technique (QRT). Most of these traditional RFFA methods are based on linear models. There have been successful application of non-linear models like Artificial Neural Networks (ANN) and Fuzzy based methods in hydrology in other parts of the world. However, there has not been any notable application of ANN in RFFA in Australia. Application of artificial intelligence may help develop improved RFFA techniques for Australia. Adaptive neuro-fuzzy inference system (ANFIS) can also be used in regional flood estimation problems. This paper presents development and testing of ANN-based RFFA methods for Australia.

Method

An initial application of ANN has been made to 452 stream gauging stations across eastern Australia to develop a RFFA model. The best model has been found to include two predictor variables, catchment area and design rainfall intensity for the average recurrence interval in the range of 2 to 100 years. The study also comprises the identification of optimum regions for RFFA study in eastern Australia based on geographic and state boundaries, climatic conditions and catchment attributes. An independent test based on split-sample validation has shown that the ANN based model can provide quite reasonable design flood estimates for eastern Australian conditions and data. Relative accuracy of various ANN-based RFFA models is assessed using median relative error and median values of ratio between the predicted and observed flood quantiles.

Results

It has been found that ANN-based RFFA model with only two predictor variables (catchment area and design rainfall intensity) can provide flood quantile estimates that are more accurate than the traditional QRT. Overall, the best ANN-based RFFA model is achieved when all the data set of 452 catchments from eastern Australia are combined together, which gives a RFFA model with median relative error of 35% to 44% and median ratio values of 0.99 to 1.14.

Conclusion

The results indicate that a relatively larger data set is better suited for successful training and testing of the ANN-based RFFA models. It has also been found that ANN-based RFFA models outperform the traditional QRT for eastern Australia.

Resource allocation in OFDM based Cognitive Radio relay networks

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Purpose

Radio spectrum is a precious and limited resource for wireless communication networks. A recent study has shown that most of the allocated spectrum today is under-utilized. Thus, the cognitive radio (CR) concept has been proposed as a method to improve the spectrum utilization. In a CR network, a secondary user (SU) is allowed to access the frequency bands that are originally allocated to the primary users (PUs) when the spectrum is not used by any PU. Also the SUs are expected to transmit without causing harmful interference to the PUs.

Orthogonal frequency division multiplexing (OFDM) has been identified as a candidate signaling technique for realizing the CR concept. For situations where there is a weak channel between the CR transmitter and CR receiver, reliable communication can be achieved by introducing a cooperative relay between the transmitter and receiver. This form of a two-hop communication system is called a CR relay network and it comprises of a source, destination and an intermediate relay. The purpose of the relay is to assist the transmission between the source and the destination.

This work is focused on power allocation in OFDM based CR relay networks. With power allocation, the transmit power is adaptively allocated to meet the varying channel conditions and to improve the system performance. The objective of this work is to maximize the instantaneous capacity of the CR network through adaptive power allocation.

Methods

In a CR relay network the power allocation involves determining the optimal power allocation at both the source and the relay to maximize the capacity without causing harmful interference to the PUs. The proposed power allocation method involves two steps: relay power allocation and source power allocation. For a given, initial source power allocation, first the relay transmit power is optimized. Then for this optimized relay power allocation, the subcarrier transmit power at the source is optimized. These two steps are alternately carried out such that the output of the previous optimization is the input to the next optimization until convergence has been achieved.

Results

The performance of the proposed optimal power allocation method is compared with uniform power allocation and the results confirm that a significant capacity improvement can be achieved by optimal power allocation.

Conclusion

This work investigates power allocation in OFDM based CR relay networks and presents an optimal power allocation technique to maximize the capacity of the CR network while maintaining the interference to the PUs below a given threshold.

Multi-frequency Study of Supernova Remnants in the Large Magellanic Cloud

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Purpose

The purpose of this study is to provide a complete sample of Supernova Remnants (SNRs) in the Large Magellanic Cloud (LMC). This work predominately focuses on the group of remnants that are older and more evolved making them harder to detect. New observations stacked with archival projects allows for high-resolution images of these SNRs and associated analysis methodologies to be employed. These include morphology, integrated flux density, spectral index, spectral map, luminosity, magnetic field, faraday rotation, polarisation, extent and surface brightness-diameter ratio ($\Sigma - D$).

As well as analysis of the individual objects, this project will provide information about the statistical properties from a complete sample of SNRs in a galaxy --- something that has never been done before.

Methods

Data for this project is sourced from personal observations carried out by the Australian Telescope Compact Array (ATCA) and archival data taken from the Australia Telescope Online Archive (ATOA). The MIRIAD package is used in this project for all data reduction and KARMA's *KVIS* for visual display of the data. Numerous MIRIAD tasks are employed depending on aim of the task. The basic steps of reduction and imaging are as follows:

Load/Format Flag Calibrate Create Dirty Map Clean Restore

Once an acceptable image is produced, various analysis tasks (as described in the purpose section) are completed making use of their own esoteric tasks.

Results

As first author, I have had two papers published so far and one accepted for publication, along with ~4 papers in preparation. I have also contributed to another two published papers and a further two in preparation. The following are a summary of the results for the two SNRs that I have published:

SNR J0529-6654 (*Monthly Notices of the Royal Astronomical Society*)

This SNR exhibits a filled in shell morphology with a size of $D = 33 \times 31 \pm 1$ pc, spectral index of $\alpha = -0.68 \pm 0.03$, peak polarisation of $\sim 17 \pm 7$ per cent. No optical emission associated with the SNR and the possibility of a SNR/Pulsar connection, which would be the 5th in the LMC.

SNR 0550-6823 (*Serbian Astronomical Journal*)

This SNR exhibits a one-sided shell brightened morphology with a relatively large size of $D = 90 \times 68 \pm 1$ pc, spectral index of $\alpha = -0.79 \pm 0.27$ and strong polarisation at 6 cm of $\sim 50 \pm 10$ per cent. There was a correlation between the optical [OIII] emission and the radio observations, which completed the remainder of the SNR.

Conclusion

A radio-continuum study is underway with the objective of providing a complete catalogue of all SNRs in the LMC so we can better understand these celestial objects.

Monte Carlo Simulation Technique to Design Flood Estimation: Regionalisation of Continuing Loss in New South Wales

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Penrith Campus

Purpose

In planning and design of water resource projects such as dams and bridges, design flood estimation is usually required. The Design Event Approach (DEA) is the commonly used method in design flood estimation where complete hydrograph is needed. The DEA is based on design rainfall and is currently recommended by the Institution of Engineers Australia in its national guideline, Australian Rainfall and Runoff (1987). However, DEA has a number of limitations; to overcome these, considerable research has been done recently on the development and application of the Joint Probability Approach (JPA)/Monte Carlo Simulation Technique (MCST) to design flood estimation. The previous applications of this method with Victoria and Queensland data have shown that MCST can overcome some of the limitations associated with the DEA and this can produce more accurate design flood estimates.

Methods

The wider application of the MCST needs regionalisation of various input variables to the runoff routing model which include rainfall parameters such as duration, intensity, temporal pattern and losses. This paper focuses on the regionalisation of the continuing loss in New South Wales (NSW), Australia so that this can be used with the MCST to obtain design flood estimates for both gauged and ungauged catchments. The regionalisation procedure considered six catchments with stream gauging stations and pluviograph stations within 30 km radius from its centre. The catchment areas range from 13 to 70 km² with an average record length of 38 years. Gamma and exponential distributions were fitted to the observed continuing loss data and Kolmogorov-Smirnov and Anderson-Darling tests were used to assess the goodness-of-fit.

Results

The study found that the continuing loss data is best approximated by exponential distribution.

Conclusion

Therefore, the continuing loss data can be generated using exponential distribution for the use with the MCST to obtain design flood estimates for both gauged and ungauged catchments in NSW. Future research considers regionalising other parameters such as rainfall duration, intensity, temporal pattern and initial loss and applying these with the MCST to derive design flood estimates in NSW.

Reasoning about the change of policies in complex environments

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Purpose

In recent times there has been rapid growth in the popularity of online social networks (OSNs), such as Facebook and LinkedIn. These services encourage users to disclose significant amounts of personal information for the purposes of connecting and sharing information with other users. However, the information shared over these sites can be used maliciously or simply result in embarrassing the user if shared with the wrong individuals due to personal nature of the information. This has resulted in a growing awareness of importance of privacy in the online environment. Though most OSNs provide frameworks that enable users to adjust their account's privacy settings these are, for the most part, insufficient for capturing the fine-grained and complex nature of the human relationships these systems are attempting to emulate. This is further compounded by the problem that users are often ill-equipped to fully understand the consequences of the various privacy settings. In this research we aim to develop a fine-grained privacy preserving access control framework based on Answer Set Programming (ASP) to address privacy issues in OSNs.

Methods

The primary concept behind this research is to use declarative logic programming as a basis for the development of a fine-grained privacy preserving access control framework for OSNs. The research will consist of a series of tasks which develop; an ASP based policy specification language, an access control system that utilises this language, a policy maintenance framework for these policies based on policy decomposition; and finally the implementation of a system which performs all the previously mentioned tasks. With ASP being well suited to large and complex search problems it serves as a solid foundation for a privacy framework which is required to encode the complexities of human relationships. By developing a policy specification language based on ASP we are able to hide much of the complexity surrounding answer set programs, allowing for general users of this framework to specify and maintain, with relative ease, their own policies.

Results

This research will provide a comprehensive formalisation of a fine-grained privacy preserving access control framework suitable for OSNs, along with its component parts supported by a system implementation of this framework.

Conclusion

This research tackles an important issue in contemporary computing; privacy and resource sharing in OSNs. Our ASP based approach should allow for the fine-grained representation and general flexibility required, but not currently present in existing OSN privacy systems.

The History of Supermassive Black Holes in the Universe

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Purpose

The primary goal of my thesis is to map out the evolutionary stages of young Active Galactic Nuclei (AGN), the bright central radiation sources of galaxies in which Supermassive Black Holes have formed as a result of separate galaxies merging together. There will be a particular focus on tracing the sequence of Infrared Faint Radio Sources (IFRSs), Gigahertz Peaked Spectrum (GPS) sources and Compact Steep Spectrum (CSS) sources. GPS and CSS sources have been suggested to be extremely young and evolving radio sources that will one day grow into large-scale galaxies. IFRSs are likewise suggested to be young, since many are also GPS or CSS sources. However, no one has ever confirmed the place of any of these sources in an evolutionary sequence. We will study the multi-wavelength properties of each of these three types of sources over a large sample at several different frequencies and resolutions, in order to detect meaningful tracers of their evolution, including their electron lifetimes, redshifts and hence linear sizes, colours and luminosity functions. This will be the first time such research will have taken place on a complete sample of this size, stretching down to AGN of very low luminosity, determining the evolution of black hole activity over cosmic time and investigating its effect on galaxy evolution and star formation.

Methods

To achieve our major goal, we have set four minor steps: (1) the study of GPS and CSS sources, (2) the study of IFRSs, (3) the construction of luminosity functions of young AGN, and (4) the study of young AGN colours. These steps will be achieved primarily using the Australian Telescope Large Area Survey Data Release 3, with Small Magellanic Cloud (SMC) radio-continuum mosaics and observations from NASA's Spitzer Space Telescope and Wide-field Infrared Survey Explorer (WISE) as secondary data. Additionally, highly resolved observations of the sources of interest will be made throughout this research with the Australian Telescope Compact Array and the Long Baseline Array. Using these data will allow us to constrain the distance and cosmological age of each AGN with significant accuracy. This will allow us to determine not only angular sizes, but linear sizes of the radio galaxies and any associated emerging jets, which may reveal properties about any previous merges that took place.

Results

A sample of over a thousand IFRSs has been gathered by cross-matching sources appearing in the WISE all-sky survey and the Very Large Array's FIRST survey. The Infrared colours of these sources have been studied against a number of other galaxy samples and the IFRSs reveal a trend similar to that of galaxies at high redshift, suggesting their faintness in the Infrared is simply due to their being so far away, and not since they are being obscured by dust.

Effective Pre-processing in SAT

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Purpose

Boolean Satisfiability Problem is a classical NP-Complete problem that has many applications in various fields including model checking, planning and so on. One reason for its popularity is effective SAT solvers that can handle large instances in spite of its NP hardness.

Most of the SAT solvers accept input encoded in CNF format, but which may contains redundant information. Some pre-processing techniques can be used to transform the formula to equivalent one but with reduced size, so that the SAT solvers can solve it more efficiently.

Resolution is a basic transformation on CNF, which eliminate a variable x by pairwise resolving each clause contains x with each clause contains the negation of x . Although this process may produce much more resolvents, some of them may be subsumed by other existing clauses, so can be deleted without losing any information.

Likewise, self-subsuming resolution and variable eliminations by substitution are two other techniques extends from resolution, which when used appropriately can effectively reduce the size of a CNF formula.

Method

In this presentation, we proposed another method to transform the CNF formula, borrowed from the idea of safe forgetting in logic. We implement this method, and do experiments in some SAT benchmarks.

Results

The experiment results show that our method can boost the efficiency of SAT solvers in some instances.

Computer Vision in Welding Seam Detection for Robotic Arc Welding

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Purpose

The majority of industrial arc welding robots are programmed through “teach and playback”. This requires a human operator to manually program the robot. This is the main reason why robotic arc welding is less common in low volume manufacturing or repair work. It is generally accepted that it is more cost effective to weld these parts manually.

To make robotic welding for these low volume production industries feasible, robots require the intelligence to recognise and locate welding seams and then plan a path to weld them automatically. Computer vision can be used to achieve these requirements. However the visual identification of narrow welding seams is difficult to achieve. This presentation will focus on the development of a method for automatically detecting the weld seam in a butt-joint configuration of mild steel materials using computer vision.

Methods

The proposed seam detection method is implemented in three stages. In the first stage pre-processing filters are used to smooth the image for the Hough Transform to detect the outside edges of the weld assembly. The second stage is a background subtraction algorithm that uses Houghlines to segment the weld assembly ready for seam detection. In the final stage, the seam is identified by analysing the remaining edges in the segmented image and removing those that do not belong to the seam. Any spurs or rough edges are removed from the seam line using the A* algorithm. The final seam line is then ready for implementation by a robotic welding system.

Results

Experimental results show that this method is capable of detecting both straight and curved welding seams without prior knowledge of the location or geometry of the seam.

Conclusion

This method offers the flexibility to detect weld seams automatically. It works well even in the presence of imperfections on the surface of the steel such as scratches and mill scale.

Fire weather and climate change impacts on bushfires for NSW

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Purpose

Bushfires are a regular feature of the Australian environment and occur with some regularity, however, the larger events which give rise to loss of life and property are key issues for land use planning and construction. NSW has a diverse array of vegetation types as well as physiographic features within the landscape. Historically, forest fires disproportionately represent the greatest risks associated with life and property loss and occur in the eastern part of NSW. A significant proportion of the western part of the State does contain some shrub land vegetation types (typically mallee), however, the western two-thirds of the State is dominated by grass fires and significantly lower population densities.

A key element of considering the impacts of bushfire events are the return periods for extreme events. These extreme events can be quantified in terms of the severity of the fire weather conditions.

Fire weather is normally expressed in terms of forest fire danger index (FFDI), grassland fire danger index (GFDI) or as disaggregated climatic conditions such as wind speed (and direction), drought, temperature and relative humidity.

Method

Weather data from 21 weather districts of NSW have been collected using the McArthur model to evaluate the variation of FFDI for up to 38 years. The extreme events were selected based on a threshold method. Then Weibull method was used in determining return periods of the extreme events and their possible variation with the climate.

Results

The results of the study have major implications in the development of building solutions for bushfire protection in NSW. This return period categorisation of extreme events allows for a risk based approach to the application of deterministic models of fire behaviour to develop performance solutions for constructing buildings in bushfire prone areas, notably forested areas of New South Wales.

Knowledge Based Decision Support System for Patient Monitoring

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Purpose

Older people and people with chronic diseases are both fast growing segments of the population, covering a broad range of different health conditions. In such cases, often external support is needed to continue their everyday living routines, which is typically given by both professional and informal caregivers. Most people in the above situation indicate they would prefer to live independently in their own homes as long as possible. The concept of “smart home” has been proposed as an approach for enabling this. The overall aim of this research is to use information gathered from vital signs monitoring devices to make care decisions, by using a knowledge based decision support system. A knowledge based decision support system follows certain rules to determine a conclusion related to the health state of the patient. The data from the monitoring devices are gathered in real time, so the knowledge based system can be used by the caregivers to make instant care decisions for the patient and take necessary actions.

Methods

Using wearable devices placed on the patients’ body, the data collected from different devices will be analysed to understand the output variations for different vital signs. In the preliminary stage of this project we will use the public domain data. The collected data will be processed in the database as per their characteristics. The stored data and then a knowledge based decision support algorithm will be applied using simple rules to identify the health status of a person.

This project intends to create new ways to deal with two different knowledge based decision support systems. In the second stage of the project, we are going to develop a large and complex knowledge based decision support system which will analyse the vital signs data for a long term. Two aspects of knowledge maintenance will be followed in this stage. One is maintaining and storing the patient health record in the database and the second one is the knowledge based decision support system based on the processed data to identify the patient’s health condition.

Results

The main output of this project is to conduct experiments using new dataset of vital signs on typical case studies for the two different knowledge based decision support system, to validate the performance of these systems. This will enable us to consider how the patient’s overall health status can be stored and used for further use. This stage will involve detailed analysis to reconcile the decisions of previous stages. Initially it includes analysis of the applicability and workability of the overall system and suggestion of ways to improve it.

Conclusion

The aim is to provide solutions to health status monitoring and integration that will provide appropriate functions and user support in the areas of independent living, home care, better management of chronic diseases and easy access to their residences. This will make it possible to increase autonomy and help them to perform their daily activities smoothly so that the elderly and people suffering with chronic diseases can continue to live in their home comfortably.

End-User Development and Evolution of Rich Internet Applications from UI Requirements

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Purpose

Business needs change frequently and is often hard to fully capture. However, end users of business applications have a comprehensive understanding of these needs though they have no technical skills to harness them. One possible solution to this challenge is empowering end-users to create and change business applications. Hence an end-user friendly UI modelling language is proposed for the development and evolution of a class of business applications called Rich Internet Applications (RIAs). Evolution is viewed with respect to the structural and behavioural model of UIs and on the underlying data model. This research aims to fill the gap that exists between RIA development methods for IS experts and end-users.

Research question:

How can we empower end-users in the development of frequently evolving RIAs?

Methods

Design Science Research (DSR) methodology will be used to develop the RIA. Creation of an IT artefact for a relevant-problem is one of the principal aims within DSR. Design Science Research in IS consists of three cycles of research, namely the relevance cycle, the design cycle and the rigor cycle. During the relevance cycle, the requirements are identified. Empowerment of end-users is a well-known business problem. The idea is to harness end-users requirements knowhow, to develop and change applications. The design cycle identifies the design requirements of the research question, how it is to be field tested and what metrics are used to demonstrate its successful use. A study of the existing RIA architectures and model driven engineering methods is carried as a part of the Rigor Cycle. Based on this, RIA design features are identified in the design cycle to manage the creation and evolution of the application using the end user UI specification as the input. New knowledge of RIA development from UI specification is captured as a result of the constant interplay between the design and rigor cycle.

Results

The constructs of the language have been developed. The language can identify the UI elements, their properties and the structural relationships among the UI elements of an application. It is also able to transform the end-user UI specification to abstract and concrete widgets, which is important in Model Driven Engineering approach. Further it derives the data model from the UI specification. The language also has constructs to manage the change in behaviour and data model at runtime.

Conclusion

Future work will address engineering approaches and the evaluation of the efficacy of the language with respect to user-friendliness, generation of the structural relationships and end user understanding of the created models.

Effect of vibratory pile driving on far field of a driven pile

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Purpose

New construction projects in urban environments are often carried out in the vicinity of existing buildings utilising the land available. The construction induced vibrations can inflict significant forces on the substructures of adjacent existing buildings. This study investigates the effect of vibratory pile driving on far field of a driven pile.

Methods

An axisymmetric finite element model is proposed to simulate pile installation from the ground surface using ABAQUS/Explicit. In order to avoid large mesh distortions around the pile, an Arbitrary-Lagrangian-Eulerian procedure is adopted with adaptive meshing. First, the finite element model was verified, using field data available for pile jacking. The effectiveness of different types of wave transmitting boundaries, which are used to truncate the finite element mesh in dynamic finite element modelling, was determined next. The truncated axisymmetric model was then used to simulate vibratory pile driving and to study the ground vibration propagation around the driven pile. A parametric study is conducted varying the amplitude and the frequency of the vibratory force. The study was extended simulating pile installation by resonant pile drivers, which is an advanced form of vibratory pile driving. The impact on the far field is discussed comparing the peak particle velocity (PPV) distributions. Influence zones are determined for the selected vibratory pile drivers with the specifications given by the American Association of State Highways and Transportation Officials (AASHTO), Swiss Standard SN640312 and Eurocode 3 for acceptable vibrations to avoid damages to existing nearby structures.

Results

PPVs were extracted at different depths along the radial direction and were plotted against r/D where r was radial distance from the driven pile and D was the diameter of the pile. Results indicate that, for a given frequency, increase in magnitude of the driving force increase the PPV. However, for a given magnitude of the driving force, increase in frequency decreases the PPV.

Conclusion

The effect of the vibratory pile driving around a driven pile was investigated based on a parametric study conducted using an axisymmetric finite element model for pile driving. For vibratory pile driving, influence zone for typical residential buildings extends up to $40D$ from the driven pile while influence zone for buried structures extend up to $10D$. When resonant pile vibrators are used, the influence zones for typical residential buildings and buried structures extend only up to $25D$ and $5D$ respectively. An influence zone for structures with architectural merit determined for resonant vibrators, which extended up to $35D$ from the driven pile.

Privacy of Location-based Services in the Internet of Things

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Purpose

The Internet of Things (IoT) is a vision of the Future Internet. IoT is where networks of applications, objects and users are connected together using wireless technologies, RFID, 3G and 4G networks, Bluetooth, GPS systems and other technologies. The interconnected network of everyday objects, along with backend systems that seek out patterns of activity among those objects, in tandem with cloud computing environments, web services, and Mobile Computing will allow our 'things' to communicate to each other. This paradigm shift in computing from a centralized network model, where data are controlled via computers, to a distributed network of smart objects pose some challenges in which privacy is the major. In the IoT, communication of data can become arbitrary. Smart objects might communicate with other objects and human users and share information about individuals, such as their locations. The ability to secretly track individuals is a major privacy concern. The vision of IoT is that overall interconnectivity would allow individuals to locate and monitor everything, everywhere and at any time. But should users worry over the collection of their location information? What are the principles that should govern the deployment of such technology? To what extent collecting personal information and tracking of people locations are accepted? And who determine that fine line between tracing and surveillance, security and privacy? How do we provide notice appropriate to circumstances to individuals when the data collected might be associated with them? Hence, this research aims at joining these questions together into a main research question: How can privacy's requirements be balanced with the security and location sharing requirements, in Mobile Computing, as part of the Internet of Things?

Methods

This work is to be carried out in four stages. Currently, in Stage 1, we are conducting a literature review that will analyse the state of the art of the current approaches of privacy and security techniques used to secure users' personal information, with special concentrations on Mobile Computing and Location Based Services. This stage will also include a discussion of the existing techniques, their specifications and their limitations. In Stage 2, we define and identify the requirements and features needed for balancing the privacy and security needs within an IoT environment based on a set of scenarios. A secure framework/model shall be proposed at this stage. Stage 3 and 4 will include the experimental works and the analysis of their results.

Results

What we have found so far is that, with the current privacy practices, users fail to recognize the impact of using new technologies, such as mobile location based services applications, on their privacy. The main outcome of this research is to develop a model for secure exchange of users' information and data over the generally insecure networks in the IoT environments.

Conclusion

The key objective of this research is to investigate the extent to which privacy requirements and/or expectations of users of location-based services are met while sharing their location information with other users or objects in an IoT environment.

eVillage for rural areas

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Purpose

Communication technologies and broadband networks offer interesting solutions for improving human quality of life. However, the improvements are less prominent in the rural areas and in developing countries. Partially, this may be related to cultural and social acceptance of such technologies in rural areas. It can also be associated with the lack of a proper architecture for utilization of such technologies in those areas. This work in progress is an attempt in developing such architecture. It is based on mapping of existing or upcoming information and communication technologies to socio-economic services and applications needed for sustainable rural areas. Based on analysis of the existing infrastructure and technical requirements, we show that wireless and cellular technologies are the most suitable choices for this purpose. Integrating these points, a network-based architecture, referred to as eVillage, is designed. To investigate the underlying issues, simulation studies for several interactive services in such an environment, using different simulation tools are then carried out. One possible goal or outcome of the research is to assist on design principle to remote service providers in provisioning interactive services.

Methods

The first phase of the research analyses the current network and communication infrastructures in developing countries. In this phase the situation in developing countries is compared against the developed countries. Based on the analysis a mapping is formulated with the available technologies to the possible services. The second phase of the research aims to design experiments to simulate the current infrastructures of developing countries. The focus of the simulation studies is to identify the underlying issues in network and application performance while providing interactive services through the current infrastructure. The simulation experiments also aim to compare the existing network infrastructures in different developing countries. Based on the result analysis the research designs a framework to identify the possible changes to improve the performance. The framework decides whether improvements are related to application level parameters, network level parameters or infrastructure related parameters. The decisions help to recognize the feasible improvements which can be achieved in this research timeline. Then the improvements are implemented, tested and analysed in terms of application and network level performance.

Results

Some of the simulation results indicate that the proposed architecture can support a reasonable number of users in rural areas. Obviously, beyond a certain number of clients, QoS becomes an issue, which to some extent can be addressed through appropriate reconfiguration of the underlying network-based systems. Other results show that provision of interactive application services through cellular and WLAN architecture experience QoS issues.

Conclusion

Wireless and cellular technologies provide viable solutions for sustainable rural community developments. However, they pose serious limitations in delivering real-time interactive applications. Interactivity is among the key prerequisites for successful deployment of several network-based solutions in such areas. This research examines some of the relevant principal issues and investigates how they may be overcome. The aim of this research in progress is to design a wireless-cellular based integrated architecture to provide interactive socio-economic services for rural areas.

Improving Reliability of Wireless Mesh Networks through Trust Evaluation

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Purpose

The research on enhancing the security and reliability for routing packets in Wireless Mesh Network (WMN) is still in a primary stage. Nodes in the wireless mesh network are dynamically self-configured and self-organized. These features bring many demands for deployment of WMN. WMNs have become an attractive area of research due to its high volume communication, ubiquitous low latency, and high levels of service coverage. Factors such as security strategy, path selection technique, power consumption have directly an influence on the performance of the Network. Achieving security in WMN is a big challenge. This is because WMN and other mobile system networks suffer from four main constraints CPU, Battery, Mobility and Bandwidth. These constraints make the realization of security in WMN more complex. Achieving security is a nontrivial challenge and has been rarely addressed. Therefore, the purpose of this research is to evaluate trust value among the participant nodes to enhance the reliability of the end-to-end packet delivery in Wireless Mesh Network.

Methods

The research methodology has two stages. In the first stage, the research analyses the current state of Wireless Mesh Network. The literature conducted in this stage reviewed the existing solutions and current practices for the aim of the identification of the gaps and shortcoming of the methods currently in use in WMN. In the second stage, various scenarios of WMN were designed and will be simulated. The research focuses on three important performance metrics. The corresponding outcomes of the experimental simulation will be used as an input for trust evaluation formula. Then based on the evaluation formula, the trust value index for each interacting nodes will be justified. In the next step, the trust value index will be used in different WMN scenarios in order to evaluate the improvement in the end-to-end reliability of the WMN.

Results

The results collected from the simulation works, carried out using OPNET, show good agreement with those identified in the literature. It confirms the need to improve the end to end packet delivery in WMN. This ongoing work should results in the improvement of reliability of packet delivery in WMN.

Conclusion

This paper try to optimize the end to end packet delivery based on neighbouring trust value in WMN. This work has the potential of being expanded to include finding ways to enhance the evaluation of trust levels in uncertain and dynamic condition. It will further investigate how a node with a higher trust value will aggregate trust information of its neighbours and how it explores and relies on a node with a higher trust value within its neighbourhood.

Validating synthetic health datasets for longitudinal clustering

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Purpose

The work presented here contributes to the field of data mining by describing an approach to generate synthetic longitudinal health datasets, and studying the effects of applying different clustering algorithms based on unsupervised learning to them. Unsupervised learning methods are based on discovering new statistically reliable actionable insights from datasets, with information about structure of the datasets unknown a priori. We use two different kinds of clustering algorithms to cluster our datasets, in order to also investigate the effect of the algorithm choice. The K-means algorithm is a point-based clustering method which places cluster centres in an arbitrary position and relocates them at each step to optimize the clustering error based on distances of cluster elements from the cluster centre. Latent Class Analysis (LCA) applies a probabilistic clustering approach using posterior probabilities: this means that although each object is assigned to belong to one cluster, it is taken into account during the computation that there is uncertainty about an object's cluster membership.

Method

We demonstrate our approach in research involving the 45 and Up Study baseline dataset, a large-scale cohort involving more than 250,000 men and women aged 45 years and over from New South Wales. Participants in the 45 and Up Study were randomly sampled from the database of Australia's universal health insurance provider, Medicare Australia, which provides virtually complete coverage of the general population. In addition, it is planned to follow up the cohort every five years. However, this study has finished only its first stage of collecting data and is currently entering the second phase to provide the first time step after baseline. In order to test and evaluate longitudinal clustering methods for future use on this data, we created a family of synthetic longitudinal datasets derived from the baseline dataset.

The main goal in creating a longitudinal synthetic dataset is to explain cluster behaviour in the next time step, as exhibited by either merging or splitting. To create the synthetic datasets we followed a systematic change pattern for successively every five percent of the cluster elements for an initial clustered state of the baseline data, adding a normally distributed random number in the range (-variance, +variance) and (-2×variance, +2×variance) of the targeted cluster. Based on this approach, three different datasets were chosen, one being the baseline dataset and the other two from the family of synthetic datasets, to compare K-means and LCA. With these three datasets we investigated the quality of each clustering method in the situations resulting from the changes in datasets, using several different validation indexes. Using this approach would give some insight for applying specific domain knowledge to decide on which clustering method is used and which model best explains the characteristics of our data. Results of this work indicate that with a small change in data, LCA would still discover almost the same clusters as in the baseline dataset.

The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council New South Wales; and partners the National Heart Foundation (NSW Division); NSW Health; *Beyondblue*: the national depression initiative; Ageing, Disability and Home Care, NSW Department of Human Services; and Uniting Care Ageing. We thank the many thousands of people participating in the 45 and Up Study. The support of CSIRO AEHRC is also gratefully acknowledged.

Towards data-centric security: preserving privacy for data stored in the cloud

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Purpose

The purpose of this study is to improve the privacy and integrity of data stored in the cloud. Cloud computing solutions offer numerous benefits to users. However, this emerging technology comes with challenges in which security is one of the major. There is a need to provide sufficient security solutions that guarantee the confidentiality of information during their lifecycle in the cloud. The data-centric approach relies on cryptographic techniques for ensuring the protection of users' data. The challenge remains on how to reliably and efficiently integrate this approach in a cloud computing environment. The study has further investigated the existing cryptographic techniques and their adaptation into the cloud model. The proposed approach ensures that only authorized users are allowed to access, share and search the data stored in the cloud in a secure manner. In this approach, the security of data is controlled and managed mainly by their owner which guarantees the confidentiality of data even against the cloud provider.

Methods

The research methodology is divided into two stages, theoretical and experimental. In the theoretical stage, the research investigates the cryptographic algorithms, and some other techniques, used to preserve the privacy and integrity of data. The research methodology is based on the data-centric security approach. Hence, it relies on the concept that the data must be self-protected with built-in security policies. That is, the privacy of data is achieved independently and does not rely on the security solutions provided by the cloud providers. Accordingly, we propose a method to reflect the data-centric security approach. In the experimental stage, the proposed scheme will be implemented and tested on a cloud environment. An experiment will be conducted to investigate practical implementation issues and to measure the overhead added to both the client side and server side. The sample cloud environment is developed by creating virtual machines on a physical server using VMware virtualization platform (vSphere). Moreover, experiments will be conducted to evaluate how extend our approach is practical and scalable.

Results

The main contribution of this research is to establish a data-centric security approach that protects data privacy and integrity within the data itself against unauthorized accesses including those by cloud providers with less possible impact on the data usability and owner overhead. The results expected to be reasonable and scalable compared to the security and functionality provided.

Conclusion

The research will provide better understanding of the privacy issues in cloud computing and will find a more comprehensive solution to it. The proposed scheme is expected to produce a simple and flexible method to demonstrate the data-centric security approach. The research experiment is expected to identify the obstacles and challenges that face the practical implementation of the data-centric security approach. The outcome of this research will contribute to form a more clear vision of data-centric security approach.

Large flood modelling in Australia: a new large flood regionalisation model

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Purpose

Estimation of large to rare floods is important in the planning and design of large hydraulic structures and many other important water resources management tasks. This is regarded as a challenge, due to the limited availability of observed flood data in this range of flood magnitudes. Methods used to estimate large to rare floods involve significant extrapolation beyond the available flood data, either using a rainfall-runoff model or empirical methods.

Methods

This paper presents a simple Large Flood Regionalisation Model (LFRM) which is relatively easy to apply in practice as it is based on few easily obtainable predictors. The LFRM assumes that the maximum observed flood data over a large number of sites in a region can be pooled together by accounting for the at-site variations in the mean and coefficient of variation (CV) of annual flood maxima. The LFRM in this paper builds on previous research work by combining it with a spatial dependence model that accounts for the reduction in the net information available for regional analysis (i.e. the number of independent sites N_e). The main interest of the LFRM is its application to ungauged catchments, which has been achieved in this study by developing prediction equations using Bayesian generalised least squares regression with the region-of influence (ROI) approach to estimate the mean and CV of the annual maximum flood series as a function of catchment characteristics. The LFRM is developed and tested in this study using data from 626 catchments across the Australian continent.

Results

A split-sample independent test, a rigorous uncertainty analysis based on Monte Carlo simulation and comparison with established methods (i.e. World Model and Parameter Regression Technique) has shown that the new LFRM that pools 3 to 5 annual maximum data from each site can provide quite reliable design flood estimates in the large to rare flood range.

Conclusion

The LFRM is still under testing and requires further refinement before it can be applied to large to rare flood estimation. Indeed it should be also stated that the LFRM should be benchmarked with other methods for further validation. It is expected that the LFRM can also be further improved with the collection of more good quality data.

Water demand and supply analysis under changing climatic conditions

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Purpose

This research will investigate the climate change impact on water resource availability in an urban catchment. In order to assess the climate change impact, an integrated approach will be developed. This approach will integrate possible future water demand and water yield scenarios to estimate water availability under changing climatic conditions.

Methods

This research has three main parts. Long term water demand forecasting model will be developed in the first part. In the second part, future water yield scenarios will be estimated under changing climatic conditions. Finally, an integrated approach will be developed. Long term water demand forecast will be identified by developing linear and non-linear multiple regression models for water use of single residential, multiple residential and non-residential sectors. Stochastic simulation of future water demands will be estimated by Monte Carlo simulation technique. Uncertainties in the water demand variables will be incorporated in the stochastic simulation. In the second part of the research, future streamflow scenarios will be estimated by a suitable hydrological model. Future climate change scenarios and catchment conditions will be taken as input into the hydrological model to get the future streamflow scenarios. Finally, an integrated approach will be developed using established probability analysis tools such as Bayesian networks.

Results

The Blue Mountains area has been selected for a case study for this research. Water consumption data for the period of 1997-2010 have been collected and used to develop the water demand model. From historical water consumption pattern, it has been found that residential sector consumed around 80% of supplied water. Rest 20% was consumed by non-residential sectors. Two types of linear model have been developed. One is yearly model for which coefficients of predictor variables are fixed for all the months. Another type of model is monthly model for which coefficients are different for all the twelve months. Three predictor variables which are rainfall, temperature and restriction level have been considered in the model. By comparing the value of relative error and Nash-Sutcliffe parameter, yearly model has been found to perform better than monthly model.

Conclusion

The integrated approach so developed will be able to answer the questions such as, what will be the probability of water shortage given water demand and yield scenarios in 2070? The outcomes of the research will be highly beneficial to the water authorities for appropriate planning and managing water resources.

The passive ambient noise HVSR technique for geotechnical characterisation of compacted ground

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Purpose

Ground compaction is a soil improvement technique widely used to (a) densify (b) strengthen (c) make less permeable a site for future geotechnical construction. Understanding the quality of compaction achieved and monitoring compaction efforts are of paramount importance to ensure that the required and/or designed outcomes are achieved. The geotechnical characterisation of compacted ground is typically performed by ordinary mechanical techniques such as the CPT, DMT and density tests. These methods provide accurate results but are quite costly and time consuming particularly when dealing with very large areas.

Methods

The innovative Horizontal-to-Vertical Spectral Ratio (HVSR) technique has been employed at the Penrith Lakes quarry, located in Western Sydney. Testing with the HVSR technique involved using a stand-alone, portable, battery operated, lightweight (about 1 kg) device to measure the ambient noise in the ground stemming from natural events and cultural/human activities which are ubiquitous on the Earth's surface. Only 16 minutes of measured ambient noise is required at each location to gain insightful knowledge of the ground structure. It is proposed in this research to develop appropriate methodologies based on the HVSR technique to facilitate the assessment and monitoring of compacted ground. This entails utilising data produced by the HVSR technique in two distinct yet complimentary ways: (1) interpretation of the measured HVSR curve produced by the signal processing of raw measured HVSR data, and (2) forward modelling of the measured HVSR curve to provide an estimate of the shear wave velocity (V_s) of the ground.

Results

Sections of the Penrith Lakes quarry have been remediated for potential housing and infrastructure construction, once quarrying has ceased. Therefore, roller compaction has been used when compaction is required at shallow depths and dynamic compaction has been used in more challenging areas where compaction is required to reach deeper depths. The results produced by the HVSR technique have been compared with available mechanical data to verify the effectiveness of the technique. Thus far, the results have been quite encouraging in characterising different forms of compaction (i.e. roller and dynamic) and providing an estimate of the V_s profile of the ground.

Conclusion

This study has shown that the innovative HVSR technique has the potential to geotechnically characterise compacted ground in a cost effective and time efficient manner. Furthermore, as an added benefit, the resonance frequencies of the tested areas at Penrith Lakes were resolved without undertaking additional work.

Detecting trends in Australian annual maximum flood series

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Purpose

Globally, observational and historical streamflow data are the backbone of the regional flood estimation methods and are used in planning and designing water resources management projects. There is an implicit assumption, so called stationarity which assumed the past events are indicative of the types of conditions expected in the future, in all the currently adopted regional flood estimation techniques in Australia. However, as the results of the potential impacts of climate change due to natural climate variability or/and anthropogenic activities this assumption may no longer be valid. It is thus essential to investigate hydrological variables for trend behaviour and to assess the potential causes for the trends that are found. The research conducted in this study investigates and quantifies trends in annual maximum (AM) flood data series in Australia.

Methods

The study uses the non-parametric Mann-Kendall (MK) and Sen Slope estimator tests for three periods: 1955-2004, 1965-2004, and 1975-2004. The selected 491 small to medium sized catchments with record lengths from 30 to 97 years long, and with minimal regulation or land cover change, represent the most extensive streamflow database compiled in Australia to date. Three different approaches are utilised to account for the effect of temporal serial correlation on the trend results, along with a bootstrap resampling approach to account for the temporal cross-correlation structure in the data when the field significance of downward and upward trends was investigated separately. The link between observed trends in AM flow data and rainfall data is also investigated.

Results

The results indicate significant downward trends in the AM flood data in the south-east and south-west regions of the country. Further investigation shows that these downward trends are field significant at the 10% significance level, whereas any upward trends are not. A weak relationship was found between the changes in the annual maximum rainfall and the annual maximum flood, suggesting the important role in antecedent catchment moisture prior to the flood-producing rainfall event. When the impact of climate variability (represented by the Interdecadal Pacific Oscillation (IPO)) was considered in the further investigation of the trends, the results indicate that the significant trends observed in the first level assessment become insignificant once the effect of IPO is considered.

Conclusion

The study suggests that the possible effects of anthropogenic climate change on flood extremes in Australia cannot at this stage be clearly distinguished from natural variability, while also highlighting the important role of antecedent catchment moisture in controlling the magnitude of the flood event.

Structural damage detection using AR model coefficients

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Purpose

Structural health monitoring has become vital to maintain safety and integrity of structures, to increase their life span, and to reduce costs of maintenance and repairs. Damage detection algorithms play a major role in any structural health monitoring systems.

The existing damage detection algorithms exhibit shortcomings such as, low sensitivity and/or accuracy, dependency on the structural model, high complexity and low energy efficiency. The objective of this work is to develop an efficient damage detection algorithm with better accuracy and sensitivity.

Methods

Statistical time-series methods have been used for structural damage detection research work for years due to their sensitivity to changes in a series of data. These methods are based on the premise that the statistical prediction model developed from the undamaged (healthy) structural measurement data would not be able to reproduce or predict the newly obtained time series, if damages exist in the current structure.

In this work, a damage detection algorithm based on Auto Regressive (AR) models is developed, which uses a Euclidean distance based index as its damage sensitive feature (DSF). This feature is computed using the coefficients of the AR model fitted to the undamaged structural response data and its damaged counterpart. A statistical evaluation is performed on the damage feature by computing its Fisher criterion of damage features of the healthy and damaged structure.

Results

The proposed structural damage detection algorithm was implemented in Matlab. The results were verified using a set of structural response data obtained from a series of impulse tests carried out by Zhu and Hao, 2009, on a two-span reinforced concrete (RC) slab while it is undergoing several damage scenarios caused by an increasing static load.

The damage detection results using the damage sensitive feature showed successful results in each of the damage scenarios. However, a few false damage indications were encountered at some points near the support locations of the structure. The responses of the sensors near those locations are subjective to the support reactions and thus, may be unreliable. The statistical evaluation of the damage feature using the Fisher criterion also presented successful indications of damage locations. These results accurately determined the damage locations in the structure.

Conclusion

The results showed that despite its simplicity, the damage feature is successful in detecting damages on the tested RC structure. Apart from the complexity of the AR model calculation, computation of this DSF from the model coefficients is simple and straight forward. The Fisher criterion - which has been used in a few previous studies as a statistical classifier for making the damage decision, was a successful method of statistical evaluation in this study. The distance feature combined with the Fisher criterion has potential for accurate damage detection in other types of structures as well.

Energy Efficient Data Compression Technique for Wireless Sensor Networks and Experimental Test on Bridge

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Purpose

Wireless Sensor Networks (WSN) consist of distributed sensors which enable fault tolerant monitoring and control of variety of applications. Wireless sensor networks are usually powered by sensors however; batteries may not be recharged in the field setting. The sensor systems are expected to utilise the minimal possible energy to extend the lifetime of a WSN. The communication module consumes a major part of energy of a sensor node. Hence data compression methods to reduce the number of bits to be transmitted by communication module will significantly reduce the energy requirement and increase the life time of a sensor node. The objective is to employ network coding technique to reduce the amount of routing information which reduces the overall energy consumption. An experimental test on a cable-stayed bridge will be conducted to demonstrate the proposed network coding technique.

Methods

Nodes of a network will take several packets at a time and combine them together for transmission in order to reduce retransmissions and to avoid collision which reduces the overall energy consumption and increases the bandwidth of a network. The experimental test on bridge is to explore different sensing and networking in real conditions, and led to creation of onsite test.

Results

Analysing the performance of network coding for energy efficiency. Experimental test on a bridge is to obtain the validation tests to show the potential of the proposed data compression technique.

Conclusion

The proposed network coding reduces the energy consumption of a sensor node. The experimental test gives the overview of the components used and software used to manage it.

Concrete deformation localisation using photogrammetry for structural health monitoring

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Purpose

Structural Health Monitoring (SHM) is vital for the maintenance and longevity of structures. Early detection of deformation in beams can alert engineers to the possibility of weakening or complete failure of a structure. Close-Range Photogrammetry is proving to be a reliable contactless technology to detect these deformations. In most applications of Photogrammetry, a pattern of reflective spots or markers is applied to the surface of the structure under test. Changes in the pattern are detected using two or more cameras, and deformations are measured between targets. However, these deformations cannot currently be localised to a higher degree than the density of the applied targets. This thesis addresses the issues of deformation localisation between targets and deformation measurement on low textured surfaces, such as concrete, using photogrammetry.

Methods

There are some issues that are presented when using photogrammetry for this purpose. These issues include matching of targets without knowledge of the scene, image correspondence with repetitive low textured patterns between displaced targets and the effects of scale and affine projections on displacement detection and localisation. To overcome these problems, two robust image correspondence algorithms have been developed that can accurately match the targets and low textured regions between targets. The first algorithm, Hierarchical Correlated Region Matching (HCRM), efficiently removes incorrect correspondences caused by repetitive patterns through a process of collapsing regions of correspondences between two images that are spatially consistent. The second algorithm aims to enhance the performance of current state-of-the-art image correspondence algorithms by calculating a rough orientation via a fast correlation and minimisation process firstly before applying the more computationally intensive algorithms such as the proposed HCRM or SIFT.

Results

Experiments have been performed using the proposed HCRM algorithm on popular image matching datasets and on simulated low textured repetitive patterns similar to those found in concrete. The results demonstrate that the algorithm outperforms current state-of-the-art methods when matching repetitive patterns. Preliminary results from the second algorithm show promise in enhancing the overall matching performance and enabling the automatic matching of photogrammetry targets.

Conclusion

Through the application of the proposed image matching enhancements to the photogrammetry process, it is expected that deformation will be localised between targets and thus measurement accuracy will be improved. Further work will be aimed at combining these image matching algorithms into a photogrammetry framework ready for experimental testing. Further experimentation will be performed on images captured of real concrete cylinder structures under compression to determine the location of deformations before critical failure occurs.

Numerical analysis on vibration of functionally graded carbon nanotube reinforced beams

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Purpose

Structural elements made of composites have shown superiorities over conventional materials in terms of functionality and structural performances. The current research project is to investigate free vibration of aligned functionally graded carbon nanotube (FG-CNT) reinforced composites using the third-order beam theory.

Methods

Carbon Nanotubes, since its discovery in 1991, have proven to be one of the most promising additions for a new generation of high performance and multifunctional engineering materials. In the field of engineering mechanics, matrix such as conventional alloys or polymers can be reinforced by single-walled or multi-walled CNTs in order to attain high strength/stiffness to weight ratios, control vibration and improve ductility. In the current state of research, the mechanical properties of nanocomposites are obtained using micromechanics approach in which molecular dynamics (MD) results have been reviewed and matched with the result of rule of mixture method.

The concept of FG materials not only combines the merits of several materials, but also eliminates the interlaminar stresses that usually exist in the laminate structures, by gradually varying the volume fraction of constitutive materials. With the progress of advanced manufacture, it has been reported that the aligned nanotube-reinforced composites were fabricated. And the improvement achieved a maximum when the CNTs are aligned along the loading direction.

This project studies the vibration behavior of the new FG-CNT composite beams with different combinations of edge support conditions, beam slenderness ratios, CNT distribution along the thickness direction and CNT volume fraction. In order to obtain accurate solutions, the third-order shear deformable beam theory is employed in this study. The energy functional of the beam system is derived using the variational method of Hamilton principle. The Ritz method is applied to obtain the eigenvalue equation for the beam vibration problem. A program for solving this eigenvalue problem is developed in Maple VI and is used to obtain the Natural vibration frequencies for the FG-CNT beams.

Results

The correctness and accuracy of the proposed numerical approach for the vibration analysis of FG-CNT composite beams are first verified through convergence and comparison studies. The natural frequency parameters of the FG-CNT composite beams are then obtained. The effects of CNT filler volume fraction, distribution, beam slenderness ratio and end support conditions on the free vibration characteristics of the beams are being discussed in details.

Conclusion

This paper investigated the free vibration of FG-CNT reinforced composite beams. The third order shear deformable beam theory was employed and the Ritz method was applied to obtain the natural frequency parameters of the FG-CNT beams. The influences of CNT fraction ratio and distribution patterns as well as the beam slenderness ratio and support conditions on the frequency parameters of the FG-CNT beams were studied.

Content aggregation for social life networks

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Purpose

An International collaborative research project has been launched to develop Social Life Networks; which are the next generation of Social Networks, aimed at supporting livelihoods of people in developing countries by providing required information just-in-time using mobile phones. In this project the specific aspect that I am working on is to help farmers to make optimal decisions at various stages of a farming life cycle by providing them aggregated information from various sources in response to their queries. Such a system can overcome many problems farmers are experiencing today due to inadequate knowledge and information.

Approach

Thus I am investigating the optimum way to aggregate contents in the context of this project as follows.

Creation of a set of abstract templates

The first step is to identify few typical usage scenarios. The next step is to obtain possible responses by talking to domain experts. These responses will then be abstracted and generalised. A template could be used to represent the abstract responses in the most logical form and the parameters that are associated with each solution will form the different fields in the template. By analysing such templates we can generate an abstract template that could suit any scenario and its fields could be configured to meet the requirements of the solution.

Template selection

When a farmer makes a query we need to select the relevant abstract template. Based on the chosen template, the information needs to be gathered from reliable sources that have been mapped with each of the fields of the template. Gathering of the information from various sources is an important aspect and this could be done by the identification of selected types of entities, relations or the event, from free text and these facts need to be transformed into structured or semi structured format so that the fields of the template could be filled. The information from the templates can be then converted into suitable formats like XML, JSON and provided to the user.

Query Expansion & domain identification

A challenging aspect is to select the correct template. To assist this when a user makes a query, the query needs to be further expanded and for this some additional information needs to be gathered. The expanded query is then used to identify the domain and sub domain of the problem.

I have identified the high level architecture required by the system and divided them into sub blocks. I need to find suitable methods to expand and implement the functionality of each block.

Capturing Tacit Knowledge and Transfer to Explicit Knowledge in Business Processes in an Organisation

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Purpose

In an organisation the functions are carried out in series of business processes. These business processes consist of many tasks that are performed by workers. To complete the tasks successfully a worker needs to have certain knowledge that is required for the task. Therefore, expert knowledge or the knowledge of the worker who can complete the required tasks is the most important knowledge for business processes in organisation, because if the expert is to leave the job, organisation will often lose its knowledge. Therefore, when a new employee starts to work in an organisation, she/he needs to acquire a particular skill, knowledge and experience to do the job. The new employee or an employee who still does not have a sufficient knowledge can gain explicit knowledge by reading documents, training manuals, policies, rules and regulations. Explicit knowledge alone however, may not be sufficient for the successful task completion. To complete the required tasks employee will also need to have the tacit knowledge. If the employee however does not have required explicit and/or tacit knowledge there will be a "*knowledge gap*".

Explicit knowledge is highly visible in documents, manuals, instructions guides, policies, rules and regulations. However, a gap in tacit knowledge cannot easily be identify because tacit knowledge is personal knowing, human experience, and hard to articulate. Codifying and capturing tacit knowledge is a challenge.

My research aims to identify how tacit knowledge can be captured and transferred to explicit knowledge.

Methods

Throughout the first year of my doctoral studies I have conducted the literature review and undertaken the analysis of knowledge frameworks, knowledge models with the aim to review and identify knowledge components crucial for specific task completions.

Through studies conducted, I categorised and identified frameworks and methods assessing tacit knowledge capturing, knowledge transferring, knowledge sharing and knowledge creations.

Result

Based on my literature reviews, I propose framework that consists of different components: extracting and collecting required information and data from knowledge resources (expert knowledge) in specific context, analysing and identifying critical knowledge in explicit and tacit knowledge, and knowledge transfer component that can transfer tacit knowledge to explicit knowledge and store in knowledge repository. I will present more details with the diagram in presentation.

Conclusion

The framework helps identify components of critical knowledge – the context, explicit and tacit knowledge required for the successful task completions. I will carry out interviews, case study and observation to test the framework and change necessities.

Cluster Validation for Optimal Number of Cluster

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Purpose

Partitioning data into finite number of k homogenous and separate groups is carried out by partition algorithm like k -means clustering algorithm. Evaluating these resultant homogenous and separate clusters from k -means algorithm is the main subject of cluster validity where the properties of k -means cluster such as density, size, and form of cluster and separability of cluster are examined. There are three main approaches external, relative and internal validations are used for formed clusters by k -means to validate their results for optimization. First two approaches are based on prior information for clustering, for example in the case of external validation to evaluate the resultant clusters are based on the pre-specified structure of the dataset while relative validation technique is based on comparing to other clustering schemes. As cluster analysis is unsupervised technique where we do not have information about making compact and separate groups, in this case we will consider only internal validation for k -means clustering algorithm to find the optimal number of groups. The purpose behind the clustering is to find the compactness, the member of every cluster should be close to each other as possible as the member of other cluster for example variance within cluster should be minimum and separation between the groups should be clear and spaced.

Methods

Here we focus on the cluster internal validation measure to check the compactness and separation of groups which will produce index to evaluate answered cluster by k -means clustering algorithm. For that there have been developed different indices like Duda & Hard index, Calinski & Harabasz index, Davis-Bouldin index, RS and RMSSDT indices and SD index. The value of these indices is between [0-1] and graphed against k number of clusters to get knee for optimal value of k . In this study, the task is to develop a new approach to find optimal number of k clusters by comparing consecutive values of k , $k+1$, $k+2$, etc to find different homogenous groups and structure for different datasets. The proposed cluster validity measure is applied for evaluating the resultant clusters by calculating the proportion of common elements in each pair of groups. The maximum proportion values are obtained for each cluster in the set of k clusters C_k compared with all clusters in the set C_{k-1} and similarly for $k+1$, $k+2$, $k+3$ and so. Validation of the resultant clusters for optimal value of k based on these proportions will be presented to demonstrate the applicability and usefulness of the proposed method.

Results

As an example, k -means clustering is applied to create homogenous groups for a breast cancer dataset from UCI datasets repository to find groups of patients related to benign and malignant cancer diagnoses for different values of k . The proportion matrix produced from resultant cluster shows while cluster formed from $k=2$ to $k=3$, $k=3$ to $k=4$ and $k=4$ to $k=5$ memberships of cluster changes. It stays stable and shows a little perturbed in the datasets at $k=5$ and present best possible optimal value is $k=5$.

Conclusion

In this study, we look forward to develop a new measure for k -mean clustering algorithm answered clusters internal validation to find best value of k clusters. The good choice of k is essential and important feature for building meaningful homogenous and separate clusters by applying k -means clustering algorithm for different kind of health datasets in two dimensional or multidimensional datasets for compactness of cluster memberships.

Long-term digital preservation and storage management

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Purpose

Over the last few years, digitisation of libraries and archives' collections has increased substantially. As more and more contents are being digitised, the need for additional storage for the long-term preservation of digital contents is growing exponentially. Although storage cost has reduced significantly over the past few years, overall cost for the management of storage for the long-term preservation of digital contents is still large. Management of storage is a major concern in the digital preservation life cycle. By selecting right storage media and storage management software will not only save costs but also reduce risks of information loss stored on the storage media.

The core focus of this study is the long-term preservation of digitised collection in the Australian research and academic libraries. The aim of this research is to study existing and emerging ICT, storage and digitisation technologies and how changes in technology over time can impact on the long-term preservation of digitised collections. It includes study of current/future data storage systems to investigate issue of sustainability/accessibility of digitised material/collections over time including technology assessment, system reliability, media stability and technology obsolescence.

Methods

This study includes an investigation of a range of data storage technologies by using a variety of resources. Research methodology includes online and desk research of publicly available data, literature, published articles, recent research and analysis of technical capabilities of new and emerging digitisation and preservation technologies.

Results

Findings from this study suggest that new and emerging technologies such as data *deduplication*, *thin provisioning* software and *virtual storage* can be used to reduce storage requirements and cost for the long-term preservation of digital collection. These technologies are designed to maximise the use of available storage by eliminating a need to store redundant and duplicate data. This will reduce the number of disks required for the data storage hence reducing overall cost of data storage. The selection of storage media and management software for the long term preservation of digital contents should be considered at the very beginning of any digitisation program.

Conclusion

Nevertheless, latest emerging technology will provide new opportunities and assist in reducing storage needs and overall storage cost for the long-term preservation of digital contents. However there are certain risks associated with the use of these technologies too. Technological obsolescence is a major threat that should be considered while using these technologies. Certain strategies should be included in any long-term preservation programs for digital content to avoid any data loss because of potential technology failures.

Network Mining: An approach for Data Mining with Network Relations

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Purpose

This study brings together Social Network Analysis from Sociology and Data Mining from Computing Science to prove the network relationships enhance the analytical models. Performance is becoming an essential indicator in various areas of human endeavour. Contemporary businesses have become more customers focused and measure their success by the level of customer satisfaction. The same can be said for part of the performance of contemporary Universities, where student experiences, research output and funding are key indicator of success. In this socio-digital age, gathering and gaining information is not a complex task and the individuals could be seen as advocates of products and services. Data mining methods such as market basket analysis or clustering help analysts understand the likelihood of products people buy at the same time or different times, which is useful information for decision making. Moreover in everyday endeavour individuals are interlinked in various relationships- family, professional, recreational, to name some, forming various social networks. The case study in study is based on university collaboration data, such as DEST publication data and Project participation data.

The goal of this study is to prove the hypothesis *"The performance of analytical models increase if network attributes are included during modelling phase"*.

Methods

Network studies have been very popular in the sociological research, but in recent years the network studies are gaining popularity in the scientific research field. The reason network studies are gaining popularity with a remarkable pace in the research industry is because the scientist across the globe whether biologists, mathematicians, sociologists, physicists or computer scientists are actively working on a new research field "Science of Networks". In biology social network studies, have helped identifying insights of spread of new diseases and techniques to control them. Sociologists use these networks to understand the societal networks as political networks on a macro level or micro level.

An integrated approach that combines network mining (or network analytics) methods with traditional analytical methods (e.g. customer segmentation or market basket analysis) can be more effective way in identifying hidden drivers of customer churn, viral take up of products to groups of relatives, households and colleagues. Customer level insights are based on hypothesis and network level insights are based on facts. This research will address the limitation of classical "independent" based data mining techniques by developing methodology and metrics to incorporate network mining approach, with traditional mining methods.

Conclusion

The study addresses a class of analytics problems where the analysis and understanding of the relationships between the people involved is essential and proves the hypothesis, network relationships enhance the analytical models.

Analysis of pile response due to excavation induced ground movements

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Purpose

In urban areas excavations for cut-and-cover tunnels and basement construction cause detrimental effects on adjacent piles. Stress relief caused by deep excavations lead to excessive lateral soil movements. The interaction of these lateral ground movements with nearby existing pile foundations develop additional loading on them. This paper investigates the additional bending moments and deflections due to excavations on the nearby existing pile foundations.

Methods

This paper presents a case study of a deep excavation carried out adjacent to a group of piles consisting of 22 m long step tapered piles. The pile group was located 0.6 m behind a temporary sheet pile wall. The excavation was primarily carried out through a layered sandy soil and supported by a sheet pile wall. The retaining wall system of the 15 m deep excavation was supported by tie back anchors at three levels. Finite element modelling is used to simulate the staged construction sequence, which involves excavation and installation of the strut system. Constitutive behaviour of the soil is modelled using an elasto-plastic model due to the limited amount of material properties available for the site. Parametric study is carried out using a well calibrated finite element model to develop design charts to establish variation patterns among number of influence factors such as geometry of the excavation, soil properties, structural system variables, pile end fixity conditions and pile location.

Results

Pile deflection and soil movements from two and three dimensional finite element analyses are compared with field data at various stages of the excavation. Under parametric study, the variation of bending moment and deflections with pile location, pile fixity conditions, unsupported and total depth of excavation, spacing of struts and soil stiffness are presented.

Conclusion

A typical instrumented section of an excavation adjacent to a group of piles was analysed using the finite element method. A two dimensional plane strain model is not sufficient to represent the three dimensional nature of group of piles. It was found that the maximum deflection of wall and pile occurs near the surface level and main contributing factor is the unsupported depth of the excavation. The factors considered during the parametric study have a significant influence on the distribution of bending moment and deflection along the pile.

Multi-layered System Design for Classifying Activities of Daily Living

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Purpose

Our research project is about a health smart home system under development where the approach will be taken to monitor the activities of daily living of resident within the smart home environment. The aims of our research project are summarized into: (a) to investigate how to construct a system for smart home applications based on multi-layered wireless sensor networks, to fuse location and motion data from different sources, and determine personal motion and location by using localization techniques on the data. (b) to utilise the above inputs to perform classification of major activities of daily living (ADLs), and variations to a subject's performance to detect whether the activity is normal. This topic addresses a growing telehealth area: remote monitoring of subjects to give carers better knowledge of health status and so to apply better healthcare management techniques.

Methods

Our research project is divided into four stages which are installing the physical layers and data acquisition, data fusion and localization techniques, the classification of ADLs, and evaluation methods. The first stage includes utilising the physical components (Wireless Access Points (WAPs), Waspmotes, and Shimmer kit) and collecting the data based on specific scenarios. The second stage is about applying data fusion model to combine the multi-layered data and using linear equation with required signal strength indicator (RSSI) to determine personal motion and location. The third stage includes using Hidden Markov Model (HMM) and decision tree algorithm to classify ADLs. The last stage will use validation tools (camera, and manual records) to evaluate the results from the system.

Results

The installation of the physical layers has been achieved and the physical components have been utilised. Currently, we are collecting data from the sensors. Also, we are in the process of combining the linear equations with RSSI to determine the personal motion and location. During the last year, we have attended HIC 2011, a poster has been accepted by the success and failure of telehealth conference (SFT 2011), and a paper has been accepted by HIC 2012.

Conclusion

We have designed our system using three physical layers: WAPs for coarse scale positioning, ambient sensor network based on Zigbee for fine scale positioning and coarse scale motion tracking, and wearable sensor network based on Bluetooth for fine scale motion tracking. The combination of ambient sensors and wearable sensors can provide an appropriate level of accuracy of motion and location data which will help to classify ADLs.

Displacement Measurements for Photogrammetry by Image Disparity Techniques

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Purpose

The measurement of translational shifts has an impact on the accurate measurements of structural objects based on modern photogrammetry and stereo matching. As displacement is introduced in structural scenarios such as cracks, stress, tension, it is important to measure the displacement with a high robustness and accuracy. One of the limitations introduced by traditional techniques is its inability to detect movements in multiple directions. To overcome this limitation, Photogrammetry may be used due to its ability to measure movements in multiple directions. However, current image processing techniques may not provide reliable results when detecting small translation shifts. Images may also be susceptible to changes in noise, illumination and occlusion. This thesis addresses the current problems of calculating displacement using image processing techniques to ensure accurate measurements in photogrammetry.

Methods

New sub-pixel displacement detection techniques have been developed to provide a more robust and accurate disparity measurement. A translation estimation method based on phase correlation (PC) has been developed to provide a robust and computationally inexpensive approach to estimating displacement shifts. Current PC methods may result in phase noise and aliasing within the low frequencies of the PC matrix. Therefore, the proposed algorithm uses an adaptive mask coupled with an essentially non oscillatory smoothing to improve the detection of disparities. Furthermore, state-of-the-art photogrammetry techniques combined with the estimated disparities may be used to improve the accuracy of structural measurements.

Results

The accuracy of the proposed techniques has been evaluated against existing methods and results to date show improvement in the detection of disparity measurements. Existing PC methods have been reported to achieve an average accuracy of up to 1/50 of a pixel. By using the improvements of the proposed methods, an average accuracy of up to 1/300 of a pixel is achievable, which is a significant improvement over existing methods

Conclusion

To improve the detection of displacement measurements, new sub-pixel displacement detection algorithms have been developed. As a result, the proposed methods provide an effective determination of translational shifts with an accuracy of 1/300 of a pixel. Furthermore, the proposed algorithms may be applied to photogrammetry where it is expected that the overall accuracy of structural measurements will increase.

Risk based approach to determine the treatment required for using recycled water for irrigation

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Purpose

Recycling the water is now an integral part of a sustainable integrated urban water cycle management. As the use of recycled water for irrigation is one of the most common applications, there is an increased risk for salinity in the vadose zone of soils that are irrigated with recycled water. This is due to the generally increased levels of salt in the recycled water compared to that of town water supply. The proposed research is to understand the long-term risks of using recycled water for open spaces irrigation. In this research open space irrigation comprising mainly recreational areas, sports fields and landscape is considered. The specific objectives of this research are (i) to quantify root zone salinity using salt transport modelling and (ii) to develop an integrated risk assessment framework using Bayesian network, for using recycled water in the urban open space. Also, a decision support system will be developed which can be used as a tool to determine the trade-offs between the risks and the cost of removing the salt from recycled water before its use for irrigation.

Methods

The study is divided into three parts, namely, development of risk assessment framework, selection of salt removal technology, and development of decision support system. The first part includes critical review of the literature to find out the effect of recycled water irrigation on the soil properties in terms of salinity. HYDRUS-1D, an advective-dispersive model coupled with transient meteorological condition with capability of solute transport in vadose zone, will be used to provide a mathematical basis to predict the long term impact of salt accumulation in the vadose zone in the irrigated field. Bayesian belief network will be used as a platform of the risk assessment framework. In the second part of the study, salt removal technologies will be identified, which can be used to minimize the risk of salinity of the irrigated land. Cost functions will be developed for estimating site specific costs for each of the technological options. Finally, a DSS will be developed to determine the desirable trade-off between the cost of implementing the technology and risk of salinization.

Results

Through an in-depth literature review, impacts of long term recycled water use in open space irrigation have been identified. The salinity level in recycled water in terms of electrical conductivity found to be varying between 0.2 to 2.9 dS/m, with an average of 1.3 dS/m. When compared to drinking water standard (0.1 dS/m), the average value is around 13 times higher. Impact of long term irrigation has been reported in different studies. After three years of irrigation, the electrical conductivity of soil increased from 105 to 235 $\mu\text{S}/\text{cm}$ (about 123% increases), cation exchange capacity of soil decreased from 9.21 to 8.61 cmol/kg and Na^+ increased from 2.95 to 5.75 meq/100g of soil. So-far an initial attempt has been made to model the accumulated salt in different layers of recycled water irrigated paddocks in UWS-Hawkesbury campus using HYDRUS 1D. However, the attempts were not successful due to the unavailability of quality data. For this reason, a long term laboratory column experiment is planned. The column studies will be conducted with soil of different paddocks of UWS-Hawkesbury with real and simulated recycled water.

Conclusion

An extensive literature review has identified the presence of salinity risk for soils irrigated with recycled water. The future work involves the verification of the HYDRUS-1D model using the column study. Following the column study, a risk assessment framework will be developed.

Vehicle Detection Based on Color Analysis

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Purpose

Detecting moving objects in videos is an important task in many computer vision applications, including human interaction, traffic monitoring, etc. When having a stationary camera, a basic method to detect the objects of interest is background subtraction. However, precise moving object detection using such a method is an extremely difficult task in a varying environment. In this research, a new technique for detecting vehicles in a traffic scene is introduced based on frame differencing and colour analysis for foreground regions (moving regions).

Methodology

There are three stages in the algorithm as shown in Fig.1: pre-processing, moving region detection, and shadow detection and removal. In pre-processing, the first three frames in the sequence are fed to the system. The frames are labeled as the previous, the current and the next frame respectively. The next frame is saved as the current frame for the next processing cycle. The RGB color space has been selected in this work to obtain better results in the segmentation process. In the second stage, a simple method is used to detect the moving region in the current frame. Both: previous and next frames are used as references to extract static regions from the current frame. The two results are then integrated to remove unwanted blobs and recover the entire figure of the object. In the last stage, shadow detection and removal is performed. The average for RGB components of each pixel within foreground region is calculated. The foreground region is scanned in both directions (horizontal and vertical) to locate the darkest pixels in each line. Threshold lines are then created accordingly to eliminate pixels which belong to shadows and the background.

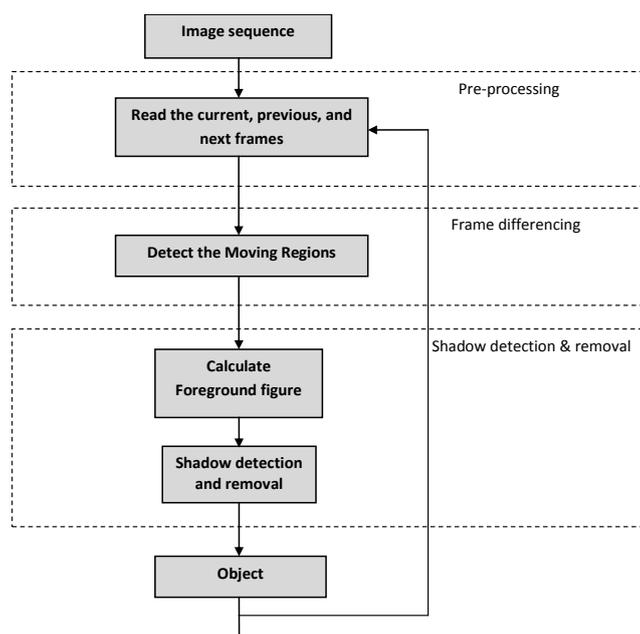


Fig. 1 Block diagram of the proposed method

Results

Fig.2 shows the detection results by the proposed method and the RGB Chroma method [1] for two frames in video Hwy III. It can be seen that the performance of the proposed method is much better than the RGB Chroma method. The RGB Chroma method suffers a lot when having strong moving shadows in the scene. In Fig.2-d, there is a large number of foreground pixels that have been misclassified as background. Besides, pixels belonging to shadow cast have been detected as part of the vehicles. Compared to Fig.2-c, the proposed method provides more accurate and precise results in detecting the actual size of the vehicles. The shadow casts have been removed effectively and the boundary area of the vehicles are correctly detected.

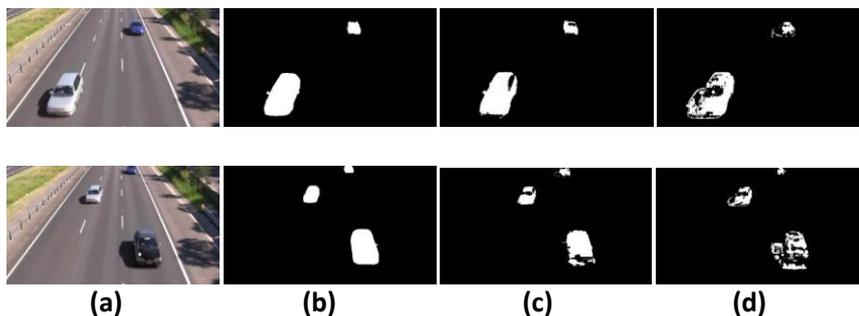


Fig.2 vehicle detection results for different frames in test videos Hwy III; (a) input sequence; (b) ground truth; (c) proposed method; (d) RGB chroma Model

Conclusion

This paper has introduced a new approach to vehicle detection in a traffic scene based on frame differencing and RGB color analysis. The RGB color analysis has been used to summarize important properties of shadow casts. As illustrated in the results, the shadow casts have been removed effectively. In addition, the proposed method has been compared to a similar method for object detection and shadow removal. Experimental results show the accuracy of the proposed approach.

Our future study is to exploit the techniques used in this paper to model the background for detecting changes in an image sequence in a varying environment (e.g., illumination changes).

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An Implantable Microstrip Ring Disk Antenna

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Purpose

Due to the electrical conductivity and the lossy nature of the biological tissue, antennas designed for free space operation will be severely affected when implanted in the human body. Hence, the performance of implantable antennas needs to be thoroughly investigated to ensure reliable operation. The purpose of this research is to investigate the performance of an implantable encased microstrip ring disk antenna (MRDA) for various biomedical applications. The antenna is operating in the industrial, scientific and medical (ISM) band at 2.4 GHz.

Methods

A simulation software (CST MWS) is used to investigate the performance of the implanted encased MRDA. First, the performance of the MRDA without an encasement is investigated in free space and in tissue mimicking gel. Then, the performance of the MRDA with an encasement is evaluated in free space and in tissue mimicking gel. Next, a parametric study will be performed on the effect of varying the relative dielectric constant of the substrate, the relative dielectric constant of the encasement, and the length of the annular ring. Finally, based on the results of the parametric study, the design of the MRDA will be modified to ensure reliable performance at 2.4 GHz.

Results

By varying the relative dielectric constant of the substrate and the encasement, and by shortening the length of the annular ring, the implanted encased MRDA can achieve satisfactory performance at the desired resonant frequency of 2.4 GHz. Selected simulation results are presented in the form of plots of the magnitude of the reflection coefficient $|S_{11}|$, the far-field pattern, and the electric field distribution without and with an encasement in free space and in tissue mimicking gel.

Conclusion

It has been shown that the biological tissue has a drastic effect on the performance of the MRDA antenna without an encasement. It has also been shown that the implanted encased antenna showed acceptable performance but exhibited a frequency shift to 1.6 GHz. By modifying the relative dielectric constant of the substrate and the encasement, along with the length of the annular ring, the implanted encased MRDA showed an acceptable $|S_{11}|$ of -14 dB at 2.4 GHz.

Automated Trading for Financial Markets

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Purpose

This paper introduces an ongoing work of developing a multi-agent platform for automated trading with software agents. This platform will be used to simulate e-Markets and interactions of autonomous trading agents to find out the possible outcomes of the markets. Automated trading has been in practice by pension, mutual funds, financial markets, auction markets and other fields such as Ad Auctions.

Methods

The proposed system is built on an existing system, known as JCAT, which has been used for Trading Agent Competition. This system allows competitors to design variety of financial markets mechanisms, but it does not allow the participants to design trader strategies. The proposed system will implement a number of new components to allow traders to compete their strategies.

One of these components is the Bank, which is the financial institution providing loan to the traders. The loan will help the traders to buy goods from the markets and generate revenue if they do not have any balance left. To enhance traders' decision-making ability, each trader will have multiple accounts. For each account the trader can have a different trading strategy.

The traded goods are assumed to be homogenous and non-divisible. Variables such as the price of a shout placed by traders remain constant during a day; but its value can be changed from day to day by considering the requirement of the market being implemented.

Results

The traders use trading strategies to generate asks and bids for a specific market, these trading strategies are based on research representing an economic model. So these strategies can be implemented to compete against each other and as a result participants can analyse the performance of the traders. There will be an overall increase in the systems capability to simulate the traders and markets. Providing more control over the traders and the markets.

Each trader is furthermore endowed with a limited budget that they can spend within a trading day. This budget prevents a trader from paying excessively high fees. Initial inventory in terms of commodity can also be allocated to the traders at the start of the game.

Conclusion

At the completion of this work, a trading agent platform will be built. This system will serve as a basis for a new tournament in the trading agent competition. It is also expected that the system can play a key part in the field of experimental economics for the purpose of simulating various financial markets in an automated autonomous way.

Efficient Energy Management Techniques for Home Area Networks on Smart Grid

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Purpose

The present Australian electricity grid is hampered by higher system losses, power quality degradation, low resilience to physical events, and consumers are non-participative. The Smart Grid is widely considered as the next generation electricity grid where the existing electricity network makes full use of information and communication technologies (ICT) for control, communication and energy management. The idea of two way communications from suppliers to consumers has the potential to save energy, reduce costs and increase reliability and transparency of the electricity network. Home area network (HAN), where smart appliances communicate with a central control device, is one of the important communication networks within the smart grid and through that consumers are expected to participate actively in controlling the demand variations and energy management.

Methods

In this study I will first identify the energy management needs of home area networks. This will be followed by a comprehensive investigation of smart metering and efficient data communication technologies through the Smart Grid. A literature review will be carried out to identify the requirements including energy usage, smart metering technologies, network topology, monitoring scenarios, types of sensors and measurements, data rates, and delay constraints of each measurement. Then, I will propose improved energy management paradigms through smart metering technologies and efficient data transmission mechanisms for home area networks based on the identified energy management requirements. Finally, I will verify the proposed mechanisms using computer modelling and show that real energy and cost savings can be achieved for the benefit of both the electricity consumer and the supplier.

Conclusion and objectives

- Accurate modelling of domestic energy usage
- Investigation of Smart metering technologies
- Evaluation of data communication techniques for the Smart Grid and energy-aware protocols.
- Propose improved energy management methods for Home Area Networks

A framework for understanding and predicting the take up and use of social networking tools in an collaborative environment

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Purpose

Online Collaborative Environments are becoming prominent environments where users can achieve collaboration with other users. However, these environments are made up of generic interface components that do not cater for the wide range of roles which one user might take on while collaborating with another. If an environment could understand and predict a user's role or behaviour in such an environment and then adapt the environment based on the understanding or prediction, this may increase collaborative output or usage by the user.

Methods

A web personalisation framework will be integrated into an online collaborative environment, such as an online social network, where the interface components will be given semantic definitions to describe behavioural stereotypes that represent a user's interaction behaviour while interacting with another user. The framework is made up of two machine learning methods, Dynamic Node Neural Networks, and Fuzzy Logic. These two methods work together to provide the adaption.

Statistical methods will then be used to analyse two trial arms, which will be established in online collaborative environments, for various variables relating to user interaction and performance of the web personalisation framework.

Results

Results have not yet been attained, and will be presented in future work.

Conclusion

By providing an online collaborative environment that can adapt to a user's behaviour stereotype with another user, the environment may make the user more effective in producing collaborative generated media. Also, by establishing behavioural stereotypes that have been formulated by past literature to establish semantic interactions, this work could be fundamental to future web personalisation frameworks of such environments.

Sensorless Control of Brushless DC Motors

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Purpose

Brushless Permanent Magnet Motors (BPMMs) are becoming attractive for most of industrial applications and consumer appliances. This is due to their simple speed and torque control, compact size, high efficiency and reliability.

BPMMs are categorised into brushless dc motors (BLDCMs) and permanent magnet synchronous motors (PMSMs). The former type is fed with rectangular current conducting for 120° electrical, where two phases conduct at a time and the third floats, known as 120° six-step control. PMSMs are operated by sinusoidal currents conducting in all phases at any given instance for ripple-free torque. However, PMSMs can operate by 120° six-step control exactly as a BLDCM with slight performance variation.

Identifying the rotor position is essential for BPMMs to operate. The position is detected by physical sensors such as Hall Effect sensors, encoders or resolvers. Sensors increase the motor size, cost, complexity, require maintenance in a confined space, and complicate machine commissioning.

Method

Sensorless control techniques can overcome the drawbacks of sensor based methods. Commonly sensorless schemes developed are inductance measurement and BEMF detection methods. The inductance technique is relatively complicated requiring machine parameters for solving complex equations to estimate the position. In contrast, various developments adopt the BEMF technique for its simplicity and being inexpensive to implement. The aim the thesis is to investigate applying a new approach called BEMF mapping (BEM). The approach is developed to provide a high degree of reliability and robustness especially under overloading and electrical noise surrounding. The method computes the actual BEMF value corresponding to commutation instances. BEM is suitable for both PMSM and BLDCM when six-stepped controlled. Simulation and experimental work performed on a six-step controlled PMSM verify the approach. Results show that BEM commutation signals closely follow the physical sensors signals. The method is highly practical for implementation especially for surface mounted motors as the saliency of the rotor is almost zero and armature reaction is negligible.

BEM is also found suitable to estimate the speed of the machine. Thus, speed control can be performed with no additional speed sensors. Consideration to provide better accuracy shall be employed to enhance the method performance.

Flood Modelling based on the Joint Probability Approach: Impacts of losses

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Purpose

In Australia, the Design Event Approach (DEA) is adopted for estimating design flood hydrographs, as recommended by the national flow guidelines, Australian Rainfall and Runoff (AR&R, I.E. Aust., 1987). Assumptions adopted by the DEA can lead to inconsistencies and significant bias in flood estimates, particularly in catchments with a strong non-linear runoff response. More recently, a significant amount of research has focused on developing and applying the Monte Carlo Simulation Technique (MCST) based on the concept of Joint Probability Approach (JPA) for rainfall-based flood estimation. This method considers the probabilistic nature of the key model inputs/parameters (such as rainfall intensity, duration, temporal pattern and initial losses) and also accounts for the correlations between these variables in the flood generation process; hence producing a probability-distributed flood output.

Methods

The catchment response to a rainfall event is complex and consists of a number of processes. These processes result in a loss of rainfall (termed rainfall losses) and are accounted for using various mathematical representations. In Australia, the most commonly used loss models are the lumped conceptual loss models, including the Initial Loss – Continuing Loss (IL-CL) and Initial Loss – Runoff Coefficient (IL-RoC). In line with the upcoming guidelines, this project aims to develop and test new loss values based on the Joint Probability Approach. The effects of various loss models on the resulting flood levels (estimated from the hydraulic model) will then be assessed.

Results

Initially the IL-CL and IL-PL models were compared and tested against more reliable flood frequency estimates. Following this several probability distributions were tested for three parameters, being the initial loss (IL), continuing loss (CL) and model parameter (k_c). It was found that the IL-CL model produced more accurate design flood estimates than the IL-RoC model. For the IL-CL model, the median burst initial loss and median continuing loss were found to be 24.2mm and 4.01mm/h, respectively. The distributions of the initial loss, continuing loss and model parameter can be approximated by the Gamma, Beta and Normal distributions, respectively. Generated values for each input, using the respective distributions, were found to preserve the statistics of the observed values very well.

Conclusion

The study found that the assumption of ARI neutrality in the current design event approach can lead to significant uncertainties in design flood estimates due to the selection of representative inputs and that the derived stochastic inputs can be used to obtain more realistic design flood estimates using the JPA.

Vortex and force characteristics of inclined offshore cylindrical structures in oscillatory flows

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Purpose

The significance of the project mainly lies in Australia's offshore industries and its intrinsic interest in the fundamental fluid dynamics research because one of the key components of Australian economy is offshore oil and gas industry. Therefore a systematic study on the topic can potentially be translated into significance cost saving for future oil and gas projects in Australian waters.

Vortex shedding is an unsteady flow that takes place in special flow velocities (according to the size and shape of the cylindrical body). In this flow, vortices are created in the wake of the body and detach periodically from both side of the body.

Vortex shedding starts to appear when the Reynolds number $Re > 40$ and become three-dimensional (3D) when $Re > 200$.

The flow characteristics around circular cylinders that subject to an oscillatory flow are governed by two parameters known as Keulegan-carpenter number ($KC = U_m T / D$, where U_m is the velocity amplitude of the oscillatory flow, T is the period of velocity oscillation and D is the diameter of the cylinder), and the Reynolds number $Re (= U_m D / \nu$, where ν is the fluid kinematic viscosity) and Stokes number $\beta (= Re / KC)$. Limited studies on oscillatory flows past an oblique cylinder have shown that the force coefficients normalized by the velocity component normal to the cylinder length direction are approximately independent of the cylinder inclination angle α if α is small. This is often known as the Independence Principle (IP) in literature. Till now, there is no general agreement about the critical value of α below which the IP is valid. The mechanism for the breakdown of IP and the variation of the vortex patterns after the breakdown of the IP are not clear either. This study will extend our understanding on vortex instability, vortex shedding regime classifications and force characteristics around an oblique cylinder in an angle range of $0 \sim 60^\circ$.

Methods

Numerical method will be used to study the vortex characteristics, flow structures and the hydrodynamic forces of inclined cylinder wakes in oscillatory flows. The numerical calculation will be carried out using the numerical model by Zhao et al. (2009). The experimental study will be carried out by Prof. Zhou at University of Western Australia. His experimental results will be available for testing the validity of numerical model.

Results

I have just started working on this research project, as a PhD student, three-weeks ago and I only learned some fundamental knowledge about vortex shedding and am learning the software for flow simulation with the help of my supervisor Dr. Ming Zhao.

Conclusion

On the future presentation hopefully I will be able to show some very preliminary results from the calculation software.

Finite Element Modelling of Guided Wave Propagation for Defect Identification in Pipes

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Introduction

In the age of change, pipelines have become indispensable parts in many processing industries, such as oil and gas refineries, fertilizers, chemical and power plants, etc. However, the condition of those pipelines is exerting profound impact on its work. For long pipes, the wide area corrosion and pitting corrosion are two major factors leading to catastrophic situation, which is including the wall thickness reduction and pinhole damage. Hence, a vast number of methods are awash with the pipeline inspection. Some of them are useless in Pipe inspection. To illustrate, the Point-by-Point Visual Inspection is expensive and time consuming as pipes have to be moved out of the insulation [1]. Besides, the Creeping and Head Wave Inspection Method (CHIME), which was reported by Ravenscroft, has some limitations on size of the specimen [2]. Moreover, the Harmonic, Longitudinal Wave Inspection Method can only be used at the longitudinal direction of pipes [3]. Furthermore, the Electromagnetic Acoustic Transducer (EMAT) is just one point measurement, in which the location of defects cannot be identified [4]. An alternative method which is being developed by Shivaraj is to use an angle wedge technique for ultrasonic circumferential guided wave in the walls of pipe and to look for reflections from defects by using the pulse-echo method. As a result, the size and location of defects can be detected and evaluated at the same time [4].

Following with this trend, this projects aims at the development of Finite Element (FE) Models representing ultrasonic circumferential guided wave inspection and characterisation of wave propagation in typical metallic pipes.

Methods

The general method in this project is to characterize mode conversion from a serous of modelling and then simulate the ultrasonic circumferential guided wave propagation in a hollow cylinder with press-stress filed and external support. Hence, three typical methods will be mentioned in this part. Firstly, some critical points of current knowledge could be obtained from Literature Review. Then, the interaction between the propagating waves and defect will be demonstrated visually from the Finite Element Model Method. The modelling processes are operated in the Abaqus software and analyses those models from simple cases to complex ones. Lastly, the final results from the FEM will be validated with the experiment data.

Progress

Some basic knowledge has been acknowledged in recent one month. The first one is about Piezoelectricity part. It is more relative to the piezoelectric ceramic selection in the FE Modelling processes. Those sections are including: the Piezoelectric Constitutive Equation, Piezoelectric Ceramic Material and Structural Health Monitoring with Piezoelectric wafer. The second part is about Elastic Wave. The general principle of elastic wave propagation can be obtained and recognized easily from the FE Modelling processes.

For future research, the modelling processes will be finished with ten steps. In the first place, the characterisation of PZT sensor and actor will be identified in the finite element analysis package software (Abaqus). Secondly, 2-D FE Asymmetric Model will be designed. Thirdly, in order to achieve the 3-D mode

dispersion and mode selection of the elastic waves, a 3-D infinite pipe will be created. The Fourth and fifth processes will to obtain the mode conversion by using the 2-D and 3-D finite pipe with the boundary condition respectively. In the sixth and seventh steps, it is necessary to add a crack-like defect on that 2-D and 3-D models. Therefore, the characterisation of the mode conversion can be easily acknowledged according to those models. In the eighth and ninth processes, the pre-stressed field will be considered and applied in the previous 2-D and 3-D models respectively. Lastly, the finite element models on guided wave propagation in hollow cylinders with pre-stress field contributed and an external supports will be finished. Furthermore, Validation and verification of the finite element modelling will to compare the available data in literature.

Summary

The aim of the work presented here is to characterize mode conversion from a series of modelling and simulate the ultrasonic circumferential guided wave propagation in a hollow cylinder with pre-stress field and external support. Hence, the issue of importance is the selection of the optimum guided wave modes and the establishment of relationships between the defect size and strength of wave reflection. Analytical and modelling studies will conducted in parallel for validation purpose.

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Multi-dimensional business process optimization for GHG (Greenhouse Gas) emission mitigation

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Purpose

Anthropogenic climate change is real and rapidly becoming a major challenge to all humans on earth. Greenhouse Gas (GHG) emissions from numerous sources, including industrial or organizational sector, is a leading contributor to climate change. Some organizational managers realizing the inevitability of government legislations or taxes want to take proactive measures to manage their own emissions. Currently organizations use various GHG emission calculating tools to quantify their emissions as the first step in managing them. Organizations strive to meet various business objectives in several dimensions. Objectives such as cost and turnaround time are managed at the business process level. However current emission measuring tools and guidelines are not aimed at measuring emissions of organisational processes. Therefore the main research question this study is going to address is "How to perform multi-dimensional business process optimization for GHG emissions mitigation?" Hence, the research proposes a framework for multi-dimensional business process optimisation.

Methods

This research follows the *Design Science Research* paradigm and aims to build an *artifact*. Thus, the proposed framework becomes the artifact, which is built to solve the main research question. It facilitates modelling, measuring, analysing, optimizing and reporting of GHG emissions. This framework, derived from the GHG Protocol, enables organizational management to optimize their business processes for GHG emission mitigation, alongside other vital business objectives. This research study consists of five stages. These stages include: Problem definition stage; Intervention stage (Building/ Action Planning and Action Taking); Evaluation stage; Reflection and learning stage; PhD finalization stage.

Results

At the time of producing this Futures Forum abstract, the candidate has completed the *Intervention stage*, where the research builds a framework. This framework contains four distinctive areas: identification (i.e. identification of organizational boundaries, processes, emission sources and business objectives); business process modelling, data collection and GHG emission calculation; business process optimization; corporate level reporting. According to an in-depth literature review on multi-dimensional optimization techniques, Evolutionary Algorithms (EA) have come up with very promising results and especially Non-dominated Sorting Genetic Algorithm-II (NSGA 2) is proving to be versatile in its applicability. Thus, in this research, NSGA 2 acts as the multi-dimensional optimization technique and forms a vital part of the framework.

Conclusion

The main contribution from this study is the framework for multi-dimensional business process optimization for the mitigation of GHG emissions. It provides systematic business process optimization for several quantitative dimensions. To date, quantitative dimensions like cost reduction and turnaround time have materialized as business objectives for business process optimization. However, GHG emission mitigation has never been considered as one objective. Therefore, another important contribution is that this study brings together new knowledge in how to multi-dimensionally optimize a business process including GHG emission mitigation.

An investigation of progressive failure of geosynthetic reinforced Deep Cement Mixed column supported embankments

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Purpose

Deep cement mixed columns have been widely used to support highway embankments constructed over soft compressible ground. In the current design practice, it is assumed that the performance of Geosynthetic Reinforced Column Supported (GRCS) embankments are identical to pile supported embankments and the constitutive behaviour of DCM columns are simulated using the Mohr-Coulomb failure criteria assuming elastic-perfectly plastic behaviour. However, cement admixed soils exhibit strain softening behaviour due to progressive failure of cementation bonds beyond yielding and classical constitutive models such as Modified Cam Clay and Mohr-Coulomb are inadequate to describe this behaviour. Therefore, during the design process, total and differential settlements, which are crucial for the embankment performance during serviceability, are underestimated and the ability of the embankment in resisting deformations is overestimated leading to unsafe designs. Therefore this paper investigates the behaviour of DCM column supported embankments when the progressive failure of the DCM columns is incorporated in the analysis.

Methods

A two dimensional numerical implementation of a GRCS highway embankment incorporating the strain softening behaviour of cement stabilised soil is used to carry out the research. This constitutive model is an extension of the Mohr-Coulomb model and has been incorporated into ABAQUS/Standard through the user defined field subroutine (USDFLD). The geosynthetic reinforcement was modelled as a linear elastic perfectly plastic material using the Von-Mises failure criteria. Embankment fill, platform fill, soft soil, and firm soil were modelled as linearly elastic perfectly plastic material using Mohr-Coulomb failure criteria.

Results

Results show that there is a considerable increment in total and differential settlements with the progressive failure of cement admixed soils. Furthermore this study investigates the load transfer mechanism from the embankment to the DCM columns, the ability of the DCM columns in resisting lateral deformations and failure modes for the GRCS embankments during the progressive failure. The finite element analysis results clearly show the bending failure mode due to progressive softening of the cement mixed soils including the plastic hinge development at the locations of the maximum bending moment within columns. Also the maximum tension in the geosynthetic layer obtained including the progressive failure is significantly higher than that obtained without any progressive failure.

Conclusion

This research establishes that the use of conventional piled embankment design procedures for the design of GRCS embankments is not appropriate and does not reflect the progressive failure of DCM columns due to strain softening behaviour of cement admixed clay.

HVSR inversion using Evolutionary Computation

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Purpose

The aim of this thesis is to assisting geotechnical engineers in the characterisation of soil profiles, using the Horizontal-to-Vertical Spectral Ratio (HVSR) technique. HVSR inversion is typically done via manual inversion or using a simple heuristic, and results in a V_s profile. The primary focus of this work is to reduce the time and complexity of obtaining a V_s profile using Evolutionary Computation within an easy-to-use GUI framework.

Methods

The first Evolutionary Algorithm (EA) developed in this study for the inversion of HVSR is called Vine Creeping Optimisation (VCO). VCO is a three module framework combining local search, global search and an archive. The archive efficiently records all previous solutions visited by way of hyper-rectangular convergence regions. Convergence regions are created based on the assumption that if multiple suboptimal solutions converge to the same local optimum, then any solutions contained between the suboptimal solutions and the locally optimal solution are also suboptimal. Using a Binary Space Partition tree data structure to store the convergence regions, VCO is able to efficiently make steps towards the global optimum by avoiding previously flagged suboptimal regions. The VCO algorithm was then developed further producing the Enhanced Vine Creeping Optimisation (EVCO) algorithm. The critical enhancement in EVCO is the incorporation of the convex hull structure to the convergence regions. Convex hull convergence regions reduce the risk associated with the convergence region assumption, by representing the contours of locally quasi-convex regions more accurately. The development of EVCO led to the exploration of a Robust Search Paradigm (RSP). RSP is concerned with the algorithm selection problem, and developing RSP further is the author's current research focus.

Results

In numerical benchmark tests EVCO was found to be the highest ranked algorithm in performance when compared to VCO and eight state-of-the-art evolutionary algorithms. Additionally, the advantages of applying EVCO to the inversion of HVSR is clear as comparable results to current methods are obtained with less a priori knowledge. A tentative GUI has provided information on unforeseen challenges that need to be overcome, mainly model evaluation speed. Until these challenges are overcome, HVSR inversion is executed with some constraints.

Conclusion

With the development of VCO, EVCO, RSP and a GUI framework; this thesis has made positive steps towards achieving the goal of assisting geotechnical engineers with the automatic inversion of HVSR. Further development of the RSP is expected to result in self generating algorithms that evolve in response to the current problem environment. Essentially, RSP should automatically generate an algorithm for any given problem.

Identification of parent distribution for at-site flood frequency analysis in Australia under the changing climate regime

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Purpose

The Australian climate is noted for its marked variability of extremes. The possibility of rapidly occurring climate change due to both natural and anthropogenic factors necessitates the acknowledgement of the uncertainty of future climate and the development of water resources management for adaptation to a changing climate. Flood frequency analysis (FFA) enables estimating the desired quantiles of extreme hydrologic events such as flood. The traditional assumption of FFA is that the underlying stochastic process is stationary in time. Under a changing climatic regime, the assumption of stationary is hardly valid, and thus requires more advanced statistical methods that explicitly account for the non-stationarity of flood characteristics. There has not been any comprehensive study for the selection of a probability distribution model in Australia for the last 20 years or so. Hence, it is an important research question how to select an appropriate probability distribution in different regions of Australia under changing climatic regime.

Methods

Based on the above scenario, the first part of this research thus attempts to identify the best fit probability distribution model and parameter estimation technique for the different regions of Australia. The second part of the research will attempt to develop robust techniques for probability model selection and parameter estimation to take into account the non-stationarity of hydrologic records, which can properly deal with time-dependent parameters of flood frequency distributions. Here the adopted methods are the Bayesian approach with covariates and the trend model approach for the probability distribution model selection. These approaches focus not only on the location parameter but also on the scale and shape parameters of the probability distribution.

Results

The outcome of the ongoing research, for the stationary FFA shows that the Log-Pearson type 3 (LP3) and Generalised Extreme Value (GEV) for the humid regions and Generalised Pareto (GP) for arid semi-arid region are the best fit probability distribution for Australian catchments. Another outcome of the research has been the derivation of the probability plot correlation coefficient test statistics for the five parameter Wakeby distribution. The regression equation of the test statistics are developed using a Monte Carlo simulation approach with various sample sizes, significance levels and shape parameters.

Conclusion

The key objective of this research is to investigate the capability of selecting the best operational flood frequency model in terms of reliability for design flood estimation in Australia and to recommend a correction factor due to the impact of climate change to adjust the results of stationary FFA.

Novel analysis of multi-species type 2 diabetes from gene expression data

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Purpose

The incidence of type 2 diabetes is reaching epidemic levels. Today type 2 diabetes is the most common form of diabetes, affecting as many as 85 to 90 percent of those who have diabetes. The James Lab at Garvan Institute for Medical Research are interested in gene expression in insulin resistance and diabetes. They have provided three gene expression datasets: two are Mouse model and one is Human. The aim of this research is to identify genes that show consistent changes in intensity for each dataset, compare genomic expression patterns across species, human and mouse, and to integrate results from these studies, and any other relevant research on detecting differential expression in the progress of developing type 2 diabetes.

Methods

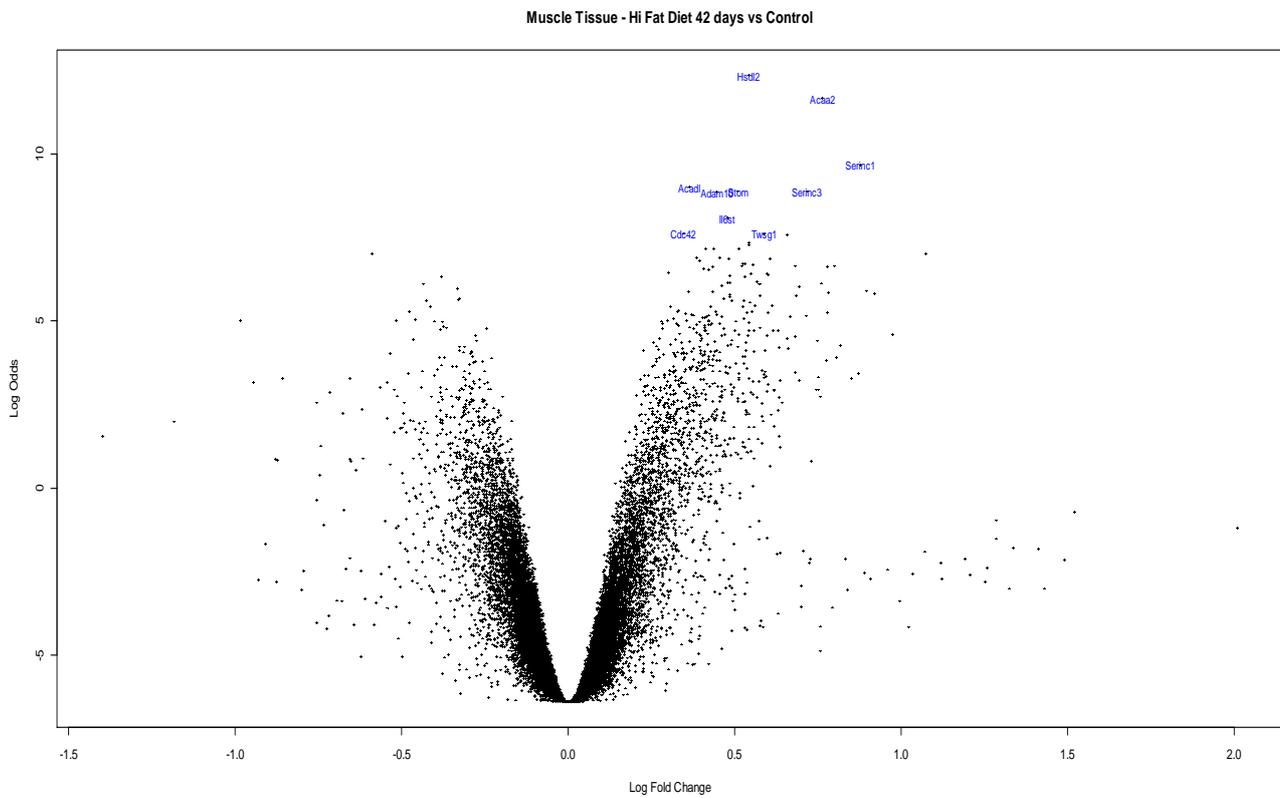
Three datasets are to be normalized in order to remove any experimental effects arising from the microarray technology. Linear models can then be fitted on the normalized data using the limma package to identify genes undergoing differential expression. Apart from finding differentially expressed genes, we are also interested in the similarities between genes. Each gene has its own expression profile and genes with similar profiles can be grouped together. We intend to try and use the datasets together to cluster samples based on gene profiles. In reality, biological processes are complicated with many molecules working together. The goal of annotating the genome is to link all information associated with gene products in order to learn how pathways function in the biological system. In situations where long lists of genes are found to be differentially expressed, we consider going beyond the analysis of individual genes because it is more sensible to look at sets of genes that are functionally related based on prior biological knowledge or experiments. We are exploring the potentially interesting gene sets using the Gene Ontology (GO) and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathways. Gene sets are selected based on the Gene Ontology terms in the mouse model and a gene set test is performed for each of the comparison in the human model. This procedure is repeated for KEGG pathways. To test if any GO terms or KEGG pathways are over-represented in a list of differentially expressed genes, we will perform the hypergeometric test.

Results

The longitudinal mouse study involving the comparison of a high fat diet to control with expression in two tissues, adipose and muscle, revealed that 1146 genes were differentially expressed after 42 days of high fat diet compared to the control group which was on a standard diet. The top 10 differentially expressed genes symbols were highlighted in the volcano plot below.

Contrast	No. of DE genes FDR < 0.01
Muscle.5 days vs Control	3
Muscle.14 days vs Control	20
Muscle.42 days vs Control	1146

Volcano Plot



Conclusion

This research project is still ongoing.

School of Computing, Engineering and Mathematics

Honours Candidates

Visual Analytics of Genomic and Biomedical Data

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Purpose

Personalized medicine is a vision for medical practice where treatment is individually tailored to each patient to maximize the effectiveness of treatments. Personalized medicine requires the construction of some form of similarity space that captures the genotypic and/or phenotypic variations among patients so that distances between patients reflect their relevant similarity or dissimilarity, and the dimensions or shape of the space reflect the global structure of the range of possible variation in the genome. The ever-growing amount of data being generated for analysis from this research has grown demand for needs to visualize the data in ways that make analysing the data more efficient. The specific goal is to be able to visualize similarities between patients and patient groups based on both genomic and biomedical data sets, so that correlations and potentially patterns could be derived to explain effectiveness of treatments.

The visualizations that are to be developed need to describe patients through genomic and biomedical data sets, whilst being interactive to allow for filtering and refocusing visualizations to views of interest. The project is conducted collaboratively with researchers at The Children's Hospital at Westmead with Acute Lymphoblastic Leukaemia (ALL) patients.

Methods

Visualizations will be explored in 2D and 3D (with experimentation in 2.5D) to effectively contain multiple dimensions of data. Modular filtering will be implemented to trim the sample down to patients of interest for more in-depth analysis. Visualisations will be also be explored to identify patients within a filtered sample that have strong similarities. Lastly visualizations will be generated from the most similar attributes to visually group all similar patients away from dissimilar patients in order to exaggerate the similar patients that are identified based on all possible criterion used.

Results

The work to be done attempts to help the research team more efficiently process the data, present an understandable set of visualizations and identify similarities between individual patients. The results that will be gained from the research should help to better inform researchers as to effectively identify effective treatments, as well as types of patients whom the treatment is effective for. The research should also allow future patients to be administered a more effective treatment based on their similarities to existing patient groups.

The effectiveness of relationship-based procurement methods in helping tackle issues in infrastructure development in Australia

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Purpose

Relationship-based procurement methods have been claimed to be effective in tackling issues in infrastructure development. Previous research on the effectiveness of relationship-based procurement methods was very general or limited towards a specific method. In addition, relevant research is mainly based on overseas construction industries and minimal research on the Australian construction industry. Therefore, this study is aimed to examine different types of relationship-based procurement methods and whether or not they are effective in helping tackle issues in infrastructure projects in Australia. The relationship-based procurement methods under study include partnering, alliances, public-private partnerships and joint ventures.

Methods

The research methods to be used to explore the effectiveness of relationship based procurement methods in helping tackling Australian infrastructure issues include an extensive literature review, an industry-based questionnaire survey, and a mainly quantitative data analysis. The industry based questionnaire survey will be a survey to be completed by players within the construction industry. The survey is designed to establish things like experience with relationship based procurement methods, industry experience, position within a company, tier of company, company's previous experience, etc. The survey is also aimed to determine effectiveness of the methods through questions about the different relationship based procurement methods.

The returned responses to the questionnaire will be used as raw data to be analysed using SPSS (Statistical Package for the Social Sciences). A number of statistical tests will be carried out on the data for detailed analysis, such as linear regression and factor analysis. The analysis outcome will then be used for discussions and conclusions.