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Department of Computer Science and Software Engineering

2022 Departmental Postgraduate Conference

8 September 2022

Jack Erskine (JE) Building

Lecture Theatre JE031

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Thursday 8 September

10:00 – 10.15	***Morning tea*** (JE215)

Session 1 *Chair: Tim*	
10:15 – 10:45	**Keynote presentation: Verizon Connect: Dr Nathan Robinson**, **Hayden White**: High Performance Traffic Routing
BSc Hons, Masters (Judges: Mukund, Andrew, Walter)	
10:45-11:00	**Grant Wong** (BSc Hons)**:** ITC delineation for aerial point clouds of forests using convolutional neural networks
11:00 – 11:15	**Nick Lee** (BSc Hons)**:** Automatic Exposure and Visual Odometry
11:15 – 11:30	**Marina Filipovic** (MSc): Teaching strategies of BDD (behaviour driven development) and their impact on product quality
11:30 – 11:45	**William Herewini** (ME): CNN identification of vineyard posts and trunks in 3D datasets
11:45 – 12:00	**Dylan White** (ME): Online Monocular Camera Auto-Calibration with Inertial Sensor Fusion

12:00 – 12.30	***Lunch*** (JE215)

Session 2 *Chair: Walter* **PhD (Judges: Tim, Clementine, Andreas)**	
12:30 – 12:45	**Sam Schofield:** Outlier removal for visual odometry using Local Flow Consistency
12:45 – 1:00pm	**Aaron Smith:** Correcting charge sharing distortions in post processing for photon counting chips
1:00 – 1:15	**Matthew Minish:** Computer-based Tutoring Systems in support of Daily Stand-Up Meetings
1:15 – 1:30	**Henry Hickman:** Helping to better teach programming at an NCEA level
1:30 – 1:45	**Amelia Samandari**: UAV Formation Tiling
1.45 - 2.00	**Di Wang PhD:** Towards application monitoring to support bug reproduction

2:00 – 2:15	***Afternoon tea*** (JE215)

Session 3 *Chair: Andreas* **PhD *(continued)***	
2:15 – 2.30	**Gus Ellerm:** LivePublication - Integrating experiment infrastructure with publication artifacts
2:30 – 2:45	**Rosalyn Rough:** Improving the Reliability and Ease of Bloodstain Pattern Analysis with Quantitative Techniques
2:45 – 3:00	**Juliet Samandari:** Post Quantum Cryptography for IoT
3:00 – 3:15	**Tim McKenzie:** Addressing Video Game Development Challenges Using Industry 'Best Practices'
3:15 – 3.30	**Camila Costa Silva:** Reusing software engineering knowledge from developer communication
3.30-3.45	**Tim Rensen:** Towards Automated Species Monitoring and 3D Mapping in Underwater Environments

4:00	***Staff Club for prizegiving and celebration*** (location: https://www.ucc.org.nz/contact-us)

Abstracts

Honours

Grant Wong

Title: ITC delineation for aerial point clouds of forests using convolutional neural networks

Abstract: Individual tree crown (ITC) delineation allows researchers to isolate trees in aerial views of forests. For trees in New Zealand forests and abroad, this delineation allows for classifying forest species and tracking changes in tree shapes across different regions and time periods. The aerial data may exist as raster imagery or as 3D point clouds, with deep learning approaches gaining in popularity over the past half decade. However, so far deep learning approaches to ITC delineation typically rely on raster imagery as part of the delineation process, with deep learning approaches for delineating forest point clouds still mostly unexplored.

In our research, we explore the potential to extend current deep learning-based 3D instance segmentation approaches, currently used in point clouds for other contexts such as indoor scenes and aerial photogrammetry, to the ITC delineation of New Zealand forests.

Nick Lee

Title: Automatic Exposure and Visual Odometry

Abstract: We propose an experiment to verify the relationship between the various image quality metrics and visual odometry (VO) accuracy. Currently, many automatic exposure (AE) algorithms assume that optimising some predetermined quality measurements of the image leads to improved VO, evidenced indirectly by their superior performance over other AE algorithms. Having first accepted this assumption, we explored image enhancement techniques to understand the chosen metrics.

However, we found no direct comparison of VO performance and the optimised image metrics. Therefore, our experiment measures the ATE of four VO algorithms over two scenes in a simulation environment at different exposure values. The results indicate that gradient-based metrics, image entropy, number of features, and feature strength, have no discernible relationship with ATE. The discoveries are significant because it implies that adjusting exposure values to optimise image is unlikely to improve VO accuracy.

Masters

Dylan White

Title: Online Monocular Camera Auto-Calibration with Inertial Sensor Fusion

Abstract: Photogrammetry, structure from motion, visual odometry, SLAM and other computer vision technologies rely on the ability interpret the physical geometry of a scene around the camera. Camera lenses have a projection that may be known but is generally known imprecisely. To make the most of the camera, the system is typically calibrated to establish a more robust estimation of the projection function from the scene to the sensor. This is typically a laborious task. If done in the factory, it adds to the cost of manufacturing. If done by the user, it requires expertise and often specialized equipment that makes the system less generally useful. Furthermore, calibrations are often not stable over time — they will change with temperature, shock, and vibration.
An online calibration method would allow calibration of a camera system in the field, by an unskilled user. Furthermore, it would allow for maintenance of that calibration as it shifts over time. In a multi-sensor system, there will be multiple indicators of camera motion. The movement of keypoints through an image as the camera moves, and an IMU for example, is another. Because both sensors are fixed to each other, they must be describing the same motion and to the extent they disagree beyond the system noise parameters, the remaining errors should be resolvable by improved calibration. The purpose of this research is to identify a means to extract that calibration.

Marina Filipovic

Title: Teaching strategies of BDD (behaviour driven development) and their impact on product quality

Abstract:
Having a common understanding of the user requirements across the whole team is crucial for the quality of a software product
There is evidence that breaking user requirements into scenarios/examples which simulate expected user behaviour and incorporating them into development practice is beneficial for the product quality. From this idea emerged BDD (behaviour driven development). This technique focuses on increasing collaboration in the team and improves the overall understanding of what needs to be built. Once this understanding is reached ATDD (acceptance testing driven development) can be implemented. A developer following ATDD uses acceptance tests (defining a feature behaviour) to iteratively drive the coding process until the feature is fully implemented. This in return, if done correctly, ensures that the implemented feature works as expected, and hence improves product quality.
Based on our SENG302 historical data, we see correlation between the adoption of acceptance test driven development and product quality. Teams that make the most of this technique delivered products of a higher quality.
The body of knowledge on how to practice BDD and ATDD adequately is still evolving, especially regarding training future engineers to use this development technique correctly.
In SENG302 we investigate which techniques used in BDD teaching are most effective. By lowering the learning curve of BDD mindset and practices for our graduates before reaching the industry we are hopeful that we will be making an important contribution to the wider software engineering community.

William Herewini

Title: CNN identification of vineyard posts and trunks in 3D datasets

Abstract: This research is part of a larger project, "MaaraTech", which aims to reduce variability in vineyard pruning that results from human decisions. The automation of any process relies on accuracy and reliability. In the case of pruning in vineyards, the robot must accurately align itself with a trunk and operate a robot arm to prune vines. Using computer vision, we can identify trunks and posts along a vineyard, creating accurate anchor-points for the robot.

This research addresses the methods of locating these anchor points. Two primary methods will be evaluated and compared, one that uses a 2D CNN, and another using a 3D CNN. The 2D CNN uses a segmentation model to identify the posts and trunks from images, producing a 2D mask. This mask can then be overlaid onto the corresponding 3D point-cloud to isolate the points representing posts and trunks. Applying a 3D clustering algorithm to these points will return the post and trunk regions, which can then be used to output geographical locations. The architecture of the 3D CNN will be based on a submanifold sparse CNN. The key attributes that will be evaluated when comparing these methods will be accuracy, robustness, and computational speed. This presentation will cover progress on the 2D CNN method and future plans for approaching the 3D CNN design.

PhD

Aaron Smith

Title: Correcting charge sharing distortions in post processing for photon counting chips

Abstract: Photon counting technology allows for the capturing of individual photons and the recording of their energy level. This technology is used in photon-counting computerised tomography scanners to record scans with high spatial resolution and discretised energy values, which allows for the identification of different materials present. However, this increased sensitivity introduces new problems which degrade image quality. One of these issues is a phenomenon where the energy of an incoming photon is split between multiple pixels, called charge sharing. Currently, there are reliable ways to correct this distortion through the addition of extra dedicated circuitry, but it is not always possible to utilise this circuitry for all energy channels on a photon counting chip. To correct these extra channels, we will analyse the potential of a neural network to learn to correct the distortions induced by the charge-sharing events in post-processing.

Amelia Samandari

Title: UAV Formation Tiling

Abstract: To address the challenge of providing collision-free flight for Unmanned Aerial Vehicle (UAV) formations, we introduce a spatial reuse scheme – for TDMA scheduling of periodic safety information –that reduces the UAVs' wait time to access the communication medium.

Camila Costa Silva

Title: Reusing software engineering knowledge from developer communication

Abstract: Software development is a knowledge-intensive activity since it requires different types of knowledge, for example, knowledge about software development processes, practices, techniques and about the domain of an application. On the other hand, throughout the development of software, developers share knowledge via informal communication channels (e.g., instant messaging tools, e-mails, or online forums). Considering that this informal knowledge may be potentially relevant for other developers and given that this knowledge is not necessarily captured and formally documented for reuse, we investigate whether developer communication is a suitable source of reusable software development knowledge. Therefore, we aim to identify software engineering-related discussions from developer communications and evaluate their relevance for reuse in software development activities.

Di Wang

Title: Towards application monitoring to support bug reproduction

Abstract: Today's web applications are often built as Single Page Applications (SPA). Just like with other types of software systems, debugging is a common activity during the development and maintenance of SPAs. To fix bugs observed during run-time, it is useful to first reproduce the bug. However, research has shown that reproducing bugs is not always possible. In this study, we will look into how Application Monitoring (AM) data can impact bug reproduction. We ask two questions: RQ1: How can AM support bug reproduction? RQ2: How does AM impact the performance of the monitored software? We developed an initial version of an AM framework and implemented it in a prototype. Our preliminary investigations using that prototype showed that it not only improves the efficiency of the bug reproduction process but also fills information gaps caused by incomplete bug reports submitted by users. Future work includes deploying the AM framework in more SPA web applications and investigating how application monitoring can be integrated better into software developer workflows.

Gus Ellerm

Title: LivePublication - Integrating experiment infrastructure with publication artifacts

Abstract: Scientific publication has remained relatively static in its approach to communication, leading to contextual issues among modern scientists - Reproducibility, Transparency, and Reuse. With the maturation of eScience technologies and infrastructure, the opportunity to integrate live computational experiments with publication artefacts promises to solve these issues while providing unique benefits to authors and readers alike. Utilising robust integrations between experiment infrastructure and publication artefacts enables dynamic articles to be written - and rewritten automatically, dependent on measures and data extrapolated from the live experiment. Authors can practice continuous integration across their experiment and their publication, providing a much stronger relationship between science done and science communicated.

Henry Hickman

Title: Helping to better teach programming at an NCEA level.

Abstract: Digital Technologies is a relatively new topic in the NCEA curriculum, first being introduced in 2011. This means that many teachers who must teach digital technologies are not experienced programmers. With NCEA redesigning their standards, and piloting them in the coming years, now is an opportune time help teachers better teach. In order to do this, we must first understand what makes NCEA unique, what kind of pedagogical approaches for teaching programming work best, what kind of support do teachers want, and what is the best way to provide them with that support.

Juliet Samandari

Title: Post Quantum Cryptography for IoT

Abstract:
Public-Key Infrastructure (PKI) uses digital signatures to provide authenticity and ensure the integrity of communication. It is known that solving the hard problems that currently provide the basis of security for digital signature protocols will no longer be computationally infeasible once large quantum computers are available. Therefore, these protocols will no longer provide security. This necessitates the adoption of new cryptographic standards that will remain secure even with the possibility of attacks from quantum computers. It is also important that we take into account the growing use of IoT devices and ensure that the new standards chosen are feasible for these devices as well. We will discuss some of these alternatives and also what special considerations are needed when considering IoT devices.

Matthew Minish

Title: Computer-based Tutoring Systems in support of Daily Stand-Up Meetings

Abstract: The Daily Stand-Up Meeting (DSM) is the primary driving force behind any highly functioning agile software development team. In software engineering (SE) education, the DSM also offers a unique entry point for educators to monitor and support student learning. In particular, we theorise that the application of a computer-based tutoring module to student DSMs might have a positive impact on student learning of qualitative skills (or soft skills) such as sustainability, self-efficacy, and communication.
The literature investigating the application and evaluation of DSMs in industry contexts is scarce; in comparison, the literature around DSMs in undergraduate software engineering project courses is almost non-existent. Through reviewing the intersection of literature involving the use of DSMs in both industry and education, and by supplementing this literature with well-established educational pedagogy, we propose an approach to supporting student learning in undergraduate SE project courses by the application of a computer-based tutoring module intended to increase reflective behaviours in students.

Rosalyn Rough

Title: Improving the Reliability and Ease of Bloodstain Pattern Analysis with Quantitative Techniques

Abstract: Bloodstain Pattern Analysis (BPA) is a discipline of forensic science which is often used at scenes of bloodshed to assist with the reconstruction of events. Seen as a pattern recognition discipline, BPA has received criticism of its subjective nature and lack of quantitative techniques. As a result, quantitative classification methods are being explored in this research project.
Deep learning using CNNs has become a popular method for image recognition and classification and so was chosen as a possible method for the classification of bloodstain patterns from images.
The available training dataset consists of digital images of laboratory generated patterns captured at high resolution and of various sizes and aspect ratios. Due to the relatively small size of the dataset, pretrained CNNs were explored to identify the most appropriate model for classifying bloodstain patterns. Furthermore, CNN models require training data sets that are uniform in shape and size to be optimally utilised, and the computational load of training requires a size restriction for the training images. Therefore a number of different pre-processing methods have been applied to the original images in an attempt to create a dataset of images of an appropriate size which still retain details of the patterns and removes any artefacts from the images that may otherwise have an influence on the training.

Sam Schofield

Title: Outlier removal for visual odometry using Local Flow Consistency.

Abstract: Visual odometry is the process of estimating the motion of a camera using images that the camera is capturing. VO is often used in robotics to provide the robot with a pose estimate when GPS is unavailable or does not provide enough precision. Traditionally, VO relied on the assumption that it was operating in a static environment. Recently there has been an abundance of work aiming to improve the robustness of VO in dynamic urban scenes. However, unlike urban environments, dynamic vegetated environments remain relatively unstudied yet are essential for expanding robotics into areas such as agriculture and forestry. We propose a method for detecting (and removing) dynamic features by exploiting the differences in optical flow patterns caused by moving vegetation and camera motion. Our results show that the proposed method improves the accuracy and significantly reduces the processing time of visual odometry in dynamic vegetated environments.

Tim McKenzie

Title: Addressing Video Game Development Challenges Using Industry 'Best Practices'

Abstract: Video games have rapidly become a massive and powerful creative industry that has far surpassed other entertainment industries such as movies and music. However, the video game development (VGD) industry is not without significant development challenges in multidisciplinary team dynamics and communication, work culture, and project management. These issues often stem from video games being a complex and confusing 'marriage' of software engineering and creative production. There is a lack of agreement in academia and even within the industry itself on 'good' or 'best' VGD practices or processes which unify these competing creative and technical aspects. So, each game studio has its own highly contextualized ad-hoc (and often closely guarded) way of working, which is often misunderstood to be 'agile'. Consequently, the absence of commonly accepted 'good' development practices and the misapplication of agile means both independent studios (especially start-ups) and even AAA studios often struggle to create successful games. Hence, through interviews, surveys, and case studies with industry studios, this research project will capture the commonly used agile software engineering and creative production practices within VGD, and, investigate the relationships between these practices and the multidisciplinary collaboration challenges studios face. From this analysis a contextualized agile VGD 'best practice' model will be proposed.

Tim Rensen

Title: Towards Automated Species Monitoring and 3D Mapping in Underwater Environments

Abstract: Scallop fishery SCA7 at the top of the South Island was closed due to stock collapse in 2017, halting commercial and recreational fishing of hundreds of tonnes of scallops, and rahui or restricted access imposed on customary fishing by local Māori. Many factors contributed to this stock collapse, including overfishing, sediment and nutrient runoff from land use, and natural events such as once-in-a-hundred-year floods turning productive seabed into sediment muck meters deep, suffocating and starving seabed communities. Scallop dredging involves raking up scallops off shallow seabed where they reside, upturning delicate seafloor, tearing apart microalgal films, resuspending sediment, and permanently changing the topology of the seabed.

For commercial scallop fishing to be more sustainable we need better harvesting and monitoring methods. Autonomous underwater vehicles (or AUVs) make if feasible to scan large areas of seabed consistently. The image data can be processed into 3D reconstructions of habitats, allowing marine scientists to analyse entire benthic habitats with a single 3D model or mosaic image as opposed to frame-by-frame in a video.

I propose an annotation method where scientists can label a reconstructed top-down image of a seabed environment, and these labels propagated to all of the individual image frames. This method requires labelling of unique scallops only once, avoiding having to label the same scallop in multiple frames. Transfer learning will be used to reduce the required amount of data in training a CNN for pixel-wise identification of scallops.

How this will help in monitoring and harvesting of scallops is in development of more efficient methods for analysing the scallop stocks and habitats from AUV video. This same robot can run scallop classification live to locate harvestable scallops and selectively pick them up, eliminating bycatch and minimising habitat damage. The result would be more sustainable scallop fisheries, and increased environmental monitoring, enhancing kaitiakitanga or our stewardship of earth.

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