



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

2024 INNOVATION SHOWCASE

Fostering industry
collaboration and showcasing
the tremendous talents of
Electrical Engineering and
Computer Science students.

Acknowledgement of Country

The University of Queensland (UQ) acknowledges the Traditional Owners and their custodianship of the lands on which we meet.

We pay our respects to their Ancestors and their descendants, who continue cultural and spiritual connections to Country.

We recognise their valuable contributions to Australian and global society.

Welcome to the 2024 Innovation Showcase

Discover tomorrow's innovators today

Running now for 14 years, the School of Electrical Engineering and Computer Science has hosted this annual showcase, highlighting projects across key fields: electrical and software engineering, computer science, and interaction design.

This event offers selected students a chance to present their projects with live demonstrations and interactive sessions.

More than just a celebration of projects months in the making, the UQ community and industry representatives come together to engage with fresh ideas and innovative solutions coming out of The University of Queensland.

School of Electrical Engineering and Computer Science

Join us to build a society that is more connected, healthy and secure.

With a focus on people, data and code, UQ's School of Electrical Engineering and Computer Science is at the leading-edge of computer science, information technology and electrical engineering.

We take pride in our reputation for teaching excellence and expert research. Our students, graduates, teachers and researchers are revolutionising technology to solve the world's greatest challenges.

Award Categories

Best hardware solution

sponsored by Rinstrum



Best user experience design project

sponsored by Shorthand



Best project in avionics and UAV

sponsored by Boeing



Best biomedical device or systems

sponsored by Cochlear



Best cyber security and data privacy project

sponsored by Data #3



Best project in microwave photonics and communications

sponsored by L3 Harris



The University of Queensland

About the University

For more than a century, The University of Queensland (UQ) has delivered knowledge leadership for a better world.

The most prestigious and widely recognised rankings of world universities consistently place UQ among the world's top universities.

UQ has also won more national teaching awards than any other Australian university. This commitment to quality teaching empowers our 55,000 current students, who study across UQ's 4 campuses, to create positive change for society.

Our research has global impact, delivered by an interdisciplinary research community of more than 2,500 academics and researchers at our 6 faculties, 8 research institutes and more than 100 research centres.

We extend our heartfelt gratitude to our industry sponsors for their generous support of the EECS Innovation Showcase.

By supporting this event, you create an environment where students can showcase their talents, collaborate with peers, and gain insights from industry leaders.

Your involvement highlights the importance of industry-academia collaboration and inspires our students to strive for excellence.

Thank you for being an integral part of our community and helping us build a brighter future for the next generation of engineers and computer scientists.

Best project with the most commercial potential

sponsored by .au Domain Administration

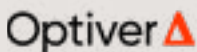
Most innovative use of XR

sponsored by .au Domain Administration



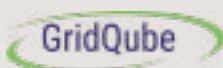
Best power & energy or electrical engineering project

sponsored by Optiver



Best software project

sponsored by GridQube



Diversity prize

sponsored by Emesent



Best distributed ledger technology project

sponsored by UQ Ventures



Best systems and software engineering project

sponsored by Reapit



Investigating the role of electric fields in axon behaviour

Micah Clarke
Justin Cooper-White

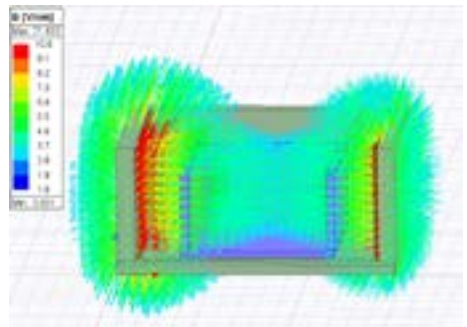
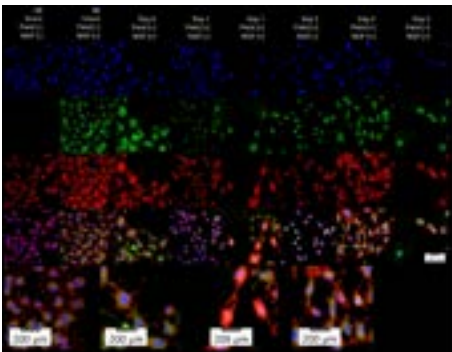
Skills

Cell culture, biology, good manufacturing practice, electrical design, ANSYS, circuit design, field theory, capacitor design

There are currently no accurate and repeatable methods for controlling cell fates in three dimensions at a tissue level. Cell culture has routinely incorporated mechanotransduction and media composition signalling modalities into controlling cellular behaviours. Despite this, using electric fields to control cellular dynamics remains a known but poorly understood method. A system capable of isolating the effects of electron interactions and electric fields could provide valuable insights into the factors driving shifts in cell behaviour.

This thesis re-examines the cell culture systems employing electric fields to understand better the role electric fields play in cell culture. This study isolates the effect of electric fields, independent of other electrical phenomena, to reveal the impact on cell growth by implementing a parallel plate capacitor system. The questions answered in this thesis were (1) whether electric fields, independent of other factors, alter cellular behaviour and (2) whether the electric field can control behaviours in repeatable and expected ways. This thesis used neural cells to test directional growth and created a system to grow cells in an electric field.

Throughout the experimental design of this thesis, many biological factors needed to be optimised, including cell density, surface modification and small molecule concentration. After designing ideal conditions for cellular differentiation, the results showed that the electric field impacts cell dynamics. Cells differentiated in the field showed an increase in cell size of up to 300%, alignment of projections in the direction of the field and expression of differentiation markers even without exposure to specific differentiation growth factors. Cells were then exposed to the field after being grown in regular differentiation conditions for a set time, and it was shown that when the field is applied, the response dynamics change.



Simulation of electromagnetic sensors for liquid classification using machine learning

June Lee

Skills

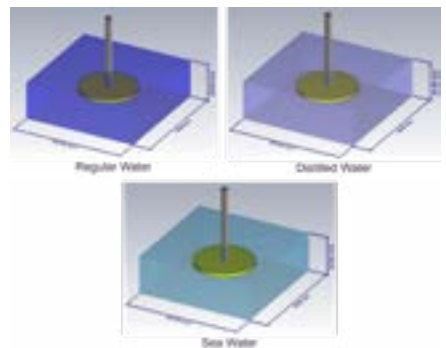
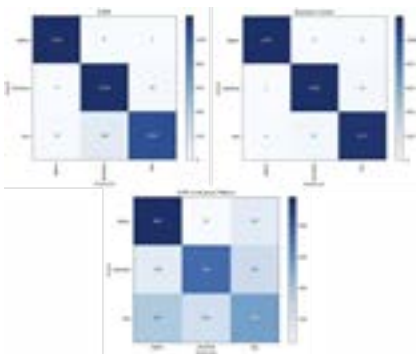
CST simulation, Python, machine learning, electromagnetic sensor, k-nearest neighbors classification, random forest classification, support vector machine classification, coaxial line probe

Electromagnetic sensors have seen substantial growth in various practical applications, particularly in integration with machine learning techniques.

This combination facilitates an opportunity for analysis and classification of materials, especially in liquid-based applications. This project proposed a sensor design based on a coaxial probe.

The developed sensor is highly sensitive and non-invasive. A model of the sensor was constructed in CST Studio Suite and a substantial amount of data was simulated to build a database for training three machine algorithms, i.e. the k-nearest neighbors, the random forest, and the support vector machine.

The results showed that descent classification accuracies were obtained by using the designed sensor.



Practical detection of adversarial face-swap deepfakes for social media platforms

Jingming Dai

With the development of AI and deep learning technology, image and video generation has made significant progress in recent years. However, these technologies have also created serious social and security issues.

Skills

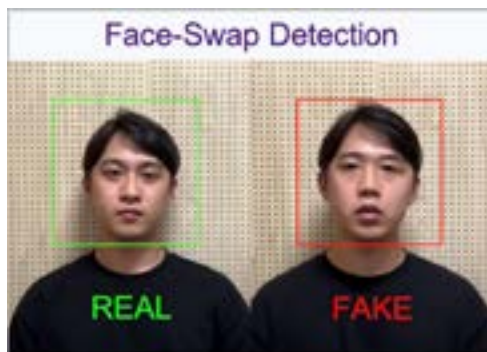
AI, cybersecurity

This study aims to improve the current deepfake detection model's generalisation ability. In the multi-scale training experiment, adding 60% scale images significantly improved the model performance on different resolution images.

Adding noise augmentation methods improved the model's detection ability on different augmented images in the data augmentation experiment.

The model combining the best scale and best augmentation methods had a 9% performance improvement in the test of multiple scales and enhanced images.

The study results show that this proposed method can effectively improve the performance of deepfake detection technology.



Security study based on the Chatgpt plugin system: identifying security vulnerabilities

Ruomai Ren

This project investigates the security vulnerabilities of the ChatGPT plugin system, which allows developers to upload external programs to enhance user experience.

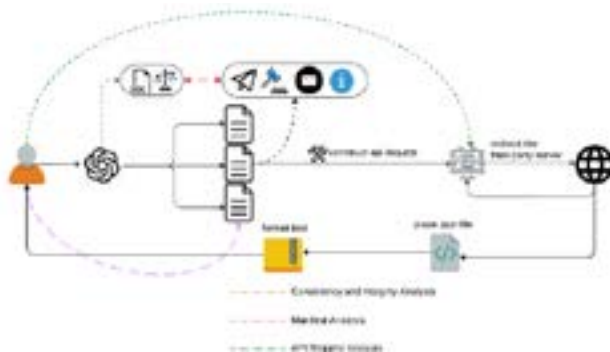
While the ChatGPT model itself is secure, the security of its plugin ecosystem has not received sufficient attention.

Skills

Plugin architecture analysis, security assessment

With over 1,000 plugins covering various functionalities, this study aims to identify security risks associated with these plugins and evaluate the threats posed by external applications interacting with the ChatGPT model.

The findings will highlight security issues and provide recommendations for improving the plugin system's security.



Catching cybercriminals: automatic deanonymisation of Bitcoin transactions

Auni Binti Abdul Azhar

From scams to ransomware attacks, law enforcement agencies have documented numerous criminal cases on Bitcoin over the years. In 2023 alone, reported ransomware cases reached 5,070, marking a dramatic 55.5% increase compared to the previous year. Additionally, dark web marketplaces such as Silk Road, AlphaBay, and Hansa have become infamous for using Bitcoin as a primary form of payment for illegal goods like weapons, drugs, and counterfeit documents.

Skills

Cryptocurrency, blockchain, Python

The core issue lies in the pseudo-anonymity Bitcoin offers, which complicates the process of tracing transactions back to individuals and hinders law enforcement efforts to hold criminals accountable. Despite the rise in cryptocurrency-

related crime, a reliable solution for deanonymising these transactions remains elusive.

With the growing threat of financial cybercrime, law enforcement agencies are urgently seeking effective methods to unmask the identities of these criminals. Researchers are actively investigating approaches like deanonymisation, which studies transaction patterns on cryptocurrency networks to link them to real-world identities.

The primary objective of this thesis is to develop a program for law enforcement that monitors and analyses Bitcoin network data, estimating the origin IP addresses of transactions by using the methodology described by Biryukov and Tikhomirov in a previous study. This program serves as a valuable tool in combating the misuse of cryptocurrency's privacy features.

De-anonymisation of Bitcoin transactions using LLMs

Takao Mizuno

Skills

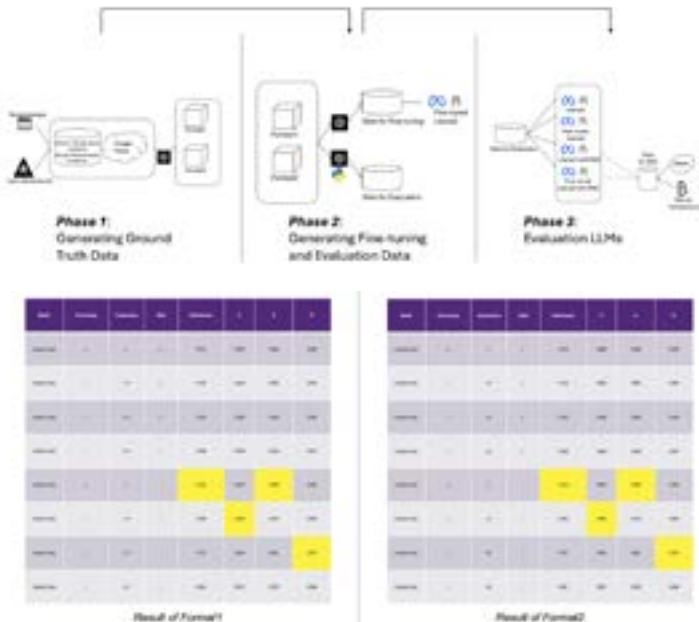
Llama2, fine-tuning LLMs, RAG, evaluation metrics for LLMs for de-anonymization of Bitcoin transactions, collecting ground truth data using exploring dark web and bitcoin transactions

This study focuses on mainly four methods.

1. How to collect ground truth data for de-anonymisation of Bitcoin transactions
2. Generating fine-tuning data and evaluation datasets based on the ground truth data
3. Devising the evaluation metrics to evaluate the performance of Llama2 for de-anonymisation of Bitcoin transactions
4. Identifying the best parameters and configurations of Llama2 to de-anonymise Bitcoin transactions

By exploring the dark web and getting Bitcoin transactions data from “ransomwhere” website which provides the Bitcoin transaction information related to ransomware payment, I obtained ground truth data for this project. For evaluation, I adopted “Faithfulness” and “BERT-SCORE”.

Through these experiments, I found that RAG must be used for de-anonymisation of Bitcoin transaction and combining prompt-engineering and adjusting top_similarity_value got higher score for de-anonymisation of Bitcoin transactions. For future works, I plan to improve the accuracy by using more high-quality data from law enforcement agencies. I aim to explore changing other parameters of RAG and other proposed methods to improve RAG performance. This research highlights the potential of LLMs to support law enforcement in tracking cybercrime. By refining these methods, we can take a step towards reducing the crimes exploiting the Bitcoin anonymity.



Smart contract vulnerabilities and auditing

Xinyang Li

Blockchain technology has been used in various industrial domains, such as Decentralized Finance (DeFi), supply chain management, and the insurance industry.

Skills

Blockchain, smart contract, large language model

While smart contracts are the codes running on the blockchain. Smart contracts help to build decentralised applications and try to ensure the correctness of cryptocurrency transactions. They facilitate automated, secure, and transparent agreement executions without intermediaries. However, they are not without vulnerabilities.

The project aims to provide a thorough investigation into the vulnerabilities in smart contracts, offering detailed descriptions, exploit scenarios and code explanations for each identified weakness. A website was developed to catalog vulnerabilities with corresponding code samples, attack methods, and defense strategies. Vulnerabilities from these data can be used to benchmark the efficacy of current auditing tools. Moreover, this project also explored different large language models (such as GPT-3.5, GPT-4o, GPT-2, and tinyLlama), observing their abilities of generating smart contracts.

Experimental results indicate that higher-level models (like GPT-3.5 and above) can generate almost perfect smart contract code after a few rounds of prompting engineering. While smaller models (such as GPT-2 and tinyLlama) are unable to generate compliant contract code directly without appropriate finetuning.



Communications system upgrade for UQ RobotX autonomous USV

Harry Steel

The Maritime RobotX Challenge is an international competition amongst academic institutes which has been running since 2014.

Every two years, competing schools enter an unmanned surface vessel (USV) to autonomously complete a number of tasks. UQ's RobotX team have been competing since 2022 and are constantly developing new systems to improve on our previous efforts.

Skills

Embedded systems, circuit design, software & electrical engineering

In previous competition outings, UQ's vessel has had significant issues in communicating with the shore control centre due to the high RF noise environments created at these RobotX

events. In an attempt to overcome these issues, I have created a system which can rotate and precisely direct a high-powered directional antenna towards our USV.



Smart PlantBed monitor and hub

Hamish Pyle

Skills

Micropython, Python, KiCAD, Fusion 360, RFM69 radio module, SGP30 air quality sensor, UV sensor V2, ground moisture sensor, VEML7700, DS18B20 temperature sensor and an E-ink display

promoting more efficient and sustainable agricultural techniques.

One of the most pressing global challenges today is the growing food shortage.

The Smart PlantBed Monitor and Hub aim to address this by offering a real-time operating system for acquiring and visualising critical plant growth variables.

Utilising radio communication and a solar-powered battery, the system monitors essential metrics such as equivalent CO2 levels, total volatile organic compounds (TVOCs), soil moisture, soil temperature, UV exposure, and ambient light.

A streamlined display provides in situ monitoring, while Grafana delivers detailed, time-dependent data analysis for deeper insights into plant health and environmental conditions



Smart RFID tags reader

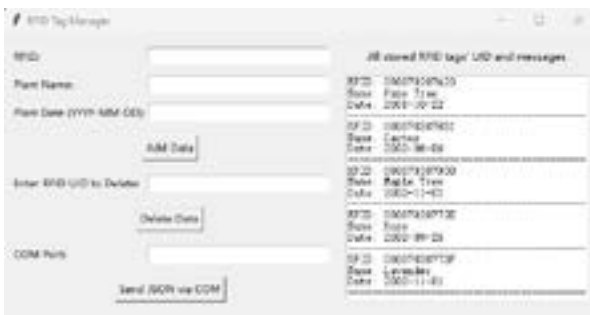
Shiping Mei

A mobile reader to detect RFID plant tags and display the plant type on either an OLED screen or on a smartphone using Bluetooth.

Also equipped with a database and software which can smartly register, delete and edit RFID tags.

Skills

Python and micropython programming, PCB design (Altium designer), embedded system design



An investigation of zero inertia power system operation

Mason Schmidt

To understand how the Queensland grid will respond to a major generator failure during and after the energy transition, this project models many scenarios in PSSE and MATLAB Simulink and generates frequency responses and stability measures to analyse this.

Skills

Power System Modelling and Simulation (PSSE and MATLAB Simulink)

DC fast charging in constrained rural distribution networks

William Webb

Electric vehicles have the capability to severely impact rural electricity supply.

The National Roads and Motorists Association (NRMA) has announced a nation-wide EV charging plan with plans to install a high output DC fast charger every 150km on major roadways.

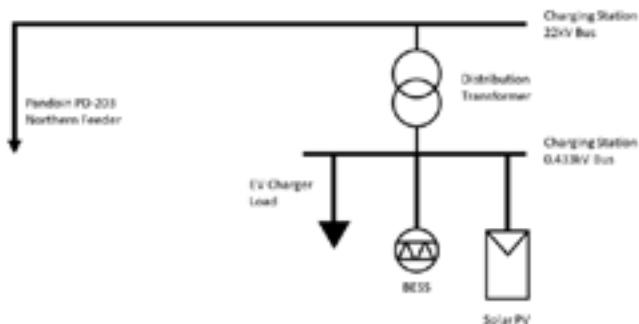
Skills

PowerFactory, EV charging, quasi-dynamic analysis

Several of these proposed charging locations are in constrained areas of the distribution network and as a result, the charging capacity of the site will be severely limited.

This project aims to investigate various charging solutions, such as installing a Battery Energy Storage System (BESS) at the charging site and comparing these solutions both technically and economically to determine if the added cost results in a significant charging capacity increase.

The end goal of this project is to present a technically feasible and economically sensible solution to this issue.



Development of a socially aware demand response algorithm for management of low voltage distribution networks

Kurt Lucas

Skills

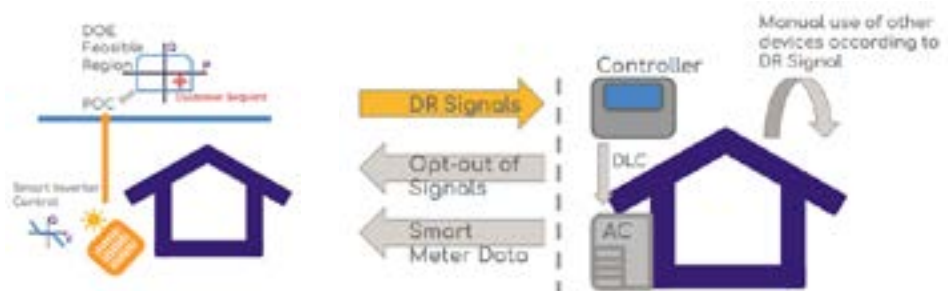
OpenDSS, Julia, JuMP, distribution networks, mathematical optimisation, Monte Carlo simulation, software system sensitivity analysis

The increasing uptake of distributed energy resources (DERs) such as rooftop solar and batteries poses significant challenges in managing low-voltage networks under current and future conditions. By integrating dynamic operating envelopes (DOE) with demand response (DR), customers will benefit from increased utilisation of their DER assets, while distribution network service providers will ensure secure network operation within statutory limits.

This work primarily focuses on reimplementing and expanding existing work on a DOE-centric DR scheme that is reliable and scalable under various network conditions. A physics-based DOE feasibility with respect to DR capacity is assessed via

the projection of household DOE connections through an iterative exploration of the underlying network model.

The Alternating direction Method of Multipliers (ADMM) optimisation algorithm is employed for DR that ensures scalable and distributed calculation of customer set points across the network. Furthermore, a framework is proposed for projecting socio-economic considerations onto the network using DR capacity and DOEs to improve flexibility for DR aggregators. The overall implementation carried out in Julia programming language has shown increases in performance and flexibility of implementation to support further exploration in future work. The simulation results validated in a real network suggest that the solving for customer set-points within these DOEs and in response to DR pricing signals ensures network integrity and scalability.



Development of power plant controllers for large-scale renewable energy farms with Siemens S7-1500 PLC

Jun Su

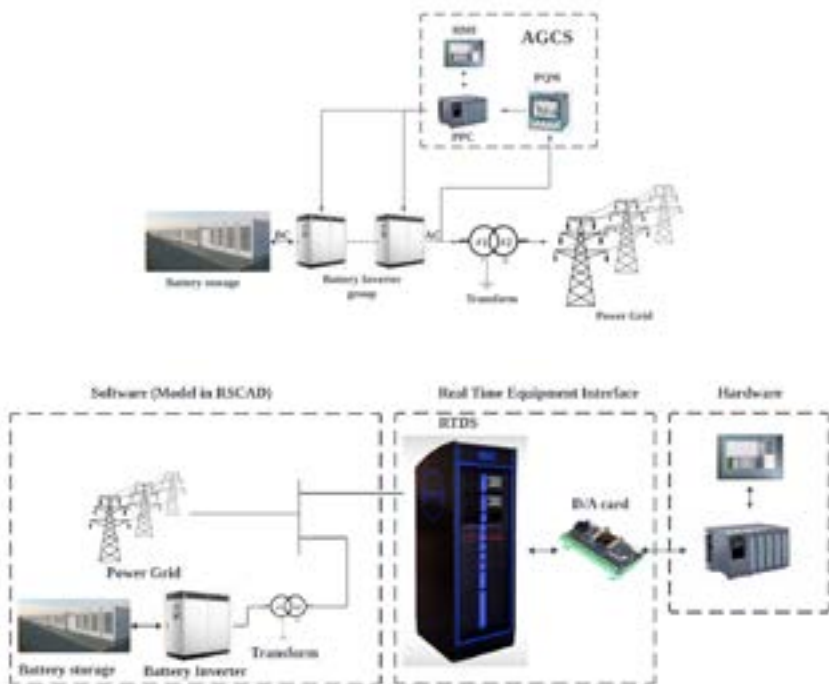
Skills

Siemens S7-1500 PLC programming (SCL language), HMI design, MATLAB/Simulink modeling, RTDS (Real-Time Digital Simulator) integration, power system control theory, PI control design, droop control mechanisms, low-voltage ride-through (LVRT) implementation, electrical system simulation

Development of a power plant controller (PPC) for large-scale renewable energy farms utilising Siemens S7-1500 PLC.

This project focuses on designing and implementing a robust control system that complies with GPS (Grid Performance Standards) for generators, ensuring adherence to frequency response, voltage regulation, active and reactive power support requirements.

The system effectively manages the output of inverter generators, maintaining stable operation and efficient power regulation through advanced droop control, LVRT function, active and reactive power management strategies.



Risk analysis of domestic solar PV installations

Patrick Mushan

Investigation into the risk of fires within household PV systems. Focused on the risk posed by DC isolators in PV systems installed before 2021.

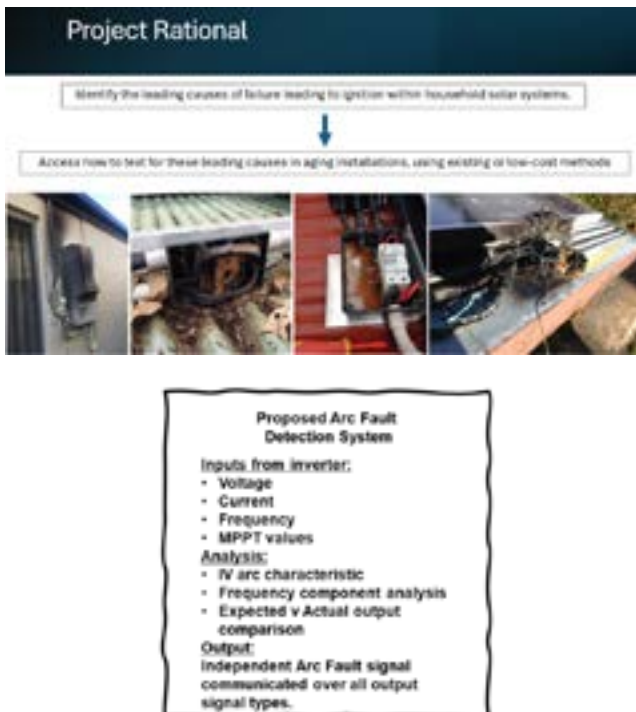
Skills

PV systems, arc fault detection, domestic PV, risk assessment, residual risk

DC isolators have been a topical point within the AS5033 standard, with them being mandated in 2012, and then removed as a requirement in 2021. This change in regulation reflects the risk posed by DC Isolators in environmentally exposed rooftop locations.

There remains a residual risk to all household PV systems with DC Isolators installed on their roofs.

This thesis aims at quantifying this risk, and posing a solution through arc fault detection processes to provide early detection for households. With the goal being to reduce the risk of fire and damage, faced by those household who have a PV system installed within the 2012-2021 period.



Stability analysis and controller design for virtual synchronous generator

Jai Flack

Skills

Analytical modelling and control design knowledge, Matlabx2Fx, Simulink

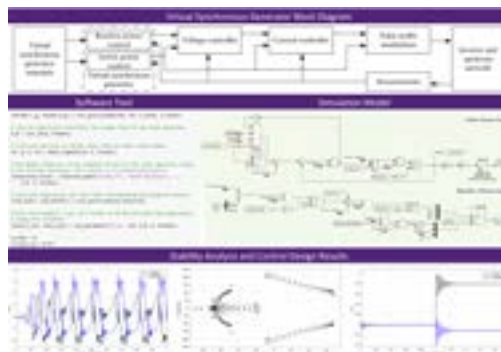
The target for net zero emissions in Australia and world-wide led to an increase of power electronic converter-interfaced generation facilities for integrating the renewable energy units. The downside of this rapid converter penetration is the diminishing essential power system stabilising characteristics like inertia, fault current, oscillation damping etc. The modern power systems are incorporating virtual synchronous generators (VSGs) that mimic the behavior of the conventional

synchronous generators through converter controls to tackle these problems.

A VSG control strategy comprises of nested control loops that models the synchronous generator principles, protection logics, and converter pulse width modulation (PWM) techniques. A proper VSG functioning is highly reliant on the design of various control loops and the interaction among the loops, failing which, the VSG along with the power system shall be prone to instability. For VSGs to support the power system stability needs, a detailed modelling, analysis and control design is vital.

In this thesis, firstly, the state-space equations of the VSG control loops like power control, voltage control, current control, and PWM stage are modelled along with the state equation of the converter filters and the upstream equivalent power system network. Rigorous procedures are performed to benchmark the developed model with that of the actual VSG response. Secondly, small signal model is derived to perform the eigen value analysis that alleviates the instability in grid-connected VSGs. The participation factor analysis of the eigen values is performed to identify the parameters that impact specific eigen values of its small signal model. This allows to zero-in on the control parameters that contribute to the instability of the VSG. Thirdly, a repetitive process of parameter tuning is performed by varying the critical control parameters in a way to lead the VSG to stable operation zone. The outcomes of the control tuning process are verified through simulation studies on Matlab/Simulink. The proposed process is a significant step towards developing appropriate control strategies for the VSG and thereby contributes to the overall power system stability.

The potential future work is to consider hybrid systems involving the VSGs and other renewable energy units like solar PV and wind energy systems, perform their modelling and control design for overall system stability.



Protor VI: The Convertible Airscrew

Jon van der Kreek

Skills

SolidWorks CAD drawings, parts, assemblies, design for manufacture and assembly, understanding of dynamic forces and vibration mitigation, part selection, testing apparatus design, data analysis, communication with manufacturers/suppliers

The Protor: Convertible Airscrew is an airscrew design which attempts to increase the viability and performance of VTOL aircraft while in translational flight by achieving higher airspeeds. The design transforms the rotors from their VTOL configuration into a higher airspeed optimised geometry. This allows the thruster to maintain efficiency in hover but increases the air's exit velocity in cruise and therefore increases the maximum air speed of the vehicle.

The previous five theses on the Protor: Convertible Airscrew have demonstrated the theoretical effectiveness of the design but have yet to produce a testable model to physically prove the convertible airscrew's design. Protor VI, this project, has achieved the milestone of producing a testable hardware

implementation which has undergone initial testing which have shown promising results, but further higher airspeed testing is required.

This project focused on iterative designs where CAD assemblies were generated and reviewed, building on previous iterations until a final design was completed. Once ordered, manufactured, and built, the design was tested in airspeeds ranging from 0-9m/s using a vortex fan to generate a headwind.

To produce an accurate, functioning design able to spin and articulate at thousands of RPMs, a high degree of precision in manufacturing was required and therefore CNC machined components were used as well as off the shelf precision parts.

The Protor VI: Convertible Airscrew has helped close the gap between VTOL and high-speed travel.

SDR-based ADS-B aircraft transponder tracking

Sam Kwort
Flynn Kelly

This project aims to create a system that can track and display ADS-B transponders of nearby aircraft within a designated portion of the sky.

By harnessing the capabilities of Software Defined Radio (SDR) and embedded systems, the goal is to provide real-time transponder data including aircraft IDs and other relevant details.

Skills

Bluetooth networking, sensor fusion, software-defined radio, embedded systems, ZephyrOS



Design and development of inline Vector Network Analyser electronic calibration devices

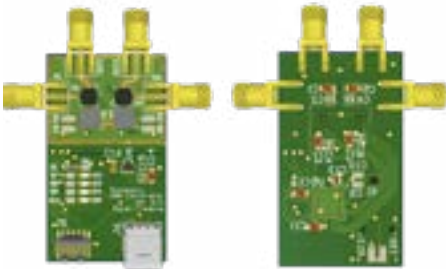
Dylan Fleming

Vector Network Analyser (VNA) calibration is an essential part of ensuring accurate measurements for frequency dependent devices.

Skills

VNA calibration, PCB design, microwave frequency

The project conducted is the design of an inline electronic VNA calibration device that utilises radio frequency (RF) switches. This device aims to reduce the amount of time taken to perform mechanical calibration for 2 port VNA device. The calibration standards used on the device are the Short, Open, Load and Thru (SOLT) NIST standards.



Interference signal source localisation with passive sensors

Weichen Sun

Skills

Passive uniform circular array (UCA), software-defined radio, Direction of Arrival (DOA), localisation and tracking

Interference signal localisation is a critical aspect of modern communication systems, particularly in environments with dense signal traffic.

As wireless technology continues to advance, the ability to accurately identify and mitigate interference becomes essential for ensuring reliable communication. Interference can degrade signal quality, reduce data throughput, and increase latency, adversely affecting user experience and system performance.

This paper explores the use of software-defined radio (SDR) to build a testbed with antenna array to estimate the direction of arrival (DOA) of interference signals, facilitating effective localization and tracking. Accurate identification

and mitigation of interference are essential for ensuring reliable communication, especially in the context of advanced technologies like 5G and IoT, where the demands on spectrum management are significant.

This study evaluates several popular algorithms, including MUSIC, alongside other recently developed methods, under varying signal-to-noise ratios (SNR) and different multipath conditions. The performance of these algorithms is assessed in both UCA and uniform linear array (ULA) configurations, highlighting their effectiveness in real-world scenarios. By employing effective localisation techniques, the research contributes to improved system optimisation and resilience.



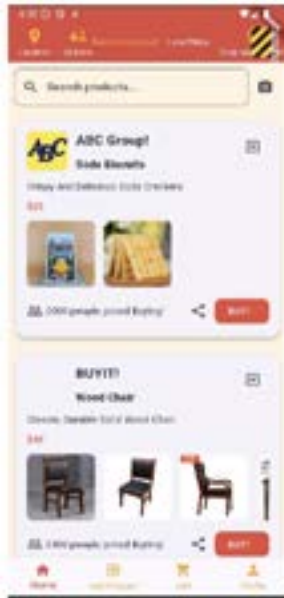
Group buying

Daniel Posner
Xuanrui Zhou
Chen Li
Youliang Gao

Skills
Flutter

An application to collect buyers and 'package' them, so that stores are able to offer discounts in return for volume of sales.

A good comparison in functionality would be Kickstarter - except this application is about obtaining discounts rather than funding.



I would walk 500 (Virtual) miles (encore)

Robert MacHunter

The Robotics Design Lab has developed a method to allow VR users to walk through virtual environments without translating in real life.

This means that they can go arbitrary virtual distances without crashing into non-virtual walls. While another project is finalising the algorithms, this project involves developing a “works like”, “looks like”, “feels like” prototype.

Skills

Electronics hardware, design synthesis, firmware development, moulding and casting

By modelling a real final product as closely as possible, this project will allow us to show potential what our technology will be like in hands of users. You may get to walk around VR using a product just like these in the very near future!

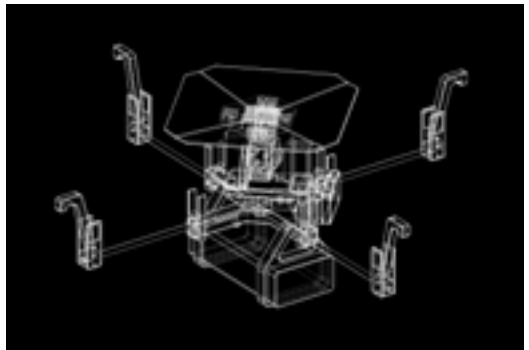
SmartBins

Jed Hoo
Joy Yin
Peter Beardsley
Lucas Ko

3D printed smart bin attachment that sorts waste with computer vision (YOLOv11 trained on custom dataset).

Skills

Computer Vision, 3D Printing, Embedded Systems, Product Management



TEBS - Technology-Enhanced Board Game System

Stuart Moyes
Erik Kelemen
Garrett Bargewell
Yuvraj Fowdar
Lin Soetanto
Christina Russo

Skills

PCB design, Raspberry Pi, Hall-effect sensors, Python, React.js, WebSocket, Embedded computing

The TEBS device is a unique gaming platform that combines the dynamic gameplay of digital board games, with the tactile feel and social advantages of physical board games.

It's features include:

- Physical pieces and large buttons communicate player movement and decisions to the digital display in real-time.
- Over 200 components, including 100 magnetic sensors, work together under the hood to detect player pieces on the game board and button presses.
- Players receive written instructions, feedback and prompts in real time throughout the game.
- Responsive, digital display that dynamically updates game board with each move.
- Comes with first game "Snakes and Ladders" with a twist - incorporating different game mechanics and mini-games (Wild Goose Chase, Falling Fruits and Pest Control) to enhance the player experience.
- Unique gameplay mechanics that give players a shortcut, detour or chance to steal the lead, swap snakes and ladders positions, and assist lagging players to catch up to the pack.
- Modular design built with future game expansion in mind.
- Flexible grid sizing up to 10 x 10 grids to incorporate multiple game designs.
- Portable, closed system that can be played offline wherever your table is.
- Affordable parts such as buttons that can be easy replaced if required.
- Accessibility-friendly with colours chosen to assist people with colour vision deficiencies and achieves a AAA rating for the WCAG's Contrast (Enhanced) Success Criterion.



Intersection of deep neural network compression and explainability

Vidyut Periyasamy

Skills

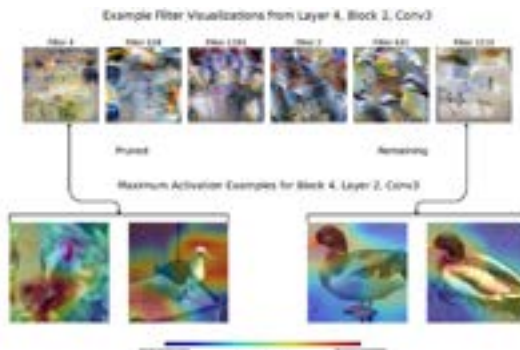
Machine learning, Deep Neural Networks, Software Engineering, Programming, PyTorch

Deep neural networks (DNNs) are increasingly employed across various domains, but their high computational and memory demands and their “black box” nature present significant challenges. Pruning, a model compression technique, reduces the computational load and memory footprint of DNNs, while explainability techniques aim to make model decision-making more interpretable. Despite the importance of both approaches, limited work has explored the relationships between pruning and explainability.

This study investigates this relationship using the ResNet50 model alongside the CUB Birds dataset. The model was pruned using both unstructured and structured pruning at various intensities. Afterwards, a suite of complementary qualitative and quantitative explainability techniques were applied to understand and explore relationships.

Findings indicate that moderate levels of pruning, ranging from 0.3 to 0.7 sparsity, retain accuracy and align with human expectations for decision-making, suggesting that pruned models maintain a level of “reasonableness” in their predictions. However, a critical pruning threshold was identified, beyond which both accuracy and interpretability decline significantly. These findings suggest that models can be effectively pruned to moderate levels for deployment in resource-constrained environments while maintaining interpretability and reliability.

Finally, this study implemented a novel pruning technique using an explainability-based pruning criterion, leveraging bounding boxes and layer-wise relevance propagation. While this implementation was unsuccessful, it highlighted key discrepancies between human and machine vision classification processes, underscoring the need to understand model decision-making processes.



Machine learning for rust optimisation

McArthur Alford

Graph Neural Networks (GNNs) are a subfield of machine learning which has in recent years seen an explosion of research and development.

Applicable to many fields, including social network analysis and molecular chemistry, GNNs have large appeal. As a result of this, the field is highly fragmented, with many substantially differing solutions to the problem of "graph learning".

Skills

Machine learning, rust, graph neural networks, sparse matrices

This thesis proposal (and subsequent thesis) focus on the implementation details of GNNs, and specifically the development of a GNN library for the rust language. Rusts unique approach to performance, reliability and usability

present a compelling foundation for developing a GNN library.

The ownership system for memory management opens up new optimisations that recent libraries such as burn have taken advantage of and are demonstrating can lead to many significant and innovative optimisations. Rust machine learning libraries also offer unparalleled portability, supporting the web, embedded, and non-nvidia gpus as first class platforms.

The motivation for this work is twofold. Firstly, to fill the gap in the Rust ecosystem by providing a robust and efficient GNN library that leverages Rust's unique features with a focus on convenience of API and portability. Secondly, to take advantage of the unique optimisations opened up by rust to enhance graph learning performance.

SwingTheory

Yiwei Zhao
William Harvey
Serene Ye
Alysha Ismail
Daoliang Kan
Peiting Tan

Skills

Machine learning, computer vision, virtual reality

SwingTheory is an innovative tennis coaching app designed for beginners to improve their swing technique using advanced technology. The app allows users to upload 10 second videos of their tennis swings, which are analysed through OpenPose and machine learning algorithms. By comparing the user's posture with a professionally modelled ideal swing, the app provides detailed feedback on how to adjust and improve form. Each uploaded video is stored in the user's history, allowing for continuous monitoring of progress over time and enabling users to revisit their previous sessions to track improvements.

The primary goal of SwingTheory is to make personalised tennis coaching more accessible. The app helps beginners bridge the gap between professional coaching and self-practice, offering tailored guidance in areas that need improvement. The feedback is not limited to generic advice but rather is based on specific movement patterns detected from the user's swing, ensuring that recommendations are relevant to the user's performance.

Additionally, the app incorporates a touch of creativity in its branding by drawing inspiration from string theory in physics. Just as string theory seeks to explain complex relationships in the universe, SwingTheory aims to untangle the complexities of tennis swings and offer a structured path to improvement. The app's user-friendly design and technical accuracy make it a valuable tool for anyone looking to refine their tennis game at their own pace.



ViTLearn: vision-text for robot behaviour learning using LLMs

Ayush Das

Natural language is a fundamental component in the development of robotic algorithms, enabling effective human-robot dialogue and guiding reinforcement learning processes. While reinforcement learning facilitates complex behaviours, optimally modelling rewards remains a significant challenge.

Skills

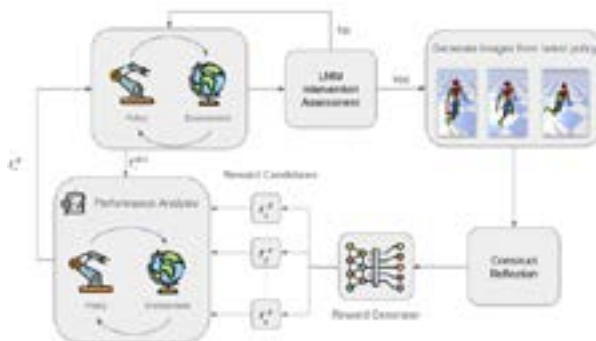
Deep reinforcement learning, robotics, Large Language Models, large multimodal models

Large Language Models like ChatGPT excel in following instructions, but the potential of Large Multi-Modal Models (LMMs), which integrate visual and textual inputs, is underexplored.

This paper proposes ViTLearn, a LMM-Reinforcement Learning framework that leverages both vision and language to shape rewards and enable more complex robotic behaviours.

Incorporating visual inputs is crucial for tasks that are difficult to articulate with words alone, as it can enhance task comprehension and performance. By fusing vision and language, ViTLearn aims to advance robotic learning and behaviour optimisation, promoting more intuitive human-robot interactions.

This project was conducted in collaboration with the CSIRO Robotic Perception and Autonomy Group.



Generative programming correctness

Jack Napier

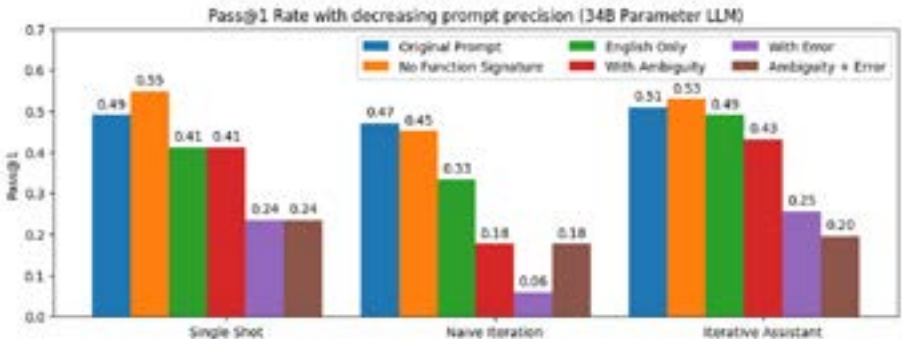
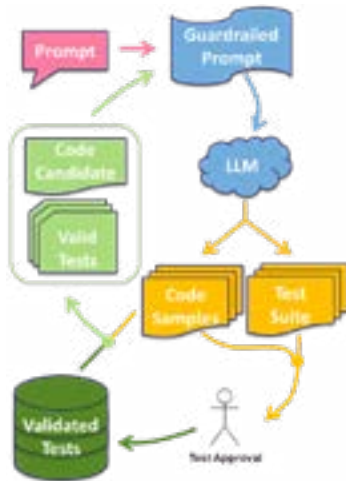
How can a non-programmer know if AI-generated code is correct?

The Iterative Assistant (IA) developed in this project explores ways of increasing confidence in the correctness of suggested code.

Skills

AI-generated code, LLMs, automated unit test generation, iterative assistant

The tool guides the user towards a correct prompt by using automated test generation (or specification generation!) to find 'interesting' test cases and ask the user yes/no questions that will help to disambiguate the prompt and improve the generated code.



Mechanical sonar scanning strategies for fast underwater obstacle detection on a reef surveying autonomous surface vessel

Lewis Luck

Skills

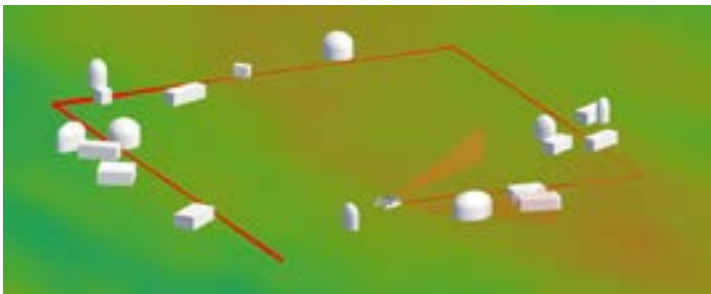
Robotics, sonar-based mapping, obstacle detection, collision avoidance

Coral reef surveys provide vital information about the health of these important ecosystems. Existing surveying methods are often manual and time-consuming operations that require teams of scientists to travel to remote locations for data collection. Instead, robotic automation can offer a more efficient and sustainable solution for continual reef monitoring. Autonomous surface vessels (ASVs) are able to navigate open waters using GPS and other onboard sensing capabilities. By virtue of having their communication array above the water, they are also able to send and receive data rapidly. In combination with a towed underwater sensor stack, such a platform has the ability to gather and transmit high resolution

data collected close to the reef on demand. However, one challenge when working with a towed sensor stack is the added risk of collision with the terrain.

This project therefore developed sonar-based underwater obstacle detection and avoidance methods to enable the ASV to navigate over hazardous and unmapped reef terrain. Sonar is necessary for the underwater environment but has an imprecise propagation profile and very slow scanning speed. To provide the greatest time for replanning and collision avoidance, adaptive scanning strategies were designed, implemented and evaluated with results demonstrating the efficacy of the scanning techniques in terms of obstacle detection speed and path proximity to obstacles.

This project was conducted in collaboration with Pipar Automation.



Nominated for Best systems and software engineering project

FloodWise

Ethan Jones
Angus Scroggie
Blair Cannon
Zachary Walls
Darcy Weedman
Miles Bojorge

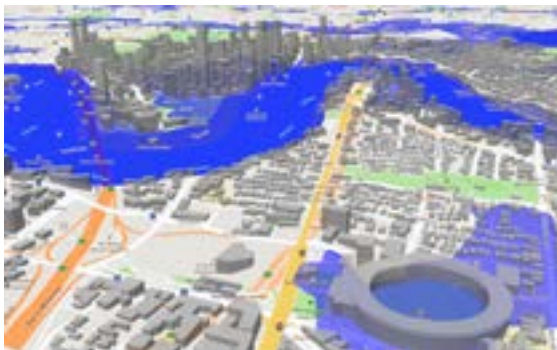
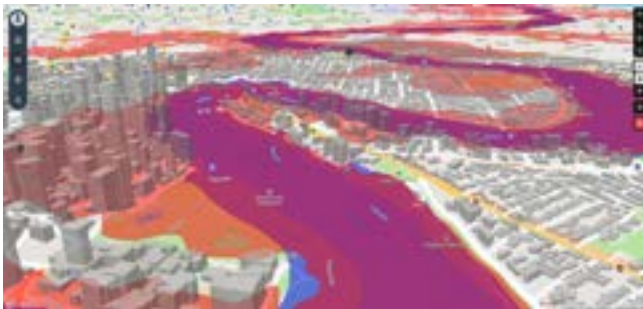
Skills

Flood detection, Artificial Intelligence, human-centered interaction

FloodWise is a Brisbane flood warning system, utilising cutting-edge artificial intelligence with a user-focused design to provide residents of the greater Brisbane area real-time flood predictions and community alerts. Our system uses a Long Short-Term Memory (LSTM) neural network to forecast flood events. This has been achieved by analysing complex time-series data, such as hourly weather patterns and river levels.

We developed a mobile-responsive web application to ensure universal accessibility across devices. This decision was informed by the need for immediate, wide-reaching access in emergency scenarios. Our mobile-first design ensures that users can interact with the system quickly and intuitively, even under the pressure of a flood event.

The platform's community-driven approach allows users to contribute and access vital information, such as shelter locations and how to be prepared. Through this balance of advanced technology, accessibility, and community engagement, our system stands as a robust and scalable solution to Brisbane's flood management challenges.



Nemo: social interactive rowing

Thomas Elliott
Peibei Wu
Jim Chi
Mitchell Anderson

Skills

User experience design, interaction design, physical computing, social and mobile computing, digital/virtual prototyping and application of design process

This project has designed a virtual cox for the rowing community to enhance the interactivity, immersion, and teamwork of indoor rowing training.

In the preliminary research, it was found that indoor rowing could not provide rowers the experience of collective synchronisation or other benefits which caused demotivation.

Supported by micro-controllers, rowing equipment, and visualisations the team has developed a simulated cox experience designed to facilitate rowing training akin to being 'on the water', offering synchronisation, motivation, instruction, and changing scenery.



Nominated for Best user experience design project

Augmented reality in luxury online retail: exploring consumer experience and decision-making

Emily Lau

The project explores the integration of Augmented Reality (AR) within luxury online retail to enhance consumer experience and facilitate decision-making in high-stakes purchases.

Skills

User Experience (UX) research, Augmented Reality (AR)

Using Media Richness Theory (MRT) as a theoretical foundation, the study investigates how AR try-on technology impacts consumer perceptions of authenticity, product confidence, and shopping satisfaction in the luxury sector.

The research assesses the effectiveness of AR in reducing uncertainties typically associated with online luxury shopping, offering brands insights into how immersive digital experiences can mimic in-store interactions and address consumer needs for detailed visual and spatial information.

By analysing user interactions and feedback, the project provides valuable design recommendations and practical implications for luxury retailers, demonstrating AR's potential to bridge the gap between online and offline shopping experiences.



Buddy: building social connections for immigrant parents

Nisha Vashist
Anthony Longhurst
Lonni Miller-Metzner
Henry Lin

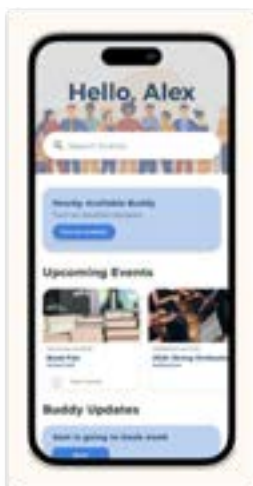
Skills

Mobile application

Buddy has been designed as a technological probe-type prototype to investigate design options to support building social connections for immigrant parents. It consists of a mobile application and a physical (kiosk-type) screen that is based at the children's school.

Immigrant parents experience higher levels of loneliness and face challenges like social isolation driven by cultural differences, language barriers, and a lack of local support networks.

Many schools, communities and existing technological solutions do not have systems in place to bridge this gap, leaving them disconnected from their new community.



Wikipedia Gender Dashboard: measuring the gender gap in Wikipedia articles.

Yahya Yunus
Gianluca Demartini

Skills

PowerBI, Wikipedia, Wikidata, Data Science

The Wikipedia editors' community has been actively pursuing the intent of achieving gender equality. To that end, it is important to explore the historical evolution of underlying gender disparities in Wikipedia articles.

This project presents the Wikipedia Gender Dashboard (WGD), a tool designed to enable the interaction with gender distribution data, including the average age in every subclass of individuals (i.e. astronauts, politicians, etc.) over the years. Wikipedia APIs, DBpedia, and Wikidata endpoints were used to query the data to ensure persistent data collection.

The WGD was then created with Microsoft Power BI before being embedded on a public website. The analysis of the data available in the WGD found that female articles only represent around 17% of English Wikipedia, but it has been growing steadily over the last 20 years. Meanwhile, the average age across genders decreased over time. WGD also shows that most subclasses of 'Person' are male-dominated.

Wikipedia editors can make use of WGD to locate areas with marginalised genders in Wikipedia, and increase their efforts to produce more content providing coverage for those genders to achieve better gender equality in Wikipedia.



Effects of customised AI shopping assistant in virtual reality shopping

Andrew Wong
Nell Baghaei
Claire Zhao

Skills

Machine learning, virtual reality, Unreal Engine

Current research in customisation and VR often focuses on self embodied avatars or on environmental choices.

Such research often find a positive correlation with customisation and VR immersion.

By allowing users to customise an avatar that aren't themselves we can see if the effects of customisation translate to other avatars.

The results of the project should help with understanding the effects of customisation and how users perceive other avatars with VR space.



High resolution haptic feedback virtual reality pen

Marco Day

This project seeks to explore high resolution haptic feedback systems in the application of VR styluses.

The goal of this project is to see if a high resolution haptic system can be designed such that writing in VR with a pen is just as natural as writing with a pen and paper.

Skills

Embedded systems, CAD modelling, Unity development

Three main haptic sensations were aimed to be replicated: the speed of a stroke, the angle of the stroke, and a sense of contact when the virtual pen interacts with a surface. This was done using an omnidirectional ball system, which when combined with an engagement system, theoretically replicates these tactile sensations.

A user study showed that using this VR pen with haptics on improved handwriting abilities compared to haptics turned off, although further research and development is still required.



Mirror Mirror on the Wall: the impact of virtual mirror on self-compassion therapy in VR

Yanzhuo Yang
Thomas Elliott
Nell Baghaei

Skills

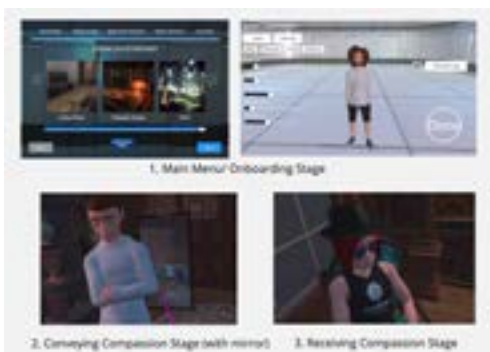
Unity, C#, Game Development, Code Compiler

In this study, we explored the potential effects of virtual mirrors in an individualised virtual reality (iVR) self-compassion therapy system using cartoon-like avatars, specifically focusing on therapy effectiveness and user experience (UX). We introduced virtual mirrors into the existing iVR app's virtual environment using Unity, placing them as "objects in the background" to reflect the conversation scenario when users are expressing compassion. Following this, 38 participants took part in experiments consisting of two iVR therapy sessions with virtual mirrors.

Overall, the virtual mirror appears to be a valuable feature to include. The results show that virtual mirrors bring slight improvements to therapeutic effects and UX compared to no-mirror groups, with nearly all participants providing neutral or positive feedback on its role in the comforting process.

Based on user feedback, we also propose the following design suggestions to improve the mirror feature:

1. Ensure mirrors fit naturally into the scene and are positioned in ways that align with real-world expectations. To maintain immersion, we recommend using natural reflections, such as from a body of water in outdoor environments, to avoid participant rejection.
2. Exclude the user interface (UI) from the mirror reflection to prevent user distraction.
3. Continue omitting the mirror when users are receiving compassion from themselves to avoid overwhelming or confusing them.





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