Virtual Internship Program 2024 - Research Projects Overview

This document provides a comprehensive overview of the research projects available for the Virtual Internship Program, including those from the the Empathic Computing Lab (within University of Auckland) and Australian Research Centre for Interactive and Virtual Environment (IVE) Research Institute within University of South Australia. These projects offer interns the opportunity to engage with cutting-edge research in the field of interactive virtual environments.

Empathic Computing Lab Projects

Project 1: The Impact of Empathic Mixed Reality Agents on User Interaction: Sensing Human Biosignals and Physical Events

Mixed Reality (MR) technology, encompassing augmented reality (AR) and virtual reality (VR), has rapidly evolved to offer immersive experiences blending digital and physical worlds. MR agents, virtual entities within these environments, play a crucial role in enhancing user interaction and engagement. Recent advancements have enabled these agents to sense and respond to human biosignals like heart rate and EDA, as well as physical events such as phone rings and door openings, allowing them to exhibit empathetic behaviors. While initial studies have shown that context-sensitive responses to real-world physical events and responses to human biosignals can increase trust and engagement with the agent, these factors have been analyzed separately. However, a combination of both factors might reveal positive and negative interaction effects. Additionally, once these Agents not only show awareness but also act upon the context, users' feelings (e.g., the feeling of paternalism) and reactions to those actions remain underexplored.

Student Skills and Background:

- Essential:
    - Unity, Python, R
- Desired:
    - AR/VR development

Expected deliverables:

- Publication in a conference/journal.

Project Duration: 6 months

ECL collaborators: Zhuang Chang

Project 2: EEG-Based User Input Preference Detection

This project explores how EEG and other physiological signals can reflect/ detect user input preferences. The intern will conduct statistical analyses on collected user behavior and physiological signal data. They will also use machine learning (ML) and deep learning (DL) models to classify different preferences stage. The intern will have opportunities to learn about EEG experimental design, setup, and data analysis, gaining hands-on experience in configuring EEG equipment, collecting and preprocessing data, and applying statistical methods.

Student Skills and Background:

- Essential:
    - Proficiency in statistical analysis and knowledge of data analysis software (e.g. Python, Matlab)
    - Experience with machine learning/deep learning models and the ability to implement and run common algorithms
- Desired:
    - Understanding of various EEG features
    - Experience with preprocessing and feature extraction of physiological data, including EEG and eye movement data

Expected deliverables:

- Development and validation of ML/DL models to classify user preferences based on physiological signals.
- Publication in a conference/journal

Project Duration: 6 months

ECL collaborators: Kaining (Kai) Zhang

Project 3: A framework to share emotion based on eye gaze, facial expressions, GSR and Heart Rate in VR collaboration

In this project, we plan to use the ML method to detect existing bio-data against user-labelled ground truth (emotion), aiming to generate a framework that can detect the user's biosignal input (eye gaze, facial expression, GSR, HR) and provide reliable emotion predictions during VR collaboration. The framework can be later used in VR applications where emotions can be detected and visualised into a virtual superpower to exert more reaction, arousal or emotion consensus.

Student Skills and Background:

- Essential:
    - ML knowledge, bioengineering/signal processing knowledge, basic AR/VR knowledge

Expected deliverables:

- publication and a framework for future research

Project Duration: 3-6 months

ECL collaborators: Allison Jing, Theo Teo

Project 4: Enhancing Empathic Emotion Regulation Skills with a Biofeedback-Driven Compassion Meditation in Virtual Reality

We're seeking an intern to join us in analyzing empirical results and further developing a compassion-focused VR meditation environment. Emotion regulation is crucial in fostering compassion and avoiding burnout. Our project involves participants engaging in a VR Compassion Meditation (CM) using biofeedback-enhanced slow-paced breathing. The aim is to improve emotion regulation skills while processing others' emotions, helping individuals manage empathic experiences without becoming overwhelmed. The intern will assist in data analysis, programming machine learning algorithms for breath sensor data, and managing Python servers to collect physiological data. We're also looking for someone interested in 3D animation to enhance visual effects like avatar body language, avatar facial expression, light and smoke particle effects during the meditation experience.

Student Skills and Background:

- Prior experience and familiarity with Unity and C#
- Experience with machine learning algorithm development and training protocols
- Proficiency in programming, particularly in Python
- Knowledge and understanding of biosignals and their interpretation
- Familiarity with running user studies, collecting data, and preparing reports
- Prior experience with version control, specifically Git or Plastic SCM
- A psychology background with knowledge or interests in compassion and meditation would be a plus

Expected deliverables:

- Assist in the system development and data analysis processes
- Collaborate in preparing a comprehensive research report, summarising the project's findings
- Co-authorship on paper publications from user studies and experiments

Project Duration: 6 months

ECL collaborators: Joy Gerry

Project 5: Data Analysis for Autobiographical Memory Recall in Virtual Reality

This project investigates how autobiographical memories (AM) are retrieved in Virtual Reality (VR) using physiological signals such as EEG, PPG, EDA, and Eye Gaze. We will analyze the impact of recalling these memories on participants' emotional states within VR environments. The intern will preprocess the physiological data and apply machine learning techniques to understand and predict the effects of memory recall on emotions. This project will provide valuable insights into the relationship between memory retrieval and emotional responses, offering hands-on experience with data analysis and VR technology.

Student Skills and Background:

- Essential:
    - Experience with biosignal data preprocessing,

    - knowledge of machine learning and deep learning techniques,
    - proficiency in Python.
- Desired:
    - Background in signal processing,
    - experience with virtual reality environments,
    - familiarity with physiological sensors and data collection.

Expected deliverables:

- Develop a process for cleaning and preparing biosignal data for analysis
- Create a machine-learning model to understand and predict the effects of memory recall on emotional states
- Contribute to a research publication in a relevant conference or journal

Project Duration: 6 months

ECL collaborators: Kunal Gupta

IVE Research Institute

The IVE is a global leader in AR and VR technology, bringing together experts from computer science, engineering, neuroscience, art, architecture, and design. Our mission is to drive innovation in AR and VR technologies to create positive changes in the world by transforming how people perceive and interact with their environments.

Research Groups:

1. Building and Urban Informatics,
2. Cognitive Neuroscience,
3. Creative Computing Studio,
4. Design for Health and Wellbeing,
5. Empathic Computing,
6. Playful Culture,
7. Studio for Complex Human Environment Design, and
8. Wearable Computing

Project 6: Using ML to detect the correlation between head movements and memory recall in virtual environments

The goal is to understand if head movements (front, back, left, or right) have a direct relation during memory and recall sessions in virtual environments such as 2D, looking glass, and VR using ML models. We are free to explore either building a lightweight ML model or using multiple existing ML-powered mental models to detect patterns or test correlations. The outcome will lead to a publication and a framework that can be used in future VR applications involving memorisation, recall, pattern/object recognition, spatial recognition, etc.

Student Skills and Background:

- ML knowledge,
- Psychology (mental model or memory and recall) knowledge or
- basic AR/VR knowledge

Expected Deliverables:

- publication and potentially an open source framework

Project Duration: 3 months

IVE collaborators: Allison Jing

Project 7: Agiles

This project is collaborative research across Arts/ Virtual Production and Game Design/ Arts-Health/ Human Factors developing a VR/ AR experience that motivates participants creativity and mobility. The project is co-designed with artists who have acquired brain injury. Outcomes include a prototype VR/AR experience for Arts-Health and rehabilitation. The project partners include UniSA Creative Computing (IVE)/ Assemblage Flinders University and the Australian Network of Art and Technology (ANAT).The intern will conduct back ground research into VR for Arts/ Health and rehabilitation. They will liase with the Unity developer to propose 3D modelling and interaction suggestions and solutions. They will participate in meetings with artists, designers and technicians.

Student Skills and Background:

- Essential:

    - Academic research skills and interests.
    - Comfortable to collaborate in an artistic process.
- Desired:
    - Experience with motion capture (Vikon), 3D modelling, Unity

Expected Deliverables:

- Prototype VR/AR experience
- Literature Review of related work
- Ethics application for subsequent research
- Research Blog for ANAT
- Academic paper for peer reviewed journal

Project Duration: 3 months

IVE collaborators: Sarah Neville

Project 8: Augmented Lab Simulation for Authentic Learning in Engineering Education

The aim of this project is to create a complete interactive Fluid Mechanics lab in the augmented reality. The initial immersive walkthrough AR has been completed using the software was 3D Vista: https://www.3dvista.com/en/. The next step is to convert this to a functional AR-based laboratory activity. This laboratory physically exists at UniSA Mawson Lakes campus. Real life experimental data will be used to create an interactive experiment.

Student Skills and Background:

- Knowledge of 3D Vista: https://www.3dvista.com/en/ or equivalent software application.

Expected Deliverables:

- A personalized interactive AR application that extends the current application. Each user is given different data and can interact with the fluid mechanics laboratory machine to perform the experiment.

Project Duration: 3 months

IVE collaborators: Rhoda Abadia

Project 9: Enhancing Intergenerational Play Through Augmented Reality (AR)

The goal of this project is to explore the potential of Augmented Reality (AR) in fostering intergenerational play and engagement. The intern will conduct comprehensive research to gauge the current landscape of intergenerational digital game design and its applications. Utilizing tools such as Figma, FigminXR, or ShapesXR, the intern will develop concept AR games and interfaces tailored for intergenerational play. Feedback will be solicited from product and service designers through remote meetings to refine these concepts, prototypes, and productions.

Student Skills and Background:

- Design Tools: Figma for initial mockups and interface design.
- AR Development Tools: FigminXR and ShapesXR for creating interactive AR prototypes.
- Communication Tools: Microsoft Teams for remote meetings and feedback sessions.

Expected Deliverables:

- A well-researched understanding of the current state of intergenerational digital game design and AR applications.
- Conceptual and functional prototypes of AR games/interfaces designed to foster intergenerational play.
- Comprehensive documentation and a final presentation summarizing the project's research, design process, and outcomes.

Project Duration: 3 months

IVE collaborators: Fanke Peng

Project 10: Develop an education tool for residential aged care facilities staff in dementia care

The aim of this project is to develop an educational tool utilizing Virtual Reality (VR) technology as its platform facilitating engagement and interactive learning experiences for residential aged care facilities staff in dementia care. The intern will conduct background research on previous projects that utilized VR as educational tools. They will also use ShapesXR, modeling software, and Unity to produce a scenario simulating a dementia care situation. Additionally, they will participate in remote meetings with staff from the Rosemary

Bryant AO Research Centre and the graphic designers to receive feedback on the simulated scene.

Student Skills and Background:

- Essential:
    - Experience with ShapesXR or similar design tools, skills in modeling, and proficiency in Unity
- Desired:
    - Design background and familiarity with user experience design principles.

Expected Deliverables:

- Make a demo video: Applying VR technology to simulate a real scenario, such as a nurse or caregiver helping people with dementia brush their teeth using a new care pathway.
- Get the experience about the Co-design and Co-creative
- Learn knowledge about XR or VR and design theory

Project Duration: 6 months

IVE collaborators: Yan Wang

Project 11: Voice support for VR De-escalation application

This project explores how Virtual Reality can be used to deliver de-escalation training and assessments. The intern will conduct research into how to integrate Meta's Voice SDK into an existing de-escalation project (Unity). They will also be tasked with prototyping the implementation of voice recognition into the application, specifically focused on the possibility of using voice commands to respond to the potentially escalating situation. They will participate in remote meetings with developers and psychologists to discuss progress and address any potential concerns or issues.

Student Skills and Background:

- Essential:
    - experience with Unity (3D) and access to Quest VR HMD (Ideally Quest 2 or onward).
- Desired:

    - experience developing for Meta Quest VR headsets. Familiarity with the Meta Quest SDK (Unity).

Expected Deliverables:

- Integrated voice recognition within the de-escalation application
- publication in psychology/tech journal/conference

Project Duration: 3 months

IVE collaborators: Tobias Loetscher

Project 12: Development of an end-user toolkit for sustainable residential retrofitting using environmental sensors and augmented reality (AR) technologies

Building performance analysis tools such as parametric modeling have been increasingly applied for retrofitting, to analyse and optimise building performance. Recent applications of augmented reality (AR) technologies for retrofitting are also presenting new opportunities to visualise building performance and enrich users' experience (John et al., 2021). As technology evolves, building retrofits can more significantly reduce energy; studies suggest that retrofitting residential buildings can save up to 86% of energy (Uidhir et al., 2020). However, there has been a lack of studies, and a lack of associated technology development, on comprehensive sustainable residential retrofitting analysis, simulation, and visualisation. This research aims to develop an end-user co-design toolkit for sustainable residential retrofitting, by utilising environmental sensors and AR technologies.

Student Skills and Background:

- IT background, AR research experience preferred

Expected Deliverables:

- An AR interface prototype

Project Duration: 6 months

IVE collaborators: Rongrong Yu, Ning Gu, Mehdi Amirkhani

Project 13: Parametric Chinese Courtyard House

Courtyard Houses (Siheyuan) are a type of traditional Chinese residential housing in Northern China, that are renowned for their long history and significant socio-cultural heritage value. Characteristics of Chinese Courtyard Houses have been studied from multiple perspectives such as aesthetic value, planning principles, cultural and historical contexts, and a variety of other perspectives. However there is still a lack of understanding about their spatial characteristics from a quantitative perspective, as well as a lack of a digital tool which could facilitate representation of its spatial characteristics. Therefore this study aims to develop a parametric system for generating plans which replicate selected socio-spatial characteristics of traditional Chinese Courtyard Houses.

Student Skills and Background:

- Architecture background required, with parametric design experience, and specifically skilled in use of Grasshopper software.

Expected Deliverables:

- A joint publication.

Project Duration: 6 months

IVE collaborators: Rongrong Yu, Ning Gu

Project 14: Game Design Prototype

Working on a playful interface to a digital collection of indigenous plants and animals my PhD student is looking for a programmer to help suggest develop a Unity or Unreal prototype

Student Skills and Background:

- Unity or Unreal game development preferred

Expected Deliverables:

- Working prototype

Project Duration: 6 months

IVE collaborators: Erik Champion