# 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: Prototyping the visual representation of human emotions for XR

This project is a design exploration of how human emotions have been visualized in media and research. This will include the study of color, movement, visual metaphors, and all other visual elements that have been used to represent emotions in books, cinema, video games, dance, or paintings, and how different genders, cultures, and generations have differentiated themselves on the emotional interpretation of these elements. This scoping exploration will then result in different design propositions for the interpersonal visualization of emotions in XR settings. The intern is expected to contribute to the background research and to the prototyping of different visual solutions in Unity for extended reality (XR).

**Student Skills and Background:**

- Essential:
    - Conducting thorough literature reviews and writing a scoping review report.
    - Experience with Unity.
- Desired:
    - Experience with shader programming (HLSL).
    - Design background.

**Expected deliverables:**

- A scoping review of related work and media.
- Prototype of different visual solutions for expressing emotions.
- Publication in a conference/journal.

**Project Duration: 3 - 6 months**

**ECL collaborators: Andreia Valente**

## Project 2: Empathic Mixed Reality Agent for Physical Exercises

This project is to investigate the impact of virtual human's awareness of user's real-time physical fatigue as measured by EMG sensors on user perception and bahaviors. We are planning to create a virtual human embodied in Mixed Reality (MR) environment doing physical exercies with users. The virtual agent is able to detect the users' real-time muscle fatigue. Based on different levels of muscle fatigue, the virtual human will make adaptive empathic responses towards users. We will manipulate the virtula human's behaviors based on the detected fatigue and we may also adopt other physiological sensors like EEG, PPG and GSR to measure users' physiological state during the experiment. This research is attempting to fill the gap of creating empathic agents that is aware of users' physiological state.

**Student Skills and Background:**

- Using Python or R for physiological data analysis;
- Literature review
- Good communication skills

**Expected deliverables:**

- One conferenece paper

**Project Duration: 3 - 6 months**

**ECL collaborators: Zhuang Chang**

## Project 3: From Pixels to Physiology: Examining the Influence of Image Features on Emotional Responses in MR

The research project will investigate the quantifiable impact of specific image alterations on emotional responses within mixed reality (MR) environments. Focused on fundamental image features like brightness, contrast, color saturation, sharpness, resolution, hue, and color balance, this study is intended to study how we can use stimuli for pupil dilation, blink rate, eye gaze, and eye movement, in order to influence other physiological signals like heart rate and electrodermal activity. The intern is expected to contribute to the background research, to the data exploration of eye signals using machine learning, and to the prototyping of a stimuli dataset for mixed reality environments.

**Student Skills and Background:**

- Essential:
    - Ability to conduct thorough literature reviews and writing a literature review report.
    - Proficiency in machine learning techniques, particularly those relevant to pattern recognition, feature extraction, and predictive modeling. Ability to apply ML algorithms to analyze complex relationships between image features, eye responses, and physiological signals.
- Desired:
    - Experience with Unity.
    - -Knowledge of MR environments, platforms, and development tools.
    - -Experience in image processing techniques and tools, with the ability to manipulate and analyze fundamental image features, including brightness, contrast, color saturation, sharpness, resolution, hue, and color balance.

**Expected deliverables:**

- A literature review of related work.
- Publication in a conference/journal.

**Project Duration: 3 - 6 months**

**ECL collaborators:** Andreia Valente

## Project 4: Using Physiological Cues to Improve Empathy and Human-AI Interaction in a Mixed Reality Environment

The goal of this project is to investigate how physiological signals such as eye gaze, facial expressions, GSR, and heart rate can be used as input and output to support empathy during human-AI interactions in a Mixed Reality environment. We will use VR headsets and GSR sensors as hardware combined with AI/ML to understand how an AI agent can influence human behaviours in the XR world.

**Student Skills and Background:**

- Generative AI skills and/or unity dev skills
- Experience in biosignal processing and/or visualisation

**Expected deliverables:**

- A working XR system that was supported by AI agent
- Research publications and demos.

**Project Duration: 3 - 6 months**

**ECL collaborators: Theo Teo, Allison Jing, Gun Lee**

## Project 5: Explore Gaze Cues Combined with LLM to Improve Communication in Mixed Reality Remote Collaboration

The goal is to utilise LLM to understand how natural conversation progresses differently with the support of an implicit gaze visualisation during remote collaboration in the MR environment. With the help of LLM and shared gaze visualisations, we can create more effective immersive interfaces to support communication in remote collaboration without detailed descriptive languages, complicated body gesturing, hand pointing, or even sketching annotations. The LLM can understand the minimal deictic languages combined with gaze indicators to prompt proper responses represented by multimodal virtual objects and interactions.

**Student Skills and Background:**

- LLM and/or Mixed Reality (AR/VR/XR)

- Experience in gaze-speech synthesis

**Expected deliverables:**

- A working MR system that was supported by LLM-powered gaze-speech interaction
- Research publications and demos.

**Project Duration: 3 - 6 months**

**ECL collaborators: Theo Teo, Allison Jing**

## Project 6: Enhancing Empathic Emotion Regulation Skills with a Biofeedback-Driven Compassion Meditation in Virtual Reality

We seek an enthusiastic intern to join us to create a biofeedback-based compassion-focused meditation environment created in virtual reality (VR). This project targets training emotion regulation and mindfulness skills to help people manage empathic distress, the feeling of hurting for others but feeling immobilized to help. Previous research has identiÔ¨Åed emotion regulation ability as a vital skill in helping people to experience compassion. In this project, participants will engage in a compassion meditation using slow-paced breathing augmented with biofeedback in a VR simulation that emulates the mental imagery in the meditation script. This involves capturing data from respiratory sensors for breath rate and visualising inhale and exhale patterns in VR. We are looking for an intern to help with the biofeedback visualizations, as well as programming the biofeedback sensors and algorithms.

**Student Skills and Background:**

- Python coding,
- Physiological data collection,
- 3D animation,
- Unity development,
- Git experience,
- Plastic SCM experience (as well as version control experience),
- C#,
- User testing experience,

- Psychological research methods

**Expected deliverables:**

- Refining machine learning algorithm and programming data to enhance cues in the biofeedback environment,
- Co-authorship on research publication,
- Development of the environment design,
- Assistance with data analysis

**Project Duration: 3 - 6 months**

**ECL collaborators:** Lynda Joy Gerry

## Project 7: Interface Design for Hierarchical Task Guidance

The goal of this project is to design an MR interface for Hierarchical Task Guidance. We need to do the literature review to decide which technique will be used in the system. We will use Hololens2 as the hardware to train user to finish a series of tasks and compare the system efficiency with the traditional linear task guidance.

**Student Skills and Background:**

- Using Python or R for physiological data analysis;
- Literature review
- Good communication skills

**Expected deliverables:**

- A working MR Task Guidance
- Research publications and demos.

**Project Duration: 3 - 6 months**

**ECL collaborators:** Bowen Yuan

## Project 8: EEG Brain synchronization in collaborative VR

This project explores brain synchronization in a collaborative search task in VR using EEG hyperscanning, showing that brain synchronization does occur. In our study we explore how change of view point and using visual cues in VR can affect the level of brain synchrony. To run the study we need to create a VR environment with two participants and asking them to look for specific objects under different criteria in the scene while measuring their brain signals using EEG to answer the research questions.

**Student Skills and Background:**

- Unity 3D development skills
- EEG signal processing using MNE Python (desired)
- Access to a pair of Quest VR HMDs

**Expected deliverables:**

- The user study VR environment
- The EEG analysis script using MNE Python
- 1st publication about the effects of changing viewpoint on brain synchronization
- 2nd publication about the effects of using visual cues on brain synchronization

**Project Duration: 3 - 6 months**

**ECL collaborators:** Ashkan Hayati

## 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 9: Virtual Environment for Concept Design

Explore the impact of different artistic styles used to developed virtual environments on design thinking while developing concepts in virtual reality. The intern's responsibilities include engaging in meetings to explore different ways of creating virtual environments that support design thinking. Utilizing tools such as Rhino, Blender, and Arkio, the intern will help develop 3D environments based on the discussions. Regular feedback sessions with supervisors and industrial advisors will provide valuable insights into their work.

**Student Skills and Background:**

- Essential:
    - Experience with Rhino/Blender, good communication.
- Desirable:
    - Access to VR Headset, Arkio, design background.

**Expected Deliverables:**

- 3D environments suitable for VR
- Literature review of related work
- Publication in a conference/journal

**Project Duration: 3 - 6 months**

**IVE collaborators:** Soroush Masoumzadeh

## Project 10: Design-led transformative reuse

Explore how design-led reuse of waste products and materials can be digitally and generatively designed into furniture and similar products, using 3D scanning, computational design and computer aided fabrication for the creation of non-traditional research outputs. The project broadly investigates the emerging role of digital tools for circular economy and the benefits of new techniques for the repurposing of waste by the design industry. There is scope to be involved at different stages of an experimental production workflow including digital inventory of waste materials, algorithmic transformation of waste into designed products, and prototype fabrication.

**Student Skills and Background:**

- Essential:
    - Experience with Rhino and Grasshopper and/or other generative 3D design tools
- Desirable:
    - Design background, familiarity with generative or algorithmic computational design techniques and/or the capacity to identify and learn appropriate tools for the brief

**Project Duration: 3 - 6 months**

**IVE collaborators:** Guy Keulemans

## Project 11: Augmented Reality and Custom Haptics for Science Hand Skill Training

Embark on the next chapter of your research journey! This experiment extends a previous project involving custom hardware for science education, now integrating augmented reality (AR) into the training experience. The successful applicant will have the exciting opportunity to dive into existing AR literature, identifying research gaps. As a valuable team member, they will actively contribute to building an intuitive and interactive user experience using design software and the Unity Game engine. Join us in pushing the boundaries of laboratory training in the dynamic field of life sciences!

**Student Skills and Background:**

- Essential:
    - User interface (UI) design
    - Previous Unity development, and C# experience.
    - Ability to work collaboratively in a research team.
- Desirable:
    - Familiarity with immersive technologies, particularly augmented reality.
    - Literature review experience, and proficient written communication skills.

**Expected Deliverables:**

- Literature review of related work
- User interface design for a training AR interactive
- Educational game development using Unity (C#)

**Project Duration: 3 - 6 months**

**IVE collaborators: Juan Pieschacon**

## Project 12: The Architect's Dream, Investigating Text/Image/Form functions within contemporary AI.

This project is based in the proposition that the pathway to enhanced innovation in architectural design, documentation and understanding is directly proportional to the sophistication of language models employed to facilitate production. Architectural theory, in this instance, acts as a pool of design prompts that give a context to the visual imagery that the AI tools express. There is, in these instances, the opportunity to test the relationship between text and image, theory and demonstration.

Implicit within these operations is the opportunity to reflect on the strength of relationships between form and meaning, finding and charting instances of consistency and divergence. At the outset, the project will challenge the users to identify what aspects of the image represent the text prompts versus the contextual material provided by the AI engine. The images will represent, it is anticipated, not only a demonstration of a text, but also the opportunity for further critical analysis and open-ended exploration.

**Student Skills and Background:**

- Essential:
    - Some understanding of design methodologies in architecture, including digital technologies including 3D modelling and documentation software.
    - Familiarity with Adobe Suite image software and an interest in game-engine software such as Unreal or Unity.

**Expected Deliverables:**

- It is anticipated that the outcome of this process will be twofold. Initially there will be the opportunity to document the matrix of design/text prompts that will provide consistency of outcomes, allowing for the development of practiced mastery of the medium. This process will be documented and published as an NTRO exhibition and a peer reviewed SOTL paper on its employment. In addition, there will be a critical revaluation of the role of architectural theory within the design studio, examining the efficacy of political agency within design practice and asking the question whether design intentions equate without feasible and coherent outcomes. This also will be published as a peer-reviewed paper.

**Project Duration: 3 - 6 months**

**IVE collaborators: Sean Pickersgill**

## Project 13: Immersive Interaction with Virtual Ceramics using AR Glasses

Create an immersive and interactive experience for users who want to explore and engage with virtual ceramics using Augmented Reality (AR) glasses. This experience will allow users to interact with ceramics as if they were physically present, enhancing their understanding and appreciation of ceramic art. The target audience includes art enthusiasts, students, researchers, educators, and anyone interested in ceramics and art. The design should be user-friendly for individuals with varying levels of expertise. The project aims to create a seamless and realistic interaction with virtual ceramics and provide an educational and entertaining experience for users. To bridge the gap between traditional and digital experiences in ceramics, the design will ensure user-friendliness and accessibility for a wide audience.

**Student Skills and Background:**

- Essential:
    - Experience with UX design tool.

- Desirable:
    - Design background.
    - Familiar with AR tools.

**Expected Deliverables:**

- A functional prototype that allows users to interact with virtual ceramics.
- User testing and feedback reports to refine the design.
- A comprehensive user manual for operating the AR glasses and interacting with virtual ceramics.
- Ongoing support and updates to ensure the experience remains engaging.

**Project Duration: 3 - 6 months**

**IVE collaborators: Rui Zhang**

## Project 14: A systematic literature review of artificial intelligence applied to architectural design

Throughout the past several decades, artificial intelligence techniques and computer-aided generative design tools, such as evolutionary algorithms, cellular automata, and artificial neural networks, have increasingly been applied within the architecture and design field. Presently, AI can now assist architects with design styles, floorplan generation, space synthesis, and many other areas. This project aims to conduct a systematic literature review, relating to the topic of AI technologies applied to architectural design, to provide a thorough understanding of the topic, and future research needs around this subject.

**Student Skills and Background:**

- Essential:
    - Background in either architecture or a related design discipline.
- Desirable:
    - Experience in systematic literature review methods.

Expected Deliverables:

- A co-authored systematic literature review paper.

**Project Duration: 3 - 6 months**

**IVE collaborators: Rongrong Yu**

## Project 15: Exploring the Use of Mobile VR for Professional Skill Development in Online Education

Investigate the potential of mobile VR technology to enhance professional skill development in construction communication and teamwork within an online learning framework. This research will involve the expansion of an existing mobile VR application to facilitate interactive sessions between two users (or multi-users?) . The study will focus on the design and development of prototype in replicating real-world construction scenarios, fostering collaborative skills, and improving communication among participants. Additionally, it will document any limitations or challenges encountered in the integration and functionality of interactive features in the mobile VR environment

**Student Skills and Background:**

- Essential:
    - Mobile VR app development skills (unity).

Expected Deliverables:

- A prototype of the mobile VR app.

**Project Duration: 3 - 6 months**

**IVE collaborators: Rhoda Abadia**

## Project 16: Agile Mobilities

Agile Mobilities is an artistic research project investigating Virtual Reality and Augmented Reality applications for mobility, balance, creativity and connecting with the joy of dancing. Agile Mobilities will be developed through a collaborative process aimed at conceiving concepts that explore creative, participant driven immersive digital experiences.

**Student Skills and Background:**

- Essential:
    - Experience with Unreal Engine.
    - Experience with Vicon Motion Capture System.

**Project Duration: 3 - 6 months**

**IVE collaborators: Sarah Neville**

## Project 17: Using Virtual Reality in Experiential Health Scenarios , AI managing behaviours of concern in mental health.

Using VR program to assess students responses to aggression in patients. A virtual program using Oculus

**Student Skills and Background:**

- Essential:
    - Ability to work with oculus headsets and download data to interpret response time for students.

Expected Deliverables:

- To support the use of the oculus headset and software to assess student responses. We haven't used them with students and we could trial it with some staff volunteers to determine any implementation issues.

**Project Duration: 3 - 6 months**

**IVE collaborators: Mike Musker**

## Project 18: Immersive journalism: news games

Explore news games (video games with a journalistic angle) as part of the immersive journalism research within UniSA Creative. I have explored VR/360¬ʃ journalism and the emergence of AR in journalism. I am now interested in the passive/ active involvement of viewers/ users in a

journalism setting and the gamification of contemporary events. I am also interested in the ethical issues around this. The project would require the building of a news game to be developed as a research output (conference, paper and as part of the immersive journalism portfolio).

**Student Skills and Background:**

- Essential:
    - Game designer (any platform). Ability to also make the game publicly playable.

Expected Deliverables:

- A journalism video game, and a literature review of the field. This will lead to a journal publication, a non-traditional research output and possibly a conference presentation in late 2024.

**Project Duration: 3 - 6 months**

**IVE collaborators: Ben Stubbs**

## Project 19: Increasing Urban Greenery through Reconfiguring our Street Spaces

Modern Australian cities are dominated by roads serving motor vehicle traffic, which exacerbates the Urban Heat Island (UHI) Effect. Many suburban roads have an over abundance of paved surfaces which have the potential to be reconfigured to incorporate a higher proportion of vegetation whilst not unnecessarily impinging on the movement function of these roads. This project has three components to it: (1) determining the extent of the UHI effect in urban environments due to paved hard surfaces of road carriageways and their adjacent footpaths; (2) examining through case studies the potential to reduce paved surfaces whilst still facilitating basic traffic functions and the effects that this could potentially have on reducing the UHI effect; and (3) examining the implications for policies governing urban and transport planning of incorporating “heat sensitive urban design” (HSUD) into the road networks of existing and new urban development

**Student Skills and Background:**

- Essential:
    - Transport planning; urban design and planning
    - Knowledge of policies in urban planning; spatial analytical skills (GIS and Computer Aided Design).
    - Written and verbal communication skills.

    - Graphical communication skills.

Expected Deliverables:

- A report detailing the project research and its findings; conference publication; and an academic journal article.

**Project Duration: 3 - 6 months**

**IVE collaborators: Andrew Allan**

## Project 20: 3D and panoramic interactive viewer

Review software (preferably open access and low cost) that can offer interactive and interesting ways to combine 3D models and panoramic backgrounds. Ideally the 3D model or aspects of the panorama can communicate with the viewer and / or with each other. Ideally the software can be modified and works across a variety of platforms. To give you an idea of recent related work, this paper examines software for historic architecture "Outside Inn: Exploring the Heritage of a Historic Hotel through 360-Panoramas" MDPI Heritage 2023, presentations using 3D: https://www.mdpi.com/2571-9408/6/5/232

**Student Skills and Background:**

- Essential:
    - Experience with 3D media, panoramas and html scripting
- Desirable:
    - JavaScript

Expected Deliverables:

- Project leading to an academic publication and working proof of concept

**Project Duration: 3 - 6 months**

**IVE collaborators: Erik Champion**

## Project 21: Augmented Reality Workflows and Prototype Tools for Museums

Develop a simple and clear visual workflow or software wizard to provide non-programmers from the museum sector a way to visualize how their historic collections can be interacted with via AR phone-based software, ideally software that does not require downloading specialised apps (for example, works in the browser). It is ideally useful for android or apple phone-based operating systems, and allows for interactivity. The aim is to use this tool or schema in workshops with museum (GLAM) people to help them develop AR-based games even if they don't have programming or interaction design experience. A way to gather data on how the tool or examples could be used would be an added benefit.

**Student Skills and Background:**

- Essential:
    - Skills in diagrams or mockups
- Desirable:
    - Interest in Augmented Reality for Android or Apple or other.
    - Interest in interaction design/user experience design

Expected Deliverables:

- A workflow, a demo, and material for possible academic paper for a conference or a journal.

**Project Duration: 3 - 6 months**

**IVE collaborators: Erik Champion**