Empathic Computing Lab
Systems That Create Understanding

Virtual Internship Program (VIP) Project Lists

April 2025 Intake

Project 1: Multimodal Applications of Interpersonal Synchrony: A Systematic Review and Research Recommendations

Project Description:

Interpersonal synchrony is a phenomenon that arises when two individuals temporally coordinate their behaviour or movements. The behavioural and neurophysiological cues underpinning interpersonal synchrony are fundamental building blocks for decoding human-to-human interactions and understanding how social connections are fostered. However, the generation of social connections has not yet been examined by simultaneously collecting behavioural, neural, and physiological data. Moreover, determining the best combination of tasks and techniques to evoke synchrony when pursuing a multimodal approach has yet to be explored. To address these challenges, we propose methodologies for examining each type of study paradigm to guide future exploration of interpersonal connections. Your internship will involve closely working with the primary author to collect and screen relevant studies for this review.

Student Skills and Background:

- Essential:
    - English language proficiency,
    - Basic statistical analyses,
    - Familiarity with article collection and data screening.
- Desired:
    - Familiarity with physiological and neural sensor data,
    - Basic knowledge of MS Office.

Expected deliverables:

- Co-authored journal publication.

Project Duration: 3-6 months

ECL collaborators: Zane Karai

Project 2: Bridging the Non-Verbal Communication Gap in Cross-Reality Meetings through AI-Mediated Symmetry

Project Description:

Cross-reality (XR) meetings face a non-verbal communication gap between VR and video conferencing users, hindering collaboration. This project proposes investigating and developing an AI-mediated system to bridge this NVC gap by focusing on symmetrical translation and representation of key non-verbal cues. The core concept is to use computational techniques to capture and translate NVC cues from both video conferencing (e.g., mouse pointer movements, facial expressions) and VR environments (e.g., gaze direction, avatar gestures) and represent them symmetrically and intuitively for participants in both realities. For instance, mouse pointer movements in video conferencing could be mapped to avatar gestures in VR, and conversely, VR gaze direction could be visualised in the video conference interface. Furthermore, we aim to explore the impact of symmetrical avatar representation, where video conference users are also represented by VR avatars (albeit potentially simpler ones) in the shared environment, and VR users are represented in a way that is understandable within the video context.

Student Skills and Background:

- **Unity or Unreal Engine:** Experience with VR development environments for building the VR application and integrating cross-reality elements.
- **Programming Proficiency (Python, C#, C++):** Required for scripting in Unity/Unreal, implementing AI algorithms, and potentially for data analysis.
- **Basic understanding of Machine Learning/AI:** Familiarity with concepts in computer vision, natural language processing, or gesture recognition relevant to NVC cue detection and translation.

Expected deliverables:

- **Research Report/Publication:** Preparation of a detailed research report documenting the project's methodology, findings, and conclusions.

Project Duration: 3-6 months

ECL collaborators: Tamil Selvan Gunaserkaran

Project 3: Enhancing Physiological and Behavioural Synchrony in Collaborative Problem-Solving Using Adaptive AI Agents

Project Overview:

Collaborative problem-solving is a fundamental aspect of human interaction, yet the underlying physiological mechanisms that facilitate successful teamwork are complex and not fully understood. This project explores using Reinforcement Learning (RL) to develop an artificial agent that can adaptively modify a cooperative task environment to improve physiological and behavioural synchrony between human participants. The project focuses on building a system where the RL agent does not explicitly direct the humans. Instead, it learns to shape its collaborative context by indirectly acting on the task environment and receiving feedback based on physiological and behavioural synchrony measures. It will explore the impact of this adaptive feedback loop on both the synchrony levels and collaborative performance during a cooperative task and collect measures of how the participants perceive this influence from the AI agent. This approach combines AI, user behaviour, physiology, and social neuroscience techniques to provide insights into the dynamic mechanisms of human cooperation.

Student Skills and Background:

- Strong programming skills in Python.
- Basic understanding of Reinforcement Learning concepts.
- Familiarity with data analysis and statistical methods, preferably using Python or R.
- Interest in cognitive science and social neuroscience.

Expected deliverables:

- **Research Report/Publication:** Preparation of a detailed research report documenting the project's methodology, findings, and conclusions.

Project Duration: 6 months (This can be adjusted based on project scope and student availability)

ECL collaborators: Tamil Selvan Gunaserkaran, Zane Karai

Project 4: Investigating the Relationship Between emotional states and Neurophysiological patterns

Project Overview:

Arousal levels have a well-established connection with physiological signals, but the relationship between neural activity, arousal, and valence remains less understood. This project analyses various datasets by analysing the interplay between physiological and neural responses. We will use statistical methods to examine correlations between physiological signals, neural activity, and emotional states (arousal and valence). The findings from this study could enhance our understanding of neural and physiological patterns related to emotion and contribute to developing more effective interventions for healthcare applications and making more empathetic agents.

Student Skills and Background:

- Essential:
    - Strong programming skills (Python preferably)
    - Statistical analysis
- Desired
    - Signal processing
    - R

Expected deliverables:

- **Research Report/Publication:** Preparation of a detailed research report documenting the project's methodology, findings, and conclusions. A conference or journal paper.

Duration: 3 months (Can be extended based on project scope)

ECL collaborators: Nastaran

Project 5: Enhancing Empathic Emotion Regulation Skills with a Biofeedback-Driven Compassion Meditation in Virtual Reality

Project Overview:

We seek an enthusiastic intern to join us in creating the first compassion-focused meditation environment created in virtual reality (VR). This project combines ancient wisdom with emerging technologies and posits an entirely new design for enhancing human-human potential and connection.

Compassion involves exhibiting concern and care towards someone suffering, paired with the motivation to alleviate that suffering. One of the barriers to compassion is empathic distress, which is what we are targeting in this VR biofeedback training. Previous research has identified emotion regulation ability as a vital skill in helping people experience compassion versus empathic distress and burnout during empathy. In essence, this project is about training people to cope with being empathic in a way that allows them not to be overwhelmed by the experience.

In this project, participants will engage in a Compassion Meditation (CM) using slow-paced breathing augmented with biofeedback in a VR simulation that emulates the mental imagery in the CM script. This involves capturing data from respiratory sensors for breath rate and visualising inhale and exhale patterns in VR.

Student Skills and Background:

- Essential:
    - Strong programming skills (Python preferably), including some machine-learning skills
    - Data processing and analysis skills, preferably from physiological sensors
    - Unity development and C# skills
- Desired
    - Signal processing
    -
    - R programming

Expected deliverables:

- Preparation of a detailed research report documenting the project's methodology, findings, and conclusions. A conference or journal paper.

Project Duration: 6 months (This can be adjusted based on project scope and student availability)

ECL collaborators: Lynda Joy Gerry

Project 6: Emotion Visualization in Mixed Reality

Project Overview:

In recent years, integrating emotion recognition into mixed reality (MR) environments has garnered significant attention, aiming to enhance empathetic interactions and communication. An example is the Empathic AuRea project, which introduced an augmented reality (AR) communication cue derived from an emotion recognition neural network trained on electrocardiogram data. This design facilitated a better understanding of emotional states, thereby increasing cognitive empathy without compromising existing communication cues.

This project aims to advance empathetic interactions in mixed reality (MR) by capturing users' emotional cues through biosensing and representing them within MR environments. The intern is expected to contribute to the background research, the prototyping of visual emotion, the user study design, and the publication writing.

Student Skills and Background:

- Essential:
    - Unity experience
- Desired:
    - Shader programming (HLSL)

Expected deliverables:

- A scoping review of related work.
- Publication in a conference/journal.
- A Unity toolkit that illustrates biofeedback through visual effects in Mixed Reality

Project Duration: 6 months

ECL collaborators: Andreia Valente

Project 7: Investigating Arousal and Balance through Biosensing

Project Overview:

Balance data provides valuable insights into various aspects of human health, including cognition, emotions, and physical stability. However, traditional tools for collecting balanced data are often expensive, cumbersome, or difficult to integrate into user studies. To address these challenges, we want to utilize the Wii Balance Board—a low-cost, accessible alternative- as a reliable platform for balance data collection. We want to create The Balance Toolkit, an open-source framework designed to streamline balance data collection, analysis, and visualization. Our toolkit will enable researchers to efficiently integrate balance assessments into their studies, making it an ideal solution for exploring the connections between balance, cognition, and emotional states in diverse populations.

We are looking for two interns to join our team: one with strong UI experience and another with strong programming skills. Together, we will contribute to developing a toolkit that includes data collection and analysis for a balance board and a full prototype of balance tasks. This application will be a research tool for studying biosensing in balance-related activities. Additionally, the interns will be expected to contribute to background research, user study design, and publication writing.

Student Skills and Background:

- Essential:
    - UI prototyping experience OR Strong programming skills
- Desired:
    - Experience with Figma OR Experience with Rust and React

Expected deliverables:

- A scoping review of related work.
- Publication in a conference/journal.
- A toolkit for balance visualization and analysis

Project Duration: 6 months

ECL collaborators: Andreia Valente

Project 8: Using Empathic Characters for Virtual Cognitive Rehabilitation

This project explores how to achieve Empathic Virtual Characters (EVCs) to improve cognitive rehabilitation using Virtual Reality (VR). Immersive VR provides patients realistic, safe environments to train working memory, attention, and executive functioning and practice coping strategies for cognitive fatigue. In the real world of cognitive rehabilitation, clinicians and patients' families are essential in supporting patients. On the other hand, this role is replaced by virtual characters in VR rehabilitation. However, in existing VR cognitive rehabilitation, virtual characters lack adaptivity to react to patients' internal states. As a result, building trust in a relationship between a character and a patient is challenging. To address this issue, we propose EVCs that have the ability to understand and acknowledge patients' internal states to enhance relationships.

Student Skills and Background:

- Essential:
    - English language proficiency,
    - Basic statistical analyses,
    - Familiarity with article collection and data screening.
- Desired:
    - Familiarity with physiological and neural sensor data,
    - Basic knowledge of R.

Expected deliverables:

- Journal publication.

Project Duration: 3-6 months

ECL collaborators: Riku Otono

Project 9: Tailoring Emotion Recognition Models for Aotearoa New Zealand

Project Overview:

Multi-modal emotion recognition (MMER) is a rapidly expanding area of research at the forefront of human-computer interaction. This project covers a user study for data collection as part of the Toku Hoa Soul Machines Project. The use of mobile devices and smartwatches to collect and process biological and audio-visual data to predict user emotions is still a relatively new area of study, and our ultimate goal is the development of tailored and optimised MMER models capable of both passive and active emotion detection. The initial user study will be undertaken with apps on both user's phones and watches.

Student Skills and Background:

- Essential:
    - Python; background in statistics
- Desired:
    - Interest or background in psychology

Expected deliverables:

- Publication in a conference/journal.

Project Duration: 6 months

ECL collaborators: Aeryn Dunmore

Project 10: Virtual Dragon's Den

Virtual Dragon's Den helps people refine their presentation skills in VR by practising with intelligent AI agents. In this immersive platform, users present their work to AI characters who act as different audience members - they could be investors critiquing a startup pitch, experts evaluating research findings, or students engaging with a complex topic. Each AI agent brings unique expertise and asks relevant questions, creating natural back-and-forth discussions that help users master their content and delivery.

What makes this platform powerful is its flexibility. A founder can practice their investor pitch with AI agents who understand market dynamics and business models. A researcher can prepare for a conference by presenting to AI peers who ask about methodology and implications. The system provides detailed feedback on everything from speaking pace to body language, and helps users improve through focused practice. After each session, users receive their conversation transcript and an enhanced version of their presentation incorporating the AI agents' suggestions. By combining VR immersion with intelligent AI interaction, Virtual Dragon's Den creates a practical environment for users to build confidence and polish their presentations before the real thing.

Student Skills and Background:

- Experience with Unity Development
- Experience with Machine Learning
- Experience with LLM models (e.g. Langchain, HeyStack, LlamaIndex, FlowiseAI)

Expected deliverables:

- A toolkit / VR Application
- Publication in a conference

Project Duration: 6 months

ECL Collaborators: Reza Farnia and Zhuang Chang