VIP Project List 2022 (Session 2)

Project 1: Neurophysiological Measures of Working Memory and the Cognitive Pupillary Response on Memory Tasks

Cognitive Load (CL) is one of the critical states that significantly impact student performance in learning content. Regarding learning, the Cognitive Load Theory (CLT) states that the human mind can't keep more than 7±2 chunks of information in the Working Memory (WM). Previous research has shown several methods to measure the CL with physiological cues. This project aims to dynamically measure CL using EEG and Pupillary responses (such as pupil dilation) captured during user interaction in Virtual Reality learning application and investigate the impact of CL on student performance.

In this project, we look at known Event-Related Potentials (ERP) events and the Power Spectrum of alpha and beta bands. Our goal is to measure the CL level and also memory state of user with our Pupillary information (such as pupil dilation, etc.), Heart Rate (HR), Galvanic Skin Response (GSR) and EEG data. This involves significant investigation time to analyse our EEG data using EEGLAB tools or alternative python plug-in. Ultimately, we will also try to implement an existing Machine Learning algorithm/method such as SVM to run on our EEG data to measure CL and student memory state.

Student Skills:
Python programming, Machine Learning, MATLAB.

Student Background:
Has knowledge or interest in EEG/ERP, or Machine Learning

Project Duration:
3 - 6 months

ECL collaborators:
Ted Ahmadi

Project 2: Inter-brain synchrony in Virtual Reality

Many studies have shown that the brains of two or more people get connected when they collaborate in the real world, e.g. in teaching, conversation, and collaboration between pilot and co-pilot. This results in the synchronization of electrical activity in the brain, which can be measured using tools such as EEG sensors in a technique known as hyperscanning. Our research is trying to explore hyperscanning research in Virtual Reality (VR). We investigate the brain synchronization of people interacting by using VR as a medium. We are also beginning to study the impact of cues inside VR, such as non-verbal behaviours and eye-gaze on brain synchronization.

This project would be suitable for those who are interested in Virtual Reality (VR), psychology, and measuring brain activity.

Student Skills:

- Skills or interests in UNITY programming **and/or** Time-series data
- C# programming, UNITY development
- VR content development
- Python programming

Student Background:
Engineering, Computer Science, Psychology, Neuroscience or related fields.

Project Duration:
3 - 6 months

ECL collaborators:
Ihshan Gumilar, Amit Barde

Project 3: Conversational Analysis of Augmented Reality Collaborative

Conversational analysis is one technique used for evaluating collaborative Augmented Reality (AR) systems. The goal of the project is to complete a detailed conversation analysis of audio recordings and machine-produced transcripts from a collaborative AR experiment. The transcripts require some tidying up, including speakers to be correctly identified and timestamps of all spoken words, including any overlapping speech. The conversational analysis involves identifying the types of sentences and phrases used. This information will be used to generate statistics about the conversational analysis.

Project Aims:

1. Detailed conversational analysis of recordings from user studies on collaborative AR
2. Understanding of users' speech patterns and interactions (overlaps, silences, responses, deictic statements, questions)

Project Outcomes:

1. Methodology for the conversational analysis of collaborative AR systems.
2. A conference paper, detailing results

Student Skills:
Skillset to analyze data, Office (Excel, Word) or Google (Sheets, Docs), R Studio (optional)

Project Duration:
3 - 6 months

ECL Collaborator:
Louise Lawrence

Project 4: Effects of Visual Cues and Viewpoint on Brain Synchronization in VR

Recent studies have shown that people's brain activity synchronises with others' (inter-brain synchrony) during social engagement and collaborations in the real world. However, there is almost no research investigating brain synchronization in VR. This project aims to explore how using different visual cues in VR could impact brain synchronization.

We have developed a Unity VR program in which two remote collaborators participate in a visual search task to find some objects. At the same time, their brain signals are recorded using EEG. In this study, we investigate how different visual cues and changing viewpoints in a visual search task in VR can affect brain synchronization when two collaborators focus on specific objects. During the study, we measure their brain signals simultaneously (EEG hyperscanning) and processed the signals to find correlations between people's brains during a collaborative task.

Student Skills:

- Skills in UNITY programming **and/or** Time-series data
- C# programming, UNITY development (implementing visual cues such as laser pointer, drawing virtual lines, etc.)
- VR content development
- Python Programming

Project Aims:

1. Exploring the effects of visual cues on brain synchronization in collaborative VR
2. Understanding how viewpoints can affect brain synchrony in VR

Project Outcomes:

1. Working software that can enhance remote collaboration.
2. One or Two research papers describing the results.

Project Duration:
3-6 months

ECL collaborators:
Ashkan Hayati, Gun Lee, Amit Barde

Project 5: User Interface Development for a 360 tour platform

The Empathic Computing Laboratory has been developing a 360 video conferencing platform that allows people to live stream 360 videos of their surroundings. This can be used for virtual tourism or teaching, among other applications. The 360 videos can be viewed on the desktop, mobile phone, or even in virtual reality.

As part of this project, we are interested in exploring other ways to share 360-degree content. In particular, we would like to create some 360-degree tours using the krpano platform (see https://krpano.com/) and develop some custom interfaces with that. The project will involve developing several demonstration 360 tours with different interface elements and testing them with people to get their feedback.

This would be a great project for a student with web development skills and who is interested in telepresence or remote tourism applications.

Student Skills:

Experience with web and server development, especially with javascript, `HTML/CSS and XML`. Background and experience with deploying code on servers

Project Duration:

3 months

ECL Collaborator:

Mark Billinghurst