A Closed-Loop Brain-Computer Interface System for the Detection of Acute Stress and Interaction with Autonomous System.

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INTRODUCTION

In recent years, there has been great strides in the integration of autonomous systems into society. Innovations such as driverless trains, self-driving cars, autonomous security, and aerial drones for surveillance and delivery (Amazon Prime Air) are slowly becoming a normality in our daily lives. The key concern of autonomous systems is the lack of human control causing situations of increases in human stress levels either through unintentional action or malfunctions such as when a drone flies to close to a person or when a self driving car make a passenger feel unsafe.

This poster will present my research into using a human biosignals to detect when a person is stressed and develop a closed loop system to improve an autonomous system's ability to adapt based on human stress levels.

RESEARCH OBJECTIVES

There are two main research objectives involved in this project:

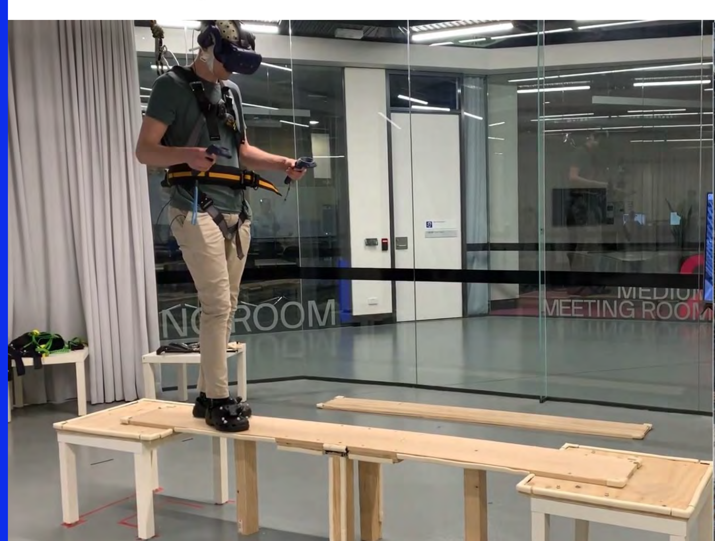
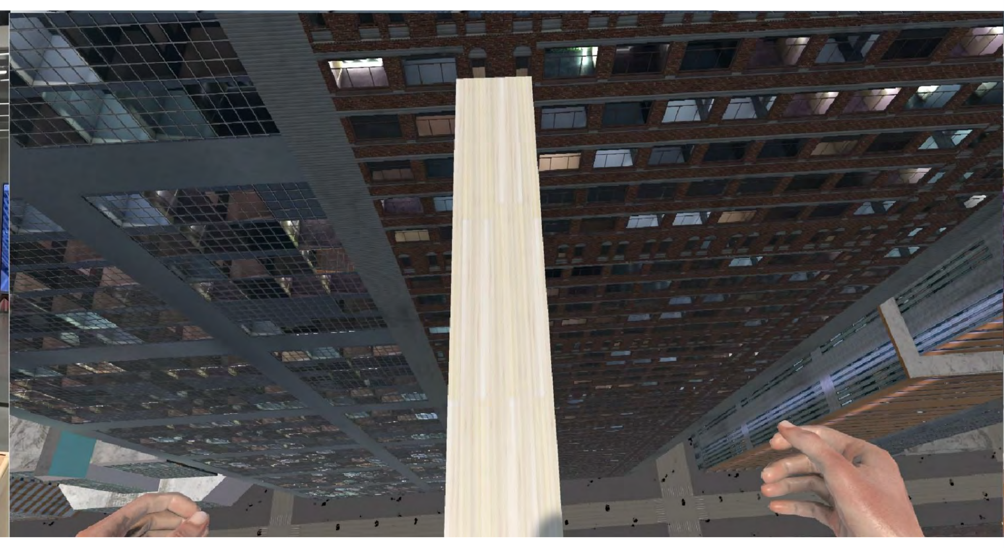
RO1: Develop a real-time model to classify stress levels using signals from a Brain-Computer Interface (BCI).

RO2: Implement a closed-loop system that alters the behaviour of an autonomous system based on an individual's stress level.

METHODOLOGY

Experiment 1: Investigate and measure the physiological effects of stress and it's effect on BCI Performance (RO1)

The first experiment aimed to capture and investigate the physiological effects of stress. Using a Virtual Reality technology, we are able to induce stress through the fear of heights [1]. Recorded biosignals are used as training data to create a classifier for the detection of stress.

Experiment 2: Investigate the effects of an drone flying in proximity (autonomous drone example) on a humans stress levels (RO2)

In light of the recent popularity of autonomous drones (food delivery, amazon prime air, drone security, etc), this experiment aims to investigate the effects of having a drone fly in proximity to a person. We hypothesis that it will increase a person physiological stress levels.



EXPERIMENT 1 OUTCOMES

Classification of Stress

Questionnaire: An effective self assessment of stress levels. However it is not feasible for real-time and real-world usage without active intervention. (Self Assessment Mannequin (SAM) rating shown below)

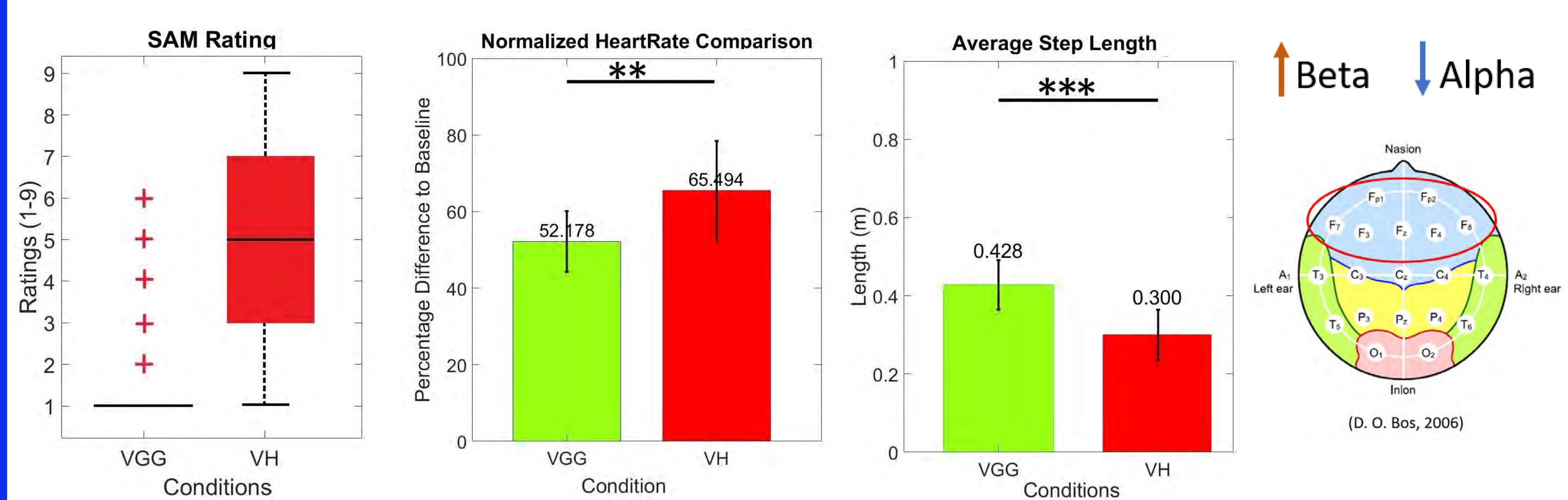
HR and EDA: These measure are reliable but usually has a longer response time and rate of change. Other factors such as exercise, weather, and general health will skew the classification of stress.

Body language and walking behaviour: Another reliable measure for stress. We used high fidelity motion tracking to capture body language and movement. The current computer vision technology is not precise enough to be used for classification.

EEG: A complex biosignals that is susceptible to noise. It is commonly used for BCI devices. If the signals are correctly interpreted and classified, it can provide an extremely react in detect changes in stress levels. [2]

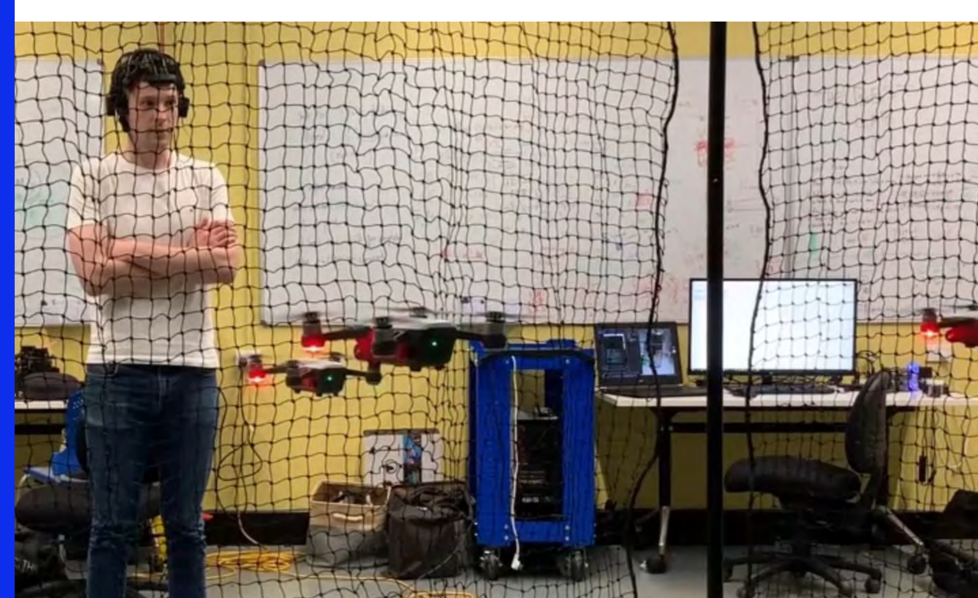
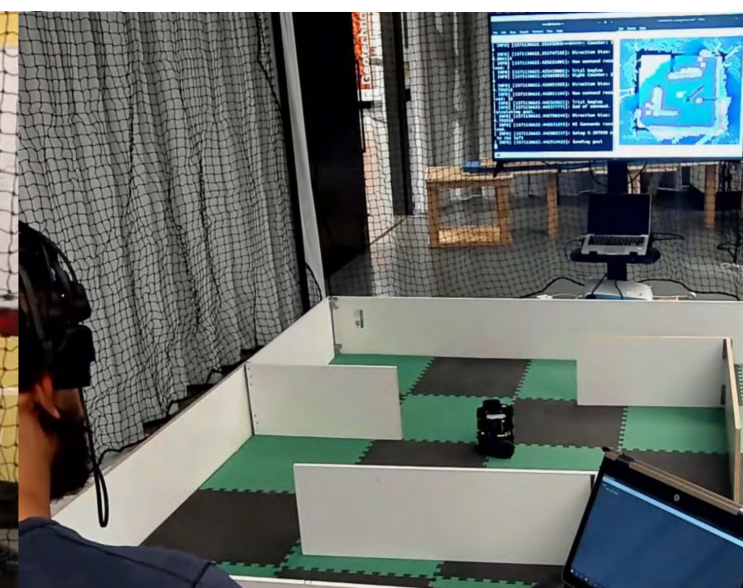
VGG- Experiment Condition walking on Ground

VH- Experiment Condition walking on Virtual Height (100m)



FUTURE STEPS

Experiment 2 will aim to data to be used for the closed-loop BCI system. The final steps of this research will be to integrate this closed-loop BCI system with an autonomous robotic system that will alter it's behaviour based on a person's stress levels. For example, drone flying autonomous will be able to perceive if an individual is uncomfortable with the flight path of the drone.

CONCLUSIONS

This research will serve to improve the behaviour of autonomous system and allow for better integration in our daily lives. By improving our understanding and detection of stress, we can better convey our intention to an autonomous system without the need of active intervention.

References

[1] M. Meehan, I. Brent, W. Mary and P. B. J. Frederick, "Physiological measures of presence in stressful virtual environments," In Acm transactions on graphics (tog), vol. 21, no. 3, pp. 45-652, 2002.

[2] D. O. Bos, "EEG-based emotion recognition," The Influence of Visual and Auditory Stimuli, vol. 56, no. 3, pp. 1-17, 2006.

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