Multi-componential Emotion Recognition in VR Using Physiological Signals

Rukshani Somarathna, Aaron Quigley, Gelareh Mohammadi
School of Computer Science and Engineering, University of New South Wales, Australia

Motivation

Emotion recognition affords new approaches ranging from context-awareness to the efficiency of system interaction with the ability to perceive and express emotions. While most studies are dominated by discrete and dimensional theoretical models of emotion, neuroscience analysis aligns with the multi-component interpretation of emotional phenomena. One such componential theory is the Component Process Model (CPM), with five synchronized components: appraisal, motivation, physiology, expression and feeling (Fig. 1). However, limited attention has been paid to the systematic investigation of emotions assuming a full CPM.

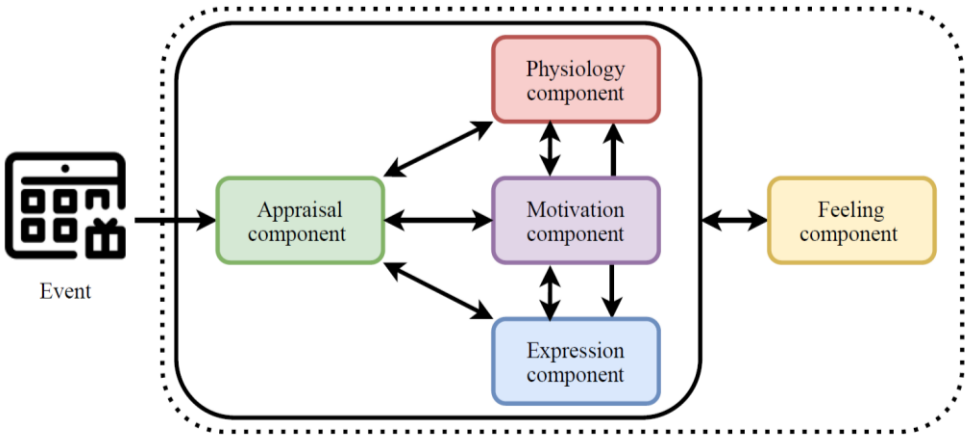

Figure 1 Component Process Model (CPM)

Goals

We propose our data-driven approach to investigate the emotional experience triggered using 27 interactive Virtual Reality (VR) games. We aim,

- To understand emotion formation assuming a full CPM
- To identify the interaction between different components of emotion
- To go beyond facial and vocal expressions to capture emotion richness

Methodology

Wearable devices

HTC VIVE Pro	• To present VR games
emteqPRO	• To collect facial electromyography (EMG)
Empatica E4	• To collect biosignals
Shimmer sensors	• To collect biosignals
Speech recorder	• To collect speech signals
IMUs	• To collect involuntary body gestures

Self-assessments

Motion Sickness Susceptibility Questionnaire	• To screen
Pre-experimental survey	• To assess demography
Big Five Inventory	• To assess personality
Brief Mood Introspection Scale	• To assess mood
Geneva Emotion Wheel (GEW)	• To assess emotions
CoreGRID	• To assess CPM

Experiment setup

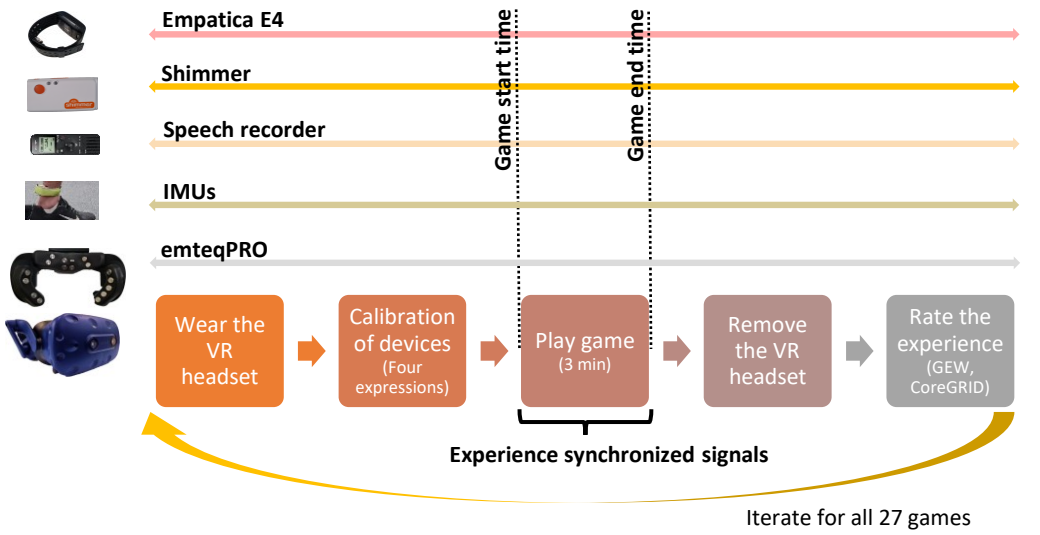

Figure 2 Experiment setup

Results

EmoCompVR dataset

- 28 participants (10 females, 18 males, mean = 24.1 & SD = 5.1 years)
- 749 valid observations

As shown in Fig. 3 and 4, to understand the possibility of facial EMG activations in representing emotions, we conducted a correlation analysis with the CoreGRID's expression items. We used *"SuperVision"* application insights (smile, frown, eyebrow raise EMGs), eight CoreGRID expression component items and discrete emotions.

Results suggest that EMG features recorded through the emteqPRO device can be used to identify facial expressions and emotional characteristics where face recording is not feasible.

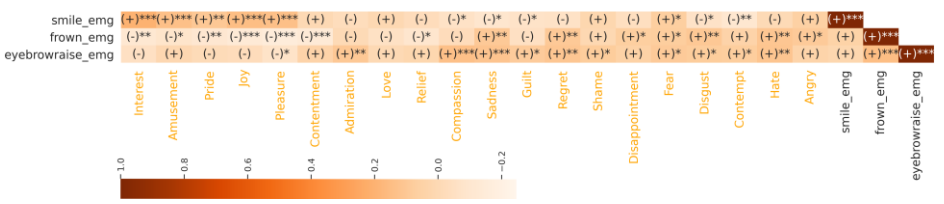

Figure 3 Correlation of each EMG expression with the CoreGRID expression componer

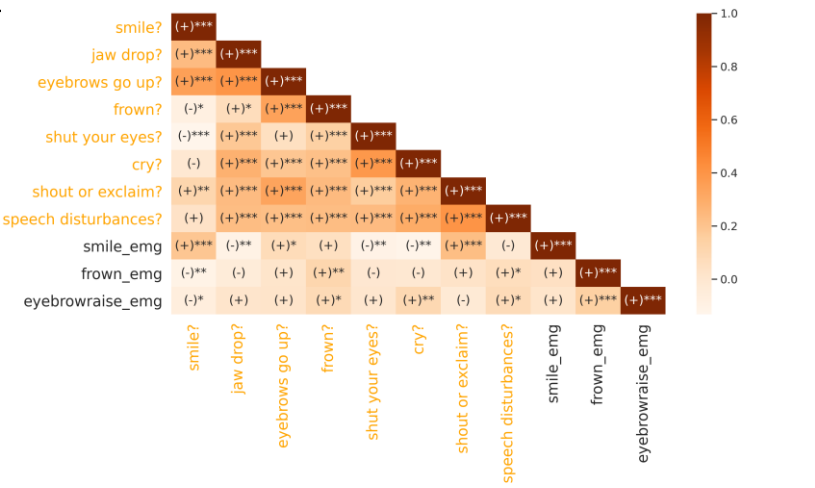

Figure 4 Correlation of each EMG expression with the emotions

Next, to analyze the possibility of using Machine Learning (ML) techniques to find the features of emotions assuming a full CPM, we trained a Random Forest (RF) classifier. Fig. 5 shows the performance of the RF classifier for each emotion. Accordingly, the accuracy of all emotions is significantly ($p<0.001$) higher than the chance level.

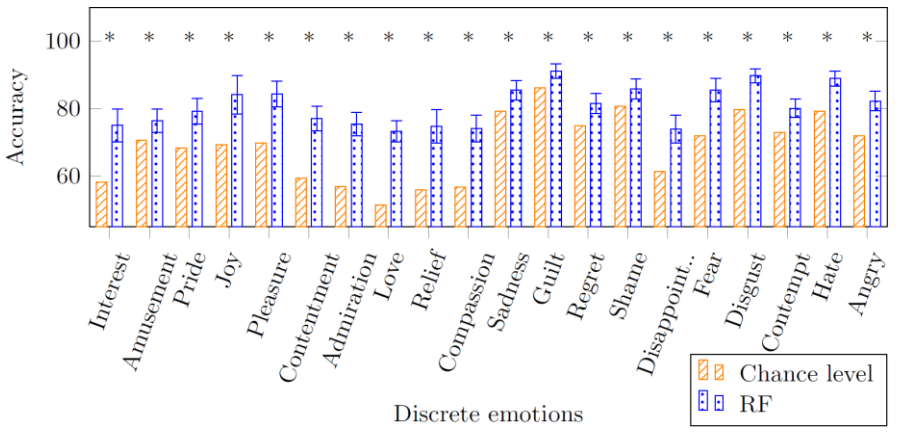

Figure 5 Accuracy of the RF binary classifiers for the differentiation of each emotion. Accuracy is compared with the chance level.

Conclusion and Future works

- CPM enrich our understanding of emotional phenomena.
- Facial EMG encodes motor expressions and discrete emotion features.
- Our findings can be used to improve user experience in adaptive game designing, education, training so forth.
- Future work leads to increasing the stability of ML models by accompanying diverse participants and using data augmentation.