Facial Expressions as a Modality for Fatigue detection in Robot based Rehabilitation

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ABSTRACT

Considerable amount of research is being carried out in robot based rehabilitation techniques. One of the main focus when building a smart rehabilitation system is its ability to adapt based on the user experience. In this poster we attempt to build such a smart rehabilitation system that recognizes the strain/ negative emotions from the participants facial expression and adjusts its force exerted. The accuracy of the system to recognize the facial expression is assessed and the accuracy of the system as a whole is estimated through user surveys.

CCS Concepts

•Human-centered computing → Human computer interaction (HCI);

Keywords

Human Robot Interaction, Convolutional Neural Networks, Facial expression recognition, Robot based rehabilitation

1. INTRODUCTION

Robotic arms are tools commonly used for physical rehabilitation such as post stroke rehabilitation. One of the useful features of robotic arms is their ability to quantify movements which is non-trivial with traditional rehabilitation techniques. These measurements support the smart adaption of robotic assistance to reduce fatigue. Assessment of fatigue during a procedure can be performed in several ways, one such way is with Electroencephalography (EEG) signals. Our approach here was to use convolutional neural networks to recognize facial expressions of the user[1] from which stress or fatigue was be predicted. It has been proven that fatigue and stress can be evaluated from facial expressions [2, 3]. With the information from the fatigue detection system, the force/movements of the mechanical arm was controlled. A user end survey was conducted from which the effectiveness/performance of the system as a whole was evaluated.

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2. PROPOSED SYSTEM

Figure 1 shows the proposed architecture. The robot is initialized with a specific outputted force. Based on the continuous input from the camera, the fatigue detection system classifies the input image frames to positive (+1), neutral (0), and negative (-1) emotion when a face is in view. The force outputted by the robot is increased by a certain value if the detection system returns either neutral or positive emotion whereas the force of the robot is decreased by a certain value if the detection system returns negative value. This means, whenever the participant exhibits a negative emotion (sadness, anger, disgust, frustration), the system recognizes that participant experienced some sort of discomfort and so the forces are decreased accordingly to avoid extreme fatigue.

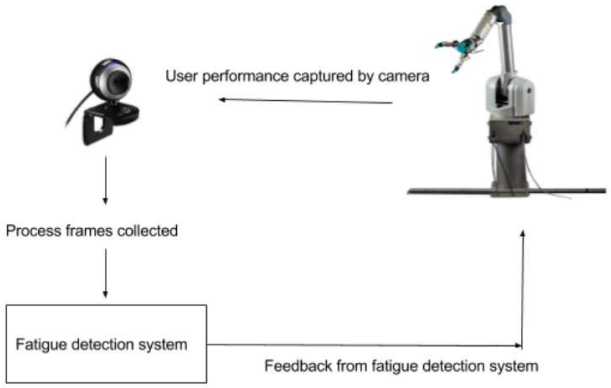

Figure 1: Architecture of the Proposed System

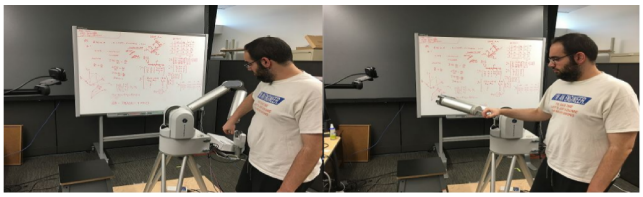

Figure 2: Kinesthetic Teaching.

3. EXPERIMENTAL SETUP

This experiment was conducted with eight participants. The participants were asked to perform a specific resistance-based exercise for three repetitions, lasting 45 seconds each. While performing the exercise, the facial features of the participants were captured to make a prediction of their emotional state from which fatigue was inferred. At the end, the participants were asked to complete a survey.

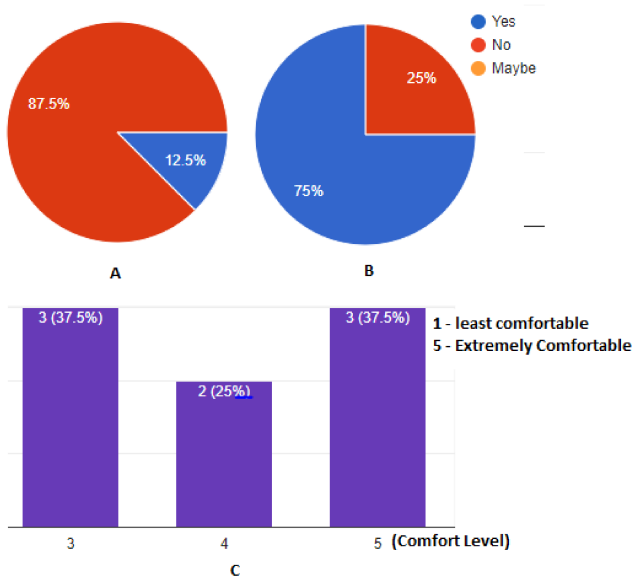

Figure 3: User Survey Results, A. Did you feel extreme fatigue, B. Did you feel the system altering forces during the session? C. How was your experience with the system?

4. EXPERIMENTAL RESULTS

For the survey, the participants were asked three questions, A. Did you feel extreme fatigue? B. Did you feel the system altered forces during the sessions? C. How was your experience with the system? The results of the survey questions are in the figure 3. The emotion from the facial expression detection system when tested to detect emotions produced an accuracy of 89 percent-91 percent with the FER-2013 dataset. The accuracy of the proposed system is based on participant surveys. From the survey we found that most of the participants (75 percent) felt that the system altered its forces from which we can infer that the facial expression recognition system read the facial features (strain) and altered the forces. Also, 87.5 percent of participants stated that they did not feel extreme fatigue. From the experiment and the survey results, we could conclude that there is some strain reflected in the facial expressions of the users during the exercises. But further research is required and many other modalities (not just facial emotions) should be considered.

Due to the expressive nature of the dataset used, more nuanced expression was not detected. For example, gritting teeth is different from a smile and the system was unable to differentiate them without an excessively furrowed brow. In the future, the convolutional neural network will be trained with a more appropriate dataset that deals only with strain level as this may resolve more nuanced expressions, and will be tested accordingly.

5. REFERENCES

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