Intelligent Emotion Recognition System Using Electroencephalography and Active Shape Models

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Abstract— **Human emotion recognition has become one of the key steps towards advanced human-machine interactions. Brain waves or Electroencephalography (EEG) is one of the frequently used bio signals in emotion detection as it is found that the signal measured from the central nervous system has a relationship between physiological changes and emotions. Using facial expressions is another mode that could be used for emotion recognition using external physiological signals.**

This project investigates the possibility of identifying emotions using brain signals and facial expressions. EEG feature extraction is done, using Relative Wavelet Energy calculation and Discrete Wavelet Transform methods for feature extraction, and Artificial Neural Network for emotion classification. For facial feature extraction Active Shape Model is used while the facial emotion classification is done using a Support Vector Machine. The solution could be used to study about the behaviour of EEG signals as well as facial expressions in different mental states.

Keywords-component; Electroencephalography; Facial Expressions; Discrete Wavelet Transform; Signal Processing; Image Processing; Neural Network; Relative Wavelet Energy; Daubechies4; Support Vector Machines; Intelligent Emotion Recognition with Music Therapy.

I. INTRODUCTION

Human emotion recognition has become one of the key steps toward advanced human-machine interactions. Much research has already been done to recognize emotions using external signals such as facial images and speech signals. Since these researches have considered emotions that are expressed purposely, it might not be the actual emotion the subject feels at that particular moment. Picard and Klein [1] have stated that humans can recognize emotions from these signals with 70%-98% accuracy, and computers are already pretty successful especially at classifying facial expressions (with an accuracy of 80%-90%). Further, they have mentioned that these high success rates are under very controlled circumstances, and will be lower in ordinary situations.

However, emotions are not just what are displayed. In psychology, an explicit separation is made between the physiological arousal, the behavioural expression, and the conscious experience of an emotion [2]. Therefore, more accurate results could be achieved using internal physiological signals such as Electroencephalography (EEG). At the same time, facial expressions are one of the best methods that could be used for emotion recognition using external physiological signal.

Aim of this research is to design, develop and evaluate a system that is capable of reliably identifying human emotions using brain waves and facial expressions. The system would also provide music therapy to enhance or degrade positive or negative emotions respectively. Therefore the prototype developed using Matlab could also be used as a stress healing system.

II. RELATED RESERACH

Study of emotion is a highly confusing area as the internal experience of an emotion is highly personal and confusing. This is mainly because human can experience a mixture of several emotions at the same time. Because of this, with the technological improvement in Artificial Intelligence researches have been started on human emotion recognition as it has the capability of taking the human-machine interaction to a more advanced level. Thus much research has been done on human emotion recognition using EEG signals as well as facial expressions.

When it comes to EEG signals, once a noise free EEG signal is acquired, features should be extracted from the physiological signal. For this, the signal is decomposed to five main frequency bands as theta (0-4Hz), delta (4 -8Hz), alpha (8 -16Hz), beta (16-32Hz) and gamma (32-64Hz). The most frequently used method for signal decomposition is Wavelet Transformation. Murugappan *et al.* [3] have used Daubechies4 (db4) wavelet function to extract features from the EEG signal. This function has been used due to its near optimal time-frequency properties and the similarity of its waveforms to the waveforms to be detected in the EEG signal. Relative Wavelet Energy calculation is another approach that could be used for EEG feature extraction. According to Guo *et al*. [4], Relative Wavelet Energy (RWE) provides information about the relative energy associated with different frequency bands present in EEG signals, along with their corresponding degrees of importance. In their research on EEG Signal classification based on RWE, they proved that features derived from relative wavelet energy in different frequency bands are useful to classify different EEG signals.

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