REAL TIME EMOTION ANALYSIS USING BRAINWAVES IN COMPARISON TO FACIAL EXPRESSION

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Abstract: Emotions play a vital role in human living and are correlated with every single word which is being spoken, without them life will be saturated and irrelevant. Understanding of the real apparent facial expressions might be difficult because part of the emotion might not be revealed outside by everyone. In the proposed method, the emotions of the human are analyzed in two different ways so that the real hidden emotion of the subject can be detected. Every human has unique brain waves, which gives better accuracy than other techniques. It ensures that the facial expression exhibited outside is real or not. The emotion analyzed will be useful in treating the person with high mental stress and also infinding the emotion of differently abled person who requires medical treatment.

Keywords: Emotion Analysis, EEG, Emotivepoc+, Convolution neural network (CNN)

I. INTRODUCTION

Emotions are analysed using facial expressions and EEG signals, which are directly collected from the brain [1]. The emotions detected using these techniques are used to identify the real time emotion of the subject [2]. To record facial expressions, we used deep learning approaches. EEG signals are recorded using emotive and machine learning approaches.

A. FACIAL EXPRESSIONS

DETECTION

Facial expressions of human will vary every minute and every second. Some of the emotions through facial expressions are happiness, sadness, anger, surprise, disgust, fear, confusion, excitement, desire and contempt. Facial expressions are movements of muscles beneath the skin of the face. These movements convey the emotional state of the individual. These
Facial expressions are used to convey different types of meaning in various contexts. Facial expressions are recorded using the movement of the facial parts. Some of the movements are given below:

Eyebrow raise distance is the distance between the junction point of the upper and the lower eyelid and the lower central tip of the eyebrow, upper eyelid to eyebrow distance is the distance between the upper eyelid and eyebrow surface, inter eyebrow distance is the distance between the lower central tips of both the eyebrows, upper eyelid and lower eyelid distance is the distance between the upper eyelid and lower eyelid, top lip thickness is the measure of the thickness of the top lip, lower lip thickness is the measure of the thickness of the lower lip, mouth width is the distance between the tips of the lip corner and mouth opening is the distance between the lower surface of top lip and upper surface of lower lip [3].

B. EEG BRAIN WAVES
Brain waves are nothing but brain rhythms of different frequencies. There are five different brain frequencies from which we can find thoughts and mental state of a person. The are Gamma waves, Beta waves, Alpha waves, Theta waves and Delta waves. Gamma waves: Gamma waves have frequency of greater than 40Hz. It is mainly associated with Higher mental activity, problem solving and consciousness. Beta waves: Beta waves have frequency of between 13Hz and 39Hz. It is mainly associated with active processing, busy thinking and active concentration. Alpha waves: Alpha waves have frequency of between 7Hz and 13Hz. It is mainly associated with calm relaxed yet alert state. Theta waves: Theta waves have frequency of between 4Hz and 7Hz. It is mainly associated with deep meditation/relaxation, REM sleep. Delta waves: Delta waves have frequency of less than 4Hz. It is mainly associated with deep dreamless sleep, loss of body awareness. Through these frequencies, emotions are classified [7]. These signals are recorded using electroencephalogram (EEG) [9]. EEG is important in the diagnosis and treatment of mental and brain neuro-degenerative diseases. The role of the EEG is to identify the mental state of a human being. Electroencephalography (EEG) is an efficient tool that helps to acquire brain signals that represents various states from the scalp surface area. In this paper brain waves are collected using EEG.

C. BRAIN COMPUTER INTERFACE (BCI)
Brain computer interface (BCI) is a new way of human computer interaction. BCI facilitates the controlling of computers or related devices without physical interaction with them. BCI is the capturing and analysis of brain signals [6]. EEG is one of the most promising techniques because it is easy to capture EEG signal and analyze those signals. In this paper, we use arduino board to read the EEG signals via bluetooth and those signals are transmitted to system via wired connectivity such as USB cable. The system will display the results.

D. MACHINE LEARNING
Machine Learning is a system that can learn through self-improvement and without coded by programmer. A machine can singularly learn from the data to produce accurate results. Machine learning combines data with statistical tools to predict expected output. This output is then used by corporate. Machine learning is like data mining. The machine receives data as input and use algorithm to formulate answers. Here, the various levels are analyzed based on the accuracy of the image pixels[5] and then they are classified into convolution layers.
DEEP LEARNING

Deep learning is a machine learning technique that helps to teach the computers to do something to humans. It is the key to control voice in consumer devices like phones, TVs, and speakers. Deep learning was introduced long years before but nowadays it becomes very popular. The results of deep learning are not possible before.

In deep learning, a computer system learns to perform classification works directly from images, text, or sound which are provided in the database [8]. Deep learning models can achieve accuracy, sometimes it exceeds human-level performance. Models are trained using a large set of data and neural networks that contain various layers [10].

Deep learning is a subset of machine learning. It is based on learning and improving on its own by examining corresponding algorithms. Deep learning works with artificial neural networks, which are formed to imitate how humans think and learn. This helps to learn the facial movements of various live images using the pixel parameters from the data information [4].

II. PROPOSED METHODOLOGY

The brain waves being recorded from the brain, they are converted from its analog form to digital and then sent to the Arduino through the Bluetooth module. The received digital signals are processed in the Arduino using the code that is provided within it. After the analyzing the signals, the result is displayed in the monitor on what emotion that the subject is currently experiencing whether the subject is angry or calm, sad or happy, amazed or frightened. Another analysis on the emotion is made by capturing the facial expression of the subject using the lens then splitting the video into frames in which the frames are used to identify the type of emotion in which the subject is experiencing right now is analyzed. Finally, the comparison is made on both the results to determine the accuracy of the analysis.

![Architectural diagram for emotional analysis using brainwaves with facial expressions](image)

The EMOTIV EPOC+ is a portable, high resolution, 14-channel, EEG system. It is quick and easy to fit and take measurements in practical research applications. It is compatible with all EMOTIV software products. The Emotiv EPOC is used to distinguish emotional states. This ability is also used to control music type, volume, light intensity, and for indicating
distress. The headset also provides head turns commands such as “yes” or “no”. Another important application of the Emotiv EPOC is essential for medical use. It is possible that the Emotiv EPOC can aid medical needs.

![Fig 2. Emotiv EPOC](image)

Fig 2. Emotiv EPOG

![Fig 3. Arduino](image)

Fig 3. Arduino

Arduino is an open-source electronics platform. It is easy to use hardware and software. Arduino boards read inputs and turn it into an output. Arduino software is easy to use for beginners. It runs on Windows, Mac, and Linux. In this paper the Arduino reads signals from emotivepoc+ via Bluetooth and sends the output to the system via wired connectivity like USB cable.

III. IMPLEMENTATION

A. BRAINWAVE ANALYSIS
The neuro signals from the brain are collected by placing the dry electrodes of the brainwave sensor on the scalp above the emotion sensitive part of the brain which is the frontal lobe. Those signals are then transmitted to the Arduino using air as the medium in which a embedded Bluetooth is used to do such transmission. After receiving the signal from the brain, the Arduino performs the programmed function which is already imported in it through the system. Then the signals are processed to detect the emotion based on the classified analogy on the emotion according to its frequency types such as alpha, beta, gamma and theta waves.

B. FACIAL ANALYSIS
In this part, the subject is focused in the lens by making the required arrangements. The system starts recording the expression given by the subject when the emotion stimulus videos are played. Then the videos are processed to extract the frames from the continuous recording in order to detect the emotion in that specific period. Here the emotion which is expressed by the subject is detected only based on capturing the facial movements.
Ubuntu as Operating system: In Ubuntu, the python program has been run in the terminal as this operating system is more flexible and supports other free source to be implemented easily. Anaconda platform: In association with tensorflow, an open source platform for machine learning and keras, an open source neural network which supports CNN (Convolution Neural Network) to classify the data. Together, they are used to make the suitable environment and opencv is used to import the libraries which make the processing of data easier. Finally, the result will be displayed in the monitor. The CNN algorithm is used for the following processes:

Feature Extraction: CNN performs a series of convolutions and pooling operations during which the features are detected.

Classification: The connected layers act as a classifier on the top of the extracted features. There is a probability for the object on the image being predicted by the classification algorithm.

IV. EXPERIMENTAL RESULT

The emotion detected directly in the real time is described above. The given figure shows the emotion specific to happiness. Similarly the other emotions can also be detected. From the analysis, the captured emotions are considered to have more accuracy with EEG signals than the facial expressions. The accuracy achieved by EEG signals is 83% which is more accurate than 66% accuracy by facial expressions.

V. CONCLUSION

The analyzed emotion through the method of sensing the brain signals are accurate and are nearer to the expected expression which must be exhibited as a result of the given stimulating video inputs. Hence this paper concludes that the EEG based emotional analysis has higher accuracy than that of the facial expression analysis.

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