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Research paper

Brain Computer Interface based Emotion Recognition Using Fuzzy Logic

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Abstract

A brain controlled robot based on Brain–computer interfaces (BCI). BCIs are systems that can bypass conventional channels of communication (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. With these commands a mobile robot can be controlled. The intention of the project work is to develop a robot that can assist the disabled people in their daily life to do some work independent on othersIn Brain computer interface has one electrode by wearing that band we got some Parameters EEG (electroencephalograph)wave. Based on the Neuron Movement it will work. And then, a fusion algorithm. The most visible EEG changes appear within the first two seconds following stimulation. The rhythm increase most significantly in the negative emotional state Level analyzer unit (LAU) will receive the brain wave raw data and it will extract and process the signal using Mat lab platform. With this entire system, we can move a robot according to the human thoughts and it can be turned by blink muscle contraction these both outputs are fed to compare both output to fuzzy logic.

Keyword: *EEG(electroencephalograph), Level analyzer unit (LAU), Brain–computer interfaces (BCI).*

1. Introduction

The patterns of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also generate a unique electrical signal. All these electrical waves will be sensed by the brain wave sensor and it will convert the data into packets and transmit through Bluetooth medium. Level analyzer unit (LAU) will receive the brain wave raw data and it will extract and process the signal using Mat lab platform. Then the control commands will be transmitted to the robotic module to process.However, an extreme environment is likely to lead to anxiety in individuals[1-6]. The Human smart helmet is a part of the wearable safety device. Most smart helmets for humans have the functionality of monitoring the environment or making phone calls. However, there are no studies on human emotion changes using a BCI with a human smart helmet in an extreme environment. Using the central nervous system for emotion recognition is an important method of physiological information recognition. For the emotion stimulation paradigm, the conventional methods utilize picture stimulators, video stimulator, sound stimulator, facial expression stimulator, and practical task stimulator. For the mental recognition, machine learning methods, such as support vector machines, neural networks, Bayes decision trees, and the hidden Markov models are adopted. Unlike the above methods, this paper focuses on anxiety representation and quantification for negative emotions and studies the anxiety level change using BCI for a human smart helmet in an extreme environmentWith this entire system, we can move a robot according to the human thoughts and it can be turned by blink muscle contraction[7-13].

2. Proposed system

In Proposed System we are using Two Technologies

- Brain Computer Interface
- Camera based image Processing

Brain Computer is based on Neuron movement in BCI one electrode is place on forehead will detect the Neuron movement. BCI module can communicate with Controller by means of wireless by using Bluetooth connection. By Using Camera and Image Processing Means we will previously load some dataset and will Train the neural network

If we give some input images it will detect and it displays emotion in screen. Both outputs are Fed to the Fuzzy Logic It will compare the outputs shown in fig 1.

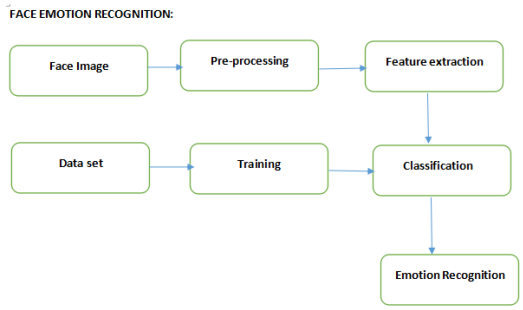

Fig1: Block diagram

3. Circuit diagram description

Brain computer interface (BCI) systems, emotion recognition are an important function. It is brain difficult to perceive the emotion of certain confined people through their facial expressions, such as deep-sea miners and coal miners. However, an extreme environment is likely to lead to anxiety in individuals. The Human smart helmet is a part of the wearable safety device. Most smart helmets for humans have the functionality of monitoring the environment or making phone calls. However, there are no studies on human emotion changes using a BCI with a human smart helmet in an extreme environmentBrain is made up of billions of brain cells called neurons, which use electricity to communicate with each other. The combination of millions of neurons sending signals at once produces an enormous amount of electrical activity in the brain, which can be detected using sensitive medical equipment (such as an EEG), measuring electricity levels over areas of the scalp. The combination of electrical activity of the brain is commonly called a Brain Wave pattern, because of its cyclic, "wave-like" nature. Below is one of the first recordings of brain activity. Content contains fig2: BCI Sensor kit

Fig2: BCI SENSOR KIT

BCI technology is a type of direct communication between the brain and the outside world. BCI is a technique to communicate with the outside world without the assistance of the brain's central nervous system and muscle tissues. The research in areas of neuroscience, psychology and cognitive science has demonstrated that many mental activities and cognitican be reflected by brain waves; therefore, emotion recognition has been introduced with the BCI technology. Using the central nervous system for emotion recognition is an important method of physiological information recognition. For the emotion stimulation paradigm, the conventional methods utilize picture stimulators, video stimulator, sound stimulator, facial expression stimulator, and practical task stimulator. The emotion features include the time domain feature 2-4, the frequency domain feature 5-6, and the time-frequency feature

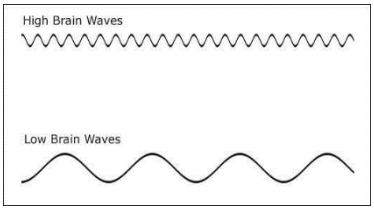

Fig 3: BRAIN WAVES

4. Brainwave Frequencies

With the discovery of brainwaves came the discovery that electrical activity in the brain will change depending on what the person is doing.

For instance, the brainwaves of a sleeping person are vastly different than the brainwaves of someone wide awake. Over the years, more sensitive equipment has brought us closer to figuring out exactly what brainwaves represent and with that, what they mean about a person's health and state of mind.After capturing all the EEG signals for different emotions, they are filtered using a band pass filter.EEG wave contains certain range for different waves from 0-100Hz.In which delta is present for 0-3Hz,theta for3-7Hz,alpha for 8-14Hz,beta for13-30Hz and gamma above 30Hz.EEG band pass filter removes power lines 50Hz noise as well as DC offset of each electrode shown in fig 3.

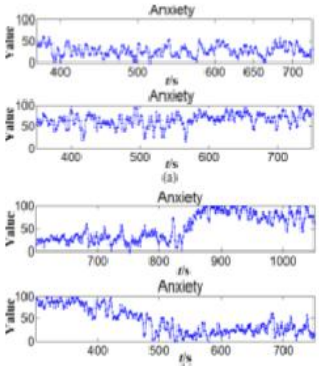

Fig 4: Anxiety Analysis

The Brain Wave Sofa: a representation of a 3 second wave of Alpha brain activity captured with a 3d EEG. Figure 4 shows the 3 seconds when the eyes closed. From the 3d-EEG the file got directly milled in foam by a 3d milling machine and then upholstered in felt by hand.

5. Significance of brainwaves

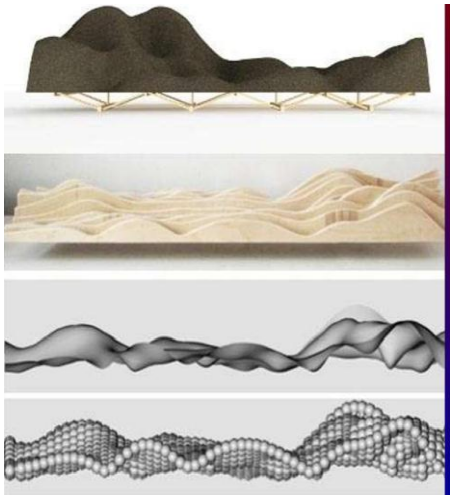

Fig 5: Brain waves

Can tell a lot about a person simply by observing their brainwave patterns. For example, anxious people tend to produce an overabundance of high Beta waves while people with depression tend to produce an overabundance of slower Alpha/Theta brainwaves. Researchers have found that not only are brainwaves representative of mental state, but they can be stimulated to change a person's mental state, and even help treat a variety of mental disorders.

Certain Brainwave patterns can even be used to access exotic or extraordinary experiences such as lucid dreaming or ultra-realistic visualization shown in fig 5.

6. Spontaneous brain potentials

Alpha, beta, theta and delta are names for typical shape of so called spontaneous brain potentials because they are not effect of some stimulus from outside, but just from inner examinee state meditation, relaxation, sleeping, calculating.

7. Different waves and their frequency

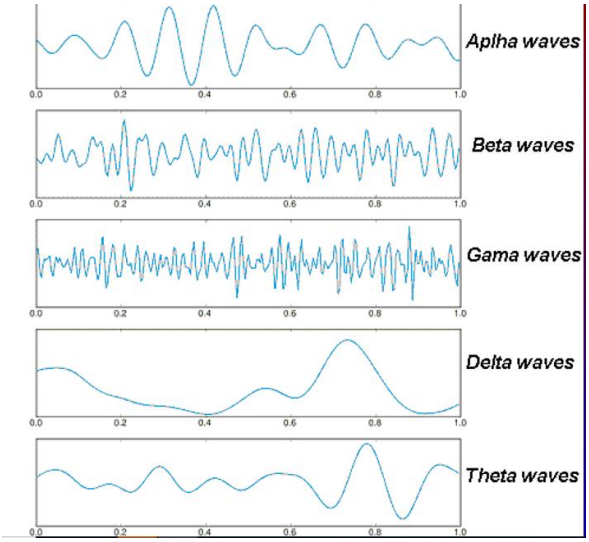

Fig6: Different Waves and Frequency

7.1. Associated Mental State (ALPHA WAVE-8HZ TO 12 HZ)

Awake but relaxed and not processing much information. When you get up in the morning and just before sleep, you are naturally in this state. When you close your eyes your brain automatically starts producing more Alpha waves.

Alpha is usually the goal of experienced mediators, but to enter it using NP2 is incredibly easy. Since Alpha is a very receptive, absorbent mental state, you can also use it for effective self-hypnosis, mental reprogramming, accelerated learning and more.

Hans Berger named the first rhythmic EEG activity he saw, the alpha wave this is activity in the 8-12 Hz range seen in the posterior head regions when an adult patient is awake but relaxed. It was noted to attenuate with eye opening or mental exertion. This activity is now referred to as posterior basic rhythm, the posterior dominant rhythm or the posterior alpha rhythm. Content contains fig5: Brain waves

The posterior basic rhythm is actually slower than 8 Hz in young children therefore technically in the theta range. In addition to the posterior basic rhythm, there are two other normal alpha rhythms that are typically discussed: the mu rhythm and a temporal third rhythm. Alpha can be abnormal; for example, an EEG that has diffuse alpha occurring in coma and is not responsive to external stimuli is referred to as alpha coma. Shown in fig 6 .

7.2. Associated Mental State (BETA WAVE-12HZ TO 38 HZ)

This is generally the mental state most people are in during the day and most of their waking lives. Usually, this state in itself is uneventful, but don't underestimate its importance. Many people lack sufficient Beta activity, which can cause mental or emotional disorders such as depression, ADD and insomnia. Stimulating Beta activity can improve emotional stability, energy levels, attentiveness and concentration. Low amplitude beta with multiple and varying frequencies is often associated with active, busy or anxious thinking and active concentration. Rhythmic beta with a dominant set of frequencies is associated with various pathologies and drug effects, especially benzodiazepines. Activity over about 25 Hz seen in the scalp EEG is rarely cerebral i.e., it is most often art factual.

7.3. Associated Mental State (THETA WAVE-3HZ TO 8HZ)

Light sleep or extreme relaxation. Theta can also be used for hypnosis, accelerated learning and self-programming using pre-recorded suggestions. Theta is seen normally in young children. It may be seen in drowsiness or arousal in older children and adults; it can also be seen in meditation. Excess theta for age represents abnormal activity.

7.4. Associated mental State (DELTA WAVE-0.2HZ TO 3HZ)

Deep, dreamless sleep delta is the slowest band of brainwaves. When dominant brainwave is Delta, the body is healing itself and resetting its internal clocks. Do not dream in this state and are completely unconscious. Delta is seen normally in adults in slow wave sleep. It is also seen normally in babies. It may be seen over focal lesions or diffusely in encephalopathy's content contains fig6: Different Waves and Frequency

8. Fuzzy logic

Fuzzy Logic FL is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in Hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. Fuzzy Logic's approach to control problems mimics how a person would make decisions, only much faster Basic Concepts in Fuzzy Logic There are two basic concepts in fuzzy logic. They are linguistic variable and fuzzy if-then rule or fuzzy rule.

```
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astor==0.6.2
bleach==1.5.0
cycler==0.10.0
dash==0.21.0
dash-renderer==0.12.1
dash-html-components==0.10.0
dash-core-components==0.22.1
gast==0.2.0
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kiwisolver==1.0.1
Markdown==2.6.11
matplotlib==2.2.2
numpy==1.14.2
opencv-python==3.4.0.12
pandas==0.20.3
protobuf==3.5.2.post1
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Fig 7: python code in fuzzy logic

Linguistic Variable It is a variable whose values are words rather than numbers. Its use is closer to the tolerance for imprecision and thereby lowers the cost of solution. It encapsulates the properties of approximate or imprecise concepts in a systematic and computationally useful way. It also reduces the apparent complexity of describing a system. In 1973, Professor Lotfi Zadeh proposed the concept of linguistic or fuzz variables. We can think of them as linguistic objects or words, rather than numbers. The sensor input is a noun, e.g. temperature, displacement velocity flow pressure, etc. Since error is just the difference, it can be thought of the same way. The fuzzy variables themselves are adjectives that modify the variable e.g. large positive error, small positive error, zero error, small negative error, and large negative error. As a minimum, one could simply have positive, zero, and negative variables for each of the parameters. Additional ranges such as very large and very small could also be added to extend the responsiveness to exceptional or very nonlinear conditions, but aren't necessary in a basic system Fuzzy if- then rule if statements are used to formulate the conditional statements that comprise fuzzy logic. A single if - then rule assumes the form where A and B are linguistic values defined by fuzzy sets on the ranges universe of discourse X and Y, respectively. The IF part of the rule X is A is called the antecedent or premise, while the then part of the rule Y is B is called the consequent or conclusion. Additional benefits of fuzzy logic include its simplicity and its flexibility. Fuzzy logic can handle problems with imprecise and incomplete data. fig 7 python code in fuzzy logic.

8.1. Implementing a BCI with fuzzy logic

In order to demonstrate the usage of fuzzy classification algorithms, it was decided to implement a simple BCI application using EEG technology and fuzzy classification algorithms.

Fig 8: Implementing BCI with fuzzy logic

The application can be used to partially control the mouse cursor on a computer screen and to better illustrate the usefulness of fuzzy classifiers specifically, it is able to detect and carry out multiple directions simultaneously, which is not possible with traditional classification algorithms based on binary logic.fig 8 implementinting BCI with fuzzy logic

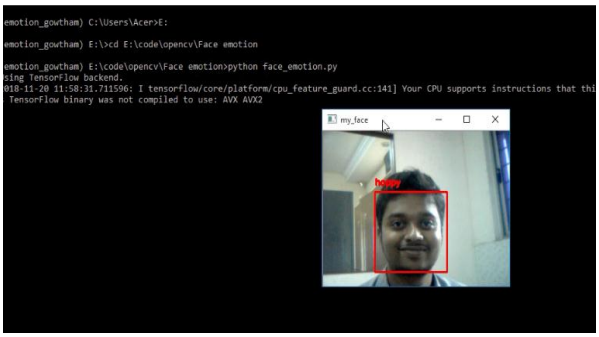

Fig 9: happy emotion

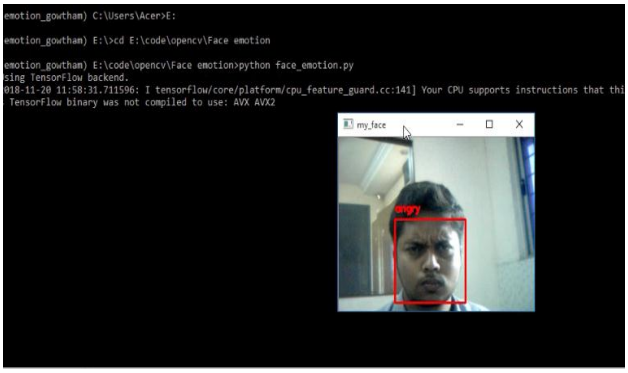

Fig 10: Angry emotion

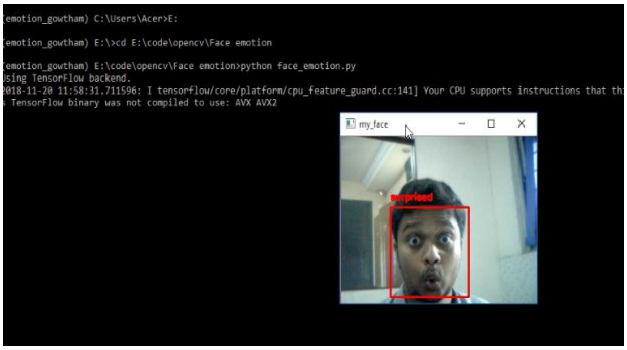

Fig 11: surprised emotion

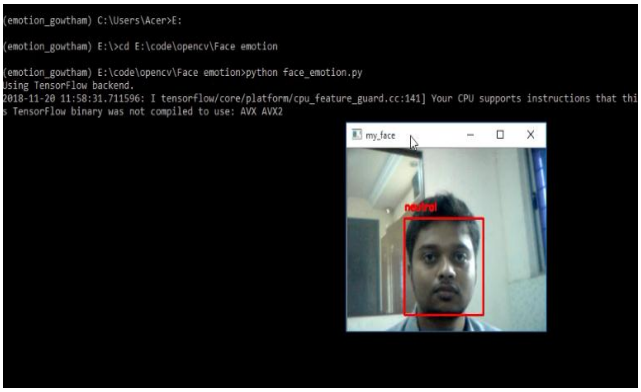

Fig12: Neutral emotion

The computer can actually take a look inside the user's head to observe their mental state. While brain-based spelling is a reality today, unfortunately, it is rather slow. Thought to text translation is typically at the rate of less than ten characters per minute. Thus,

it seems that practical application of BCI technology in the area of translation would require a dramatic increase in this communication rate. Along with the spelling of words using brain signals the Identifying, recognizing emotions or feelings through brain signals is the next big thing.fig 12 neutral emotion

9. Conclusion

The emotional state of a person defines their interaction with other people or objects. Therefore, the recognition of human emotions is becoming a concern in the development of systems that require human-machine interaction. The goal in recognizing human emotions is easier and more enjoyable computer use, for example .As future work, we plan improve our results analyzing what EEG feature is more active during the feeling of emotion by each participant of our experiment. According to this evaluation, we will insert a step to identify the feature that is more active during the experiments in each user and adapt our emotion recognition system to receive the more significant rhythm for each participant.fig 11 surprised emotion

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