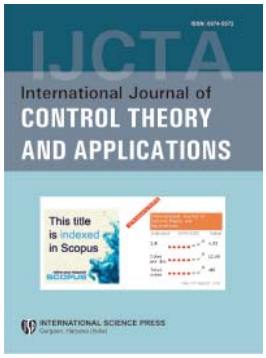

International Journal of Control Theory and Applications

ISSN : 0974–5572

Volume 9 • Number 40 • 2016

Emotion Analysis using Brain Computer Interface

Vatsla Chauhan[a] M. Uma[b] S. Karthick[b] and Vaibhav Nagpal[a]

[a]*B.Tech, Department of Software Engineering ,SRM University, Chennai,*

E-mail: vatslachauhan@gmail.com, vaibhavnagpal195@gmail.com

[b]*Assistant Professor, Department of Software Engineering, SRM University, Chennai,*

E-mail: umaprabhu78@gmail.com, karthik.sa@ktr.srmuniv.ac.in

Abstract: Research in the Brain-Computer Interface (BCI) was initially for their essential role as assisting devices for the physically challenged, whereas now it is proposed for a wider range of applications. Our project focused on recognizing emotion from human brain via EEG signals. We have developed a stress-reduction system to analyze EEG signals and classifying them into 5 main frequencies (alpha, beta, gamma, theta and delta) and then change the emotional state of the subject, if subject is found to be stressed, by use of video and audio. This system was designed using prior knowledge from other researches and is meant to assess the emotion recognition using EEG signals. To perform this assignment, the dataset was gathered from people by showing them pictures and videos to obtain their EEG signals.

Apart from analyzing the emotional state of a person, we would also work on the following process :

1. Changing the emotional state of the subject by the use music, videos and pictures.
2. Depiction of frequency range i.e., emotional state of a subject using Arduino board.

These experiments will be performed on a group of people at different hours of a day for better results. The base paper used for the project is the framework of noninvasive EEG based Brain Computer Interface.

Keywords: *Brain Computer Interface, Electroencephalograph, Music Theraphy, Stress relieve model, NeuroSky.*

1. INTRODUCTION

Emotions are any conscious experience categorized by brain activity and high degree of pleasure or displeasure. Emotions are often linked with mood, temperament and personality. For the past 40 years, Paul Ekman suggested that there are 6 basic emotions - anger, disgust, fear, happiness, sadness and surprise. Also, according to the processing model of emotion by Klaus Scherer, the components that provide a sequence of events in an emotional state are :

1. **Cognitive appraisal:** Provides an evaluation of events and objects.
2. **Bodily symptoms:** The physiological component of emotional experience.
3. **Action tendencies:** A motivational component for the preparation and direction of motor responses.

4. **Expression:** Facial and vocal expression almost always accompanies an emotional state to communicate reaction and intention of actions.
5. **Feelings:** the subjective experience of emotional state once it has occurred.

2. BRAIN COMPUTER INTERFACE

Brain-Computer Interface is like a pathway between wired brain and external device. It is commonly used for researching, mapping, assisting and repairing human cognitive or sensory-motor functions. BCI works on the neurons in our brain, each nerve connected to one another by axons and dendrites. Then an electric signal is produced by the difference in electric potential in ions when neuron to neuron are as fast as 250mps. The basic mechanism of a BCI is to measure the minute difference in voltage between the neurons. Then the signal is amplified and filtered.

2.1. Brain waves

There are five type of electrical patterns or brain waves which can be observed by researchers through electroencephalograph. If even one brain wave is produced more or less than the other, it doesn't mean that it is optimal or better but it could be dangerous. Throughout your day, all the five waves will be displayed but one wave will always dominate the others as per the emotion. For example, while waking up you will have slower waves(alpha or theta) activity more as compared to beta wave.

Beta wave is used for logical thinking and conscious thought. There are two sets of beta – low(13-18Hz) and high(19-30Hz). The high beta wave often expresses that the subject is subjected to stressed state which can be increased by the use of coffee or energy drinks and in order to decrease the beta wave, the method of meditation has proved most effective.

Alpha wave helps us calm down when necessary and promotes feelings of deep relaxation. There are two sets of alpha – low(8-10Hz) and high(11-13Hz). It can be increased by the use of alcohol, marijuana and antidepressants.

Gamma wave is used for learning, memory and information processing. There are two sets of gamma – low(30-35Hz) and mid(36-42Hz). To attain high gamma wave, extreme meditation is recommended. Theta wave is used for daydreaming and sleeping. It functions on 4-8Hz frequency. In order to increase the theta wave, the use of depressants is done. Delta wave is associated with the deepest levels of relaxation, restorative and healing sleep. Its functioning frequency is 0.5-4Hz. In order to increase delta wave, the use of depressants and sleep is advised.

These frequencies are recorded for the analysis of the emotional state.

Table 1
Brainwave frequencies and functions

Unconscious			*Conscious*	
Delta	*Theta*	*Alpha*	*Beta*	*Gamma*
0.5 – 4Hz	4 – 8 Hz	8 – 13 Hz	13 – 30 Hz	30 – 42 Hz
Instinct	*Emotion*	*Consciousness*	*Thought*	*Will*
Survival Deep sleep Coma	Drives Feelings Trance Dreams	Awareness of the body Integration of feelings	Perception Concentration Mental activity	Extreme focus Energy Ecstasy

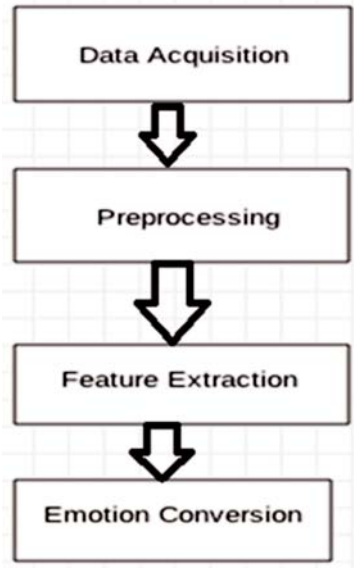

Figure 1: Element of BCI

There are three main functions of BCI, namely – data acquisition, pre-processing, feature extraction and emotion conversion depict in fig1.

2.2.1. Data Acquisition

The signals are measured in electrical or physical phenomena as in voltage by a device. It is the process by which the EEG signals from the subject are analysed by NeuroSky and forwarded to computer.

2.2.2. Pre-processing

Preprocessing module defines amplification, filtering of EEG signals and also artifact removal(mainly eye-induced artifact).

2.2.3. Feature Extraction

Feature extraction is a process in which the frequency of signals is converted from analog to digital form.

2.2.4. Emotion Conversion

If the subject is stressed, the emotional state will be changed by use of audio, video or pictures.

3. METHODOLOGY

The Stress reduction system will be focussed on analysing the brain waves by a device called “NeuroSky” and then transmitting them to the system so that the program can produce a graph to depict the waves in fig2. If the subject wave are inclined towards high beta that signifies the subject is stressed and then a video is played to calm the subject down(alpha wave).

Firstly, the device will be placed on the head of the subject with attaching the two sensors on forehead and lower earlobe respectively for acquisition of signals properly. Then, the device and the system is connected with the use of Bluetooth where blue light depicts connectivity and red light depicts disconnection. The removal of ambient noise and muscle movement along with eye blink detection come among the few processes in pre-processing. After connecting the device, the algorithm on the system will be run for next 5-6 mins to analyse the emotions of the subject. The feature classification process will categorize emotions into 5 waves –

1. Alpha (low or high)
2. Gamma (low or mid)
3. Theta
4. Beta (low or high)
5. Delta

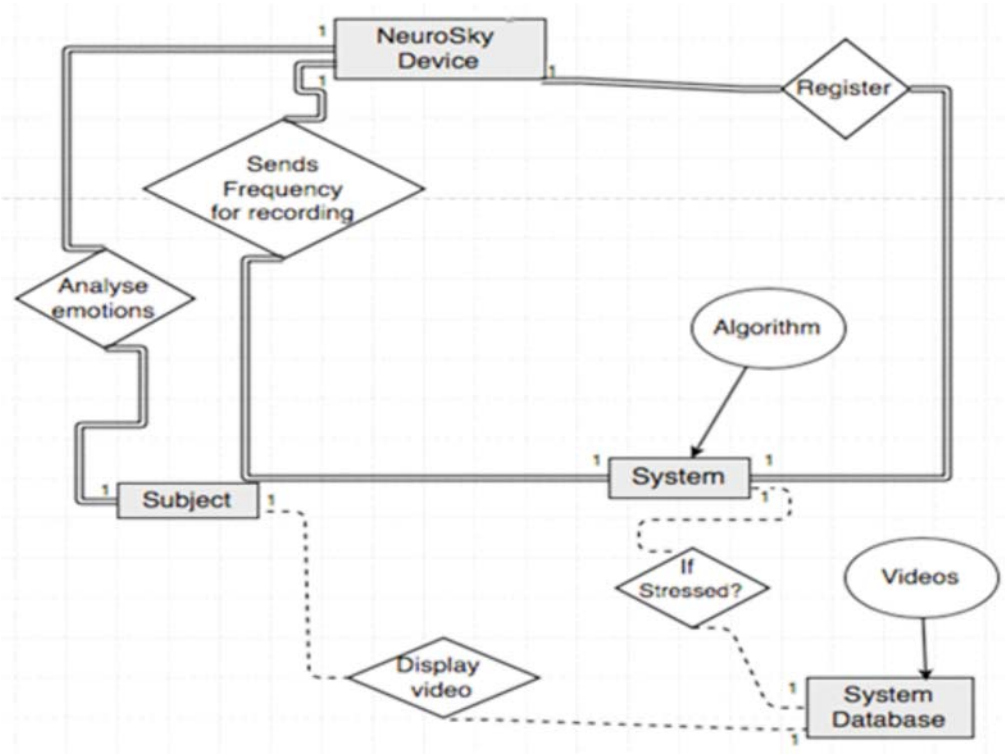

Figure 2: Architecure of emotional analysis

These frequencies will be depicted as separate waves on a graph for a specified amount of time. Also, an Arduino board will be connected to the system that will show if the subject is stressed or not by the blinking technique. If the subject is found to be stressed (High Beta wave), the Arduino board will show a constant light without blinking whereas if the subject is not stressed (any other wave), the Arduino board will show blink of light continuously. For reference to high beta wave (Stressed state), the system will show a video or audio clip that will lower the emotional level. To analyse the emotional state of the subject while the video or audio is playing, the algorithm will be called again and a new graph will be made. Our project basically focuses on the beta range i.e., 18-30 Hz for analysing the stressed emotional state.

```
if ((frequency_wave)>18&&(frequency_wave)<30)
arduino_board=1;
else
arduino_board=0;
```

The program was experimented on 5 subjects at different interval of time in a day to analyse their emotional state variations. The subjects were chosen at random out of our classroom. The emotional and mental health of these subjects were stable and healthy.

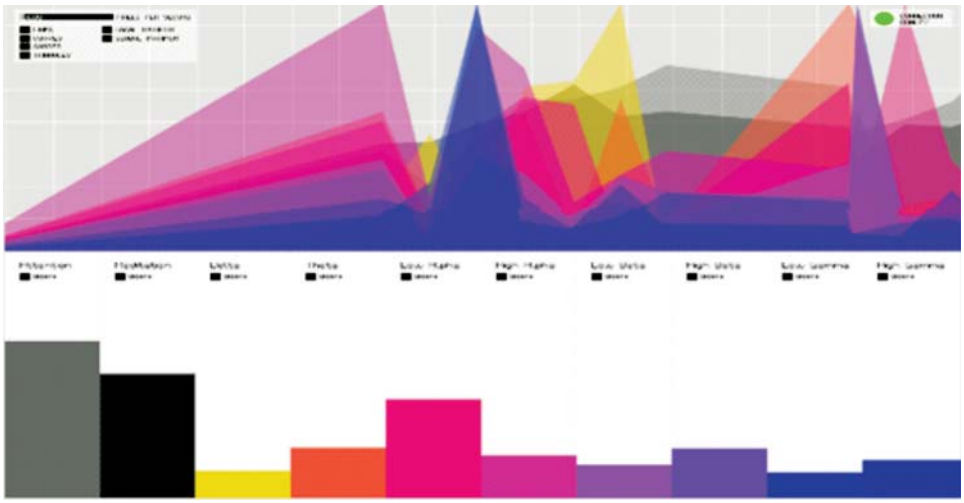

Figure 3: Different emotional frequency analysis

NeuroSky was founded in 2004 in Silicon Valley, California. The company adapts the electroencephalography (EEG) and electromyography (EMG) technology to fit in entertainment, automobile and health. This device uses inexpensive dry sensors for linking low-cost EEG signals whereas older devices use conductive gel between sensors and head. It also includes built-in electrical "noise" reduction software/hardware, and utilize embedded for signal processing and output depict in fig4.

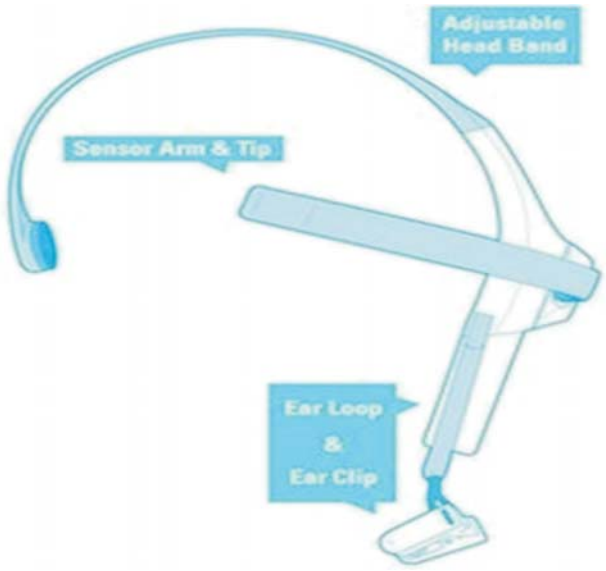

Figure 4: NeuroSky device the ear clip is clipped on the lower part of ear lobe.

This Device includes :

1. Adjustable Head Band

   It is placed on your head and can be adjusted as per required.

2. Sensor Arm and Tip

   The arm extends up to your forehead and the tip is placed on your forehead to take EEG signals.

3. Ear loop and ear Clip

   Ear loop is aligned behind the ear and

4. On/Off Button

   This button is used to switch the device on and off and for connectivity purposes.

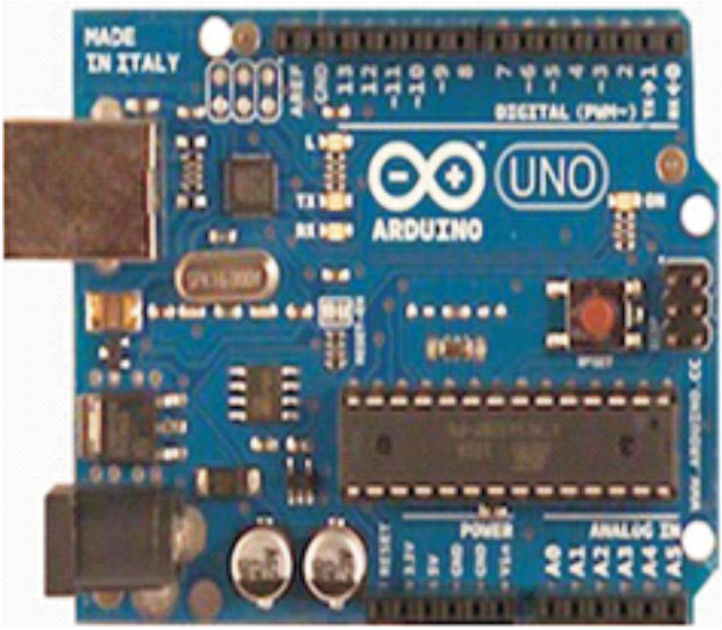

Figure 5: Arduino board

Arduino board is an open source software which is based on easy-to-use hardware depicted in fig5. It is able to read input and blink light, detect finger on a button, etc. It is used as both a physical programmable circuit board and a piece of software, or IDE that runs on your computer, used to write and upload computer code to the physical board. In our project, Arduino uno board will be used. It is microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Arduino board will be connected to the system that will show if the subject is stressed or not by the blinking technique. If the subject is found to be stressed (High Beta wave), the Arduino board will show a constant light without blinking whereas if the subject is not stressed (any other wave), the Arduino board will show blink of light continuously.

3.1. MindRec Software

MindRec software is a NeuroSky specific program which helps to record all continuous streaming data from the NeuroSky MindSet as well as video synchronized with brainwaves to the hard disk depicted in fig6. It provides monitor-filtered raw signal, ITS spectrum and spectrum transition in real time. It also displays the brain waves like alpha, beta, gamma, theta and delta. It records data in .csv file format and you can read it through excel sheets. Below is the screenshot of the software.

Our main objective of the project is to detect the high beta wave (stressed state) in the subject, if present and improve it in such a way that the resultant output is alpha wave (calm state). According to Dr. David Lewis-Hodgson of Mindlab International, the song - “Weightless” is the top most relaxing song as compared to all the songs in the world.

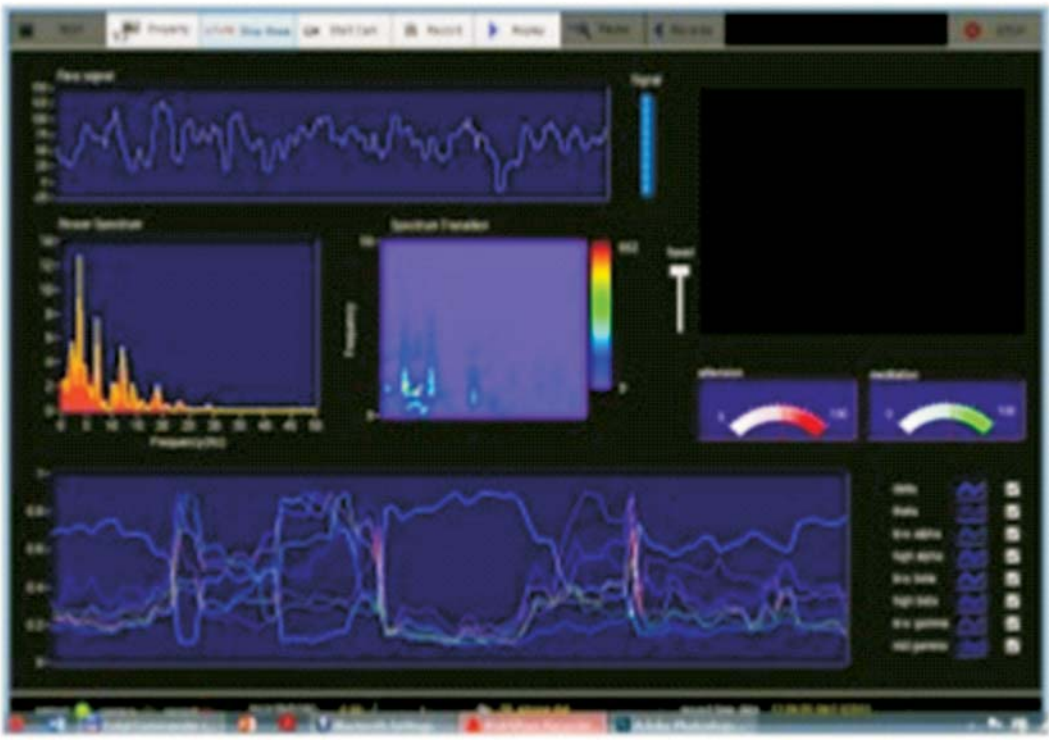

Figure 6. MindRec software

Band creates the 'most relaxing tune ever'

A British band has worked with sound therapists to create a tune described by scientists as the "most relaxing song ever".

3K 111 14 3K Email

10:34AM BST 16 Oct 2011

Boffins say the eight minute track, called Weightless, is so effective at inducing sleep it should not be listened to while driving.

Carefully arranged harmonies, rhythms and bass lines help to slow the heart rate, reduce blood pressure and lower levels of the stress hormone cortisol.

Manchester trio Marconi Union worked with sound therapists to create the soothing tune, which also slows breathing and reduces brain activity.

Scientists played the song to 40 women and found it to be more effective at helping them relax than songs by Enya, Mozart and Coldplay.

The study - commissioned by bubble bath and shower gel firm Radox Spa - found the song was even more relaxing than a massage, walk or cup of tea.

The women were connected to sensors and given challenging puzzles to complete against the clock in order to induce a level of stress.

They were then played different songs as their heart rate, blood pressure, breathing and brain activity were recorded.

Studies found Weightless was 11 per cent more relaxing than any other song and even made many of the women "drowsy" in the lab.

It induced a 65 per cent reduction in overall anxiety and brought them to a level 35 per cent lower than their usual resting rates.

The song features guitar, piano and electronic samples of natural soundscapes.

Print this article

UK News
News » Health »

In UK News

Celebrity Sightings: 25 March

Up Helly Aa Festival

Aviemore Sled Dog Rally

Figure 7

The above article shows the reduction of stress level using song - "Weightless". It induced a 65% reduction in overall anxiety and brought it down to 35% lower than their usual resting rates[11]

4. CONCLUSION

This project is used to detect emotions using brain-computer interface. The various techniques referred for our paper are explored from few previous research papers. The frequencies produced by the human brain are analyzed using a device called NeuroSky and then sent to the computer. The emotional state produced by the brain activity is categorized using five frequencies. Then the waves are sent to the system so that the program can differentiate the emotional state using graph. If emotional state is found to be stressed, then the Arduino board will show a constant light without blinking whereas is not stressed, then the Arduino board will show blinking light continuously. According to our project if the stressed state is present, then video or audio is played to calm the subject down and simultaneously the emotional state is also being analyzed. The architecture diagram as depicted above can elaborate the process.

REFERENCES

[1] A.B. Smith, C.D. Jones, and E.F. Roberts, "Article Title", *Journal*, Publisher, Location, Date, pp. 1-10.

[2] Praveen kumar1, M. Govindu2, A. Rajaiah3 "Automatic Home Control System Using Brain Wave Signal Detection", IJESC ,2014 .

[3] Christian Mühla , Brendan Allisonbc , Anton Nijholtd & Guillaume Chanele, "A survey of affective brain computer interfaces: principles, state-of-the-art, and challenges ",DOI: 10.1080/2326263X.2014.912881,2014.

[4] Scott Makeig, Grace Leslie at al, "First Demonstration of a Musical Emotion BCI", © Springer-Verlag Berlin Heidelberg, pp. 487–496, 2011.

[5] Sander Koelstra at al, DEAP: A Database for Emotion Analysis using Physiological Signals, IEEE TRANS. AFFECTIVE COMPUTING.

[6] Taciana Saad Rached[1] and Angelo Perkusich[1] , "Emotion Recognition Based on Brain-Computer Interface Systems", *book* ISBN 978-953-51-1134-4, 2013 .

[7] Yisi Liu,, Olga Sourina,, Minh Khoa Nguyen, "Real-time EEG-based Emotion Recognition and its Applications", Transactions on Computational Science XII,Volume 6670 of the series Lecture Notes in Computer Science pp 256-277,2011

[8] Nitin Kumar, Kaushikee Khaund, Shyamanta M. Hazarika , "Bispectral Analysis of EEG for EmotionRecognition", doi. org/10.1016/j.procs.2016.04.062.

[9] Seda Guzel Aydin. Turgay Kaya,Hasan Guler "Wavelet-based study of valence–arousal model of emotions on EEG signals with LabVIEW" doi:10.1007/s40708-016-0031-9,2016.

[10] Mohammad, Shakib Moshfeghi Aliye Tuke Bedasso Jyoti Prasad Bartaula.Emotion Recognition from EEG Signals using Machine Learning, Bachelor Thesis Electrical Engineering March 2013.

[11] http://www.telegraph.co.uk/news/uknews/8830066/Band-creates-the-most-relaxing-tune-ever.html