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EEG DATA ACQUISITION & ANALYSIS FOR HUMAN EMOTIONS

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ABSTRACT

EEG brainwaves supply useful information for prediction of emotion status of human. In this study, EEG signal acquisition, EEG signal characteristics, analyzing techniques of EEG signals, used software tools have been examined.

A Python program that to analyze concentration, anxiety and obsession levels of several healthy voluntary persons has been evaluated and processed.

Two different experiments were designed using visual stimuli in order to determine which regions of the brain were active and the relation was determined between emotions and activity centers. Emotion prediction program was operated uneventfully for concentration, anxiety and obsession by using Emotiv EPOC+.

INTRODUCTION

EEG signal which is generated by cortex is a indicator that shows human brain activity. EEG have many real applications such as psychology , brain computer interfaces and medical studies. In this study, EEG will be used as a psychological application that is emotion state determination of human.

Problem definition: Accuracy problems in results of emotion analysis using EEG signals, and the lack of a program for emotion detection using analysis methods.

Design objective: Design a Python program for emotion state determination of human and analyzing active regions of brain according to corresponding emotions.

Tasks: -Determination of Concentration
-Determination of Anxiety
-Determination of Obsession
-Determination of Other emotions active regions

EEG SIGNALS

Electroencephalography (EEG) signals which are produced by neurons in the brain can give information about brain activity of human.

EEG activity is quite small and measured in microvolts (uV). EEG signals are analyzed based on main frequency bands such as Delta, Beta, Theta etc.

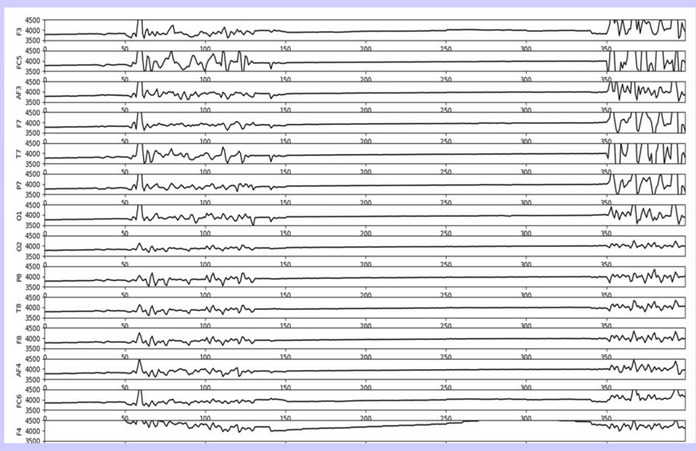

Figure 1: Sample of 14-Channel EEG Signal

FLOW DIAGRAM OF EMOTION DETERMINATION PROCESS

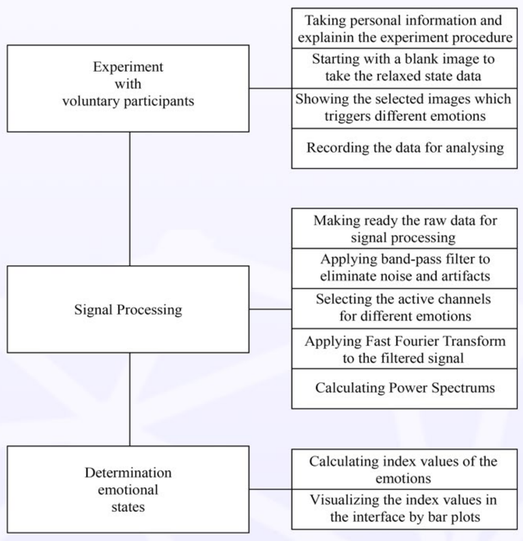

Figure 2: Algorithm of Emotion Determination Process

EPOC+

In this study, EPOC+ 14-channel EEG measurement device was used and its 14 electrodes are also based on 10-20 electrode system as shown as in figure.

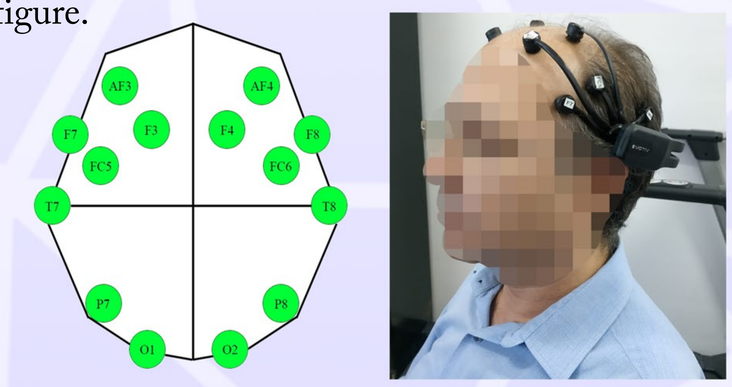

Figure 3: Electrode Positions and Placing on Head

EPOC + is an selected for its electrodes positioned specially in the frontal lobe because the emotion states are related with EEG data which are measured from frontal lobes.

Figure 4: EEG Measurement Device Emotiv EPOC+

METHODOLOGY

In this study, for analyzing the EEG signals and determination of emotional state, raw EEG data was subdivided into sub-frequency bands and the emotions associated with the frequency bands were selected from the literature. The level of the dominant emotion in the frequency bands was obtained by the ratio of the power of the frequency bands to Theta band.

Table 1: EEG Frequency Bands and Related Emotions

Type of Wave	Frequency Band(Hz)	Activities
Delta	0.5 - 3.5	Deep Sleep Awaken
Theta	3.5 - 7.5	Stress Disappointment
Alpha	7.5 - 12	Obsession Disengagement
Low Beta	12 - 20	Active Thinking Focusing
High Beta	20 - 30	Anxious Stress
Gamma	30 - 100	Attention Happiness

EMOTION ANALYSIS PYTHON PROGRAM

A Python code which can be used to measure and analysis the EEG signals were developed with two modes (Experiment (Test) Mode and Measurement Mode) with two interfaces.

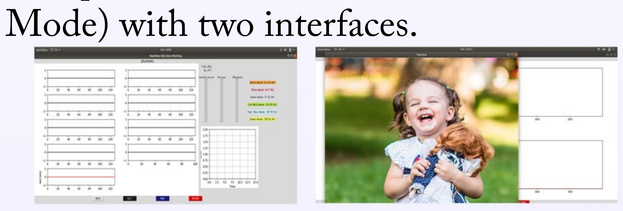

Figure 5: GUI Samles of the Developed Program

Experiment (Test) Mode was developed for the determination of the active regions when different emotion states realized. Measurement Mode was developed for recording and analyzing raw EEG signal and then determination of concentration, anxiety and obsession levels in real time.

EXPERIMENT AND RESULTS

In this study, experiments have been designed in order to learn which emotion creates activity in which part of the brain by using visual stimulus.

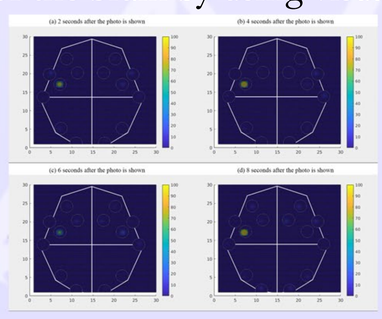

Figure 6: Visualization of Brain Activity

All recorded brain activity data were then compared and determined which regions of the brain were active for which emotion. These regions were shown with interpolarated plots in MATLAB.

Table 2: Emotions and Active Regions

Emotion	Common Active Electrodes
Happiness	Frontal + Temporal
Sadness	Frontal + Pariental + Temporal
Awe	Frontal + Temporal + Occipital
Fear	Frontal + Occipital + Pariental
Amusement	Uncertain
Erotic	Frontal
Anger	Frontal + Pariental
Disgusting	Frontal + Temporal
Uneasiness	Frontal + Occipital + Pariental
Pity	Frontal + Occipital + Pariental
Confusion	Frontal
Insent(Food)	Frontal + Occipital + Pariental

CONCLUSION

In this study, EEG characteristics, anxiety, concentration and obsession determination by using EEG and a Python program which analyzes the EEG data to emotion acquisition are described.

In the light of the data obtained from the experiments, it was determined in which regions of the brain specific emotions created activity. The obtained data were compared with the studies in the literature and it was proved that the emotions such as happiness and disgust can be generally determined.

REFERENCES

[1]: Li Xin, Sun Xiao-Qi, Qi Xiao-Ying, Sun Xiao-Feng, “Relevance Vector Machine Based EEG Emotion Recognition”, 2016 Sixth International Conference on Instrumentation & Measurement, Computer, Communication and Control (IMCCC), 2016.
[2]: Erik Andreas Larsen, “Classification of EEG Signals in a BrainComputer Interface System”, pp.25, Norwegian University of Science and Technology, 2011.
[3]: Mu Li, Bao-Liang Lu*,“Emotion Classification Based on Gamma-band EEG”, 31st Annual International Conference of the IEEE EMBS, USA, 2009.