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OBSERVATION OF THE EFFECTS OF PLAYING GAMES WITH THE HUMAN BRAIN WAVES

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Graphical abstract

Abstract

The purpose of this paper is to observe the human brain waves when a person playing video games. The game proposed is Counter Strike (CS) 1.6. There are 30 samples of human brain wave will be collected. The EEG signal will be recorded before playing a game and after playing a game. The threshold value is used to filter the data collected to acquire clean brain waves. Then, extraction of sub-band Alpha and Beta is done by Band-pass filter. Power Spectral Density (PSD) is performed in analysing the brain waves to acquire peak amplitude of the Alpha and Beta sub-band frequencies. The pattern of Alpha and Beta is carried out by using the histogram to observe the relationship between games and mind state of humanity. It is observed that the Beta-band increase and Alpha-band decrease after the samples playing game.

Keywords: Game; human brain waves; Alpha-band; Beta-band

Abstrak

Tujuan kertas ini adalah untuk melihat gelombang otak manusia apabila seseorang bermain permainan video. Permainan dicadangkan adalah Counter Strike (CS) 1.6. Terdapat 30 sampel gelombang otak manusia akan dikumpulkan. Isyarat EEG akan direkodkan sebelum bermain permainan dan selepas bermain permainan. Nilai ambang digunakan untuk menapis data yang dikumpulkan untuk memperoleh gelombang otak bersih. Kemudian, pengeluaran sub-band Alpha dan Beta dilakukan oleh penapis Band-pass. Power Spectral Density (PSD) dilakukan dalam menganalisis gelombang otak untuk memperolehi amplitude puncak sub-band Alpha dan Beta. Corak Alpha dan Beta diperhatikan menggunakan histogram untuk melihat perkaitan antara permainan dan keadaan minda manusia. Adalah diperhatikan bahawa peningkatan Beta-band dan penurunan Alpha-band selepas sampel bermain permainan.

Kata kunci: Permainan; gelombang otak manusia; Alpha-band; Beta-band

1.0 INTRODUCTION

As the world is growing up into modern technologies, game has become a popular trend among the people nowadays. It is classified as one of the favourite activities for most of them. Children in the United States played an average of 1 hour and 13 minutes of video games every day in 2009 which are nearly threefold increase from 10 years earlier and people of all ages are playing video games [1]. From the past research, video games contribute to good and bad effect to person. Significantly, the person who plays video

games may have good concentration, memory and good solving skills [2]. But prolonged time of gaming usually causes the brain not to have enough rest and disturb the emotion of the person, mostly stress effect [3]. Game contributes to attitudes, emotional and behaviour of a person. The aggressive thoughts, feelings, and behaviour are more likely to increase when the person playing games [4, 5]. The emotional state of person who played game causes changes to brainwaves signal. In the most recent study state that playing game will lead to stress and depression to human brain [3, 4]. The brain's natural response to stress is an increase of Beta and a decrease in Alpha activity [6]. So a scientific research is needed to prove the exact mind state when person playing game by analyse the brainwave of human brain. There most popular and practical method to analyse the brainwave of human brain is by EEG brainwaves detection.

EEG is a study of electrical potential of the brain measured by the electrodes on the scalps that are rich in information on mental activities and emotional states [7]. Due to its high temporal resolution, EEG provides good observational data of variability in mental status. It has been proven that EEG shows good correlation with the mental stress in terms of alleviation of the Alpha power and the escalation of the Beta power can also indicate that the brain is disturbed [8]. EEG measurement can be implemented to patients, normal adults, and children with basically has no risk or limitation [8]. EEG become one of the most effective tool in measuring brain activity in medical measurement area because of it high capabilities in detecting the normal and abnormal brain electrical activity. EEG brainwave signal characterize by amplitude and frequency. The frequency range of EEG is from 0.5 Hz until 100 Hz. But the frequency from this range is so general and contain some frequency range that does not important, so the EEG signal is separated and divided into four main types of brainwave consist of Delta (0.5 Hz - 4 Hz), Theta (4 Hz - 8 Hz), Alpha (8 Hz - 13 Hz) and Beta (13 Hz - 30 Hz). However this study focused on the probability of adopting Alpha or Beta waves range between 8 Hz until 30 Hz as mental stress indicator. Alpha brain waves is ranging from 8 Hz to 13 Hz, around 8 to 12 cycles per second, which indicates a relaxed state of mind which is good for inspiration and faster in learning facts. Distinct for Beta brain waves, it ranged from 13 Hz to 30 Hz, which is around 13-30 cycles per second that are the fastest, representing the most intense state of alertness which result of heightened mental activity and maximum mind power. EEG signal can be analysed by three different methods which are time-based, frequency-based and time-frequency based [8]. The raw EEG signal is in time-based, so the frequency analysis technique or spectral analysis technique is used to analyse the original signal. Threshold value will be used to remove line noise and Butterworth-band pass filter also applied to the signal. Band pass filter used to extract sub-band of Alpha and Beta frequencies. Fast Fourier Transform (FFT) is applied to extract the signal from time-based to frequency-based. The features extracted are Power Spectral Density (PSD), which is obtained by calculated highest power of the FFT value. If the Beta frequencies of the analysed subjects shows higher rate than the Alpha frequencies, than it shows that the game give stress state of mind to subjects which conclude that game actually give tension to human brain. The data analysis obtained from the PSD value will determine the stress effect of game to human brain signal.

Game is the new addiction that hard to be handled. The problem of game addiction isn't as simple as playing too much or really enjoying video games. The effect of game can be observed through the person mental state and behaviour. The mainly symptom of gaming are aggressive behaviour and health issue. Either the time consume per day to play game is short or long, it still may effect person's mental and physical state. Most people claim that game give stress mental effect because of too much pressure from the game to the brain. Even sometimes by playing game person can feel more enjoy and relax from daily routine, but the prolonged time of gaming still cause the brain to have not enough rest. A scientific research is needed to prove the actual state of brain activity when playing game. So EEG signal brainwave detection was applied to this research to analyse the stress effect of gaming to human brain signal.

The objective of this paper is to observe the state of the human brain before and after playing game and analyse Alpha-band and a Beta-band of human brain wave when playing a game.

2.0 EXPERIMENTAL

The flow chart of methodology starts with data collection (Fig. 1). Then the EEG signals are pre-processed to remove the noise. Next, the Power Spectral Density (PSD) graph is plotted after done Band-pass filter and set the threshold of signal amplitude. After that, all the maximum points of the PSD graph are plotted in a histogram in order to determine the changes of Alpha and Beta band signals.

The experiment will take place in laboratory, located in floor 1 of PSM laboratory. The place can keep away the subject from any disturbance like human noise, noisy surroundings and hot temperature. The variable is control to avoid any interference to subject which may affect the data that will be analysed. The Emotiv Epoc system and Counter Strike (CS) game were installed on the two personal computers (PC) at the laboratory.

Before the Emotiv is placed on the sample's head, Saline water is used to moisten the sensor of the device. It is to keep good signal interface between the head and device. The component of Emotiv needed consist of saline water, headset, Bluetooth device, USB cable for charging and headset cap (Fig.2).

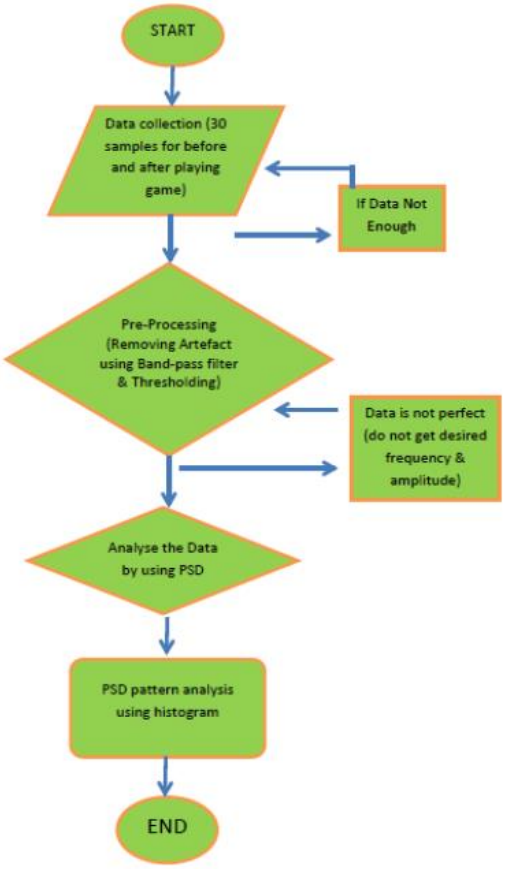

Figure 1 The flow chart of methodology

Figure 2 Emotiv component

The Emotiv is placed on the head of sample to start collecting EEG data. The collection of EEG data before playing the game is collected by the subject closing their eyes for 5 minutes. While closing the eyes they are advised not to fall asleep and move their eyeball a few times. After that they will start playing CS for 10 minutes with the Emotiv EPOC placed onto their head. While playing the games, they need to minimize the movement of hand to avoid any noise which can affect the data. Each experiment took 17 minutes to 20 minutes to complete for each sample. Only Fp1 and Fp2 channel are recorded in EEG collection. The raw EEG data recorded is processed offline using the intelligent signal processing techniques which were developed in MATLAB.

This is an example of EEG data collection (Fig. 3). Both PCs was used, one for capturing EEG signal and other one used for playing the game. Two PCs were used because when the volunteer is playing the game during data collection, the EEG signal captured by another PC need to be monitor to ensure a good signal was captured.

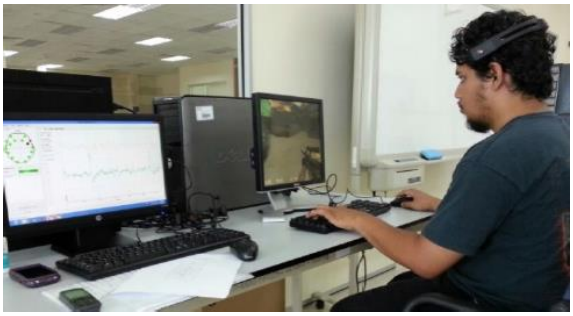

Figure 3 EEG data collection

The EEG raw data for a sample capture from the Emotiv testbench software (Fig. 4). Based on the software, left hand side picture, it shows the contact quality between the scalp and EEG sensor. Green color indicate the signal is good, red indicate poor signal meanwhile black indicate no signal of EEG. The waveform shows the signal from different channel. Only Fp1 and Fp2 channel were recorded. The sampling rate is 128 Hz. From the Emotiv testbench software, channel spacing, minimum and maximum amplitude also can be observed. The data then was analysed by using MATLAB programming tools.

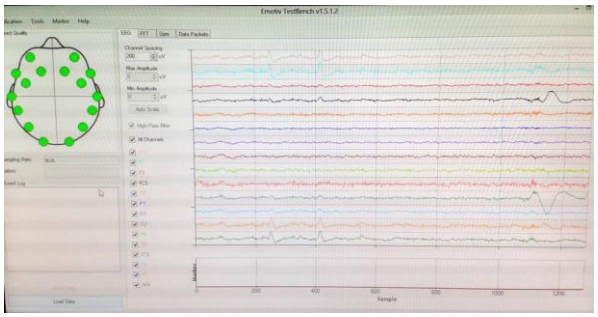

Figure 4 EEG raw data

The pre-processing is the second method in this analysis. In this process, the data was pre-processed by using signal processing and execute in MATLAB software. Two methods which are artefact removal and Band-pass filter were implemented in pre-processing step to analyse the data. Artefact removal was done to remove the noise in the EEG signal which produced by the blinking of the eye and the movement of the sample during the experiment. The

signal was considered as an artefact when it is less than -100 µV and more than 100 µV.

In data analysis, the PSD was used to obtain the signal from pre-processing method. PSD was calculated the highest value peak of PSD graph. Since the frequency domain was in spectral analysis, the PSD signal was obtained by applied FFT to the power of square to the signal. In observing and analysing the PSD pattern for the Alpha and Beta value, histogram chart was used. The values of PSD for all 30 samples were sum up to plot the graph. From the graph, the value for the highest peak for each band will be determined to conclude as a result.

3.0 RESULTS AND DISCUSSION

This sub-section, the analysed result of the experiment was discussed. The aim of the result is to compare the state of brain before playing game than after playing game in term of Alpha and Beta frequency bands of human brainwave.

The PSD histogram from Fp1 channel for one sample (Fig.5). It represents the histogram from one sample. From the figure shown, it can be observed that the PSD value for Alpha decreased after playing a game, while the Beta value increased after playing the game. It is observed that the sample experience higher level of stress compared to relax level.

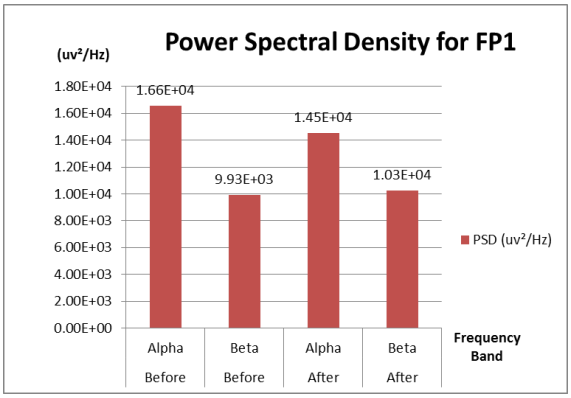

Figure 5 A sample of PSD histogram from Fp1 channel

The PSD histogram from Fp2 channel for one sample (Fig.6). From the figure shown, it can be observed that the PSD value for Alpha decreased after playing the game, while the Beta value also decreased after playing the game. It is observed that the person signal has decreased in both relax and stress state. To get more accurate and clear result, the sum of all 30 samples for both channel were analysed.

The PSD histogram from Fp1 channel for 30 samples (Fig.7). From the figure shown, it can be observed that the value of peak amplitude of Alpha for all 30 samples was decreased after playing the game. Meanwhile for the Beta frequency, it showed high increment after playing the game. It is observed that mind occurred to have stress effect after playing game.

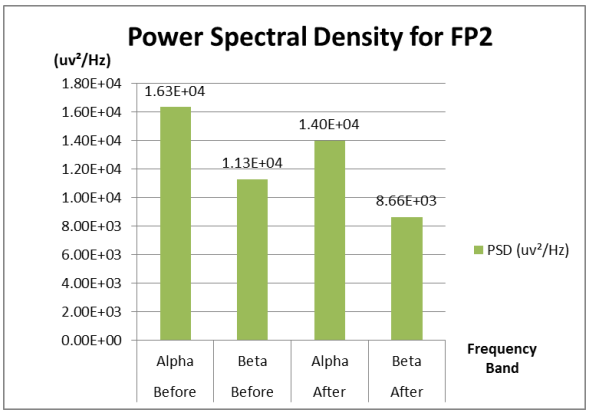

Figure 6 A sample of PSD histogram from Fp2 channel

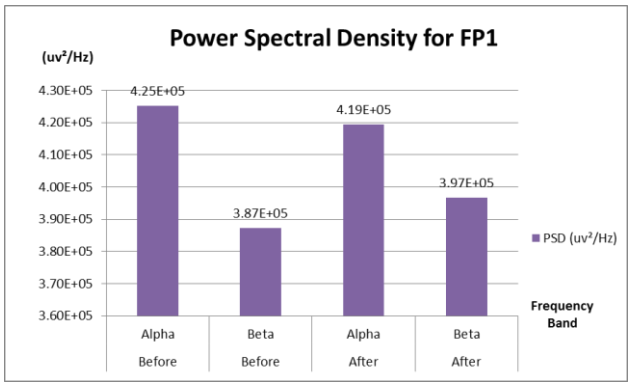

Figure 7 PSD histogram from Fp1 channel for 30 samples

The PSD histogram from Fp2 channel for 30 samples (Fig.8). From the figure shown, it can be observed that the peak amplitude of Alpha for all 30 samples was decreased after playing the game. The difference between the values of Alpha slightly small compared to Fp1 channel. Same goes to Beta band, where it shows that the PSD value was increased after playing the game. Both channels have the high Beta PSD value compared to Alpha value.

From the analysis of all the 30 samples EEG signal, the result shows that Beta frequencies is higher than Alpha frequency for both Fp1 and Fp2 channel. It is observed that people became more stress after playing a game.

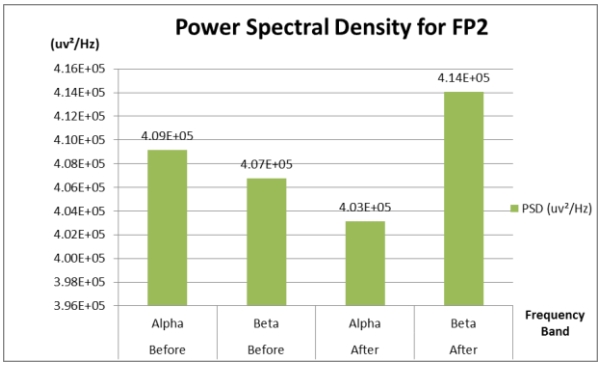

Figure 8 PSD histogram from Fp2 channel for 30 samples

4.0 CONCLUSION

The result of observation of the effect of playing games with human brain waves has been discussed in the previous section. The result was focused on analysis of Alpha-band and a Beta-band of the human brain wave before playing games and after playing games. The analysis is done by observing the PSD pattern from Fp1 and Fp2 channels of 30 samples. The result showed that most subjects experienced higher Beta-band frequency after playing the game, which indicated the person in stress state. For Alpha-band, the frequency was decreased slightly and shows subjects experienced decrement of relaxing state. Therefore, it is observed that the person experienced stress effect when they playing a game.

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