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Research paper

Analysis of Golfer'S Brainwave Signal During Par Tee Ireland and Driving Range Game

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Abstract

Ways to improve sport performance become exceptional contemporary interest. Nowadays, many studies use human brain as an input signal include eyes blinking, attention and meditation to control the exchange process. Brain–Computer Interface (BCI) requires generating control signals for external device by analysing the internal brain signal. The objective is to identify the signal of brainwave which gives effect to performance of golfer. The analysis involved the meditation (α) and attention (β) state of different golf players. In this project, the brainwave of golfer's will be analyzed based on the movement before club strike the ball. EEG signal used to find out the features by using Fast Fourier Transform (FFT). The analysis included three categories of player include beginner, intermediate and professional. Two types of game have been considered which are Par Tee Ireland and Driving Range. The project interfaces MATLAB software with an EEG headset. The data has interpreted in time and frequency domain graph that show different level in an attention (β) state for both games. Brainwave signals indicated players' performance and lead to better performance. This data benefits increasing the performance of golfer to become the professional golfer by using electroencephalography (EEG) headset in future study.

Keywords: *Attention Brainwave; FFT in Alpha and Beta Wave; Focus of Golfer; Neurosky Mindwave.*

1. Introduction

Ways for improving sporting performance become exceptional contemporary interest. Elite sports competitions are major social and cultural events and the constant pressure to enhance results has turned the study of sports performance into huge issue. As a result, sports professionals become interested in brain imaging, both as a route to a better understanding of the basic mechanisms connected to sporting behavior and as a means to create new methods for improving performance. Similarly, as possessing physical prowess, elite athletes must develop a range of sport specific cognitive skills and exhibit superior integration across the domains of perception, cognition and action [1]. In addition, the use of brain stimulation techniques increases critical ethical issues that have yet to be fully notify by sports practitioners for their advantage [2].

A unique way for understanding the performance improvement has been to analyze cerebral activity through electroencephalography (EEG). Besides that, the potential to optimize performance is recommended by training an individual's EEG to increase or decrease in a required direction by individual techniques such as EEG biofeedback (also called neurofeedback) [3]. Therefore, this has potential to be applied to golf sport because golf sport is not an extreme sport, it is a sport required mind to focus to get a better performance [4],[5]. The second reason golf sport it involves a movement that connect to brain wave so it very perfect for this study. For this study to be a success, it must follow the correct process starting from data extraction by MATLAB from the golfer that wear the EEG headset. The data can be interpreted different frequency bands and will be compared to see the state of golfer brainwave whether it is in focus range when do practice or training hitting ball.

In golf sport Malaysia, to get a better performance or if want to be a professional still in traditional way. A new approach wants to be introduced there is by using EEG headset to give a signal to golfer whether the state of their mind in a focus state or not when they do a practice or training. From that, it can help to get a better performance not just the hit the ball blindly without do not know it help to get better performance or not.

2. Problem Definition

To play golf well up to your capability it requires learning how to focus your mind on executing each shot. Golf requires total concentration but just for brief periods of time. Between each shot a golfer is able to socialize with his playing companions or enjoy the beautiful scenery along the course. A golfer can learn how to improve his focus just as he can learn how to improve his swing.

Develop key swing thoughts. These are aspects of your swing that you want to concentrate on, such as making sure your takeaway is slow and smooth. Forget about previous bad shots and focus on the next shot. Dwelling on a missed short putt, for example, only serves to draw your focus away from properly planning and executing the next shot with precision. Many amateur golfers let anger get the best of them and swing too hard or too fast on the next shot with predictably poor results.

2.1. Experimental Procedure

EEG signals can be divided into waves or rhythmic patterns associated with specific signal frequency. The signal generated by activities undertaken by human. In general, brain wave patterns are categorized as delta, theta, alpha, beta, and gamma band which is measured in Hertz (Hz) in cycles per second. Mindwave EEG device was developed by NeuroSky Inc., San Jose, CA. This device consists of eight main sections, ear clips, ear flexible arm, the battery, power switch, adjustable head band, tip sensor, and the sensor arm of Thinkgear chipset [6].
Therefore, the aim of this project was implemented to investigate the level of human attention. Figure 1 shows the overview of the entire project.

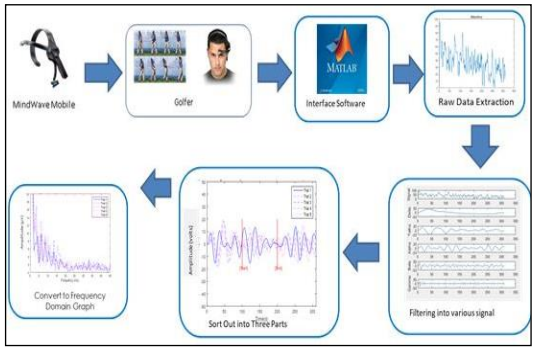

Fig. 1: Block diagram of the entire project

The flow process of raw data is convert to the final graph as in this software, the script has been creating to read the attention code from golfer as a raw data in time domain. The process is shown process raw data to until the frequency domain. Figure 3 shows the flow process raw data of brainwave of golfer.

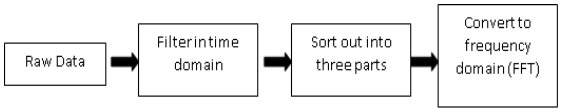

Fig. 2: Flow process raw data of brain wave of golfer

2.2. Data Conversion to FFT

The EEG data signal in form of time domain actually harder to extract than in form of frequency domain where some of the features are hidden and can only be remarked in frequency domain. The time domain signal represented by a waveform where the analysis is mainly based on the voltage – time plot or current – time plot. In time domain analysis, the variable is always measured against time. Its operation is not very informative or efficient in signal processing. Frequency domain signal can be represented by a spectrum and good for automatic recognition by computer. Fast Fourier Transform is one of the technique that can be used to convert the signal from time domain to frequency domain. Fourier series is used to describe a periodic signal x (t) in the form of sine and cosine (or complex exponentials). Figure 3 shows the raw signal and single sided amplitude spectrum from mindwave.

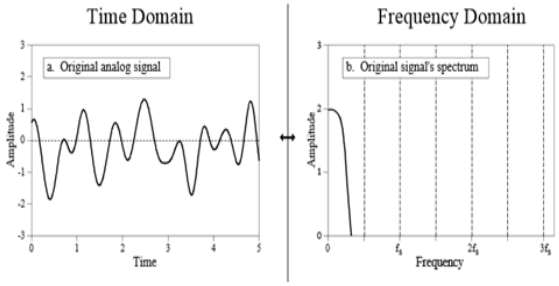

Fig. 3: Raw signal and single sided amplitude spectrum

3. Results and Discussions

In this project, the data had collected based on three categories; beginner, intermediate and professional player. Each player has two different of games that consists of five hits for each player. The data collection performed within 310 second for each trial. The assumptions of all games within 310 seconds will be divided into three parts of data. The shortcoming of EEG headset is it has lag in 10 s before reading. Thus, the reading of brainwave was taken in every trial within 5 minutes and 10 seconds. Figure 4 shows how the data of 310 seconds divided, the detailed as follows:

i. a = 10 – 100 second, extraction α wave (Ready state)
ii. b = 100 – 200 second, extraction β wave (Focus state)
iii. c = 200 – 310 second, extraction α wave (Normal state)

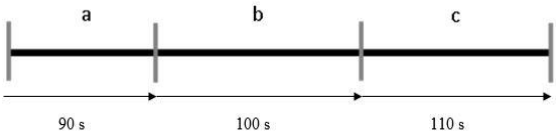

Fig. 4: Parts of data division

3.1. Analysis in time and frequency domain

The analysis for this project in the first game and second games include of two types the first one is time domain and the second is frequency domain graph. Besides that, there are three types of player which is player 1 as beginner, player 2 as intermediate and player 3 as professional. For the first game, it consists of five trials that need a higher focus of player to make a hit for ball target into the hole (dogleg). In a second game it consists of five trial, but in this game, player will need a set a certain target of distance on their mind, so it needed the level of focused and totally different in the first game. For this game player will make a high swing using a club in driving range. The graph is divided into three parts for the first is when player in a ready state, the second is when player in a focus state and the last is after the hit it the brainwave return to relax state. Figure 5 shows the Par Tee Ireland games and Figure 6 show the Driving Range games.

Fig. 5: Par Tee Ireland

Fig. 6: Driving Range

3.1.1. Example of Trials (Ready State)

Figure 7 shows the graph of time domain and Figure 8 shows the frequency domain graph of the Alpha wave signals for player in first game before player make a swing, it is between 10 to 100 second.

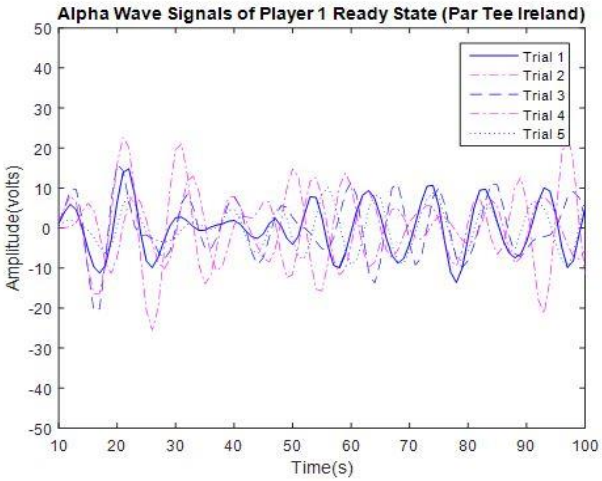

Fig. 7: All trials in Time domain- Ready State (α)

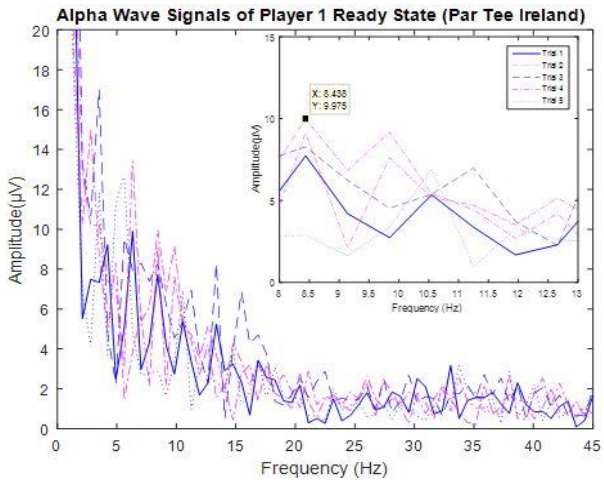

Fig. 8: All trials in Time domain- Ready State (α)

3.1.2. Example of Trials (Focus State)

Next, the Figure 9 shows the graph of time domain beta wave for player during hit at a focus state. Figure 10 shows the frequency domain graph of the Beta wave signals for player in first game during hit, it is between 100 to 200 second. For the brainwave pattern, it shows the most random pattern is the best attention state. The brainwave pattern for the beta wave state the lower the amplitude in a time domain is the good focus of player.

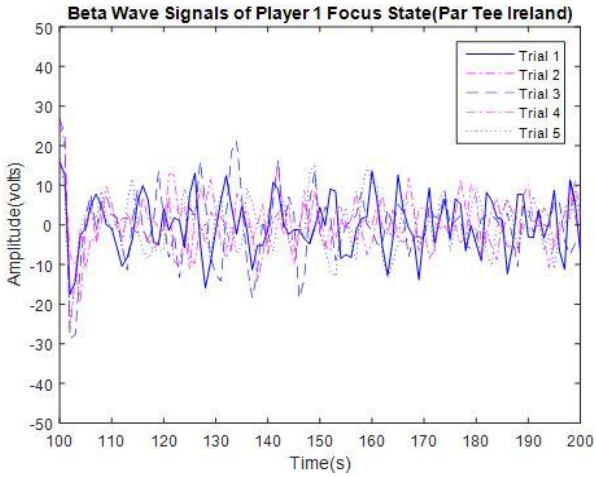

Fig. 9: All trials in Time domain- Focus State (β)

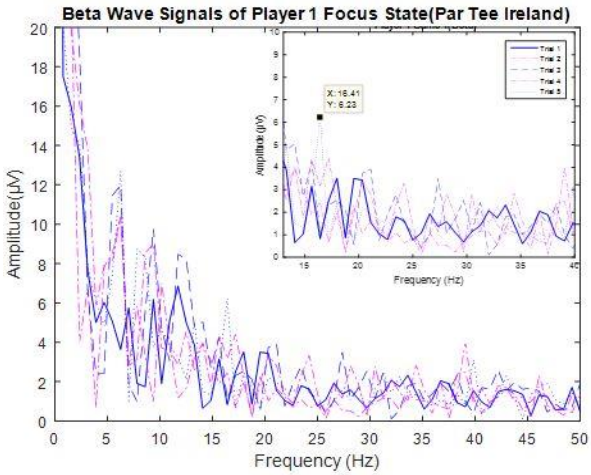

Fig. 10: All trials in Frequency domain-Focus State (β)

3.1.3. Example of Trials (Normal State)

After entering the focus state the player return to normal state which is alpha state. Figure 11 shows the graph of time domain and Figure 12 shows the frequency domain graph of the Alpha wave signals for player after player make a hit, it is between 200 to 310 second.

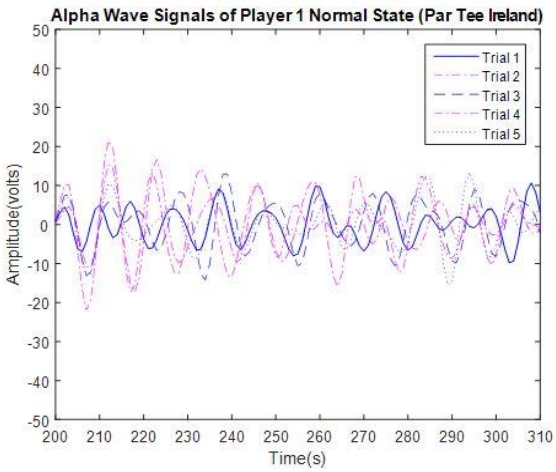

Fig. 11: All trials in Time domain- Normal State (α)

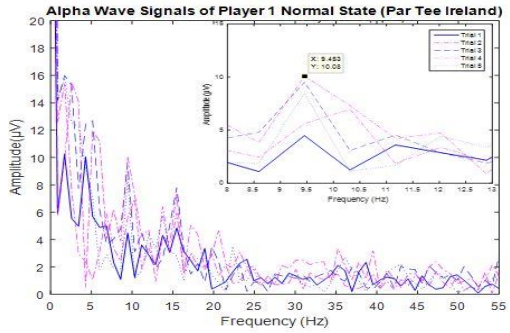

Fig. 12: All trials in Frequency domain - Normal State (α)

4. Discussion

The analysis will be divided into three parts comprises time and frequency domain for player 1, 2 and 3. Each player will enter the two state of wave which is first one is high alpha (ready state), second is beta (focus state) and last one low alpha (normal state). Based on data that been plot in graph the value of the best frequency is being tabulated into the table to see a different between player in both band wave whether in alpha or beta wave. Based on the graph been plotting, the data for every highest peak point for each trial can be tabulated into a table in a value form.

Table 1: Amplitude data for all trials at first game (Par Tee Ireland)

Player	State of Player	Trial				
		1	2	3	4	5
	R (α)	7.733	9.138	8.285	9.975	6.91
1	F (β)	3.519	3.985	5.05	4.436	6.23
	N (α)	4.48	6.96	9.512	10.08	8.499
	R (α)	6.357	10.07	3.852	7.539	6.846
2	F (β)	4.659	5.228	3.669	5.808	4.839
	N (α)	6.161	10.12	8.044	6.076	13.56
	R (α)	6.806	9.988	8.289	7.89	8.138
3	F (β)	8.718	5.89	6.743	3.637	8.266
	N (α)	9.157	4.184	10.62	10.51	8.118

R=Ready, F=Focus, N=Normal

Table 1 shows the data for all trials in the first game (Par Tee Ireland). From the table, it shows the best signal of brainwave for every player in which trials. For the player 1, the trials 4 shows the best amplitude data which is well balanced for ready and focus state and at the trial 4 shows for the ball in. While for the player 2, at the trial 1 the player already shows the best amplitude signal. Lastly, for the player 3 at the trial 2 give a well-balanced amplitude signal of brainwave.

Table 2: Amplitude data for all trials at second game (Driving Range)

Player	State of Player	Trial				
		1	2	3	4	5
	R (α)	9.425	8.446	10.13	8.695	8.599
1	F (β)	3.615	2.854	5.029	5.271	5.935
	N (α)	8.452	6.937	8.471	6.536	6.132
	R (α)	6.632	6.81	12.94	9.552	8.095
2	F (β)	5.845	5.247	6.92	4.032	4.058
	N (α)	9.952	8.458	9.365	6.387	7.215
	R (α)	8.453	9.29	9.942	4.251	8.886
3	F (β)	3.34	5.131	6.658	3.741	6.411
	N (α)	10.33	7.471	5.839	6.823	5.679

R=Ready, F=Focus, N=Normal

Table 2 shows the amplitude data for all trials in the second game (Driving Range). Based on the Table 2 it shows the best signal of brainwave for every player in which trials. For the player 1, the trials 3 shows the best amplitude data which is well balanced for ready and focus state but at the trial 3 shows the distance that player get is at minimum range. While for the player 2, at the trial 3 shows the best amplitude signal and the highest distance range for intermediate player. Lastly, for the player 3 at the trial 2 give a well-balanced amplitude signal of brainwave and at this trial player 3 get the highest distance from other player.

5. Conclusion

As a conclusion, the aim of this project to identify the brainwave signal to golfer performance is achieved. The usability and reliability of the EEG Headset on the MindWave Mobile has been confirmed, hence able to be utilized in this project. The EEG Neurosky Mindwave is work in meditation (α) and attention (β) state which is alpha and beta band.

This project used Matlab software as interface to evaluate the performance of the EEG signal by using plotting into graph. This design assured in order to facilitate the process of assessing performance and making analysis between attention (β) and meditation (α). The coding is designed to show the attention signal and raw EEG signal time domain and then convert to frequency domain. It is used to perform the data collection.

The analysis has been done between three categories, which are beginner, intermediate and professional player. The data are taken based on attention state to compare the performance between these two bands. The analysis is done by collecting data of every player between two different games. From the comparison between each player in two type of games, it can be concluding that the most suitable player for a better brainwave is professional player based on attention state. This player brainwave pattern has most significant band between each part of games. The result shows that in the first game (Par Tee Ireland) the average value between each player is different based on the level of player in attention (β) state, the average amplitude value for player 1 is 4.2105 μV, player 2 is 4.712 μV and player 3 is 6.6508 μV. Meanwhile, in the second game (Driving Range) the average amplitude value for each player in a attention (β) state which is for player 1 is 5.029 μV, player 2 is 6.0835 μV and for player 3 is 4.2355 μV. Based on this two games player 3 shows the best amplitude data at the first game because the player can hit all to ball in but at the second game player 2 shows the best amplitude data rather than the other two player. By using the professional player brainwave pattern as reference, the attention EEG signal will easier to classify because at the first game is used more attention (β) state rather than the second game. So, the most prefer brainwave signal is pick from the professional player. The reference brainwave signal will be used in order to alert players whether their brainwave in the attention state or not, it is to improve the performance of golfer.

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