BRAINWAVESCLASSIFICATION TOWARD HUMANEMOTION BASED ON EEG SIGNAL

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ABSTRACT

The important role of communication between human's brain and computer has been increased during the last years. In this research, the main focus of this thesis isanalysingbrain wavesthat associated with the internal emotion of human. The analysing processis achieved by reading the EEG signals from user brain.NIA deviceis used in this research to read the signals from the frontal lobe of the brain. This sturdy base on reading brain wave signals in order to be representedas an avatar facial expression. The aim of this research is to show the influence of alpha and beta brain waves toward emotion classification through EEG signal. In addition,the researchis analysing brain signals in order to represent happy and sad emotions. The classification of human emotion through brain computer interface can be interpreted through speed of brain waves signal. The velocity is used to calculate the speed of brain signals for each emotion. The results provedthat the velocity of sad emotion is faster than happy emotion. As a conclusion, this research shows the speed for each emotion which can be used to specify the internal emotion characteristic of a user. User emotion is represented as a facial expression of virtual human in 3D environment. These results can be used to create a good classification because it specifies the average of speed for each emotion.

ABSTRAK

Peranan komunikasi dan computer merupakan di antara otak manusia bidang yang semakin meningkat kepentingannya dalam beberapa tahun kebelakangan ini. Dalam kajian ini, focus utama adalah menganalisa hubungan di antara gelombang otak dan emosi dalaman manusia. Proses penganalisaan dapat dicapai dengan membaca isyarat EEG dari otak manusia. Peralatan NIA digunakan dalam kajian ini untuk membaca isyarat dari lobus hadapan otak. Isyarat gelombang otak dibaca dan diwakilkan melalui paparan ekspresi wajah. Matlamat kajian ini adalah untuk mengkaji pengaruh gelomban gotak alpha dan beta terhadap klasifikasi emosi melalui isyarat EEG. Kajian ini memfokus kepada analisa isyarat otak untuk menentukan emosi gembira atau sedih. Klasifikasi emosi manusia melalui antara muka otak-komputer boleh ditafsirkan melalui kelajuan isyarat gelombang otak. Halaju digunakan untuk mengukur kelajuan isyarat otak untuk setiap emosi. Hasil kajian mendapati halaju isyarat otak untuk emosi sedih adalah lebih tinggi dari emosi gembira. Kesimpulannya, kajian ini menunjukkan bahawa kelajuan isyarat gelombang otak boleh digunakan untuk menentukan emosi dalaman manusia. Hasil penentuan emosi manusia diwakilkan melalui ekspresi wajah manusia maya dalam persekitaran 3D. Hasil kajian boleh digunakan untuk mencapai klasifikasi yang baik kerana purata kelajuan isyarat gelombang otak untuk setiap emosi dapat ditentukan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The main role of brain computer interface (BCI) is to provide a realisticinteraction between user and computer applications. BCI system can help people to make a control on the real environments for example a television, lighting the room or computer according to their brain signals (Fatourechi*et al.*, 2007).It is very complex task to translate human brain signals into orders to be represented in computer applications like 3D character because it needs signal classification and feature extraction in addition to translate the features into device commands by using translation algorithms. At the same time, facial animation control of 3D character is not easy because of the complexity of facial parts.

In addition to using the BCI system in different applications, emotion recognition plays significant role in human daily life. The applications of emotion recognition have been used in various fields such as entertainment, E-learning and virtual worlds, etc. The significance of emotion recognition increased because of the importance of human computer interface applications. The editing process of facial expression in 3D virtual human environment is not easy to control and manipulate. Basically, Emotions can be recognized based on speech, text, or facial expressions(Yisi *et al.*, 2010).

Specific properties of user brain activities which are related to intention control of user emotion are measured. These properties are translated to control

devices. In general, Facial expression of virtual human can be controlled in several ways. Previous control methods only focused on user involvement without reflecting the inner emotion of the user. In fact, new control that can accurately transfer emotion of user into virtual human is becoming critical issues of the research. This research attempts to provide a goodclassification of brain waves toward human emotion by reading the brain wave signal, classify, interpret and transfer it to virtual human.

1.2 Problem Background

The productivity of BCI research programs has been improved during the last few years. One of reasons to increase BCI programs is the necessities of disabled people. These programs focused on improving new technologies for communication and control between human brain and virtual human. The main target of BCI systems is to provide primary communication capabilities of disabled people until they can express their internal feelings and make contact with other people in addition to implement some basic programs like word program(Wolpaw *et al.*, 2002).

BCIrely onthe brain electrical signal to create a good representation of human brain waves. On the other hand, facial expressions are very important to create natural interaction between brain signals and virtual human in 3D virtual environments. The previous researches generated interaction between human and avatar; they focused on building a scheme to recognize facial expressions by using facial motion graph (FMG).

The recognition of facial expression depends on the similarity between the FMG of the user and the new FMG model by using continuous dynamic programming (Yan and Haihong, 2001).Different methods and techniques are

proposed for facial expression recognition which used active appearance model (AAM) by extract the facial feature points then analyse local facial changes and use some simple facial features to form an effective classifier (Fangqi and Benzai, 2007**)**. Other methods used Gabor filter for feature extraction of facial expression recognition from simple static facial images in order to create interaction between human and avatar(Lajevardi and Lech, 2008).

Previous researches used facial feature extraction of 3D face based on two main processes: extract features and feature point projection of the face. The two processes are using Viola-Jones to detect about face and Active Shape Models (ASM) to extract the features. These methods created facial animation on 3D character from realistic sequences of real face image(Sumarsono and Suwardi, 2011).

In addition, the studies focused on creating interaction between user and avatar based on facial recognition of user by extract user facial features then represented by avatar facial expressions. On the other hand, other researchers developed using brain waves for human emotion detection depend on electroencephalogram EEG of human (Almejrad, 2010). On the other hand, several studies have been concentrated on using EEG for emotion classification based on particular features of the user.The previous studies used a particular stimulus for human emotion acquisition.

After getting emotions, they proposed using neural networks with back propagation algorithm for emotion representation from EEG signals(Yuen *et al.*, 2011).As a result, many researches focused on facial expression of virtual human in 3D environment. The essential aim was to create interaction between human and virtual human without paying attention on represent internal emotions of the user as an avatar facial expression.

As a conclusion, BCIrelies on the interaction between user brain and computer applications. Thisresearch tries to translate user intent into commands to be represented as avatar facial expression in order to achieve the goal of the research. Future technology will concentrate on human recognition because of BCI researches are a multiple discipline problem which includes engineering, psychology, mathematics in addition to computer science.

1.3 Problem Statement

In this research, there are many research questions need to be answered. The most important question is how to classify the brain signal for the inner emotion of user to be represented as avatar facial expressions.

These are some research questions:

- Why we need to represent human emotions based on brain signal classification?
- What is the parameter that can be used for brain signal classification?
- How the brain signal is used to classify the internal emotion of user?
- Which type of avatar facial expressions is shown in this research?
- How many human emotions are classified in this research?

1.4 Research Objectives

The main research objectives are:

- Toidentify parameters of human brain signals that associated with the internal emotion of human.
- To analyse human brain signal based on signal speed of two basic human emotions happy and sad.
- To evaluate human emotion based on emotion strength.

1.5 Research Scope

The objectives of the research are achieved by identifying the scope which covers the following aspect.

- This research only focuses on reading brain signal which is coming from commercial brain computer interface that has two signal alpha and beta.
- This research focuses on classifying brain signals of human which associated with happiness and sad emotions to be represented as avatar facial expression.
- In this research, the time frequency technique is used for signal classification.

1.6 Significance of Research

This research attempts to achieve goodrepresentation of human emotion based on the brain signals. The classification of brain wave signals is used to represent two basic emotions happy and sad. As a result of that and depend on reading brain signals from EEG of user, this research classifies the signals which associated with the inner emotion of the user then transfer it to virtual human to create a good representation of human emotions.

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