

Brain Computer Interface Control for Facial Animation

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Abstract—In this paper, we describe the inner emotions of user to build a natural interaction between brain activities and 3D virtual human in virtual environment by classifying the signals according to alpha and beta frequencies. The classification of brain signals will help to determine range of emotion. We only focused on two primary emotions which are representing calm and focus mode. These two main emotions will be used as the basic for other emotions.

Index Terms—inner emotion, 3D virtual human, virtual environment

1 INTRODUCTION

In these days, we have seen expansion of human technology and growth of communication. The main role of brain computer interface (BCI) is to provide a communication between human and computer. The significance of emotions recognition has increased because of the importance of human computer interface applications. The editing process of facial expression is very complex process. Basically, we can recognize the emotions from the speech, text, or facial expressions [1].

The main element in brain computer interface is using algorithm that converts brain signals from the human into commands which make control for the computers. The operations of (BCI) depend on effectiveness between the controllers. Good (BCI) will enables people to make control for some aspect of their environments for example a television, lighting the room, or computer depend on their brain signals [2].

It's very complex task to translate human brain signals to be represented in virtual human because it needs signal classification features then translate these features into device command by using translation algorithms. At the same time the Control for the facial expressions of a computer which generate 3D virtual human is a complex problem because the face has a lot of details. Specific properties of brain activity that relate to user's intent to the control process on a computer.

In general, Facial expression of virtual human can be controlled in several ways such as slider based or GUI. Previous control like slider based or GUI [3], only focused on user involvement, the emotion didn't reflect the inner emotion of user. In fact, new control that can accurately

transfer emotion of user into virtual human is become a critical issues of the research.

2 RELATED WORK

During the past few years, productivity for (BCI) research programs has started. (BCI) programs increased because of the needs for disabled people. These programs concentrated on improving new technologies for communication and control between human brain and virtual human. The main target of (BCI) was to provide disable people with the basic tools that help them to communicate with the others and to implement some programs

Emotions are very important in our life. The application for emotion recognitions have been used in different fields such as games and educations, etc. [4].

On the other hand, facial expressions are very important to create a natural interaction between brain signals and virtual human in 3D virtual environments. The previews researches created interaction between human and avatar. They focused on using facial motion graph (FMG). The recognition of facial expression based on the similarity between the (FMG) of user and the new (FMG) model by using continuous dynamic programming [5]. There are Different methods and techniques proposed for facial expression recognition which used Active Appearance Model (AAM) by extract the facial feature points then analyze local facial changes and use some simple facial features to form an effective classifier [6]. Other methods used Gabor filter to feature extraction for facial expression recognition depend on the simple static facial images [7].

Previous researches used facial feature extraction control of 3-Dimensional face model by using two main processes: facial feature extraction and feature point projection.

The two processes are using Viola Jones for the face detection and Active Shape Models (ASM) for the

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extraction. These methods generated facial expressions animation on 3-D face model from the Real-time image sequences of real human face [8]. In addition to using the real time image sequence of human face to generate facial expressions animation on 3-D face model, other researchers developed using brain waves signals for human emotion detection depend on the (EEG) electroencephalogram of human [9].

As a result, we can get a 3D facial expression for virtual human by using different methods. One of the most common methods to generate 3D facial expression depends on the manipulation process of 2D image. The manipulation process of 2D image based on the movement of number of control points by user [10]. As a conclusion, (BCI) depends on the interaction between user brain and computer. This interaction is to translate the user's intent into commands for device to achieve different purposes.

Future technology will base on recognition because of (BCI) research is a multiple disciplines problem, which includes engineering, psychology, mathematics, in addition to computer science.

2.1 Brain Computer Interface

BCI means the direct communication channels between brain and computer. Many devices used to concentrate on reading brain signals and transfer these signals to the computer. Most of these devices can be used to disabled individuals to improve their abilities. The growth of using human computer interface (HCI) can be used in different fields [11]. Some researchers used a new channel to communication which related to human brain signals according to electroencephalogram (EEG) and other measure tools. The primary role of EEG is to explain the brain activities.

In these days, (BCI) can help to determine the intention of people according to the brain signals. Electrical signals of human brain provide a good representation of emotion condition of human which can be used as a controller for avatar or robot. There are different methods used to detect and read brain signals functions.

EEG is widely used because it's easily to implement and control from the other methods which using to explain brain signal functions. As a result, most of the BCI models depend on EEG. BCI based on EEG to change the electrophysiological into commands to computer [4]. BCI system consists of input (user electrophysiological activities), also have output which represent (the commands to device) and the last thing is the tool which translate input to output.

3 METHOD

3.1 Brain Computer Interface & Facial Animation

Human facial animation is a challenging problem because human face consists of many parts and a lot of details. So the animation of these points is not easy to control and manipulate. Facial animation is very necessary in our live and in different fields like, medicine psychology and computer graphics. Without facial animation, we can't generate facial expressions because facial animation for 3D virtual human depend on the points movement of 3D facial model that generate human expressions like fear, happiness, sadness, and anger. Many techniques used for facial animation. The main target for these techniques is to control on the face parts. Facial animation can be categorized into two types: parameterization and interpolation.

Interpolation is easy to use and control for 3D facial animation from other techniques. This method is simpler than other methods because it concern about providing a key-frames. Key- frame animation needs all the properties of the geometric model of all facial expressions. The weakness in this model is time consuming so that this model is suitable to intermediate expressions. In the same time, this technique is very effective. Interpolation based on a bank of facial expressions. To decrease this problem of interpolation approach, the researchers suggested a parameterization of facial animation. This model depends on one basic model to any face so we don't need to use bank of facial expressions. They concentrated on create optimal control for the face and the control for the facial expressions will be independent from the other face controls. [12].

3.2 Brain Signal Classification

One of the most important characteristic of interaction between human brain and avatar is feature classification. We can classify human brain signals which based on EEG into five primary types of frequencies Alpha, Beta, gamma, delta and theta. In our experiments, we only focus on two types of frequencies alpha and beta. The control on avatar expression depends on frequency range for alpha and beta. The human has many emotions like fear, happiness, sadness, anger and so on. We can categorize each emotion into specific range of frequency. From our experiments, we get two states relax and concentrate mode. as shown in Table 1, 2.

TABLE 1. RANGE OF FREQUENCIES FOR RELAX MODE

Brain Waves	Sec1	Sec2	Sec3	Sec4	Sec5	Sec6
Alpha1	11	9	10	9	6	15
Alpha2	1	2	14	6	1	2
Alpha3	1	1	3	1	1	2
Beta1	5	2	1	1	1	1
Beta2	1	1	3	1	1	1
Beta3	1	1	1	1	1	1

Alpha divided into Alpha1, Alpha2, Alpha3 and Beta divided into Beta1, Beta2, and Beta3. The frequency ranges from 1 to 20 Hz.

In table1, the value that we got it for relax mode start from 1 to 15Hz. On the other hand, we got different values for the concentrate mode. As shown in Table 2.

TABLE 2. RANGE OF FREQUENCIES FOR CONCENTRATE MODE

Brain Waves	Sec1	Sec2	Sec3	Sec4	Sec5	Sec6
Alpha1	20	15	7	19	20	12
Alpha2	12	13	7	15	17	18
Alpha3	2	7	9	7	13	9
Beta1	5	7	10	8	4	5
Beta2	18	9	5	5	8	12
Beta3	20	20	20	20	20	20

In table2, the value that we got it for concentrate mode is from 2 to 20. As a conclusion, and after many experiments, we can see the difference between relax and concentrate mode. In relax mode, we didn't get the maximum number of frequencies. The number of frequency in each second for relax mode is less than the number of frequency for concentrate mode during the same time. The frequency is the number of wavelength during certain time. In this case, the certain time is six second for relax and concentrate mode but the number of wavelength in concentrate mode more than the number of wavelength for relaxes mode.as shown in figure1 and 2.

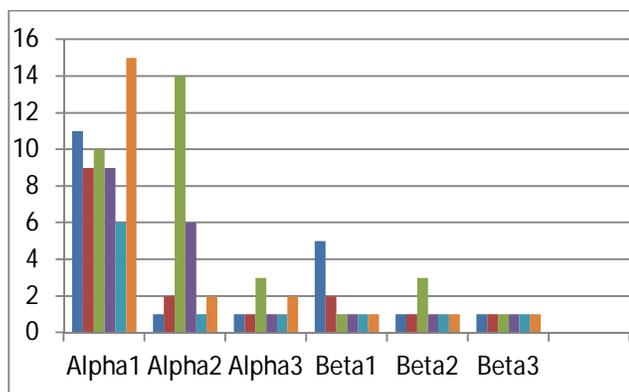


Fig.1. Relax Mode Flowchart.

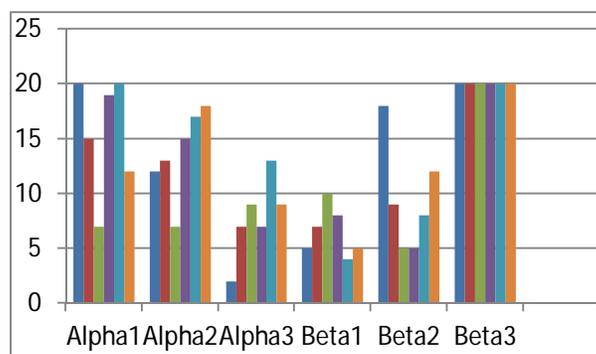


Fig.2. Concentrate Mode Flowchart.

4 CONCLUSION

As a result, facial expressions can be categorized according to relax and concentrate mode to create the natural interaction between user and avatar. Human emotions will depend on these two emotions to create the interaction. The interaction will be more effective because it based on the inner emotion for user by using alpha and beta signals to build that communication.

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