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# Emotional Icon Design representative Game Player's state of emotion using Brainwave

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**Abstract.** The purpose of this study is to design a model to evaluate emotion felt by game players while they are playing game, by means of analyzing brainwave. According to the studies in physiological psychology field, it is known that person's emotional state is interrelated with biological reaction of human body. Furthermore using those biological data has an advantage that it can distinguish person's emotional state in subjective way compared to the survey method. In this paper, we propose new model enabling to evaluate person's emotion using brainwave. To use brainwave in evaluating emotion, we analyzed brainwave by extracting data through two channels, Fp1 and Fp2 and used Fast Fourier transform (FFT) to convert the data. Then we applied the resultant data to our emotional model.

**Keywords:** Interactive art, Artworks, Immersion, Media art, Installation.

## 1 Introduction

As IT convergence technology has evolved, the importance of user's emotional state and bio-signal based service has emerged in development of products and contents. At the same time, it has become a key successful factor in emotional engineering to capture user's bio-signals varying at user's emotion. Furthermore, as the development of human-center products has increased, the studies on usability evaluation through survey such as Jakob Nielsen[1] have been actively conducted. However, usability evaluation through survey has drawback that comes from the fact that the survey tends to be subjective by nature. It means that the evaluation results done by different users for the identical product or service are not consistent. To overcome this problem, a number of studies on recognition of user's emotion based on bio-signals such as brainwave, pulse wave, respiration, skin conductivity and electrocardiogram are actively performed[2][3].

Among various contents, especially, game is necessary to evaluate in diversified way. Considering the game production process at the moment, there is a process to

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verify and evaluate quality for the core functions of game. However, this verification process too much focuses on finding out the missing part of core functions and picking up the critical defects in specific parts rather than emphasizing on curiosity stimulating emotion. Game evaluation system is almost same as the conventional game production process. Thus it is strongly necessary to construct new evaluation system enabling to assess user's emotion as well as usability.

The purpose of this paper is to design a model that can evaluate the user's emotion in an objective way by measuring brainwave while the game player is doing game. Chapter 2 describes the related works including game evaluation system, emotional engineering model and electroencephalogram(EEG). Chapter 3 presents the design of emotion evaluation model using brainwave. Finally, chapter 4 draws conclusion.

## 2 Related Works

### 2.1 Emotion Recognition Index

Electroencephalogram (EEG) is an electric signal generated by cooperative action of brain cells. Human brain presents a large number of movements depending on interconnection and activity of millions of neurons in human brain. Brainwave is a record of these brain activities. Recently, there are a number of studies actively conducted with focus on analyzing the brainwave, measuring the game player's states and applying the brainwave signal to the game interface [4][5][6]. This method can be applied to the game test even in the development phase. Analysis index is necessary in order to obtain quantitative values of positive/negative, arousal/relaxation corresponding to the measured bio-signal level.

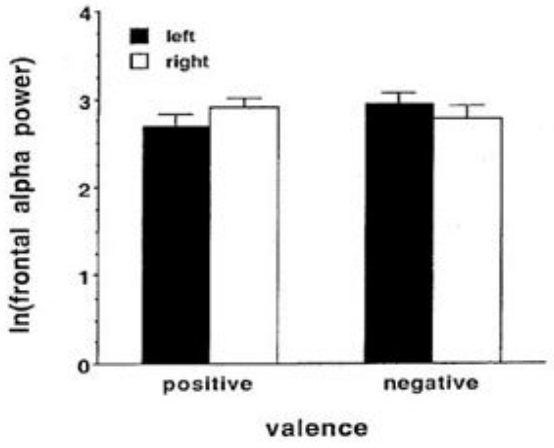


**Fig. 1.** Asymmetric index

 

To decide whether person's brain is in positive or negative state, we use the asymmetric index which indicates that left-brain is activated in case that user has positive emotion and right-brain is activated in case that user has negative emotion [7]. Brainwave of the frontal lobe is measured to distinguish how much left and right brain is activated. Asymmetry between left and right brain can be compared using the level of alpha wave. To distinguish that the state is in arousal or in relaxation, we use SEF (Spectral Edge Frequency) which is an index to quantify a bias between high frequency and low frequency. This is based on the characteristics that people's brain generates high frequency wave in arousal state and low frequency wave in relaxation [8].

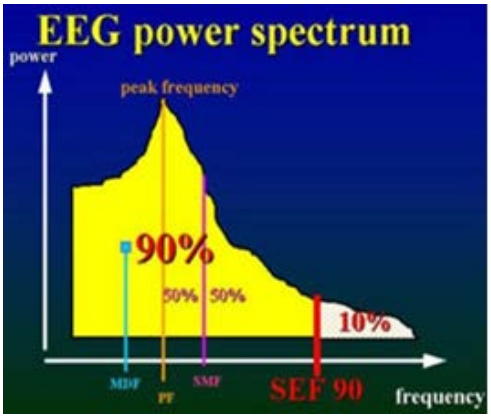


**Fig. 2.** SEF-90

## 2.2 Emotional Engineering Model

The emotion evaluation index can be constructed by several steps. First step is selection of emotion dimensional model. Second step is applying the extracted values obtained from the brainwaves to the model. Then the user's state can be obtained in quantitative way. Emotion dimensional model has been completed by contribution of a number of researchers including Michelle, Russell, Thayer and Zhang. In particular, emotion model introduced by Russell[9] is a Circumplex Model with three basic emotional states: pleasure, arousal and domination. Since this model requires the cognitive analysis, it considers two states, pleasure/displeasure and arousal/relaxation as two principal components. Emotional states can be represented in a two-dimensional emotion-space made up of two axes. In this paper, we analyze brainwave and quantify the value ranging from -5 to +5 at pleasure/displeasure and arousal/relaxation axes. We will apply the quantified values to Russell's emotional model.

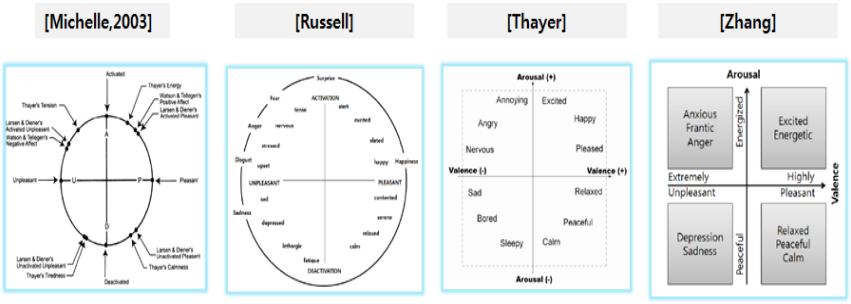


**Fig. 3.** Emotion Dimensional Model

## 3 Model and Emotion Cognitive Index Design

### 3.1 Emotional Model Design

In this study, we propose the method that enables to quantify brainwave signal recorded from the subjects into value ranging from -5 to +5 in real-time at the basis of two axes (pleasure/displeasure and arousal/relaxation) employed in Russell's emotional model. Horizontal axis represents Valence level for pleasure/displeasure., while vertical axis represents Arousal level for arousal/relaxation. Figure 4 depicts emotional cognitive process through analyzing brainwave signal. Based on the quantified level of arousal and valence, we produce a set of emotional icons with 11th different level for better understanding for user.

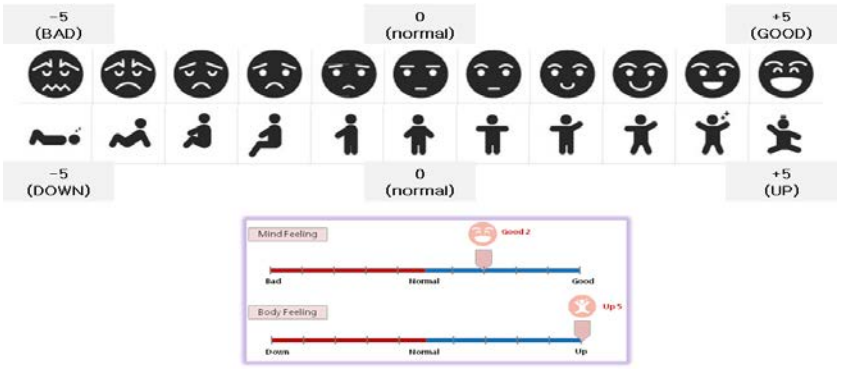


**Fig. 4.** Emotional Icons

### 3.2 Design of Emotion Cognitive Index Using Brainwave

Experiment was conducted by extracting and analyzing the signal generated by the frontal lobe which involves in controlling emotion using two channels (Fp1 and Fp2). For doing this, firstly, we calculated asymmetric index based on the difference of alpha waves coming from left brain and right brain. Then we applied the asymmetric index to valence which is pleasure/displeasure axis. SEF value was applied to arousal value at arousal/relaxation axis. SEF indicate the frequency at the position where sum of total power spectrums starting from 0Hz becomes x%. SEF is also used for monitoring depth of anesthesia. SEF-95 is suitable for evaluation of arousal level. Figure 5 illustrates the emotion recognition process.

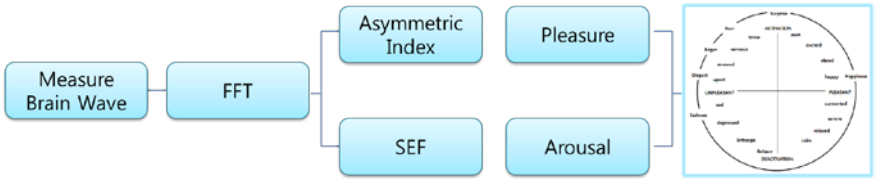


**Fig. 5.** Emotion Recognition Process

## 4 Conclusion

Recently, products and contents have been developed with focus on better usability and user's emotion rather than their functions. Among wide range of products, especially, game requires the method to evaluate fun, usability and emotion since the production of game needs vast amount of money and time. In this paper, the model to evaluate an emotion of game user using brainwave has been designed.

For future work, we would measure the emotion of users by adopting the model proposed in this paper after constructing experiment group. Acquiring measurement data, we will create emotion DB to store the data. Based on the DB data, we will compare our method to traditional survey method. Furthermore, we will verify reliability of our emotion evaluation model.

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