A Study on Brain Information Processing Mechanism for Music Genre Distinction

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Abstract—Cultural Content Technology (CT, Culture Technology) for the development of cultural industry and the commercialization of technology, cultural contents, media, mount, pass the value chain process and increase the added value of cultural products that are good for all forms of intangible technology. In the field of Culture Technology, Music by analyzing the characteristics of the development of a variety of applications has been studied. Associated with EEG measures and the results of their research in response to musical stimuli are used to detect and study is getting attention. In this paper, the musical stimuli in EEG signals by amplifying the corresponding reaction to the averaging method, ERP (Event-Related Potentials) experiments based on the process of extracting sound methods for removing noise from the ICA algorithm to extract the tone and noise removal according to the results are applied to analyze the characteristics of EEG. In addition, using LORETA (Low Resolution Brain Electromagnetic Tomography) program have attempt to simulate the brain CT scan. LORETA programs by using the active region of the brain to review and listen to music when trying to identify new areas of the brain response that is meaningful.

Index Terms— EEG, Event-Related Potentials (ERPs), Timbre, Brain-Computer Interface, LORETA

I. INTRODUCTION

The past 10 years the field of neuroscience, especially the brain achieved academic achievement beyond the scope of the science has changed the paradigm of the humanities. Such as fMRI and EEG, patterns of brain activity that can directly observe the development of tools and the brain turned out to be a secret traditionally belonged to the realm of philosophy, mind, consciousness of self as the problem went beyond the field of Engineering and Medicine.

Brain is currently the most likely solve the mystery of human behavior is key. Nonetheless, the relevant part of the human heart, and the relatively slow pace of research side.

The birth of the human race has evolved at the same time keep the music is cultural factors. Music is a big framework of social and cultural forms and other cultural factors also have a lot of influence. In particular, recent cultural content technology (CT) in the field of music by analyzing the characteristics of the development of a variety of applications is underway. Sensitivity of our five senses (sight, hearing, smell, taste, touch) can be induced to be among the most information via visual stimuli can be obtained is known to cause a lot of emotion. So far the cause of emotional center of the visual or auditory or both made sense in most cases is rolled. Increasing interest in brain research and neuroscience research, with recent research and how the music has been diverse. That One human brainwave measured Some Stimulation Given actual our brain stimuli cognitive and processing nerve through mechanisms to investigate. Methods to measure brain waves is EEG (Electroencephalogram) and ERP(Event-Related Potentials). ERP presents a particular event or stimulus when the stimulus and the match or after a short time is the answer appears on EEG[1]. ERP recorded in the EEG for brain respond to certain stimuli from the extract by the results of the amplified signal is averaging one. ERP for the first time in 1939, Davis was used as a psychology research methods. The auditory stimuli were given, then 100-200ms after he relatively large negative reaction occurs, and found that[1].

Fig. 1. Separates ERP from EEG, The Process which gives a Signal Average

[Hantz et al, 1992]

Since the most of the auditory ERP study began to be active, in response to visual stimuli of a given language were discussed. Musical stimuli used in ERP studies have begun to date recently, Klein and Besson and Macar research can be counted representative example. This experiment with the language stimulates the brain response to musical stimuli that focused look at the difference. Music information processing itself, other studies have focused on the early tone, pitch, not the music itself, such as 'musical noise' was dealt with, increasingly being studied, such as melody, harmony progression to higher-level cognitive processes that require the scope has expanded to. Music perception and whether the primary areas of research scholars of the river is about two hundred and fifty people in the world. Existing research on the brain and cognitive function is
limited to basic research related.

The purpose of this paper, based on the tone of the brain auditory cortex (T3, T1, C5, C6) regions of the brain for sound signal processing (Fpz, Cz, Fz) to analyze if there are any changes in the area, contrary to the feelings of people decent music, the music selection is based on a fountain, advertising production, such as the movie OST CT applications in the field of intelligent emotion recognition is to apply.

II. EXPERIMENTS AND DATA ANALYSIS

A. Experimental technique measuring brain regions

Commonly used methods for measuring EEG of the 19 international 10-20 system, and even measuring the area [2], a more precise method for measuring the MCN electrodes measured in the 32 areas or 41 areas may be measured [3] [4].

![Fig. 2. International 10-20 System](image)

Increase the number of measurement channels to obtain the correct value, but the amount of data processing time drop in efficiency as compared to maintain proper channels is necessary to study. In this paper, the brain area measurement objective subjects in 3 different tones of the music when you hear the EEG signal changes in observing and analyzing it so Auditory Cortex region largely were observed, the stimulus applied in this area which fats and the brain appears to change the sound signal processing occurs, if any changes were observed.

In this research, EEG signals to measure the electrode of the International 10-20 system Auditory Cortex (T3, T1, C5, C6) regions of the brain for sound signal processing (Fpz, Cz, Fz) region as measured by EEG signals were used as experimental data. When measuring EEG, GND, as shown in Figure 3 was measured from the face view, REF was in the area below the ear.

![Fig. 3. Proposed electrode locations](image)

LAXTHA QEEG-8 equipment of the 8-channel was used, and using TeleScan S/W of LAXTHA, EEG signals being transmitted to the computer, so as to convert TXT acquired EEG signals, using MATLAB, EEG raw data was converted from time-domain to frequency domain and analysis that[5].

Given that the sensitivity of EEG changes Sampling Frequency was measured by setting the 512Hz. First, before entering this study three kinds of music genres(pop, rock, new age) classified, and the volume of the music used in the experiment (dB) through headphones and listen to everyday comfort in the size of 75dB was decided to unify[8].

![Fig. 4. Proposed electrode locations in LORETA (left side, top, right side)](image)

There’re no experiments in the past, deaf hearing-winning eight-ins for a total of 20 adult males were 10 times. Experiments with 1-minute intervals were to have to hear one minute rest. In this study, there kinds of music (New Age, Rock, Dance) and an auditory stimulus to create a relaxed state before the period of auditory stimulation for the condition except for the sight, taste, touch and smell stimuli from the external environment for was blocked.

Experimental method is as follows. 1 minute rest in the middle of listening to music. Experimental details are the same as in Figure 5.

![Fig. 5. Content and Process of the experiment](image)

Measurement of equipment LAXTHA 8 channels of QEEG-8 was used during the 7 channels. The 7 kinds of regions (T1, T3, C5, C6, Fpz, Cz, Fz)and the REF, GND to set the exact position and it’s shown in Figure 3.

B. Proposed EEG analysis

EEG for a brief overview of previous studies, you generally want to increase recognition of the EEG preprocessing given through the process by removing interference noises[6].

Typically, preprocessing remove interference noises and improves the recognition rate of EEG[6]. It’s also remove the noise using a band pass filter and feature extraction algorithms such as ICA, ICA and BSS(Blind Source Separation) in order to solve the problem, as developed signal processing method, the existing PCA(Principle Component Analysis) and the
orthogonality between different nested signal does not require[7]. One measure M N signals $S_X$, the overlap would be recorded, when $X$ and $S$ of the equation is as follows.

$$X(t) = AS(t)$$

(1)

Where $A$ is mixing matrix is called, each of which is nested in any way signal that they give information about. One problem that we know not only for the $X$ measure. Signal $S$, as well as a idea how they are mixed signals may be. However, if you know the value of $A$ or $S$ may know, the rest is an unknown quantity. In other words, if you know the mixing matrix $A$, the following equation (2) of the original signal $S$ from a simple equation can be calculated. A pool as the inverse of matrix $W$ is called.

$$S(t) = A^{-1}X(t) = WX(t)$$

(2)

After the preprocessing of the signal wave, such as $\alpha \beta$ waves and to analyze each frequency domain-specific signals are common, each by frequency analysis of EEG may increase or decrease throughout the brain[2][3].

According to existing studies of the brain, each area of the brain, has a different role and, in general, rather than direct analysis of EEG with frequency conversion, respectively, for each frequency band is analyzed in the brain. In general, the following EEG frequency bands for each, as shown in Figure 6. And Table 1. Divides.

![Fig. 6. The Separated Result of EEG signals for each Frequency](image)

According to previous research organization in each frequency band, characterized by low-frequency noise is about the movement is often, eyes closed, alpha waves increased in the same relaxed state and eyes, I have been known to decrease[10]. Beta waves when a conscious activity, gamma waves when attention is increased [11].

Analysis of the EEG focus in most studies being conducted to solve the noise problem, the measured signal in this paper the low-frequency gamma wave from 0–4Hz waves were removed. Remove this range because the frequency of the beating of the heart, eyes, mouth and facial movements, such as electrodes noise low frequency oscillation is due to the impact.

<table>
<thead>
<tr>
<th align="left">Type of EEG Signals for each Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td align="left">Freq band (Hz)</td>
</tr>
<tr>
<td align="left">:----------------</td>
</tr>
<tr>
<td align="left">0.2–3.9</td>
</tr>
</tbody>
</table>

C. FFT(Fast Fourier Transform)

If the data collected EEG, time and amplitude continuous waveform data in analog form are obtained. Therefore, the process need to be addressed first, a continuous EEG signals can be processed on a computer to change the digital signal is discrete. Time domain changes in the frequency range of the data that is used to process the Fourier Transform is a mathematical expression is defined as follows.

$$H(f) = \int_{-\infty}^{\infty} h(t)e^{-j2\pi ft} dt$$

(3)

$$H(f_n) = \sum_{k=0}^{N-1} h_k e^{-j2\pi kn/N} = H_n$$

(4)

Discrete Fourier transform computation time required, but the amount of N, FFT is reduced to calculate time. In this paper, the time domain using an FFT to the frequency domain transformation of the EEG signals, depending on the size of the frequency signals are arranged in a graph of the signal will be able to analyze the frequency components.

D. Power Spectral Analysis

EEG analysis is representative of a variety of methods is also necessary for spectral analysis [12]. Power spectral analysis through FFT theta, alpha, beta waves, and band using gamma power(power spectrum) that is based on obtaining. At this time of the scalp electrodes that occur in the absolute power of spectral power is called. While the absolute power of the entire frequency band based on the absolute power of each band calculated as a percentage value relative power of each frequency band is called.

Power spectral analysis of the relative power spectral analysis by comparing the absolute thickness difference of the skull, measuring the electrical condition of the scalp, measuring variables such as helping to reduce tension, and brain and cognitive function well because it shows the relevance of research on brain function has been widely used in.

E. Analysis using LORETA

For the last 20 years to identify the source of the EEG inverse program has been a breakthrough. Inverse program currently used as a bipolar model with distributed source model can be used to separate the two groups. LORETA(Low resolution electromagnetic tomography) as a functional brain imaging techniques have been introduced by Pascual-Marqui.
LORETA belongs to the distributed source model has taken the most smoothest constraint. Thus, LORETA maximum synchronization among the group of neurons adjacent to the active site seem to reflect the distribution of the three-dimensional. LORETA maximum advantage of the two sections that you want to compare the different between the activation of the brain cortex gives statistical comparison[14][15].

In this paper, LORETA programs by using data form previous studies using the inverse problem was tested[13].

EEG measurement equipment to measure the voltage of the EEG changes in the time domain when the scroll mode is represented by a row. Therefore α wave, β wave, θ wave, and γ waves are used to extract the FFT. Conversion and converted it into the frequency domain values that result again shows the power spectrum (Fig. 8.) is shown below. Three kinds of different genres of music I have heard, but clearly different genre New Age music and the piano and violin ensemble with a strong beat dance music was found to be expressed.

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Looking at this graph, for example, quieter than the $\alpha$ wave of dance music and when I hear the gentle New Age music can be found to increase, rock music did not feature the term, While dance music is active in the whole $\theta$ waves were able to confirm that. As mentioned earlier, measuring the relative power spectrum to reduce the variables are widely used in the analysis. However, as this study measured the increase in channels at the same time more than three kinds of variables to measure the absolute power spectrum, when compared to the data has the advantage of easy to recognize at a glance.

![Graph](image)

Quantifying the value of the data tabulated above, an experiment that is shown in Table 2.

### Table 2. For comparing the absolute value of each power spectrum

<table>
<thead>
<tr>
<th></th>
<th>Normal State</th>
<th>New Age</th>
<th>1st Rest</th>
<th>Rock</th>
<th>2nd Rest</th>
<th>Dance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ wave</td>
<td>18.7</td>
<td>23.4</td>
<td>19.8</td>
<td>26.7</td>
<td>37.2</td>
<td>38.7</td>
</tr>
<tr>
<td>$\beta$ wave</td>
<td>12.7</td>
<td>9.6</td>
<td>9.4</td>
<td>10.2</td>
<td>10.5</td>
<td>12.5</td>
</tr>
<tr>
<td>$\gamma$ wave</td>
<td>6.7</td>
<td>4.6</td>
<td>4.3</td>
<td>4.7</td>
<td>4.2</td>
<td>3.7</td>
</tr>
<tr>
<td>$\theta$ wave</td>
<td>11.3</td>
<td>12.6</td>
<td>9.2</td>
<td>9.6</td>
<td>22.8</td>
<td>61.5</td>
</tr>
<tr>
<td>total</td>
<td>85.9</td>
<td>79.3</td>
<td>66.6</td>
<td>81.4</td>
<td>89.8</td>
<td>139.2</td>
</tr>
</tbody>
</table>

Data set list from two well-made waves and waves of the data set. Sell when you’re relaxing in the following table values are increased when the song is so relaxing after it was found to be stable. This time the songs are so accustomed to the experiment was cut comfortably can. And when the theta waves increased, increasing research attention is the result. So close your eyes and listen to music theta waves over time because the focus will be natural to dance when I hear an unusually large amount of the power spectrum value of 61.5 was out. Over time, the focus should be scattered over the late experimental music is another reason for the high concentration of people and easy to remember the source of intense beats and melodies tend to remember longer. The following Figure 14. For each kind of time-varying EEG power spectrum for each experiment, the distribution of the state line to appear as a line graph was found. As shown in Figure 14. Beta, Gamma waves wave over time, there were no significant changes according to the alpha and theta wave form shows a gradual increase.
CONCLUSION

In this paper, the brain waves of sound through the person if any changes occur throughout the experiment had analyzed the results for each channel, auditory cortex (T1, T3, C5, C6) of a T1, T3, C6, depending on the type of music, the reaction zone was the signal for the brain to the sound processing zones (Fpz, Cz, Fz) in the frontal area of Fpz favorite song or what his reaction to the song could be determined.

Cz, depending on the type of area did not produce any consistent pattern. One of the causes of the Cz region who are in the measuring head, not bond well with the experimental medium consisting of a signal generated artifact seems to be a lot. Dance music when I hear an unusually large amount of the power spectrum value of 61.5 was out. Over time, the focus should be scattered over the late experimental music is another reason for the high concentration of people and easy to remember the source of intense beats and melodies tend to remember longer.

In this study, the S / W using MATLAB TeleScan and basic, but the future depends on the extraction and analysis of experiments measuring brain waves to a more accurate analysis should take advantage of BIOSEMI's EEGLAB.

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REFERENCES