

# **An Analysis in the Correlation between Frontal Lobes/Occipital Lobes Parts' Neural Waves in Case of 3D Syndrome Outbreak While Watching 3D Object**

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## **Abstract**

*3D image technology advancement served as the turning point that shows the potential of the 3D technology to be used for next generation broadcasting technology. Due to this reason, diverse image contents were produced using 3D technology, but side-effects began to surface while watching 3D image contents. Some users complained of fatigue, dizziness, and nausea while viewing the contents produced in 3D. As such, researches are underway on the 3D syndrome symptoms detection. However, the reality is that there are not many researches that address basic measures and the technologies themselves. Accordingly, this research paper analyzed the correlation of the brain wave signals at the frontal lobe/occipital lobe parts to analyze the change in the brain wave signal during 3D image viewing when 3D syndrome occurs and to realize the automatic 3D syndrome detection system with the key findings.*

**Keywords:** *Brain wave, visual fatigue level measurement, correlation, frontal lobe, occipital lobe*

## **1. Introduction**

3D image technology is the technology that uses the binocular vision principle that entails perceiving the 3D space by using two eyes. Numerous technologies are being developed and many researches are underway due to the success of the image contents. However, images produced with 3D image technology are different from the images produced with existing 2D technologies in the sense that they cause physical, psychological and biological side-effects. 3D images cause sense of fatigue, dizziness, nausea and others due to the mismatch of the focal length and convergence angle and difference in the images that are provided to the two eyes. As such, there are people who complain about the side-effects. Accordingly, there are researches underway on the Bio-Signal detection following 3D syndrome symptoms, but the reality is that there are not many studies conducted on the objective index for detection and on the coping measures. Accordingly, this research paper sought to analyze the correlation between the changes taking place in terms of the brain wave signals and the 3D syndromes by conducting correlation analysis following the changes in the brain wave signals at the frontal lobe/occipital lobe parts and to detect the characteristics of the change in brain wave that occurs when 3D syndrome results during 3D image viewing..

## **2. Related Works**

As 3D image contents of diverse formats emerge these days, diverse studies are underway to try to measure the visual fatigue level that results when viewing in an objective manner.[2]

These studies are being carried out since existing subjective method is rather limited. When emotion of the fatigue level according to the measurement method is offset, a disadvantage is that the measured level of fatigue cannot be trusted. To resolve these problems, researches that can measure visual fatigue level objectively are being carried out after extracting the information that can become measure by analyzing Bio-signal or image.[1-6]

### **2.1 Visual Fatigue Level Measurement using Brain Wave**

Brain wave which is one of the Bio-signals includes information on the psychological state such as feeling sleepy or anxiety, and on the physical reactions such as movement of the eyes, hands and feet. Thus, this can be used as a method for analyzing sense of fatigue felt by human beings in a quantitative manner [1]. Accordingly, research was carried out to measure sense of fatigue following different situations through the brain wave analysis in diverse environments where fatigue may be felt. Recently, research on brain wave analysis is carried out to study the instance when viewers' visual fatigue level results due to the emergence of diverse devices such as 3D display [6]. The studies on the above mentioned brain wave analysis based visual fatigue level analysis shows that the level of fatigue felt by human beings can be measured objectively by quantifying the level of fatigue through the analysis of the change in the brain wave. However, brain wave is too one form of Bio-signals. Thus, it may act as noise element when measuring level of fatigue since change in brain wave may be stimulated by diverse emotional states. Moreover, another problem is that fatigue may result due to the discomfort felt by subject or due to the tactile sense stimulation since there is a need to attach multiple sensors on the head based on the set regulation compared to other Bio-signal measurement method.[1][6]

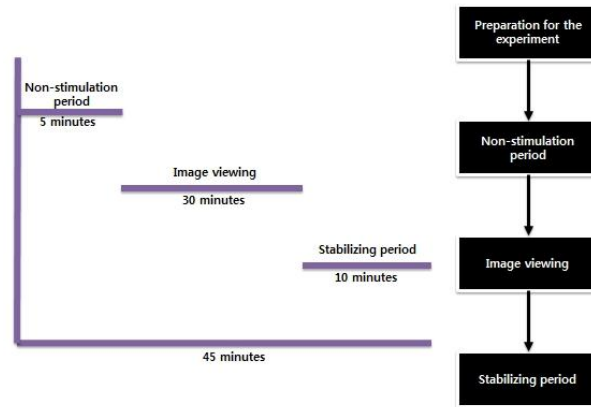
## **3. Configuration of Experimental Environment**

This research paper conducted the experiment of analyzing the brain wave signal correlation when 3D syndrome occurs by extracting the subjects' brain wave signal during 3D image viewing. Towards this end, subjects' brain wave signal was classified into the period before 3D image viewing, during image viewing, after image viewing and the time when subjects feel the 3D syndrome. Then, extraction took place to recommend the change in the brain wave and the discernment index that are manifested when the 3D syndrome appears through the frontal lobe/occipital lobe parts in order to analyze the correlation of the brain wave signals at the frontal lobe/occipital lobe parts.

### **3.1. Environmental Factors**

To conduct the experiment recommended by this research, experiment booth (about 320x180cm) was configured for one person as shown on. While experiment was underway, external factors (light, noise and so forth) was minimized to increase the immersion level when viewing 3D image which in turn maximized reliability of the results. As for the viewing distance, 3D TV(42 inches) that enables 3D image output and the subjects' distance were set to 160cm.

### 3.2. Methods



**Figure 1. Experimental Methods**

#### 3.2.1. Preparation for the Experiment

As for the preparation stage for the experiment, the subjects were explained about the contents and procedure of the experiment and then their agreement was obtained. Then, disk electrode for brain wave measurement was attached on the subjects' head in accordance to the 10-20 international standard for electrode placement rule. The disk electrode was placed at the "F7(ch1), F8(ch2), T3(ch3), T4(ch4), T5(ch5), T6(ch6), O1(ch7), O2(ch8)." The placement of the brain wave electrode used in this experiment is as follows. The locations, F7, F8 that correspond to the frontal lobe are the parts that handle the ability to focus on the surrounding and space-time perception. At the temporal lobe that handles auditory perception processing and emotion, T3, T4, T5, T6 points are used while occipital lobe uses O1, O2 points that handle visual perception. Brain wave was used by leveraging the QEEG-8(LAXTHA, Korea) equipment, which is the tool for measuring the brain wave of the eight channels. To ensure that the subjects can record the time when they felt 3D syndrome during the experiment, they were provided with entry key pad. While 3D image is prepared, subjects are also provided with the head set and 3D goggles to be used while viewing 3D image. To minimize the noise that may result when measuring brain wave while experiment is underway, subjects are trained in advance to minimize movement.

#### 3.2.2. Non-stimulation Period

This stage is the non-stimulation period prior to the 3D image viewing, and the subjects' brain wave is measured for five minutes while they are stable. The brain wave measured during this stage is used as the standard brain wave to compare with the wave that results in case of 3D syndrome outbreak.

#### 3.2.3. Image viewing

This stage is carried out with the goal of extracting change in the subjects' brain wave during the 3D image viewing. While stable, subjects are to view 3D image for 30 minutes. And they have to wear Polarized Method based goggles and head set, needed for 3D image viewing, to increase level of immersion. When subjects feel 3D syndrome symptoms such as dizziness, eye ball fatigue and nausea while viewing image, they record the time when 3D syndrome was felt by using the entry key pad.

### 3.2.4. Stabilizing Period

This stage is the stabilizing period after 3D image viewing . Subjects remove the goggles and the head set after watching 3D image. The brain wave is measured for 10 minutes while they are stable. The purpose of this stage is to discern out the possibility of 3D syndrome appearing during the stabilizing period and to analyze the exact time when 3D syndrome symptoms may surface. The subjects who feel the 3D syndrome during this stage used key pad to record the time.

## 4. Experimental Results

This research paper conducted the experiment of analyzing the brain wave signal correlation when 3D syndrome occurs by extracting the subjects' brain wave signal during 3D image viewing. Moreover, analysis was conducted by distinguishing the frequency broadband of the brain wave signals into alpha wave, beta wave, delta wave, theta wave and gamma wave, which are the customary classifications for brain wave signals when analyzing the correlation between each channels.

### 4.1 Analysis on Correlation between Channels of Each Frequency Range in Frontal/Occipital Lobes

alpha wave	ch1 - ch2	ch1 - ch3	ch1 - ch4	ch1 - ch5	ch1 - ch6	ch1 - ch7	ch1 - ch8	ch2 - ch3	ch2 - ch4	ch2 - ch5	ch2 - ch6	ch2 - ch7	ch2 - ch8	ch3 - ch4	ch3 - ch5	ch3 - ch6	ch3 - ch7	ch3 - ch8	ch4 - ch5	ch4 - ch6	ch4 - ch7	ch4 - ch8	ch5 - ch6	ch5 - ch7	ch5 - ch8	average
Max -Stimulation	0.41	0.39	0.38	0.37	0.38	0.43	0.43	0.39	0.46	0.56	0.43	0.39	0.39	0.46	0.47	0.46	0.43	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Max -Stimulation "Percentage Change with Watching 3D image"	-27.03%	-42.04%	-27.03%	-34.36%	-26.30%	-22.20%	-26.73%	-30.95%	-4.19%	-29.95%	-20.45%	-29.41%	-25.41%	1.65%	-21.55%	-20.45%	-25.39%	-27.03%	-27.03%	-27.03%	-27.03%	-27.03%	-27.03%	-27.03%	-27.03%	-27.03%
Stabilizing with Watching 3D image	0.39	0.38	0.38	0.37	0.38	0.43	0.43	0.39	0.46	0.56	0.43	0.39	0.39	0.46	0.47	0.46	0.43	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Percentage Change with Watching 3D image	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%
Stabilizing with Watching 3D image	0.39	0.38	0.38	0.37	0.38	0.43	0.43	0.39	0.46	0.56	0.43	0.39	0.39	0.46	0.47	0.46	0.43	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Percentage Change with Watching 3D image	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%	-30.95%
delta wave	ch1 - ch2	ch1 - ch3	ch1 - ch4	ch1 - ch5	ch1 - ch6	ch1 - ch7	ch1 - ch8	ch2 - ch3	ch2 - ch4	ch2 - ch5	ch2 - ch6	ch2 - ch7	ch2 - ch8	ch3 - ch4	ch3 - ch5	ch3 - ch6	ch3 - ch7	ch3 - ch8	ch4 - ch5	ch4 - ch6	ch4 - ch7	ch4 - ch8	ch5 - ch6	ch5 - ch7	ch5 - ch8	average
Max -Stimulation	0.37	0.39	0.37	0.32	0.39	0.41	0.41	0.35	0.42	0.52	0.39	0.34	0.34	0.46	0.41	0.41	0.39	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Max -Stimulation "Percentage Change with Watching 3D image"	-11.19%	-14.79%	-4.95%	-21.80%	-20.90%	-19.54%	-11.87%	-19.65%	-2.74%	-10.52%	-4.95%	-10.52%	-5.95%	2.67%	-4.95%	-10.10%	-10.10%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%
Stabilizing with Watching 3D image	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Percentage Change with Watching 3D image	10.25%	-4.95%	3.79%	-4.45%	-0.10%	-0.10%	0.99%	-4.75%	1.29%	8.60%	-2.43%	0.00%	1.65%	5.62%	-0.09%	-4.51%	-2.17%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%
Stabilizing with Watching 3D image	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Percentage Change with Watching 3D image	10.25%	-4.95%	3.79%	-4.45%	-0.10%	-0.10%	0.99%	-4.75%	1.29%	8.60%	-2.43%	0.00%	1.65%	5.62%	-0.09%	-4.51%	-2.17%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%	-11.19%
gamma wave	ch1 - ch2	ch1 - ch3	ch1 - ch4	ch1 - ch5	ch1 - ch6	ch1 - ch7	ch1 - ch8	ch2 - ch3	ch2 - ch4	ch2 - ch5	ch2 - ch6	ch2 - ch7	ch2 - ch8	ch3 - ch4	ch3 - ch5	ch3 - ch6	ch3 - ch7	ch3 - ch8	ch4 - ch5	ch4 - ch6	ch4 - ch7	ch4 - ch8	ch5 - ch6	ch5 - ch7	ch5 - ch8	average
Max -Stimulation	0.44	0.37	0.39	0.35	0.41	0.5	0.44	0.41	0.42	0.41	0.44	0.4	0.47	0.48	0.46	0.49	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Max -Stimulation "Percentage Change with Watching 3D image"	-14.65%	-20.25%	-13.65%	-20.90%	-22.96%	-19.51%	-19.51%	-20.90%	-4.95%	-19.51%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%
Stabilizing with Watching 3D image	0.39	0.37	0.39	0.35	0.41	0.5	0.44	0.41	0.42	0.41	0.44	0.4	0.47	0.48	0.46	0.49	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Percentage Change with Watching 3D image	-10.91%	-20.25%	-7.26%	-20.25%	-19.26%	-17.74%	-11.82%	-20.25%	-2.05%	-19.51%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%
Stabilizing with Watching 3D image	0.42	0.34	0.37	0.31	0.37	0.49	0.4	0.39	0.4	0.42	0.43	0.38	0.45	0.48	0.44	0.49	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Percentage Change with Watching 3D image	4.77%	-8.11%	-2.63%	-13.65%	8.11%	20.25%	-10.52%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Stabilizing with Watching 3D image	0.39	0.37	0.39	0.35	0.41	0.5	0.44	0.41	0.42	0.41	0.44	0.4	0.47	0.48	0.46	0.49	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Percentage Change with Watching 3D image	-10.91%	-20.25%	-7.26%	-20.25%	-19.26%	-17.74%	-11.82%	-20.25%	-2.05%	-19.51%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%	-10.52%
beta wave	ch1 - ch2	ch1 - ch3	ch1 - ch4	ch1 - ch5	ch1 - ch6	ch1 - ch7	ch1 - ch8	ch2 - ch3	ch2 - ch4	ch2 - ch5	ch2 - ch6	ch2 - ch7	ch2 - ch8	ch3 - ch4	ch3 - ch5	ch3 - ch6	ch3 - ch7	ch3 - ch8	ch4 - ch5	ch4 - ch6	ch4 - ch7	ch4 - ch8	ch5 - ch6	ch5 - ch7	ch5 - ch8	average
Max -Stimulation	0.34	0.27	0.37	0.32	0.3	0.39	0.35	0.35	0.39	0.29	0.39	0.32	0.33	0.46	0.35	0.41	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Max -Stimulation "Percentage Change with Watching 3D image"	-4.09%	-20.25%	14.15%	-20.25%	-11.93%	10.66%	-2.29%	-10.27%	-4.01%	-20.25%	-4.09%	-10.27%	-5.86%	0.00%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%	-20.25%
Stabilizing with Watching 3D image	0.34	0.27	0.37	0.32	0.3	0.39	0.35	0.35	0.39	0.29	0.39	0.32	0.33	0.46	0.35	0.41	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Percentage Change with Watching 3D image	1.05%	-10.69%	4.45%	-2.45%	-0.21%	10.66%	9.69%	-9.69%	4.97%	9.75%	-10.27%	-7.90%	3.08%	1.65%	-2.45%	-10.69%	-10.69%	-10.69%	-10.69%	-10.69%	-10.69%	-10.69%	-10.69%	-10.69%	-10.69%	-10.69%
Stabilizing with Watching 3D image	0.34	0.26	0.33	0.28	0.27	0.39	0.34	0.35	0.39	0.29	0.37	0.3	0.3	0.46	0.37	0.41	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Percentage Change with Watching 3D image	0.00%	-18.52%	-10.27%	-15.38%	-16.67%	10.66%	11.76%	0.00%	10.27%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Figure 2. Coefficient Correlation and Change Rate of Frequency Band Channel of Frontal/Occipital Lobes

This research paper analyzed the correlation by each channel following frequency broadband of the brain wave signal(non-stimulation period (5 minutes), period during 3D contents viewing (30 minutes) and stabilizing period (10 minutes)) collected from the subjects in order to analyze the brain wave signal correlation of the frontal lobe/occipital lobe parts, and the results are shown on figure 3.

According to the results shown on figure 3, coefficient of correlation among channels for each frequency broadband at the frontal lobe/occipital lobe produced same result in which they were high at the ch4-ch6 and ch3-ch5. In the alpha and delta wave broadband, change in the coefficient of correlation during the non-stimulation period when subjects were not watching 3D image and during the stimulation period when they are viewing, manifested high figure, at least 13% in all channels except for ch3-ch5, ch4-ch6. In case of the beta wave broadband, change in the coefficient of correlation during the non-stimulation and stimulation periods manifested high figure, at least 10% in all channels except for ch1-ch8, ch-ch8. Moreover, change in the coefficient of correlation for the gamma wave broadband manifested

at least 3% on average. In case of the theta wave broadband, change in the coefficient of correlation manifested at least 5% in all channels except for ch3-ch5, ch4-ch6 that manifested low change rate.

According to the analyzed result, it has been found that measurement by utilizing correlation coefficient of channels apart from ch3-ch5 and ch4-ch6, the changes in correlation coefficient between non-stimulation/ 3D watching stage stabilization/3D watching stage are the feature vector which can be utilized for detection of 3D syndrome symptoms by utilizing correlation coefficient of brain wave in frontal/occipital lobes. Especially, speed of change in correlation coefficient between non-stimulation/watching and stabilization/watching stage have been appeared to be highest in alpha and delta waves compared to the others and it seems that this can be utilized for detecting 3D syndrome symptoms properly.

## 5. Conclusion and Further Studies

This research paper conducted the experiment of analyzing the brain wave signal correlation when 3D syndrome occurs by extracting the subjects' brain wave signal during 3D image viewing. Moreover, it analyzed the correlation of the brain wave signals at the frontal lobe/occipital lobe parts to detect the vector of the brain wave signal that is related to 3D syndrome. The experiment results manifested that the growth rate when correlation analysis was conducted among the frontal lobe/occipital lobe channels was shown as well as those of the 3D image viewing, stabilizing period, 3D image viewing and non-stimulation period. It was demonstrated that the correlation growth rate was higher in case of the delta and alpha wave broadband compared to others. When the analyzed results are used, it is presumed that the accuracy rate of setting up objective index for the change in the Bio-Signal related to 3D syndrome will increase. The possibility of mitigating 3D syndrome going forth will decrease by detecting 3D syndrome area and by developing related technologies.

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