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STUDY TO EXTRACT THE SIGNIFICANT VIBRAIMAGE VARIABLES FOR EVALUATING DROWSINESS STATE CORRELATED FROM EEG DATA

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Abstract: *Abstract Previous Drowsiness evaluation methods used driver-dependant sensor, where it burdened drivers to wear sensors and also distracted or limited drivers to drive freely. Due to this limitation and driver-unfriendly method, new drowsiness evaluation method was required.*

Therefore, this research was evaluating new method by using vibration image technology with EEG parameters and correlations. Six subjects were forcefully induced with drowsiness, and EEG signals and image data of each subject was measured by using new method. Measured EEG signal was analyzed by FFT (Fast Fourier Transform) analysis to extract Alpha, Beta, Theta, and Delta parameters.

Also, measured image data was extracted by using 'vibration image technology' to achieve nine parameters such as A1, and etc. Obtained parameters were compared using correlation analysis. Result of this comparison showed that there was significant relationship between measured parameters and drowsiness. Conclusively, this new method will improve and compensate the limitation of existing method of measuring drowsiness.

Keywords: *Vision, Drowsiness, Vibraimage, EEG.*

1. Introduction

Many studies have been conducted on the perception and assessment of drowsiness and the importance of such studies is also emphasized depending on the risk of accidents caused by drowsiness. Accordingly, the studies are under research and development to evaluate drowsiness based on biometrics. However, the limitations that require the sensor to be attached directly to the driver make it difficult to apply it to the actual driving situation. To address these limitations, a number of vision-based recognition technologies are being developed and the studies are being conducted accordingly. In particular, among those technologies, the vision-based technologies using cameras are widely used, and Microsoft's Kinect is a representative example. Many studies have been conducted which want to recognize humans with a vision based technology, but the most of them are now recognized using gestures or variations of eyelid or etc. Usually these are used a lot for conducting instructions or simple recognition, and biometrics based on physiological mechanisms are still in short supply. A new vision-based measurement technology is required to measure a person's feelings or state of physiology. Many parts of the biometrics are being studied, including the autonomic nervous system and respiratory and cardiovascular system. It is a vestibular system that is affecting the regulation of these areas. The vestibular system represents the micro-movement, called as VER (Vestibular Emotion Reflex) [1, 2, 3]. Vibraimage is a technology developed by V.A. Minkin to measure human emotions and emotional

state by measuring the micro-movement of vestibular system [1, 2, 4]. As Vibraimage technology is used to analyze micro-movement through video image, in this study, we want to measure and analyze the physiological phenomena arising from the sleeping environments together with EEG data to identify the possibilities in finding and evaluating the effective variables against drowsiness through video image.

2. Research method

The previous studies that evaluate to detect the sleepiness/drowsiness state are using the most reliable EEG devices [5, 6]. This study is using EEG devices to acquire biometrics that register the drowsiness state and then, simultaneously Vibraimage parameters were compared and analyzed to find out the most highly co-related variables.

2.1. Testee and experiment procedure

This study was researched on the basis of a sleepy driving scenario. The subjects were repeatedly shown to be used for the long highway driving, the inside of the laboratory was dimmed, and the synchronized video images with EEG accusation were captured and saved for using to compare Vibraimage variables and EEG data at the same time. 33 persons with 20 ~ 30 ages took part in the experiment. (Male 20, Female 13). All subjects limited the intake of caffeine before testing and conducted the experiment at dawn to easily cause drowsiness. The subjects were also rewarded for their involvement in the experiment in order to increase their participation in the experiment. All of the subjects attached a electro-cap sensor (cap form) so that its impedance was less than 5 Ω, and conducted the experiment from a awakening state to sleepiness state.

2.2. Variables

The subjects then were obtained by video images taken with EEG device under infrared rays at experimental room, which resulted in a total of eight channels (F3, F4, T3, T4, C3, C4, O1, O2) that were selected for this study among 21 channels.The video image data was shot in front of infrared at a resolution of 1280 × 720. The resulting variables of Vibraimage were to indicate 10 variables (Aggression, Stress, Tension, and Suspect Balance, Charm, Energy, Self-Regulation, Inhibition, and Neuroticism) and all other parameters [7]. In the raw data, the amplitude variables are four basically. And the frequency variables are six basically. Also, the symetry variables are seven and many prcoessing variables by combination.

2.3. Analysis method

Among the data collected in the experiment, EEG data was extracted by band (Hz) from Delta, Theta, Alpha, and Beta, and was derived from the image analysis. In order to compare the data extracted from the video image analysis, the data was converted into FFT for 1 second increments based on time. In the comparative analysis, we analyzed

EEG data and Vibraimage variables acquired for 10 second periods of awakening and drowsiness based on the point of sleepiness at Drowsiness Level [5]. Vibraimage 8 software was used in Vibraimage analysis that has each raw data with 0,25 second on time basis. The analysis was based on the variation in the drowsiness state versus the awakening state for each data, and the statistical analysis was performed using the independent sample T-test and Mann-Whitney test respectively. In addition, the measured data were also correlated with the each difference in the individual testee's EEG data and Vibraimage raw data.

Figure 1 shows the screen on which Vibraimage images are analyzed.

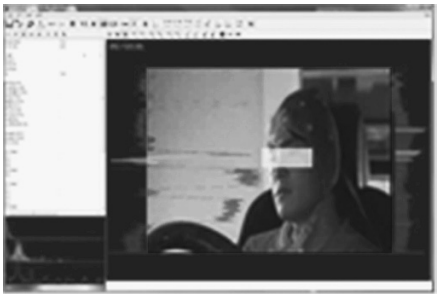

Fig. 1. Vibraimage analysis software

3. Result

Based on the variation between the awakening state and the time of drowsiness, a Mann-Whitney test was performed as neither of the eight channels was satisfied by the band.

The test results are as shown in Table 1.

Table 1

Mann-Whitney test result

		C3	C4	O1	O2	F3	F4	T3	T4
Delta	Z	−.638	−4.951	−1.892	−2.385	−.345	−.327	−.731	−1.747
	P	.524	.000	.058	.017	.730	.744	.465	.081
Theta	Z	−2.359	−5.438	−2.214	−2.929	−.586	−1.467	−1.514	−3.792
	P	.018	.000	.027	.003	.558	.142	.130	.000
Alpha	Z	−5.552	−6.169	−4.391	−4.603	−6.174	−5.355	−4.469	−6.153
	P	.000	.000	.000	.000	.000	.000	.000	.000
Beta	Z	−.824	−1.913	−.850	−.943	−.347	−1.239	−1.452	−1.156
	P	.410	.056	.395	.345	.728	.215	.147	.248

As the result of test of normality, F3 and F4 variables in Vibraimage variables were satisfied on the basis of variation between the awakening state and the point of drowsiness as EEG analysis method. And then, those two variables (F3, F4) were analyzed by the independent sample T- test and others were performed by Mann-Whitney test.

The Sample T-test result is shown in Table 2.

Table 2

Mann-Whitney / Independent T-test result

	A1	A2	A3	A4	F1	F2	F3	F4	F5
Z	−2.672	−5.327	−6.797	−3.658	−2.414	−4.860			−7.182
P	.008	.000	.000	.000	.016	.000			.000
T							8.066	9.418	
P							.000	.000	

Table 1 that EEG data were acquired on causing drowsiness shows the significant differences in C4 and O2 values of Delta band in EEG data, while the significant differences were seen in C3, C4, O1, O2, and T4 values in Theta band. For alpha band, all 8 channels showed the significant differences, and for beta band, they all were not significant and in the pattern they also showed the increasing patterns for delta, theta, and alpha. As shown on Table 2 for Vibraimage data, F3 and F4 variables were proven by T-test that indicates the significant differences and, the variables A1, A2, A3, A4, F2, F5 were verified by Mann-Whitney test that resulted in the significant differences. Based on the measurement method, the two results show that there are two ways to determine the drowsiness state that the significance is verified statistically. The two measureable methods were then identified as likely to be assessed for the drowsiness analysis and, as a result, a correlation analysis was performed between the two methods. The correlation analysis was performed by the overall average data from the subjects of EEG and Vibraimages during the period of drowsiness state. As a result, the results showed 67 significant variables, 5 median variables, 62 low variables, and 221 non-significant or non-correlative variables out of the total 288 related to each variable. However, as the analysis showed the statistical significance for each measurements, the correlation analysis was performed for each subject to reduce the individual differences in the biometrics.

Table 3

Correlation analysis result — (±).6 over [Testee 1]

VIBRA	Bandwidth	EEG	Correlation	p–value	N
A1	Theta	C3	.708*	.022	10
A2	Beta	C3	.824*	.003	10

Table 3 (*the end*)

VIBRA	Bandwidth	EEG	Correlation	p–value	N
A4	Theta	C3	.696*	.026	10
		O1	.679*	.031	10
		T3	.693*	.026	10
		T4	.654*	.040	10
F1	Theta	C3	.723*	.018	10
F2	Alpha	F3	.647*	.043	10
F3	Theta	F3	.785**	.007	10
	Beta	F4	–.702*	.024	10
F4	Theta	F3	–.761*	.011	10
F5	Theta	C3	–.658*	.039	10
		O2	–.634*	.049	10
	Alpha	C4	.647*	.043	10
		F4	.827**	.003	10
	Beta	C4	.842**	.002	10
		F3	.674*	.032	10
		F4	.687*	.028	10

As shown on Table 3, the analysis results for testee 1 show the correlation between the electro-vibration and vibration image variables. Some variables that show over (±) 0,6 among the variables with the significant differences could be identified.

4. Conclusion and discussion

In this study, we studied using EEG and vision technology, which are commonly used to make an assessment for drowsiness state. Many assessments are made using the traditional measurement method, EEG device. The new measurement method, Vibraimage technology, is a vision technology based on psycho-physiological mechanisms.

We wanted to determine the potentially possibilities for new measurement methods to assess the drowsiness state by identifying differences between the two measurement methods and analyzing the correlation.

EEG and Vibraimage were used for the evaluation of drowsiness state depending on the measurement method, and both methods showed the differences depending on the point of drowsiness compared to the point of awakening. As both methods are shown to be capable of assessing the drowsiness state, we analyzed to see the correlation

between the sleepy periods. As both methods are shown to be capable of assessing the drowsiness state, they analyzed to see the correlation between the sleep areas. There were a number of highly correlated variables as the result of the correlation analysis between the different testees, while the correlation was not high in the overall comparison for the sleepiness period. This shows that there are the individual differences in the biometrics. As shown on Table 3, testees other than testee 1 were also able to identify a number of highly correlated variables. This was done by verifying the correlation between the two measurement methods, and it was possible to assess the drowsiness detection using Vibraimage technology. However, this analysis considers the individual differences and should be supplemented later by the various studies.

By using the vision technology based on physiological mechanisms, it is expected to be used a lot in areas such as the driver's drowsiness detection and recognition of biometrics, which have been studied in contact methods.

This study is very significant as a fundamental study to identify the possibility of detecting the drowsiness state using Vibraimage technology, which is the newly revolutionary measurement technology.

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