Analysis of Brain Signals During Personal Perception of Facial Images
Luis Diago $^{1,2}$, and Ichiro Hagiwara $^2$

$^1$ InterLocus Inc, Japan
$^2$ Meiji Institute for Advanced Study of Mathematical Sciences, Meiji University, Japan

Abstract
Recent researches have included a physiological monitoring as part of the human–computer interface. Using a thermal camera as a computer peripheral almost the full range of vital signs can be extracted, including localize blood flow, cardiac pulse, and breath rate. On the other hand, since the original demonstration that electrical activity generated by ensembles of cortical neurons can be employed directly to control a robotic manipulator, research on brain–machine interfaces (BMIs) has experienced an impressive growth. In order to go beyond a human-like multimodal analysis of multiple input signals acquired by different sensors, in this paper, we present the spectrum and topographic scalp maps derived from brain signals reflected by the presentation of 20 images to a group of four subjects. Results demonstrate that the spectrum distribution and the symmetry of topographic maps can be used to classify subjects perceptions about facial images.

Keywords – iyashi expressions, personal perceptions, holographic neural networks

1 Introduction
In the past decades, pioneer researchers have tried to apply EEG data analysis techniques developed in electrical engineering and information theory, including time/frequency analysis and Independent Component Analysis (ICA) [1,2,3,4,5]. These techniques have revealed EEG processes whose dynamic characteristics are also correlated with behavioral changes, though they cannot be seen in the averaged ERP. For example, short-term changes in spectral properties of the ongoing EEG in specific frequency bands may be correlated with cognitive processes, e.g. expectancy of a target stimulus and with visual awareness. To date, the majority of BCI systems rely on EEG recordings. In this paper we research some possible brain features for learning and predicting subjects evaluations about a small dataset of facial images in order to gain a clear idea of what it means for a face to be iyashi according to the computational models [6,7].

2 Analysis of Facial Perceptions
This paper is a continuation of our previous works [6,7] in which we introduced fuzzy quantification to build a MF describing how subjects classify iyashi-stimulus into fuzzy groups. Compared with former HNN and SVM classifiers, the proposed combination of HNN with FQ-II achieved the best classification accuracy using less training iterations than SVM classifiers (see [6] for details). However, there were ambiguous cases where the subject himself could not decide the state that has been induced by the system. Sparked in part by the growing interest in the evaluation of multiple communication channels to determine the inner states of a person [8,9], we combine the facial expressions of the subject with signals from the brain to clarify the state induced on the person in ambiguous situations. The extraction of cognitive state information from neural signals will produce appropriate feedback to the system and it will increase the classification accuracy.

2.1 Correlation between facial features
The main goal of the simulations is to gain a clear insight into the reasoning made by HNN. The same 20 images represented by the same number of parameters presented in [7] were evaluated by one hundred and fourteen subjects between 15 and 70 years old (102 Japanese and 12 non-Japanese, 47 females and 67 males) and were used to train different neuro-fuzzy classifiers. The participants rated each stimulus on the scale ’0'-NO, ’1'-DON'T KNOW’, ’2'-YES to express whether or not they feel an iyashi-stimulus. Figure 1 shows the set of parameters used to describe the 20 faces.

2.2 Acquisition of brain signals
The increase in classification accuracy in current systems due to the inclusion of the new modality of brain signals is not evident. To measure brain activities, noninvasive measurement of the brain functions such as functional Magnetic Resonance Imaging (fMRI), Magneto-encephalography (MEG), electro-encephalogram (EEG) and Optical Tomography have been developed. Emotion Spectrum Analysis (ESA) [4] has been developed to evaluate human emotion such as Anger, Joy, Sadness and Relaxation using EEG signals. Recently, a

\[ \text{Figure 1 – Face Parameters and Facial images} \]

1 the subject cannot decide if yes or no
Generalized Emotion Near Infrared-spectroscopy Analysis System (GENIAS) [5] has been introduced. GENIAS allows estimating quantitatively human emotion by using Near Infrared-spectroscopy (NIRS) signal. NIRS is a non-invasive functional neuro-imaging method that measures regional brain activations in terms of e.g. oxygenated or deoxygenated hemoglobin with low cost and high time resolution of 0.1 second. However, the dimensionality of features coming from brain signals increases with the number of acquisition channels. For example, GENIAS uses more than 4000 features obtained from second and third order correlation coefficients between signals coming from 24 channels. In comparison with GENIAS, in which the subject was asked to recall each emotion and the affect recognizer is linear, proposed system uses paintings and photograph for emotion induction and it is based on a nonlinear HNN affect recognizer.

Currently, most EEG researchers still interpret their data by measuring peaks in event-locked ERP averages. Free availability of more general and easy-to-use signal processing software for EEG data may encourage the wider adoption of more inclusive approaches. In the following we report the preliminary results using EEGLAB software toolbox for Matlab (freely available from http://www.sccn.ucsd.edu/eeegl/) to extract brain features during the evaluation of Iyashi-stimulus.

3 Experimental Results

In order to keep the emotional state of the subjects as uniform as possible, in the experiment the subjects performed a calculation task for 60 seconds, rested for 90 seconds with their eyes closed. The stimulus pictures were presented continuously at 10-second intervals. Then, they rested again with their eyes closed during 90 seconds. The experiment was repeated twice for two second intervals. Then, they rested again with their eyes closed.

Figure 1, O2, T3 and T4) are used.

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Figure 2 – Acquisition of brain signals using the ESAM [4] system with one subject.

Figure 3 – Non-Iyashi stimulus presented to the subject.

Figure 4 – Iyashi stimulus presented to the subject

Figure 3 show one example image classified by the subject as Non-Iyashi stimulus. Stimulus and brain signals corresponding to each channel (y-axis) during 10 seconds (x-axis) used for evaluating the image are shown in the upper part. In the lower part, the channels spectra and topographic scalp maps are shown. Each colored trace represents the spectrum of the activity of one data channel. The leftmost scalp map shows the scalp distribution of power at 6 Hz, which in these data is concentrated on the back midline (i.e. O1 and O2). The other scalp maps indicate the distribution of power at 10 Hz and 22 Hz. The same information is represented in Figure 4 for an Iyashi stimulus classified by the subject. Similar results have been obtained with four subjects.

4 Conclusions and Future Works

After observing the spectrum and topographic scalp maps derived from brain signals reflected by the presentation of each of the 20 images, we found that those images that are evaluated as 2 (Iyashi stimulus) show a peak greater than 10db in the spectrum below 5 Hz (see Figure 3 in comparison with Figure 4). Also note that the topographic maps in the bands 5 and 10 Hz show greater symmetry for Iyashi stimuli than for non-Iyashi stimuli. As the distribution of power for the 22 Hz band is similar in both cases more research is need to remove noises affecting the high frequency band of 20Hz.

5 References