EEG signals in hearing emotional voice by PCA

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At present, we have a semantic differential scale (SD) method to estimate human emotion quantitatively. However, it is difficult to estimate human emotion strictly. Because everyone cannot understand the same readings on question items. Therefore, we must use the index originated by another things.

In order to define the index, some researcher use bio-signals. There are many bio-signals to estimate human emotion. Especially EEG signals are strongly related to human emotion.

Our purpose is to estimate human emotion by EEG signals [1]. In this paper, we focus on the human emotion when subjects hear emotional voice. We record EEG signals in hearing anger-voices and calm-voices and analyze these EEG signals by principal component analysis (PCA). We show the relationship between EEG signal processed by PCA and emotion.

We record EEG signals when subjects hearing anger-voices and calm-voices. The experimental task is as follows: 1) Beep sound is shown to subject during 1 [sec] 2) From 2 to 3 [sec], no sound is shown. 3) The voice stimuli (anger-voice or calm-voice) are shown. 4) From 2 to 3 [sec], no sound is shown. The emotional voices were recorded from an amateur actress. She read several Japanese family names in order to avoid the influence of the word meaning. The order of voices stimuli is at random. One experiment includes 58 trials. EEG signals are recorded according to inter national 10-20 system method. The number of subject is 4 males.

EEG signals are processed by time-frequency analysis. In this paper, we focus on High alpha wave (10-12Hz). The windows function is Blackman window. Size of window is 1000 [ms] and shift length is 10 [ms]. We calculate Hi-alpha wave content rate in each frame. Next, in order to analyze the change of time-course, we perform simple linear regression analysis after represented-stimuli and obtain the gradient. Finally, we perform PCA against the gradients.

Fig. 1 shows diagram between 3rd component and 4th component by PCA. Blue point shows results in calm-voice and red point shows results in anger-voice. Blue points represent in first quadrant and second quadrant. Red points represent in third and fourth quadrant. From these results, it is possible to separate EEG signals in calm-voice with EEG signals in anger-voice by PCA.

Fig. 2 shows contribution rate. Contribution rate of 4th component is about 10% and from first component to fourth component, cumulative contribution is over 70%. Therefore, 4th component include some information of emotional processing.

In conclusion, we record EEG signals in hearing anger-voices and calm-voices and analyze these EEG signals by principal component analysis (PCA). From these results, it is possible to separate between EEG signals in anger-voices and EEG signals in calm-voices by PCA.

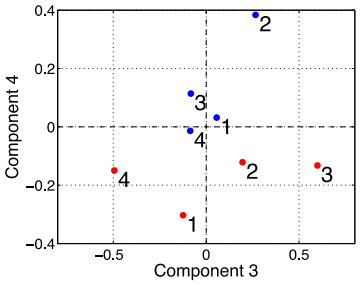

Figure 1: Diagram between 3rd component and 4th component in PCA.

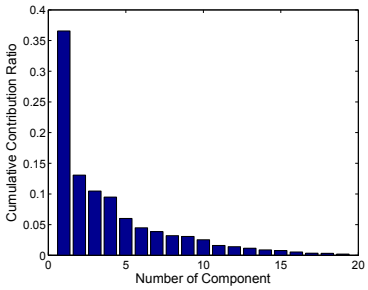

Figure 2: cumulative contribution

REFERENCES

[1] Arao Funase, Shinji Sako, Tadashi Kitamura, and Takumi Ichi, "A Study of the Influence on EEG Activity by Hearing Emotional Voice," Proc. of 012 International Workshop on Nonlinear Circuits, Communications and Signal Processing, 2012, pp. 289–292.

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