가상현실환경에서 멀미 측정을 위한 생리신호 분석

박민재, 김현택*, 박광석
서울대학교 의공학교실, 고려대학교 심리학과*

Practical BioSignal analysis for Nausea detection in VR environment

M. J. Park, H. T. Kim*, K. S. Park
Biomedical Engineering, Seoul National University
Psychology, Korea University*

ABSTRACT

We developed nausea, caused by disorder of autonomic nervous system, detection system using bio-signal analysis and artificial neural network in virtual reality environment. We used 16 bio-signals, 9 EEGs, EOG, ECG, SKT, PPG, GSR, RSP, EGG, which has own analysis methods. We estimated nausea level by artificial neural network.

Introduction

In virtual reality environment, so many people suffer VR motion sickness, such as nausea, headache, eye strain[1]. Many research about motion sickness are published by using manual analysis method such as using questionnaire[2]. But because threshold of nausea reporting is different between the subjects, nausea reports are different each other, too.

In this research, we developed motion sickness reduction system, which use bio-signal analysis and Artificial neural network and ICA, wavelet and etc.... We use 16 bio-signals which have its own analysis method, to analysis simulator sickness. Because traditional off-line bio-signal analysis methods are not sufficient at real-time analysis and don't have same characteristics for input parameters of artificial neural network between the subjects, we should modify the methods.

Main discourse

We developed bio-signal analysis method which is fitted for virtual reality environment. For example, in previous research, we used skin temperature itself, but our desired features are parameters which is well expressed changing of bio-signal. Therefore, we use not only data in virtual reality environment, but also data in real environment. We divided three stages in experiment procedure, resting, starting, main. Resting vs starting means virtual reality sickness, and starting vs main means motion sickness. For macroscopic nausea estimation, we use resting vs main navigation. In addition, bio-signals have their own analysis methods. EEG signal's frequency band is 0.2~50Hz, although EGG signal's frequency band is 3cpm(0.05Hz)~15cpm(0.25Hz)[3]. Because EGG is very low frequency signal, analysis method is not common.

We use 16 bio-signals, 9 EEGs, EOG, ECG, SKT, PPG, GSR, RSP, EGG.

1. EEG analysis

   We divided 9 spectral bands, delta, theta, alpha, beta, gamma and fast alpha, slow alpha, fast beta, slow beta. For using delta (0.2-4Hz) band which conflict frequency band of EOG, we use ICA (Independent Component Analysis) to remove EOG artifact in EEG signals[4].

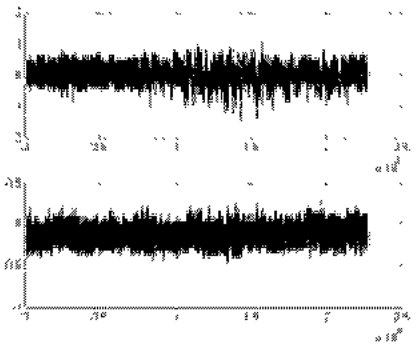

Fig 1. Remove EOG artifact from EEG by ICA

2. EOG

   We estimate eye blink count[5] using modified Tomkin's method of ECG analysis.

3. ECG

   We estimate heart rate variability. For very slow HRV detection, we use wavelet[6].

4. SKT

Skin temperature is a little variation bio-signal. We measured the rate and the variation of main navigation vs resting stage.

5. PPG

PPG is paced bio-signal with ECG. We estimated PTT[7] (Pulse Transit Time) using PPG peak-to-peak detection methods and ECG R-peak detection methods.

Fig 2. Definition of PTT

6. GSR

GSR have two types in varying shape. One is pulse type, the other is step type. Common character between two types is increasing. We measured increasing amount of GSR

7. RSP

RSP is paced with ECG. We estimate respiration count and mean, standard deviation of rate

8. EGG

EGG is very low frequency signal. For time resolution of analysis and satisfaction of Nyquist theorem, we set length of dataset 20 seconds. We estimated only 9 cpm (cycle per minute) activity which indicates nausea, but we don't use 3 cpm activity which indicates normal gastric activity.

After these analysis, we trained artificial neural network which is two layer feed forward back-propagation network[8], to estimation bio-logical changes like nausea.

Conclusion

We developed nausea detection system which uses real-time bio-signal analysis methods and artificial neural network. Using results of artificial neural network, we can decrease simulator or motion sickness in almost real-time. This research can help enjoying more comfort virtual reality environment.

Reference

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