Title:

Navigation of Quadcopter based on Electrooculography Signal

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Introduction:

Electrooculogram (EOG) is a bio-potential signal that can play an important role in Human Computer Interface (HCI) systems. EOG, which is the result of moving human eye bulb has the advantage of relatively easy recording (due to its higher amplitude and signal-to-noise ratio (SNR)) compared to the other modalities like electroencephalography (EEG). EOG signals can be acquired by placing electrodes on the surface of skin's face (near the subject's eye). Real-time processing, classification, and feature extraction are other important factors in HCI systems.

Material and Methods:

In designed system, EOG signals based on the eye movements from center point of screen to the 4-middle edges of it, are online recorded and processed. Signals recording are made by Ag/AgCl electrodes positioned around the eyes of subject. For ease and fast use of the system, these electrodes assembled on a normal protection eyeglasses. Therefore, by mounting this eyeglasses on the subject's face, electrodes will be automatically placed on the desired locations for EOG signal recording . According to structure of this platform, the movement artifacts, which are one of the main error sources in eye movement detection, are degraded dramatically. For signal pre-processing, a low pass filter with 20Hz cutoff frequency showed a good performance in noise elimination.

During the experiment, user should sit in 50cm distance of the monitor center point and move his/her eyes toward the middle of 4-sides of monitor. In order to detect and remove the artifact of blinking or wrinkling forehead, voltage amplitude threshold and time threshold is applied. Finally by extracting eye movements' pattern from a subject, the respective commands for quadcopter navigating are sent. Two final separate tests have been designed. One for user's eye movement detection accuracy based on recorded EOG signal and the other for elapsed time for navigation a quadcopter on a certain path, both by manual and designed HCI system navigating.

Results:

In 250 recorded eye movements (5 subjects, 5 trials each and each trial 10 eye movements), system demonstrates average accuracy of 94.4% in eye movement detection that shows the high rate of system's success in eye movements/artifacts discrimination. The required voltage/time thresholds were calculated for each subject at the beginning of each experiment. The processing software was trained based on them for the experiment. From the subject's eye movement to sending respective command for quadcopter navigation, there was a 0.6s delay for vertical/horizontal channels. The developed hardware and software showed a better accuracy with less time lag compared to the previously reported studies.

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