LETTER TO EDITOR

Dear Editor,

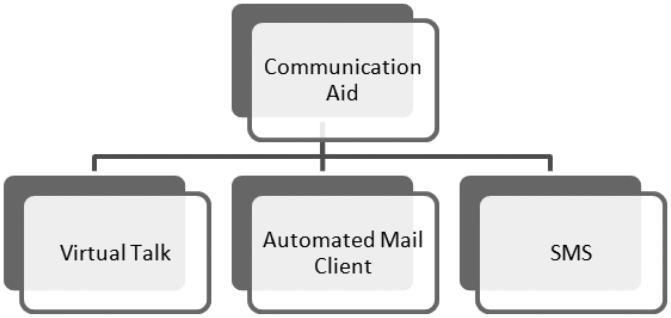
Computer-based Communication Aid using EEG for Paralytic Clients

Compared to the past, there has been a tremendous increase in the number of paralytic clients. According to the 2001 Census, there are approximately 61,33,960 paralytic clients in India. Since they find it very difficult to perform some vital functions such as communication, it is necessary to help them overcome the problem. Therefore, research was conducted to design a system which would enable paralytic clients to control basic operations independently, with the help of their individual EEG (Electroencephalogram) signals.

EEG is a test that measures and records the electrical activity of the brain. It has been found that the EEG signals obtained during voluntary eye blinking are clear signals with larger amplitude (approximately around 260mV) than that of normal EEG (10-100mV). Also, the frequency of the EEG wave during eye blink (4-7 Hz) will differ from the normal EEG wave (8-30Hz). (Singla, 2011). An efficient algorithm for detecting the occurrence of eye blinks has been developed.

The system developed by the authors, known as Communication Aid, consists of 3 modules – Virtual Talk, Automated Mail Client and SMS.

Figure 1: Overview of a system block diagram



The signal is acquired using surface electrodes from the forehead – Fp1 – Fp2 Montage. It is then amplified using INA118P and acquired using NI USB DAQ to create a pulsed output. This is used to run 3 communication modules – Virtual Talk, SMS and E-Mail.

Virtual Talk is a module in which a voice file is played based on the client's selection, with a designed set of toggling LEDs. The client will be able to select the preferred LED through an eye blink. On doing so, a voice file which is attached to the corresponding LED gets played. (These voice files are some of a person's essential or basic needs.) Each LED has a particular word corresponding to it, making it user-friendly.

In the E-Mail module, the client will be able to type (using a keyboard simulated in LabVIEW) and send mail using SMTP protocol (LabVIEW). The typing process is done via a set of LEDs (toggling) that are selected through an eye blink. On selection of a particular LED, the letter corresponding to that LED is generated in the mail box (Scherer, 2004). Once the mail is generated through a series of eye blinks, it is sent through SMTP protocol using LabVIEW.

The SMS module is similar to E-Mail, except that the message is delivered using GSM synchronised with LabVIEW through VISA protocol. The output for each is a display text box and a voice alert system.

The electrode placement was inspired by the work, "EEG-based Emotion Recognition - The Influence of Visual and Auditory Stimuli", which mentions that electrode placement for this kind of procedure is most suited to "Fp1 – Fp2" Montage with reference to A1/A2 (Bos, 2006). This selection of electrode placement is supported by the fact that eye blink activity is more dominant in the frontal region, making it preferable to the extraction of data from all over the skull. Also, the method of eye blink extraction is supported by the work of AbdRani and Mansor (2009), "Detection of Eye Blinks from EEG Signals for Home Lighting System Activation". In this work, the authors stated that eye blinks are typically categorised by signals with relatively strong voltages. They are often located by setting a threshold and classifying all activity exceeding the threshold value as eye blinks. A paper by Chambayil et al (2010), "Virtual Keyboard BCI using Eye blinks in EEG", mentioned that a character can be typed at the rate of 1 character/minute which is very time-consuming. This problem has been overcome in the system proposed currently, which enables a rate of 25-40 characters/minute.

In his work, "Extraction of ocular artifacts from EEG using independent component analysis", Vigirio (1997) used EOG signal to extract eye blink from EEG signal. For this, two bio-signals were employed for extraction. This can be done only with EEG wave through template matching technique, which reduces constraint on the client. The limitations offered by EEG are few. Since SNR is low,

processing of EEG should be done in a well-refined manner. In case of improper shielding, loud ambient noise may interfere. This can be reduced by using active noise control. The limitations caused by EEG can be overcome by using proper circuits that appropriately remove artifacts. Eye blinks are used as control signals in this BCI. With the help of maximum amplitude and minimum amplitude in a sample window, eye blinks from non-eye blink signal can be detected (Harun, 2009). It was found that eye blinks can be detected successfully from 90% of the records after applying the proposed eye blinking detection algorithm to EEG signals. 100% detection could not be achieved. From repetitive experiments, it was found that there is a one second delay in time between eye blink and the activation of a particular action. By reducing this delay, character spelling rate can be increased further.

Thus, the proposed communication system with 3 modules provides the client with a more convenient and less frustrating method of access, as thoughts can be conveyed faster. Since the character spelling rate is considerably higher, fewer eye blinks are needed to complete a message. This makes it user-friendly and suitable for bed-ridden clients, amputees and old people as well. Virtual Talk panel will play the sound files of the word which the client needs to convey. The alphabet boards allow the client to convey thoughts with more specificity. From the results, it is safe to say that the proposed protocol will be a major breakthrough in the field of assistive devices, and clients will feel comfortable about sending mail and SMS. The success rate of this system is around 90% for the younger age group and 65% for the older age group. Lower success rate among elders is due to the fact that they take time to adapt to a system which can be increased with voice feedback.

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