A COMPUTER BASED COMMUNICATION AID FOR PARALYTIC PATIENT USING EEG

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Abstract: It Is estimated that around10% of the whole population needs rehabilitation services. EUROSTAT reports a percentage of 10.3% disabled people in the general population. For example, every year there are about 30,000 survivors of strokes, 25,000 survivors of head injuries and 7,000 with spinal cord injuries and paraplegic. A person may become paralytic if they meet accidents, physical injury, stroke, poisoning etc. Paralysis is a state where a patient would be unable to move their limb or body's part due to the inactiveness of the muscle in that area. Based on the area and region of paralysis, it can be classified into paraplegia, hemiplegic and quadriplegia. These kinds of people find great difficulty in communicating with people and in expressing what they feel and what they want. By analyzing and taking all their difficulties into account we have developed a Communication system which can be used by these people. We have developed a system where the patient can send mail, SMS and express what he/she feel or want. Our project deals with the usage of EEG signals acquired from the surface of the forehead communication device. It aims at assisting paralyzed patients to communicate with others properly. The functional limbs or muscles of the body are accessed so as to assess maximum possible muscle potential

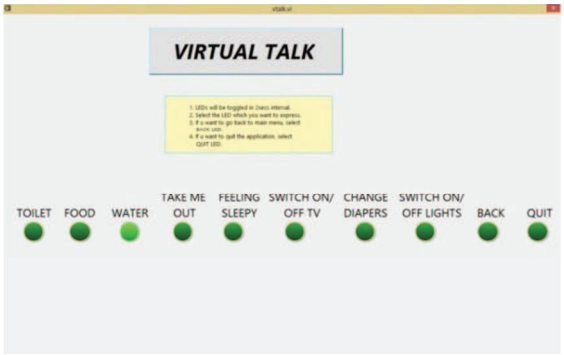
Keywords: Paralysis, Communication Module, EEG.

Introduction: The number of paralytic patients has increased tremendously when compared to the past. According to census 2001, there are approximately 61, 33,960paralytic patients in India. They find great difficulty in performing some of their vital works such as communication. So, it is necessary to aid them in overcoming the above mentioned difficulty. Taking this as our problem statement, a project is made which will enable the paralytic patient to communicate with people with the help of their own EEG (Electroencephalogram) signal. The proposed work will ease the paralytic patients to overcome these difficulties. EEG is a test that measures and records the electrical activity of the brain. It was found that EEG signal obtained during voluntary eye blink condition, produces clear signals with larger amplitude (approximately around260mV) than that of normal EEG (10-100mV). Also, the frequency of the EEG wave containing eye blink will be different from the normal EEG wave (in an active state it is around8-30Hz) which will be around4-7Hz. An efficient algorithm for detecting the occurrence of eye blinks is developed. This eye blink is converted into pulse, which is used in this module. In this protocol we have used a software called NI Lab VIEW, it is a graphical stimulation software in which we were able to extract the eye blink and to design our communication module

Basis of Paralysis: A Paralysis is generally loss of muscle function for single or more muscles. Paralysis can be determined by a loss of feeling (sensory loss) in the affected area if there is sensory damage as well as motor. A study conducted by the Christopher & Dana Reeve Foundation, suggests that about 1 in 50 people have been analysis with paralysis. Paralysis is most often occurred by damage in the nervous system especially the spinal cord system. Other major occurence are stroke, trauma with nerve injury, poliomyelitis, botulism, spina bifida, multiple sclerosis, and Guillain-Barré syndrome. Temporary. Normally paralysis occurs during REM sleep, and dysregulation of this system can lead to episodes of waking paralysis. Drugs that interfere with nerve function, such as curare, can also cause paralysis. There are many known causes for paralysis and perhaps more yet to be discovered. Pseudo paralysis is voluntary restriction or inhibition of motion because of pain, in coordination, orgasm, or other cause, and is not due to actual muscular paralysis.

Source of EEG Activity: The brain's electrical charge is maintained by billions of neurons. Neurons are electrically charged (or "polarized") by membrane transport proteins that pump ions across their membranes. Neurons are constantly exchanging ions with the extracellular milieu, for example to maintain resting potential and to propagate action potentials. Ions of similar charge repel each other, and when many ions are pushed out of many neurons at the same time, they can push their neighbors, who push their neighbors, and so on, in a wave. This process is known as volume conduction. When the wave of ions reaches the electrodes on the
scalp, they can push or pull electrons on the metal on the electrodes.

Fig 1: Virtual Talk



Methodology: Our system, Communication Aid consists of three modules – Virtual Talk, Automated Mail Client and SMS. The signal is acquired using surface electrode from the forehead. It is then amplified using INA118P and acquired using NI USB DAQ to create a pulsed output. This is used to run three communication modules –Virtual talk, SMS and email. The output for each is a display box and a voice alert system. The steps are described in detail below

Virtual Talk: Many of the paralytic patients find great difficulty in expressing what they feel and what they want. In order for them to overcome these difficulties we have built a virtual talk module using LabVIEW.

We have built a set of LEDs which will be toggling; the patient will be able to select the preferred LED through an eye blink. On doing so, a voice file which is attached to that corresponding LED gets played(these voice files are some essential or basic needs of a person). Each LED will have a particular wording and picture corresponding to it. This aids the patient in selecting the correct LED

Automated Mail Client: Automated mail client is a very great innovation in the field of assist devices (communication). Here, the patient will be able to type (using a keyboard stimulated 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. Once the mail is generated through a series of eye blinks the mail is sent through SMTP protocol using LabVIEW

SMS: Short Message Service (SMS) is a text messaging service component of phone, which uses a standardized communication protocols which allows the exchange of short text messages between mobile phone devices. This service was unreachable for paralytic patients, but not anymore. We have made a module through which the patient will be able to send SMS to anyone. The typing is done through the keyboard which is stimulated in Automated Mail Client and the message is sent using mobile protocol in LabVIEW

EEG Signal Amplification: The EEG is read from the patient by placing electrodes over his forehead and reference electrode near auricular region. Since EEG is weak in amplitude, it should be amplified. For that purpose, preprocessing circuit is employed. It contains impedance matching circuit to match the impedance of system with our body's impedance. Across capacitance is used to match the frequency component of our body. It is followed by the amplifiers and filters. Amplifiers consist of instrumentation amplifier and operational amplifier. Instrumentation amplifier is built using INA118P. The gain of this amplifier is decided by the resistance of gain resistor, R6. For further amplification, OP-AMP is used, which is built using LF356. The gain of OP-AMP is around 1000. Capacitor, C_4 is used for coupling purpose between the amplifiers. Filters used are – Band pass filter (0.1 – 40 Hz) and Notch filter (50 Hz), to remove noises such as power line interference and other bio-signals. The filtered EEG is then fed to NI Lab VIEW to extract eye blink and using it for our applications through NI DAQ 6009

Communication module: The raw signal acquired is processed using virtual instrumentation software Lab VIEW. In order to convert the EEG signal in to a control signal that is a pulsed wave, the EEG signal is processed by a series of steps. First the signal is rectified by a squaring operator and then it is smoothened by a smoothening filter and after that using a threshold operator a pulsed wave is produced. The threshold is set accordingly dependent on the patient's ability. Now this pulsed wave can be used for communication process.

Control Logic for Communication Window: After the processing is done digitally, the signals are used to trigger three separate modules which can be chosen as desired. They are virtual talk, automated mail client (AMC) and SMS

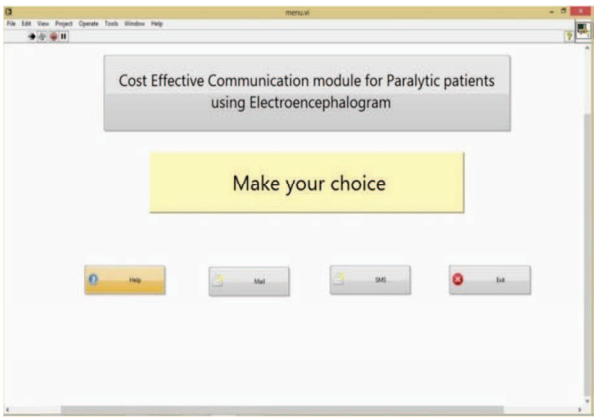


Fig 2: Main Menu

Fig 2 shows the menu window of our application. It can be seen that there are three options i.e. Help (virtual Talk), Mail and SMS along with Exit button, these options are made to toggle using LabVIEW. If the patient wants to choose an option and his eye blink matches with the preferred option toggle, then that option is selected. Once the option is chosen, the corresponding front panel of that option will be opened. Suppose, the patient wants to quit the application, he needs to select Exit button by blinking correspondingly. In the Virtual talk module, a window is created using a set of 10 predefined commands that include basic necessities such as need for food ,water, general help, usage of toilet, switching off of lights, get off wheelchair , change of diaper, change of position, play music, good morning and good night. These commands are placed alongside LEDs that is each set to blink in series after a time period of say 5seconds.When the patient requires a certain command; he provides a trigger when the LED glows for that respective command. This also enables a voice alert system. The Alphabet panel consists of all the 26 alphabets along with special characters such as 'space' and 'return'. Using the same logic as the previous panel, the LEDs blink in series for each alphabet and this can be used to create a string of words. On selecting return, the word is displayed in a separate display box.The below figure shows the email window of our application. From the figure, it can be noticed that two options are provided – Confirm and Cancel.

Confirm button is used to send the mail and cancel is to discard the mail. Recipient address and message is shown for the user to verify that the mail is correct and can be sent. Typing message is same like typing mail. Once the message is created, DONE button is used to send the message. Sending the message is accomplished using Mobile module in LabVIEW. DONE button is selected to bring the control to the main menu for module selection. After using the application, EXIT button in main menu is used to quit the LabVIEW

Results and Discussion: The above experiment was conducted for 4 subjects whose age is in the range of 19-22 years. The experiment is done in an environment surrounded by various instruments to determine the system's stability. The amplitude of normal EEG signal and EEG signal with eye blink and frequency of eye blink obtained from the 4 subjects is tabulated as shown in table1.From the table, it can be noticed that average amplitude of the eye blink is around 3.45 V The EEG of one subject along with FFT is shown in the Figure 5. From the figure, it can be depicted that the amplitude of the EEG signal after 2 stages of amplification is ~3.6 V. Also, it can be noticed that 50Hz power line interference is suppressed completely with the help of the Active twin-T notch filter. The maximum peak obtained in the FFT is near 6.25 Hz, indicating that the maximum power of the patient's EEG lies in the region of delta whose frequency is of 4-8 Hz

Table 1: Amplitude and frequency of subjects EEG

Subject	Amplitude of EEG (V)	Amplitude of EEG with Eye blink (V)	Frequency of Eye Blink (Hz)
Subject 1	3.40	5.8	4.63
Subject 2	3.00	6.6	3.37
Subject 3	2.60	6.4	3.25
Subject 4	2.24	6.1	5.28
Subject 5	2.82	6.2	4.13
Subject 6	2.74	6.2	4.26
Subject 7	2.50	6.3	3.75
Subject 8	3.20	6.5	4.20
Subject 9	2.90	6.0	4.45
Subject10	3.10	6.4	4.90

Conclusion: The communication system has three modules and thus provides more comfortable and less frustrating method of access to the subject as they can convey their thoughts faster. Also few pulses are required from the subject for us age of the system. This system is highly suitable for those who are bedridden and require communication of their needs to others for helping them do their day today basic needs. The additional sound files that are installed acts as an added advantages it can allow people to quickly and effectively understand what the subject is trying to convey. The alphabet boards allow the patient to converse his thoughts with more specificity. From the results we had got we could very well say that our protocol will be a very great breakthrough in the field of assist device and the patients would love and enjoy sending mail and SMS. The success rate of our system is around 90% in adults and 65% in elder people. From our experiments, we found that there is a delay of 2 seconds in time between the blink and the activation of the particular action..

Appendix: Appendixes, if needed, appear before the acknowledgment.

Acknowledgment: The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments. Avoid expressions such as "One of us (S.B.A.) would like to thank ... ." Instead, write "F. A. Author thanks ... ." Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page.

References:

1. Ding,Q.,Tong, K., Li, G.,"Development of an EOG(Electro-Oculography) Based Human-Computer Interface ",Proceedings of IEEE EMBS, Shanghai, China,2005, pp.6829-6831
2. Kumar,D.and Poole,E., "Classification of EOG for Human Computer Interface", Proceedings of IEEE EMBSIBMES,USA,2002, pp64-67
3. F.H Jian, "Biometric System Based on EEG Signals by Feature Combination," International Conference on Measuring Technology and Mechatronics Automation, 2010, pp.752-755
4.] S. Gupta, H. Singh, "Preprocessing EEG signals for direct human-system interface," IEEE International Joint Symposia on Intelligence and Systems (IJSIS '96), 1996, pp.32
5. Krolak, A., and Strumillo, P. "Vision-Based Eye Blink Monitoring System for Human-Computer Interfacing", Institute of Electronics, Technical University, Lodz, Poland.
6. Glass,K.A., Frishkoff,G.A., Frank,R.M., Davey C., Dien, J., Malony, A.D., Tucker, D. M."A Framework for Evaluating ICA Methods of Artifact Removal from Multichannel EEG", Institute of Electronics, Technical University, Lodz, Poland
7. Manoilov,P. P. "EEG Eye-Blinking Artifacts Power Spectrum Analysis", Proceedings of Int. Con.on Computer Systems and Technologies, CompSysTech'06, V.Tamovo, Bulgaria, 15-16June2006, pp.IIIA.3-I-IIIA.3-5.
8. Z. Li, S. Hui, C. Shigang, L. Chuo, B. Yan, X. Longteng, L. Ziman, "Research of Brain-Computer Interface Technology Based on LabVIEW," Fourth International Conference on Natural Computation, 2008, vol. 6, pp.72-80
9. S.O. Al Mehairi, H. Barada, M. Al Qutayri, "Integration of Technologies for Smart Home Application," IEEE/ACS International Conference on Computer Systems and Applications, 2007, pp.241-246.
10. M.S Abd Rani, Bachelor Degree Thesis, “Detection of eye blinking from EEG signal for home lighting system activation” , Universiti Teknologi Mara,2009.

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