Electro-oculogram based rehabilitation using bioengineering techniques for neural disorder person.

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Abstract

Living creatures especially human, always aimed to commune every process or incident that take place within the environment, to lead an easy and luxurious life. Everyday a person has to execute certain basic tasks to control their body movements or particular parts of the body. Paralyzed people do not have control over some of their body parts. However, there are persons who are severely paralyzed and they cannot move themselves. They need some assistive technologies to fulfill their needs. A person with disabilities, mainly total paralysis is often unable to exploit the biological communication channels such as voice and action. One such condition was massive Brainstem Lesions, Stupor, Guillain-Barre Syndrome and Traumatic Brain Injury. In these conditions they cannot move their muscles, but they can able to control their eye movement, which leads to a condition called locked in state. In this state the person were unable to control all the motor neural activity which leads to other communication technique to convey their thoughts with others using eye movements. To solve this problem eye controlled interfaces are needed. Human Computer Interfaces help individuals with disabilities to communicate through a computer using a digital channel and make life more prosperous for the paralyzed patients and further enhance their quality of life with the support of bio-based HCI.

Keywords: Electrooculography, Human computer interaction, Man machine interface, Feed forward neural network, Elman recurrent neural network, Singular value decomposition.

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Introduction

According to WHO 70 million individuals with impairment in India were faced with problems of access to basic and specialized health care services and around 4% need support for rehabilitation services. Some of the primary problems faced by individuals with disabilities were physical inaccessibility and financial barriers in accessing health care. Despite the government of India and the state governments having introduced several health schemes for the needs of the disabled, these do not adequately ensure their right to full and equal health care. Established on the statistic from the Department of Social Welfare, the recorded number of disabled people due to inability stood at 7,435,139 was shown in Table 1.

Table 1: *Disabled population by type of disability in India.*

Type of Disability	Males	Females	Persons
In Speech	1,122,896	875,639	1,998,535
In Movement	3,370,374	2,066,230	5,436,604
Total	4,493,270	2,941,869	7,435,139

The reports from WHO confirms that disabled people in India were critically increased in last few years due to high population. In the last few years, the development of an assistive technology for people with disabilities, improving the traditional systems has been a major increase. Modern world with technologies offer better interfaces for disabled to increase the quality of life by introducing new assistive techniques with the help of HCI. Hence, an aid and facilities being modernized to remodel the quality life of the disabled people [1]. Research on various strategies of computer communication and control has been focused using three varieties of modes such as voice communication, electrical brain activity and eye movements. Speech recognition has been successful in hands free control of computer operations, but it was not useful for handicapped individuals, who have no speech capability, such as those with quadriplegic cerebral palsy, brain activity needs extensive training and further the method is slow because of low sensitivity and specificity, whereas eye movement function has received a great attention within the search of non-conventional ways of controlling computer techniques using Electrooculography [2].

Assistive device with the help of eye movements are effectively used as new communication medium for person with disability. To lead a relaxed life and to improve the life style for disabled there was a need of EOG based HCI [3]. This paper discuss about rehabilitative devices that can aid the physically challenged by allowing them to interact with a computer system using only eye movements and neural networks. The

primary goal behind this research is to study various rehabilitative devices used by paralyzed individuals to overcome their disability to lead a comfortable life without others helps.

Human computer interaction

HCI is sometimes referred to as Man Machine Interaction (MMI) or Computer Human Interaction (CHI). HCI is a mechanism of interaction between machine and a man by collecting individual pattern from some specific activity and converts that activity patterns in to meaningful control commands to operate any device. The primary goal of this technique is to connect the people with the help of machines to share the thoughts to minimize the barrier between paralyzed person and the caretakers. In everybody's life HCI playing important role to fulfill the basic need with help of technology. With the beginning of robots in daily life, mainly in providing services to people with special needs, there is a strong necessity for simple and natural control interfaces. To control a robotic arm, a wheelchair or any other device, it requires a signal to operate the device. The signal can be electrical, non-electrical or any other particular type. Most of the times the signal used for intelligent rehabilitation aids are an electrical signal generated from the human body [4-7].

Rehabilitation device

Nowadays, many people suffer from an inability. This incapability can be called as paralysis. Even though they can able to move their eyes even though, they cannot move their body muscle. Researches in developing a new rehabilitation device for disabled people are being carried out extensively. Rehabilitation device is an assistive technique which helps the disabled or paralyzed individual to behave like normal person by converting bio signal to control signal to overcome the biological channel by means of communication. Many interfaces like Brain Computer Interfaces, Human Machine Interfaces were present in the modern world, but Human Computer Interface attract all the researchers as well as patients with neuro-disorder due to easy to use, low cost and reliable. For each and every type of disorder different types of rehabilitation device are design to carry out the needs of individual person. Nowadays there are two different types of rehabilitation devices are available in market. They are bio signal based rehabilitative device and non-bio signal based rehabilitative device. Both types of rehabilitative devices are totally different and also varied according to their special needs [8-10].

EOG recording

Non-Invasive cup electrodes are placed near to the above, below and right left of the human eye to measure the horizontal and vertical tasks performed by the subjects. Whenever the human subjects move their eyes in same direction, the resting potential will vary. These variations cause some potential and measuring this potential is called Electrooculography. Electrode gel especially silver chloride is act as interface between the skin and the electrodes. It acts as gate between skin and the electrodes, which passes the electrical signal from eye movements to amplifier to enhance the signal. If the human subject start to rotate their eyes, alternative positive and negative signal will be generated and displayed in the bio amplifier according to the eye movements [10,11].

Literature survey

Some of the EOG based rehabilitating devices used for immobilized persons were given below [10]. Ramkumar et al., developed EOG based HCI using Singular Value Decomposition (SVD) and Band Power with Feed Forward Neural Network and Elman Neural Network and obtained classification efficiency of 83.36% and 98.50% for SVD features and 84.60% and 98.46% for Band Power features using the two networks respectively [11]. Ramkumar et al., developed EOG based HCI using the Parseval and Plancherel theorems and Feed Forward Neural Network and Time Delay Neural Network. In this study the performance obtained from individual classifiers were compared to find the best classifier. Finally classification accuracy of 91.40% and 90.89% for time delay neural network for two feature extraction methods. The study proves that Time Delay Neural Network was better compared to Feed Forward Neural Network [12]. Ramkumar et al., designed EOG based HCI using Convolution and Singular Value Decomposition method with Time Delay Neural Network and Feed Forward Neural Network correspondingly for twenty subjects. From the study we obtained the maximum average classification accuracy of 90.99% and 90.10% for convolution features and 90.88% and 89.92% for SVD features using two classifiers respectively [13]. Ramkumar et al., designed Human Computer Interface using Electrooculography from ten subjects for eleven tasks to collect the prominent features. Parseval`s Theorem and dynamic network model were designed to analyze the obtained signals. The average classification accuracies were observed to vary from 80.72% to 91.48% and 85.11% to 94.18 % for the classifier correspondingly [14]. Ramkumar et al., developed EOG based HCI from twenty subjects using Reference Power and Layered Recurrent Neural Network and obtained accuracy of 90.74% from twenty subjects [15]. Ramkumar et al., designed EOG based HCI using nine movements for ALS patients from six subjects. Features were extracted using statistical method and categorized with Time Delay Neural Network to identify the eye movement signals. The designed network illustrates the average mean classification accuracy of 87.72% for six subjects [16].

Conclusion

From this study we analyzed and discussed about HCI, Rehabilitation, EOG recording and some of the EOG based HCI developed for elderly disabled. Through this study we found that Neural Network classifier performance was appreciable compared to other classifiers. So most of the researchers using neural network classifiers for developing the assistive device for elderly disabled using artificial intelligent.

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