Brain Machine Interface Automation System: A Review

Prachi Kewate, Pranali Suryawanshi

Abstract: The Research and development of brain-controlled robots have received a great deal of attention because of their ability to bring back to people with devastating neuromuscular disorders and improve the quality of life and self- dependence of these users. BMI (Brain Machine Interface) systems are viable for motor disabled person who cannot move their limbs or are paralyzed. For such people BMI can serve as a boon as only by just thinking about the task it can be done with the help of EEG based robots. An automation system where humans will interact with the system through EEG signals using BMI concept.BMI uses brain activity to command, control, actuate and communicate with the automation system directly through brain integration with peripheral devices and systems. A brain actuated wheelchair will serve beneficial to the motor disabled person for moving from one place to another. Signals from brain will be acquired with the help of dry electrodes and those signals are processed in the system processor. The processed signal will be then applied to the Wheelchair depending on the instructions given by the person sitting on it.

Keywords: Brain Machine Interface, P300, SSVEP, ERD/ERS.

1. INTRODUCTION

ABRAIN–MACHINE INTERFACE (BMI) is a communication system that does not depend on the brains normal output pathways of peripheral nerves and muscles. It is a new communication link between a functioning human brain and the automation system. These are embedded interfaces with the brain, which has the ability to send and receive signals from the brain. BMI uses brain activity to command, control, actuate and communicate with the world directly through brain integration with peripheral devices and systems. The signals from the brain are taken to the computer via the implants for data entry without any direct brain intervention. BMI transforms mental decisions and/or reactions into control signals by analyzing the bioelectrical brain signals. While linking the brain directly with machines was once considered science fiction, advances over the past few years have made it increasingly viable. It is an area of intense research with almost limitless possibilities. The human brain is the most complex physical system we know of, and we would have to understand its operation in great detail to build such a device.

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An immediate goal of brain-machine interface study is to provide a way for people with damaged sensory/motor functions to use their brain to control artificial devices and restore lost capabilities. By combining the latest developments in computer technology and hi-tech engineering, paralyzed persons will be able to control computer painter or robotic arm by thought alone. In this era where drastic diseases are getting common it is a boon if we can develop it to its full potential. Recent technical and theoretical advances, have demonstrated the ultimate feasibility of this concept for a wide range of space-based applications. Besides the clinical purposes such an interface would find immediate applications in various technology products also. Various physiological activities of human will emit weak electricity; the brain is composed of brain neurons. Therefore, the brain signal is biological signal associated with brain, i.e. brain waves. The activity of Brainwave has certain laws, which is corresponding with the brain's consciousness in some degree, when people are at different states of joy, anxiety, drowsiness, the frequency of brainwave will be significantly distinct. BMIs provide new output pathways for the brain by translating measurements of brain activity into inputs for an external device. These output pathways typically function in one of two different ways: process control and goal selection. In process control, measurements of brain activity are used to specify an immediate action to be taken, such as moving a cursor to the left or to the right. In goal selection, measurements of brain activity are used to specify the desired output after a sequence of actions, such as the location at which the cursor should end up [4]. The basic idea of BMI is to translate user produced patterns of brain activity into corresponding commands. A typical BMI is composed of signal acquisition, signal analysis and automation system [3]. The key technology of BMI is to convert the EEG input of the user into a control command fig 1. The very important part of BMI research is to adjust the mutual adaptation relationship between the human brain and the BMI system, i.e. to find a suitable signal processing, making nerve signals convert into the command or an operation signal that can be recognized by the computer in real time, quickly and accurately by the means of BMI system

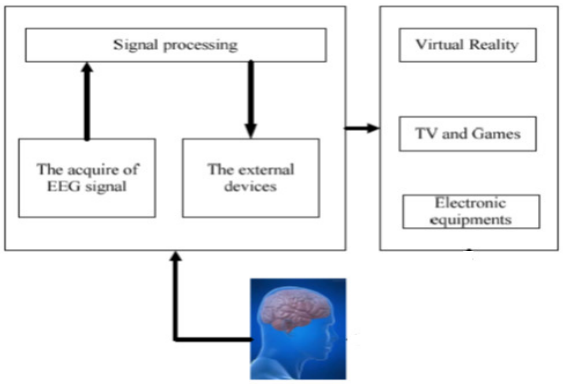

Fig1. The Structure of BMI System

BMI gives direct pathway between human and physical devices which can be done with the help of biological signals. EEG is one such biological signal. BMI systems are viable for motor disabled person who cannot move their limbs or are paralyzed. For such people BMI can serve as a boon as only by just thinking about the task it can be done with the help of EEG based mobile robots. EEG based robots can serve as powerful aids for severely disabled people in their daily life, especially to help them voluntarily. Brain controlled mobile robot require higher safety since they are used to transport disabled person. Thus, the BMI systems that are used to develop these robots need better performance. In the first part of the paper an introduction about the paper has been given. In the second part a brief literature survey about the related papers has been presented and lastly in the third part conclusion about the paper has been given as follows:

2. LITERATURE REVIEW

Recently, research and development of brain-controlled robots have received a great deal of attention because of their ability to bring back to people with devastating neuromuscular disorders and improve the quality of life and self- dependence of these users. It includes various applications such as a cursor on the screen [4], selecting letters from virtual keyboard [5], browsing internet [6], and playing games [7]. Based on the techniques used in BMI the literature review is classified as follows:

2.1 P300

P300 is an event related potential (ERP) which is bring out to make a decision. A technique positive potential typically occurs around 300 milliseconds after a rare event occurs. After several presentations of the items the target can be recognized with almost 100% confidence. This setup has the advantage of requiring no training from the user and only a few minutes to train the P300 detecting system. This is noteworthy since most of the other BCI techniques require a very long training phase, up to several months in the case of slow cortical potential devices The brain- computer interface (BCI) mouse based on P300 waves in electroencephalogram (EEG) signals [2].The system presents two unique features: it completely dispenses with the problem of detecting P300s (a notoriously difficult task) by logically behaving as an analogue device (as opposed to a binary classifier), and it uses a single trial approach where the mouse performs an action after every trial (once per second). Visual stimuli consisting of 8 arrows randomly intensified are used for direction target selection for wheelchair steering. The classification is based on a Bayesian approach that uses prior statistical knowledge of target and non-target components. Recorded brain activity from several channels is combined with a Bayesian sensor fusion and then events are grouped to improve event detection. The system has an adaptive performance that adapts to user and P300 pattern quality.[15] The classification algorithms were obtained offline from training and then validated offline and online. The system achieved a transfer rate of 7 commands/min with 95% false positive classification accuracy**.** A working prototype of a wheelchair which works in an office or office environment has been implemented with slow but safe P300 system [18]. A motion guidance strategy has been proposed to provide a safe and efficient control without complex sensors thus avoiding the problem of low information rate of the EEG signal.

2.2. SSVEP

SSVEP is steady state visual evoked potential. A visual evoked potential (VEP) is an electrical potential-difference, which can be derived from the scalp after a visual stimulus, for example a flash-light. VEPs after stimuli with a frequency < 3.5 Hz are called “transient” VEPs. If the stimulation frequency is > 3.5 Hz they are called “steady state” VEPs because the individual responses overlap and result a quasi-sinusoid oscillation with the same frequency as the stimulus To minimize the need for training prior to using a BCI, a framework dependent upon steady state visual-evoked potential (SSVEP) [13] reaction of the cerebrum also can be utilized. The SSVEP is a low-level reaction in the visual cortex to an outer visual boost with a constant frequency. A brain–computer interface (BCI) based on steady state visual-evoked potentials (SSVEPs) is combined with a functional electrical stimulation (FES) system to permit the client to control stimulation settings and parameters. The framework requires four glimmering lights of different frequencies that are utilized to structure a menu-based interface, empowering the client to communicate with the FES system. A brain computer interface (BCI) based on steady state visual evoked potentials (SSVEP) is presented. For stimulation a box equipped with LEDs (for forward, backward, left and right commands) is used that flicker with different frequencies (10, 11, 12, 13 Hz) to induce the SSVEPs.[16]

2.3. ERD/ERS

Brain activity recorded non-invasively is sufficient to control a mobile robot if advanced robotics is used in combination with asynchronous EEG analysis and machine learning techniques. Until now brain-actuated control has mainly relied on implanted electrodes, since EEG based systems have been considered too slow for controlling rapid and complex sequences of movements. We show that two human subjects successfully moved a robot between several rooms by mental control only, using an EEG based brain-machine interface that recognized three mental states [17]. One such application where author presents an interface for navigating a mobile robot that moves at a fixed speed in a planar workspace[1], with noisy binary inputs that are obtained asynchronously at low- bit rates for human user through an electroencephalograph(EEG). This paper is actually a simulation based paper. A portable brain-computer interface (BCI) system for the inner ideas expressing by voice is designed and fabricated [3]. The dry electrode is used in this system to record Electroencephalography (EEG).The EEG signal is recorded by the dry electrode, and afterward intensified, prepared progressively by the application specific integrated circuit (ASIC), and the obtained processed signal can be used to control the external output equipment. The Berlin Brain Computer interface (BBCI) [12]venture improves a non-invasive BCI framework whose key characteristic are: 1) The utilization of overall built engine abilities as control ideal models; 2) high-dimensional characteristics from multi channel EEG; and 3) propelled machine studying strategies. Spatio-spectral changes of sensor meter rhythms are utilized to segregate envisioned developments (left hand, right hand and foot). An electroencephalographic analysis based, self-paced (asynchronous) brain-computer interface (BCI)is proposed to control a mobile robot using four different navigation commands: turn right, turn left, move forward and move back[14]. A self-paced BCI system distinguishes between two states: (i) a non-control (NC) state in which subjects can be involved in a mental activity other than controlling the BCI, and (ii) an intentional control (IC) state, in which subjects can control the system by specific mental tasks The same concept of BMI as explained in these papers above is going to be used in the proposed work. BMI can be used to develop such an automation system where motor disabled person will be able to move from one place to another. The person who have motor disabilities and are paralyzed are not able to move any of his limbs so in such a condition this proposed system will be a boon to them. They have to only think of certain direction where they want to move and thus the system will take them to that particular direction. A brain controlled wheelchair may serve as an application to them.

3. CONCLUSIONS

The Brain Machine interface is a vast topic for research and development. The techniques used in the BMI vary from application to application. P300, SSVEP, ERD/ERS are some of the techniques used presently. Each technique has its own advantage and disadvantage. Thus we should be opt in choosing technique used in our application depending on the program we are implementing.

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