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EEG-Based Brain-Controlled Communication Robots: A Survey

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Abstract: **The analysis and development of brain-controlled robots have received an excellent deal of attention as a result of their ability to bring back to folks with devastating fasciculus disorders and improve the standard of life and self- dependence of these users. BMI (Brain Machine Interface) systems are viable for motor disabled one that cannot move their limbs or are paralytic. For such folks BMI will function a boon as solely by simply puzzling over the task it may be through with the assistance of electroencephalogram based mostly robots. AN automation system wherever humans can act with the system through electroencephalogram signals victimization 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 motivated chair can serve helpful to the motor disabled person for moving from one place to a different. Signals from brain are no heritable with the assistance of dry electrodes and people signals are processed within the system processor. The processed signal are then applied to the chair counting on the directions given by the person sitting thereon.**

Keywords: **EEG, BCI, Disabled users, Neuro, Coritical, Micro System, Sensors, Implant**

I. INTRODUCTION:

A BRAIN–MACHINE INTERFACE (BMI) could be a communication system that doesn't depend upon the brains traditional output pathways of peripheral nerves and muscles. it's a brand new thanks to communicate between a functioning human brain and therefore the automation system. These square measure embedded interfaces with the brain, that has the potential to transmit and receive signals from the brain. This interface transforms mental selections and reactions into management signals by analyzing the bioelectrical brain signals. It was once thought of as a fantasy to link the machines directly with the brain, however now-a-days with immense development within the neurobiology it's possible to try and do therefore. And still the analysis goes on. Brain could be a advanced system nervosum whose operation we will got to explore it intimately. By victimisation new technology and advanced engineering, disabled person will be ready to paint with the assistance of robotic arm, to fly an plane, to drive AN motorcar, etc. Various physiological activities of human can emit weak electricity; the brain consists of brain neurons. Therefore, the brain signal is biological signal related to brain, i.e. brain waves. The activity of Brainwave has sure laws, which is corresponding with the brain's consciousness in some degree, once individuals square measure at completely different states of joy, anxiety, drowsiness, the frequency of brainwave can be considerably completely different. BMIs offer new output pathways for the brain by translating measurements of brain activity into inputs for AN external device. These output pathways generally perform in one among two completely different ways: method management and goal selection. In method management, measurements of brain activity square measure accustomed specify a right away action to be taken, like moving a pointer to the left or to the right. In goal choice, measurements of brain activity square measure accustomed specify the required output once a sequence of actions, like the placement at that the cursor ought to find yourself .Signal Recordings of brain activity employed by BMI will be either invasive or non-invasive. Invasive BMIs require surgery to introduce electrodes directly or within
cortex, whereas noninvasive BMI don't do therefore. Noninvasive BMI will use varied brain signals as inputs, like graphical record (EEG), magneto encephalogram (MEG), Blood chemical element level dependent (BOLD) signals and (de) hemoglobin concentrations. attributable to the value and convenient use in practice, electroencephalogram has been the foremost well-liked signal that's used to develop BMI systems. the essential plan of BMI is to translate user created patterns of brain activity into corresponding commands. A typical BMI (Fig 1) consists of signal acquisition, signal analysis and automation Brain Machine Interface Automation System The key technology of BMI is to convert the electroencephalogram input of the user into an impression command.

The vital a part of BMI analysis is to regulate the mutual adaptation relationship between the human brain and therefore the BMI system, i.e. to seek out an appropriate signal process, creating nerve signals convert into the command or AN operation signal which will be recognized by the pc in real time, quickly and accurately by means that of BMI system.BMI provides direct pathway between human and physical devices which may be through with the assistance of biological signals. electroencephalogram is one such biological signal. BMI systems square measure viable for motor disabled person who cannot move their limbs or square

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measure paralytic. For such individuals BMI will function a boon as solely by simply thinking about the task it is through with the assistance of EEG primarily based mobile robots.EEG primarily based robots will function powerful aids for severely disabled individuals in their way of life, especially to help them voluntarily. Brain controlled mobile robot need higher safety since they're accustomed transport disabled person. Thus, the BMI systems that are accustomed develop these robots would like higher performance. The paper is organized as follows-In the primary a part of the paper introduction regarding the paper has been given. Second half explores regarding the target and research methodology i.e. specifically however the planned system can work and therefore the differentiation of assorted parts in them. Lastly the expected outcome regarding the steered paper has been given ending with the conclusion.

II. SORTS OF BRAIN LAPTOP INTERFACE

A. Invasive Brain laptop Interfaces

Invasive Brain laptop Interface Devices area unit those ingrained directly into the brain and has the very best quality signals. These devices area unit accustomed give practicality to paralytic individuals. Invasive BCIs may be accustomed restore vision by connecting the brain with external cameras and to revive the utilization of limbs by exploitation brain controlled robotic arms and legs. the matter with this kind of device although, is that connective tissue forms over the device as a reaction to the foreign matter. This reduces its efficiency and will increase the danger to the patient.

B. partly Invasive Brain laptop Interfaces:

Partially Invasive BCIs, on the opposite hand, area unit ingrained within the bone however outside the brain. Though signal strength exploitation this type of BCI device could be a bit weaker, partly invasive BCIs has less risk of connective tissue formation.

C. Non Invasive Brain laptop Interfaces

Non invasive brain laptop interface, though it's the smallest amount signal clarity once it involves human action with the brain (skull distorts signal), is additionally the safest. this kind of device has been found to achieve success in giving a patient the flexibility to move muscle implants and restore partial moment. One of the most well-liked devices beneath this class is that the graphical record or electroencephalography capable of providing a fine temporal resolution. it's straightforward to use, comparatively low cost and moveable.

III. SIGNAL ACQUISITION

To modify communication with the assistance of a BCI, 1st brain signals ought to be measured. Completely different ways to realize this goal, starting from the invasive activity of electrical potentials at single neurons to the noninvasive activity of large-scale hemodynamic brain activity, are according in the literature. We tend to review a number of these ways below, starting from the graphical record that permits for measurements of electric potentials at massive special scales. we tend to continue with the electrocardiogram (ECOG) and microelectrode arrays, which allow for activity of potentials at smaller spatial scales. Next, ways for mensuration magnetic brain activity and hemodynamic brain activity area unit delineate. The different ways area unit compared in terms of temporal and spatial resolution, invasiveness vs. noninvasiveness, and in terms of complexness of the equipment required for playacting measurements.

Graphical record

The graphical record is one among the foremost wide used noninvasive techniques for recording electrical brain activity. Since its discovery by Hans Berger (Berger, 1929) the graphical record has been used to answer many different questions about the functioning of the human brain and has served as a diagnostic tool in clinical follow.

The graphical record could be a well-liked signal acquisition technique as a result of the required devices area unit straightforward and low cost and since the preparation of measurements takes solely a little quantity of time. graphical record signals area unit recorded with little silver/silver chloride electrodes with a radius of regarding 5mm, placed on the scalp at standardized positions (see fig. 1). Conductive gel or brine is used to improve the conduction between scalp and electrodes.

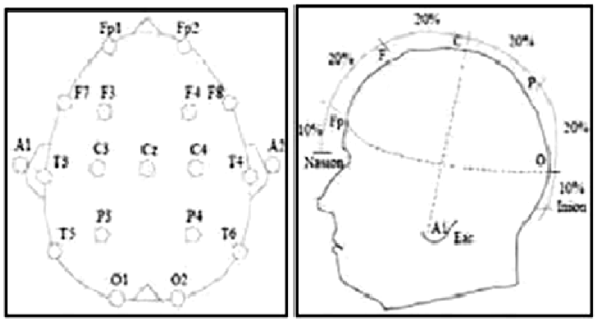

Fig. 1: standardized positions for electrode placement according to 10 - 20 international system

To understand however graphical record signals area unit associated with info processing within the brain, it's necessary to initial review the structure and functioning of neurons. Neuron incorporates a cell body (soma), an axon, and a nerve fiber tree fig. 2. The nerve fibre is "output channel" of neurons and connects via synapses to the dendrites (the "input channel") of alternative neurons. The means of communication between neurons area unit action potentials, i.e. electrical discharges created principally at the soma of cells. Action potentials move the nerve fibre of cells and result in a release of neurotransmitters once incoming at a conjunction. The neurotransmitters successively trigger a flow

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of ions across the cell membrane of the nerve cell receiving the nerve impulse. The flow of ions across the plasma membrane results in a modification in membrane potential, i.e. to a modification within the potential between living thing and animate thing house. If the membrane potential reaches a essential worth of around -50 μV a brand new action potential is triggered, and knowledge is transmitted via the axon to alternative neurons. The signals measured with the graphical record area unit thought to be principally a sway of knowledge process at pyramidal neurons settled within the cortex five. Pyramidal neurons have a pyramid-like soma and huge top dendrites, oriented perpendicular to the surface of the cortex (see fig. 2). Activation of AN excitative conjunction at a pyramidic cell results in an excitative postsynaptic potential, i.e. a web influx of absolutely charged ions. Consequently, enlarged animate thing negativity can be determined within the region of the conjunction. The animate thing negativity results in animate thing positivism at sites distant from the conjunction and causes animate thing currents flowing towards the region of the conjunction. The temporal and spatial summation of such animate thing currents, at many thousands of neurons with parallel homeward-bound dendrites, results in the changes in potential that area unit visible within the graphical record. The polarity of the graphical record signals depends on the sort of synapses being activated and on the position of the synapses. As shown in fig. 2, activation of excitative synapses in superficial animal tissue layers corresponds to negative surface-potentials. Activation of excitative synapses connecting near the soma of a cell corresponds to positive surface-potentials. For restrictive synapses the inverse is true: activation of synapses in superficial animal tissue layers corresponds to positive surface-potentials, and activation of synapses connecting near the soma of a cell corresponds to negative surface- potentials. while not information regarding the spatial distribution of synapses the sort of junction action will thus not be inferred from the polarity of surface potentials five.

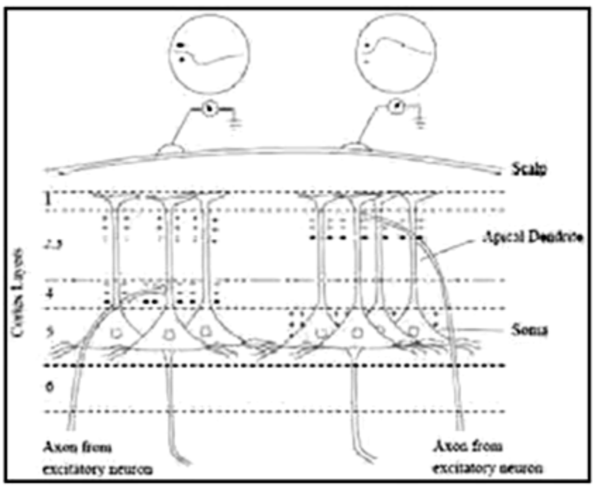

Fig. 2: Generators of the EEG

The potential changes associated to extracellular currents atpyramidal neurons square measure largely visible at electrodes placed over the active brain space. However, as a result of volume conductivity in the bodily fluid, skull, and scalp, signals from an area ensemble of neurons additionally unfold to distant electrodes. The potentials caused by the activity of a typical plant tissue macrocolumn (of diameter 3-4mm) will unfold to scalp electrodes that square measure up to ten cm aloof from the macrocolumn6. an additional impact of the tissue barrier between electrodes and neurons is that low-amplitude activity at frequencies of quite forty cps is much invisible within the EEG. The EEG so could be a world measurement of brain activity. Consequently, it's tough to use the EEG for drawing conclusions regarding the activity of little brain regions, not to mention the activity of single neurons. additionally to the effects of volume conductivity, the analysis of the EEG is more complicated by the presence of artifacts. Artifacts is due to physiological or nonphysiological sources. Physiological sources for artifacts embody eye movements and eye blinks, muscle activity, heart activity, and slow potential drifts as a result of transpiration.

V. APPLICATIONS

In theory any device that may be connected to a laptop or to a microcontroller can be controlled with a BCI. In practice but, the set of devices and applications that may be controlled with a BCI is proscribed. To know this, one has to think about that the quantity of knowledge which might be transmitted with gift day BCI systems is proscribed. The everyday information transfer rate realizable with Associate in Nursing EEG primarily based BCI is regarding twenty to forty bits/min. As a further obstacle mostpresent day BCI systems operate solely in synchronous mode. In synchronous mode, communication is feasible solely throughout predefined time intervals. this suggests the system tells the user when it's able to receive succeeding command and limits severely the potential variety of applications. In asynchronous mode users will send commands whenever they want.30 a number of the applications potential with current BCIs square measure delineated below.

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