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A Survey on Human Brain Interface

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Abstract- A complete blessing in disguise"-for completely paralysed people with none of their body parts functioning. Virtual human brain is an astonishing technological milestone which allows the quadriplegic patients to control the computer using their thoughts.

Index Terms- Amyotrophic Lateral Sclerosis, neurons, Pedestal, Neuroprosthetic device, Digital Signal Processing, EEG, Motor cortex.

I. Introduction

The Virtual human brain is a system (electrodes, sensors, and computer) in which brain activity in the patient is monitored and the intention of the user is converted into computer commands[1]. This system senses, transmits, analyzes and applies the language of neurons. It is very useful for patients with amyotrophic lateral sclerosis (ALS) or spinal cord injury [1] . It is a branch of science exploring how computers and the human brain can be meshed together. It sounds like science fiction (and can look like it too), but it is motivated by a desire to help chronically injured people[1].

II. PRINCIPLE

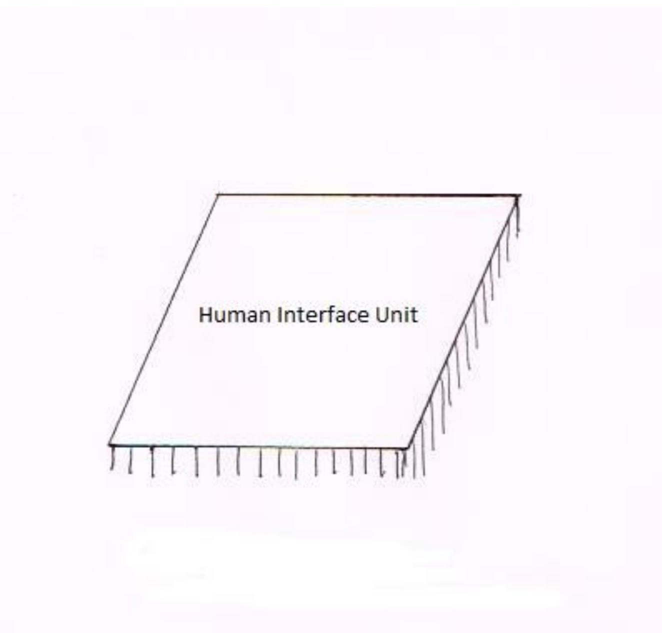

Fig: Virtual Human Brain [1]

The principle of operation behind this system is that with intact human brain functioning brain signals are generated. The signals generated are interpreted and translated into the cursor movements [2][1]. This offers the user an alternate pathway to control a computer with thoughts. In this system, a sensor is implanted within the brain of the patient. This sensor monitors the activity of the brain from a small group of neurons. The sensor after interpreting the brain signals sends the electrical pulses, which are encountered by the neural signal interpreter which in turn sends the commands to the Computer (input)[1].The technique used here is Neuro feedback.ie. A Neuromotor prosthetic device converts the brain activity into computer commands. By this means, a paralyzed people can move a robot arm or drive their own wheelchair, just by thinking about it [3]. The sensor implanted in the brain uses 96 hairs –thin electrodes that senses the electromagnetic signature of neurons firing in specific areas of brains, for example, the area that controls the arm movement [1]. The sensor translates that activity into electrically charged signals, which are then sent to an external device and decoded in software .the decoder connects to and can use the brain signals to control an external device.

III. NEUROMOTOR PROSTHETIC DEVICE

To successfully translate thoughts into actions, a BMI motor neuroprosthetic device would be required to incorporate several discrete functions [4]. These include detection of an appropriate "brain intent" signal in some real-time modality, rapid extraction of the signal from the available data (in the face of noise), communication of that signal to some form of internal or external actuator device, and then feedback on the task to determine whether and how precisely the "brain intent" command was actually performed. Each of these steps often emulates rather widespread steps occurring within the human nervous system and encompassing all normal brain function [5] [8]. This is a wired technology where a sensor implanted on brain and electrode is hooked up to travel to pedestal on the scalp [1]. From there, a fiber optic cable carries the brain activity data to a nearby computer. To interpret the brain signals even EEG can also be used. The signal generated by the brain is converted into the form of waveforms.

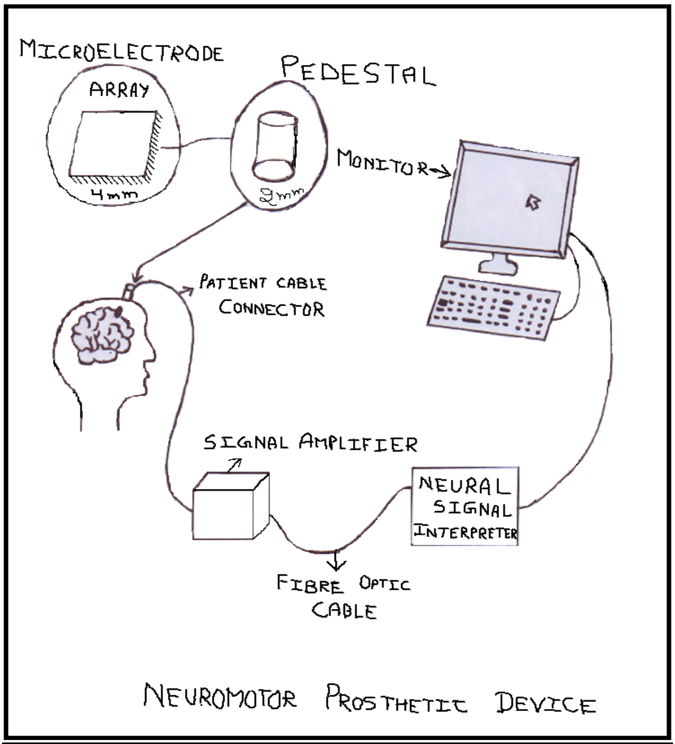

Fig: Neuromotor Prosthetic Device [1]

Motor cortex controls voluntary movements of the body. Those wires feed back to a tiny array – an information storage device – attached to a "pedestal" in the skull. Another wire feeds from the array into a computer. The obtained brain waveforms (EEG) signal can be done in time domain, e.g.: by comparing the amplitudes of EEG and infrequency domain. DIGITAL SIGNAL PROCESSING techniques can be used for sampling and band pass filtering the signal [6]. Calculating these time or frequency domains features and then classifies them.

IV. A TINY CHIP IMPLANT

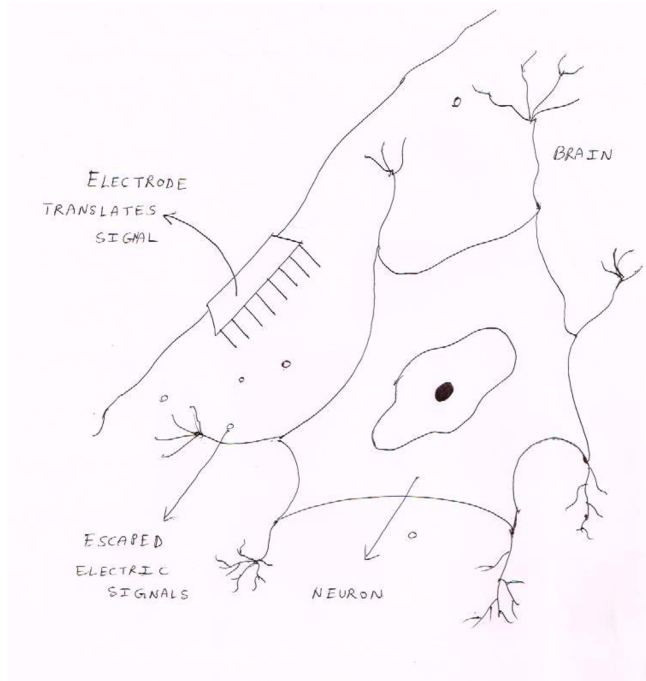

Fig: Tiny chip implant [1]

The above figure shows how the brain signals are captured by the sensor [1]. A day is not far when hooking up Brain to a system of electronic stimulators plugged into the muscles of the arm or legs. That would open up the prospect of patients moving not just a cursor or their wheelchair, but their own bodies [7]. A well advanced software need to be developed which is compatible enough to get the input commands as brain signals and perform the activity as required.

EEG Signal Analysis

Electroencephalography (EEG) has been used for decades to measure the brain's electrical activity. Planning and performing a complex movement (e.g., reaching and grasping) requires the coordination of muscles by electrical activity that can be recorded with scalp EEG from relevant regions of the cortex. The EEG signals are recorded from electrodes placed on the scalp [9]. The EEG preprocessing equals there are two types of EEG recording Monopolar, Bipolar. Monopolar picks up the voltage difference between the active electrode at scalp and the reference electrode on the ear lobe. Bipolar gives the voltage difference between the active electrodes which are placed on the scalp. The EEG signals are characterized by the following rhythms: delta waves, theta waves, alpha waves and beta waves. The frequency range of delta activity is 3Hz or below and found predominantly in infants up to 1year and deep sleep stages of normal adults. Theta activity has a frequency range of 4Hz to 8Hz. It exists in normal infants and children as well as during drowsiness and sleep in adults. Presence of high

BANDWIDTH	FREQUENCY(HERTZ)	AMPLITUDE (V)	LOCATION
Alpha	8-13	<50µ	Occipital/ Parietal regions.
u-rhythm	9-11	Varies	Precentral regions.
Beta	13-30	25	Frontal region.
Theta	4-8	Varies	Varies
delta	<3	Varies	Varies

theta activity in awake adults suggests abnormal and pathogenic conditions. Alpha activity has frequency range of 8Hz to 13Hz. It is usually seen in posterior region of brain in each side, being higher in amplitude in dominant side. The amplitude is less than 50µV. This is the major rhythm seen in normal relaxed adults. Beta has a frequency range of 13Hz to 30Hz and is predominant in frontal portion. This rhythm is present in alert or anxious subjects. The characteristics said above strongly depend on individual, age the brain signals are highly complex and random frontal portion and mental state.

V. FUTURE ENHANCEMENTS

Using this virtual human brain system the process of "MIND READING" can be done of individuals[1]. The thoughts of animals and birds can be read in near future. A completely self operated ROBOT can be designed which when interfaced with computer can perform the actions as per the thoughts of the user. Wireless and miniature version of this system can be created so that no physical sensor implantation is required[1].

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