Proposed System for Controlling of the Robot using the Brain Signal

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Abstract: This paper introduces proposed system which gives control of robot using brain signals (EEG) based on Brain–computer interfaces (BCI). Electroencephalography is a medical imaging technique that reads scalp electrical activity generated by brain structures. Electrodes read the signal from the head surface, amplifiers bring the microvolt signals into the range where they can be digitalized accurately, converter changes signals from analog to digital form, and personal computer (or other relevant device) stores and displays obtained data. BCIs are systems that provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. With these commands a robot can be controlled. The motto of the paper work is to develop a robot that can help the disabled or paralysed people in their daily life to do some work independently
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Keywords- EEG signal Sensor, BCI Section.

I. INTRODUCTION

There is a growing interest in the use of brain signals for communication and operation of devices for physically disabled people. Here, we are analyzing the brain wave signals. For obtaining basic brain patterns of individuals, subjects are instructed to close their eyes and be relaxed. Brain patterns form wave shapes that are commonly sinusoidal. Human brain consists of millions of interconnected neurons. The patterns of interaction between these neurons are represented as thoughts and emotional states. The brain can be divided into three sections: cerebrum, cerebellum, and brain stem [4]. The cerebrum consists of left and right hemisphere with highly convoluted surface layer called cerebral cortex. The cortex is a dominant part of the central nervous system. Each cerebral hemisphere is formed of four lobes:

- Frontal Lobe- Contains motor area.
- Parietal Lobe- Contains sensory area.
- Temporal Lobe- Contains area of hearing & memory.
- Occipital Lobe- Contains area of vision.

According to the human thoughts, this pattern will be changing which in turn produce different electrical waves as shown in table no. 1.

TABLE 1: CLASSIFICATIONS OF BRAIN WAVE

Type of Brain wave	Frequency range	Mental states and conditions
Delta	0.1Hz to 3Hz	Deep, dreamless sleep, non-REM sleep, unconscious
Theta	4Hz to 7Hz	Creative, recall, fantasy, imaginary, dream
Alpha	8Hz to 12Hz	Relaxed, but not drowsy, conscious
Low Beta	12Hz to 15Hz	Relaxed yet focused, integrated
Midrange Beta	16Hz to 20Hz	Thinking, aware of self & surroundings
High Beta	21Hz to 30Hz	Alertness, agitation

A muscle contraction will also generate a unique electrical signal [4]. When brain cells (neurons) are activated, flow of current is produced. EEG measures mostly the currents that flow during synaptic excitations of the dendrites of many pyramidal neurons in the cerebral cortex. Usually, they are measured from peak to peak and normally range from 0.5 to 100 µV in amplitude [5], which is about 100 times lower than ECG signals. So they need to be amplified for further processing. Differences of electrical potentials are caused by summed postsynaptic graded potentials from pyramidal cells that create electrical dipoles between soma (body of neuron) and apical dendrites (neural branches). Brain electrical current consists mostly of Na+, K+, Ca++, and Cl- ions that are pumped through channels in neuron membranes in the direction governed by membrane potential [4]. The detailed microscopic picture is more sophisticated, including different types of synapses involving variety of neurotransmitters [1]. Only large populations of active neurons can generate electrical activity recordable on the head surface. Between electrode and neuronal layers current penetrates through skin, skull and several other layers.

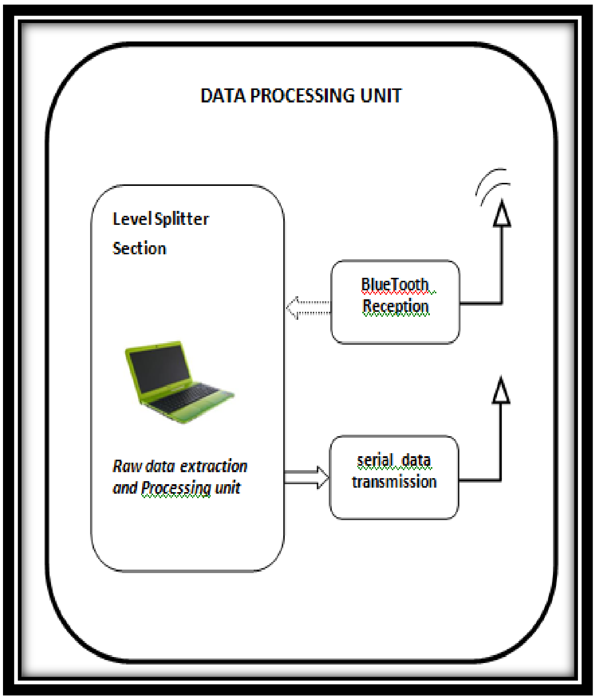

Fig 1: Data processing unit

Figure no. 3 shows processing unit. All these electrical waves will be sensed by the brain wave sensor and it will convert the data into packets and transmit through Bluetooth medium. Level splitter section (LSS) analyses the level and gives the robot movement for the person who is sitting in the wheel chair. Level analyzer unit (LAU) will receive the brain wave raw data and it will extract and by means of Fourier transform power spectrum from the raw EEG signal is derived [1]. In power spectrum contribution of sine waves with different frequencies are visible. This processing of the signal can be done using MATLAB platform which is shown in data processing unit fig 1 in the block diagram. Then the commands for controlling the robot will be transmitted to the robotic module which is known as the vehicle section as shown in fig 2. With this entire system, we can move a robot according to the human thoughts and it can be turned around by human thoughts. Electroencephalography (EEG) is the measurement of electrical activity in the living brain. In this system we will use a brainwave sensor MW001 (NeuroSky) to analyze the EEG signals [1].

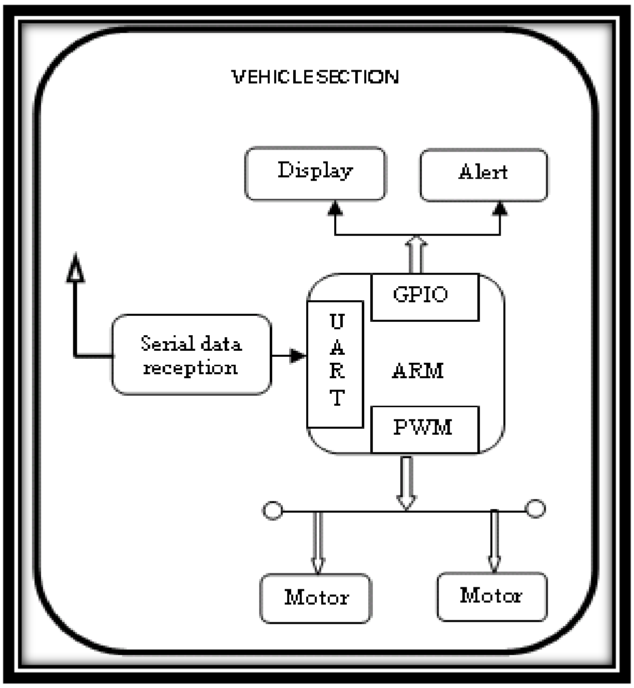

Fig 2: Vehicle section

This system consists of processing and recording the raw EEG signal from the Mind Wave sensor in the MATLAB and through Bluetooth transmission, control signals will be passed to the robot. Mind wave sensors are used to sense the EEG signals of individuals in the Brain Control Interface (BCI). The BCI is a direct communication channel between the brain and an external device to provide direct communication and control between the human brain and physical devices by translating different brain patterns activity into commands in real time. This system consists of a Processor using ARM7 core, brain wave sensor and alert unit as hardware parts and an effective brain signal system using MATLAB platform.

In this system initially the person's attention level or else the driver's drowsy level should be found out by the Brainwave Sensor MW001 [6]. Whenever a person is starting the car, the brain wave sensor unit will calculate the blinking level i.e. attention level and it will compare with the minimum attention levels of human when ever not sleeping. If it is below the set point then automatically vehicle will move without any problem. In a case if the blinking levels will cross the set point, then the vehicle will stop and vehicle driver will get an alert. Most case, we can compare the driver's blinking levels with stored blinking levels. Now, the driver has to check whether the robot move or not. If he is a not walking then the robot will automatically start. But if he is normal mode then the vehicle will run and there is no alert. Once the car received blinking command it will stop regardless the place. Further, if the owner wants to move the vehicle he has a need to come normal mode. This will help to avoid the movement during in person. The existing system is not having any remote control operation, Depend on others to operate and No muscle contraction sensing and the proposed system is having the Brain wave analysis for the signal which are taken from the human brain as shown in the block diagram, is having controlling of the robot using Human thoughts, Self controlled and operating facility for not to depend on others to operate and having Bluetooth communication between the operating system and brain wave sensor.

II. BLOCK DIAGRAM OF EEG SYSTEM:

Fig.3 Block diagram of the integrated EEG system.

The above figure shows the block diagram of EEG System. The raw EEG signals obtained from the electrodes have amplitudes of the order of micro volts and contain frequency components of up to 300 Hz. The signal is amplified approximately ten thousand times. High pass filters with a cut-off frequency of usually less than 0.5 Hz are used to remove the disturbing very low frequency components such as those of breathing. On the other hand, high-frequency noise is mitigated by using low pass filters with a cut-off frequency of approximately 50–70 Hz. Notch filters with a null frequency of 50 Hz are often necessary to ensure perfect rejection of the strong 50 Hz power supply. The signals are converted to digital form by using ADC to store the signal in a computerized system.

III. BCI INTERFACE SECTION

Brain–computer interfacing (BCI) (also called brain–machine interfacing (BMI)) is a challenging problem that forms part of a wider area of research, namely human–computer interfacing (HCI), which interlinks thought to action. As shown in below figure BCI can potentially provide a link between the brain and the physical world without any physical contact. In BCI systems the user messages or commands do not depend on the normal output channels of the brain. Therefore the main objectives of BCI are to manipulate the electrical signals generated by the neurons of the brain and generate the necessary signals to control some external systems. The most important application is to energize the paralysed organs or bypass the disabled parts of the human body. BCI systems may appear as the unique communication mode for people with severe neuromuscular disorders such as spinal cord injury, amyotrophic lateral sclerosis, stroke and cerebral palsy.

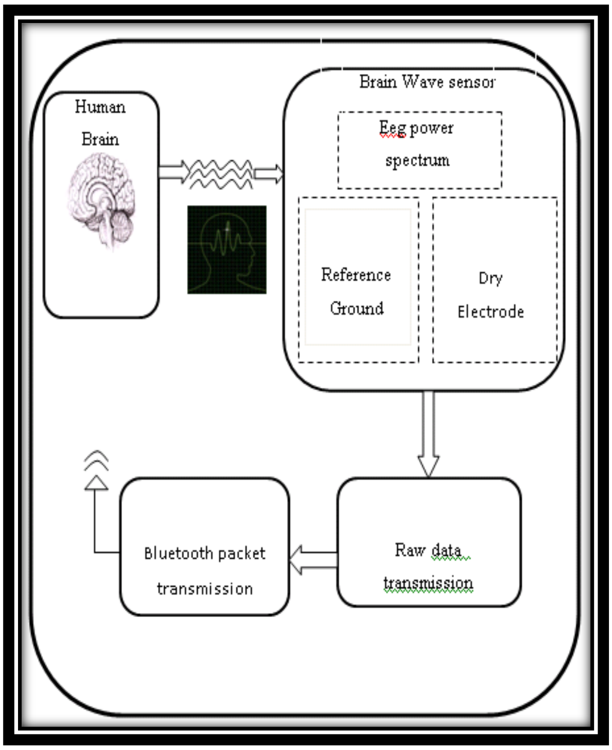

Fig 4: Brain computer interface section

A BCI may monitor brain activity via a variety of methods, which can be coarsely classified as invasive and non-invasive. Most non-invasive BCI systems use electroencephalogram (EEG) signals; i.e., the electrical brain activity recorded from electrodes placed on the scalp. The main source of the EEG is the synchronous activity of thousands of cortical neurons. Measuring the EEG is a simple non-invasive way to monitor electrical brain activity, but it does not provide detailed information on the activity of single neurons (or small brain areas

IV. NEUROSKY BRAINWAVE SENSOR:

The sensor used to sense the brain wave in this system is MW001 (NeuroSky) [7].The below figures shows indication of EEG sensor.

Fig 4.1: EEG Sensor

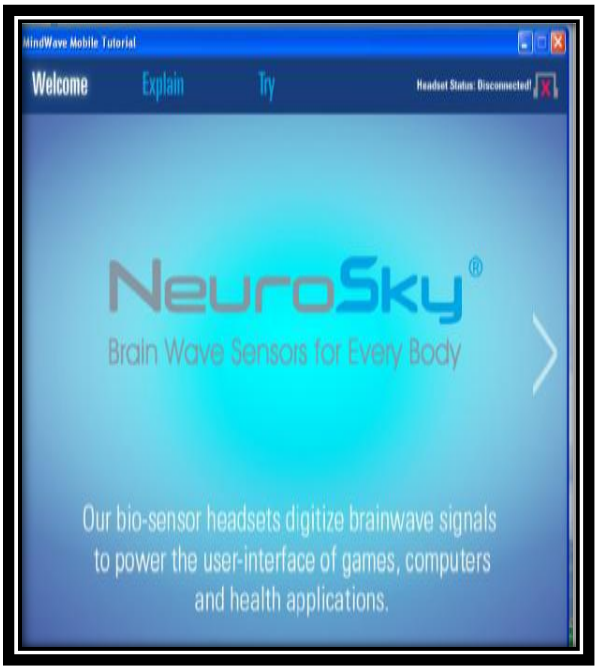

Fig 4.2: Sensor status indicator

Fig 4.3: Sensor status indicator

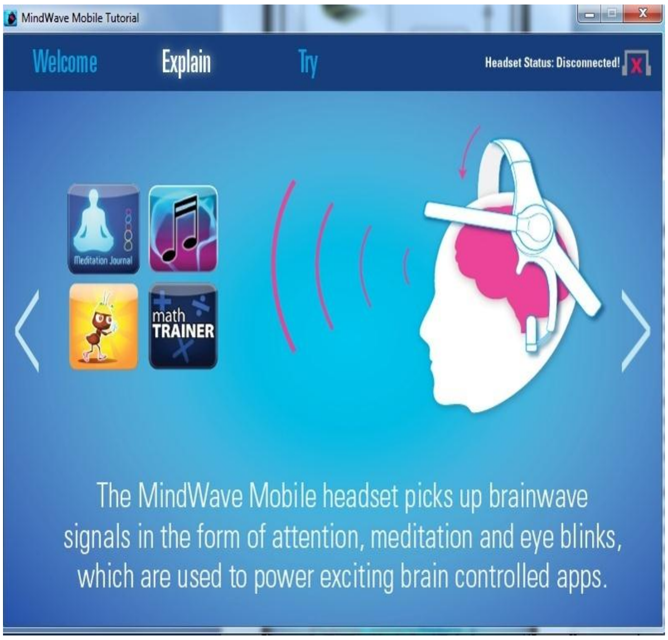

Fig 4.4: Sensor status indicator

V. APPLICATIONS OF EEG SIGNALS

Speed is the major advantage of EEG signals. The complex patterns of brain activity happening within fractions of a second can be recorded after a problem has been recognized. EEG provides less spatial resolution compared to MRI and PET. Thus for better allocation within the brain, EEG images are often combined with MRI scans [4]. EEG can determine the relative strengths and positions of electrical activity in different brain regions.

Applications of the EEG in the field of Research and clinical are:

- Alertness monitoring , coma and brain death;
- Locating of damage following head injury, stroke, tumor, etc;
- Monitor of cognitive engagement (alpha rhythm);
- Producing biofeedback situations, alpha, etc;
- Control anesthesia depth ("servo anesthesia");
- Investigate sleep disorder and physiology.

Test epilepsy drug effects;
Monitoring the human and animal brain development;
Testing of drugs for convulsive effects;

VI. CONCLUSION

The primary goal of this brain-controlled mobile robots system is to help the paralysed person. The EEG Electrodes read the signal from the head surface, amplifiers bring the microvolt signals into the range where they can be digitalized accurately, converter changes signals from analog to digital form, and personal computer stores & displays these signals.BCI is used to have direct communication between human & physical system. The accuracy of system is high so it can be implemented successfully. The main difference between brain-controlled mobile robots and other brain-controlled devices is that these mobile robots require higher safety because they are used to transport disabled people.

VII. REFERENCES

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