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Embedded Based Brain Controlled Electric Wheelchair Using Lab View

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Abstract— Independent mobility is core to being able to perform activities of daily living by oneself. The Brain Controlled Wheelchair (BCW) is a system designed for people, who are not even able to use physical interfaces like joysticks or buttons for controlling. This project proposes a system with a shared control architecture that couples the intelligence and desires of the user with the precision of the wheelchair.The goal is to develop a system usable in hospitals and homes with predefined movements, which can help these people,regain some mobility. The intensified challenge in thisis to provide continuous and precise 2D control of the wheelchair from a Brain Computer Interface, which is typically characterized by a very low information transfer rate. Besides, as design constraints, that BCW needs to be safe, ergonomic and relatively low cost.

Keywords: *BCI*, EEG, Electric Wheelchair.

I. INTRODUCTION

Amyotrophic Lateral Sclerosis (ALS), brainstem stroke, brain or spinal cord injury, cerebral palsy, muscular dystrophies, multiple sclerosis, and numerous other diseases impair the neural pathways that control muscles or impair the muscles themselves. Those most severely affected may lose all voluntary muscle control and may be completely locked- in to their bodies.

Brain-computer interfaces (BCI) allow for direct communication between a person's brain and technical devices without the need for motor control. Among different input signals for BCI control, electroencephalography (EEG) appears viable for wheelchair control due to its high temporal resolution and portability.

II. PROBLEM STATEMENT

A common feature in all BCIs is that, since the recorded brain signal is very noisy and has a large variability, either the uncertainty on the command will be high, or the time between consecutive commands will be long, in the order of seconds. So, precision of the system is improved so that system will be reliable.

III. RELATED WORKS

The paper sited in [2] presents how control the direction of an electric wheelchair using only EEG signals. We have developed a recursive training algorithm to generate recognition patterns from EEG signals. This demonstrate the utility of the proposed recursive training algorithm and the viability of accomplishing direction control of an electric wheelchair by only EEG signals.The beta wave amplitude of EEG, jaw clench, and eye muscle signal [Electrooculogram (EOG)] are used to control the speed, forward/backward switching, and the direction, respectively. In the system, it is clear that the primary control signals for the mobile robot are jaw clench and eye muscle signals. The brainwaves are limited to controlling the speed of the mobile robot. The control objective was to move the mobile robot but without any specified or desired target positions.

The paper sited in [3] presents the working prototype of a Brain Computer interface based Wheelchair that can navigate inside a typical office and hospital environment with minimum structural modification. Wavelet Packet Transform (WPT) method was successfully used for feature extraction of mental tasks from eight channels EEG signals. Original signal were decomposed at the 5th level node (5, 3).WPT coefficients give the best discrimination between the directions of wheelchair in the relevant frequency band. The WPT coefficients were used as the best fitting input vector for classifier. Radial Basis Function network was used to classify the signals.

The paper sited in [4] describes canonical variate analysis (CVA) that is used to select subject–specific features that maximize the separability between the different tasks and that are most stable (according to cross validation on the training data). These features are then used to train a Gaussian classifier. Then, the shared controller can determine what actions should be taken, based upon the user's input, given the context of the surroundings. The shared controller couples the intelligence and desires of the user with the precision of the machine.

The paper sited in [5] presents a wheelchair control methodology in which the motion of the chair is controlled based on the inputs from user (P300 brain signals), data obtained from obstacle avoidance sensors and by using localization algorithm. The brain signal processing is not fast enough to control wheelchair in real time so these signals are used to make long term decisions like choosing a distant destinations and complex obstacle avoidance.

IV. BCI BASED ON EEG

Among different input signals for BCI control, electroencephalography (EEG) appears viable for wheelchair control due to its high temporal resolution and portability. The signal interfaces like Chin controller is inconvenient to use, ultrasonic non-contact head controller has relatively low

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accuracy and voice controller gives delayed response to voice command hence not useful in noisy environment. The EEG has typical amplitude of 2-100 micro volts and a frequency spectrum from 0.1 to 60 Hz. Data was recorded for 10 sec during each task and each task was repeated five times per session per day. EEG was recorded using eight standard positions C3, C4, P3, P4, O1 O2, and F3, F4 by placing Ag-Agcl silver electrodes on scalp, as per the international standard 10-20 system of electrode placement.The frequency bands; delta (0.5 - 4 Hz), theta (4-8 Hz), alpha (8-13 Hz), beta (13-22 Hz) and gamma (30-40 Hz) are measured using electrodes. These frequencies are used for controlling the movement of the wheel chair. The

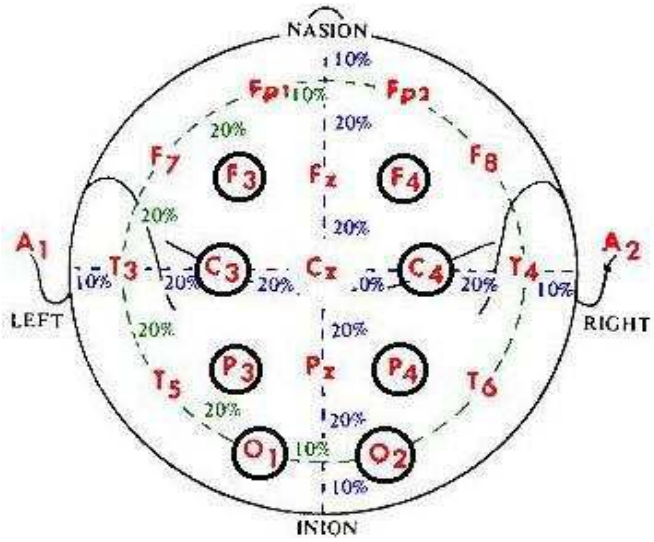

Fig.1 Montages for Electrode Placement

Brain-Computer interfaces use EEG signals which can be controlled by the user. These types of EEG signals fall into two main classes; evoked responses which are EEG components evoked by a specific sensory stimulus, such as a flashing light, and spontaneous EEG signals which consist of EEG components that occur without stimulus, such as the alpha rhythm or the mu rhythm.Occular artifacts, Muscular artifacts and Eye blink artifacts are very common in EEG data; they produce low-frequency high-amplitude signals that can be quite greater than EEG signals of interest.

V. Wheelchair System

Wheelchair control methodology in which the motion of the chair is controlled based on the inputs from user, data obtained from obstacle avoidance sensors and by using localization algorithm. This system consists of thought acquisition, thought processing and thought transmission steps to be performed before it is interfaced with the wheelchair motors for controlling it. We are operating and controlling the wheel chair based upon the feedback from the electrodes which is fixed in human and also the same to be visualized in Lab view Software. Here we interface the electrode pulses to the microcontroller by amplifying and filtering the noise levels. Using serial interface we connect the hardware in Lab view software communicating with brain-actuated wheelchairs. Firstly, acquisition of the EEG signal from user scalp is obtained using optimum electrodes. EEG scalp potentials obtained are amplified, digitized and transmitted to a processor and after processing the output of the processed signals are used to control the wheelchair.

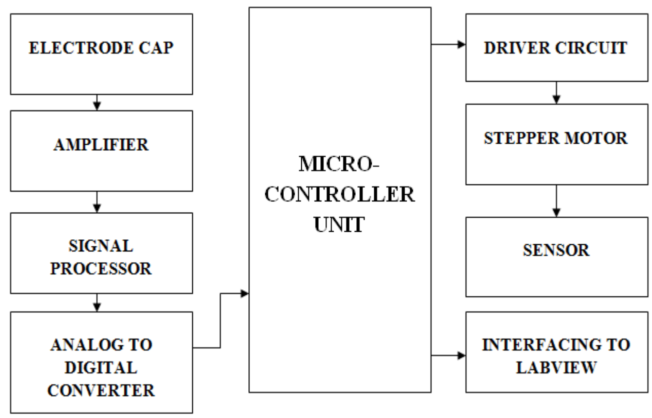

Fig.2 Block Diagram of Wheelchair System

A. Electrodes

The EEG recording electrodes and their proper function are critical for acquiring appropriately high quality data for interpretation. Many types of electrodes exist, often with different characteristics. Commonly used scalp electrodes consist of Ag-AgCl disks, 1 to 3 mm in diameter, with long flexible leads that can be plugged into an amplifier AgCl electrodes can accurately record also very slow changes in potential. Needle electrodes are used for long recordings and are invasively inserted under the scalp. Skin preparation differs, generally cleaning of the skin surface from oil and brushing from dried parts is recommended.

B. Signal Conditioning

These sensors, in turn, require signal conditioning before a data acquisition device can effectively and accurately measure the signal. Key signal conditioning technologies provide distinct enhancements to both the performance and accuracy of data acquisition systems.The signal conditioning involves Amplification, attenuation, isolation, filtering and excitation.

C. Interfacing

ADC Provides a link between the analog world of transducers and the digital world of signal processing and data handling. When signals are in digital form they are less susceptible to the deleterious effects of additive noise. The RS-232 interface is the Electronic Industries Association (EIA) standard for the interchange of serial binary data between the signal conditioner and the Lab View software for determining the directions according to the brain activity.

VI. Processing Wheelchair System

The brain activity is processed and signal conditioned and through the recursive training, the direction is determined comparing with the predefined matches. Accordingly, the driver circuit couple the output bits obtained from signal processing to the wheelchair motor.

Simulation

The simulation of the EEG signal obtained from electrodes is done using Lab View. It consists of block diagram and front panel showing the direction indication through LED. The block diagram in Fig.3 describes the underlying code of the program.

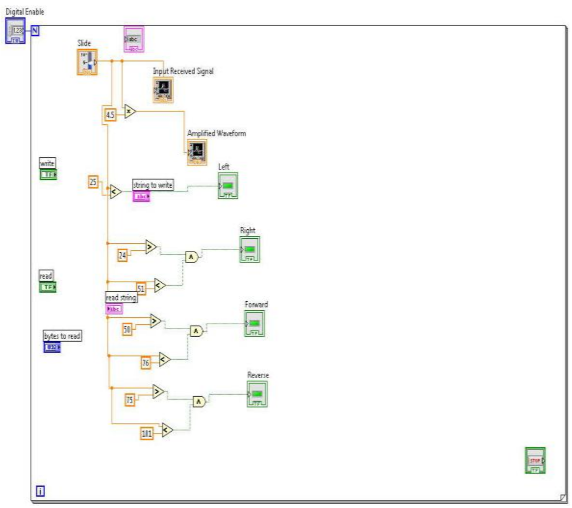

Fig. 3 Block Diagram of the Simulation.

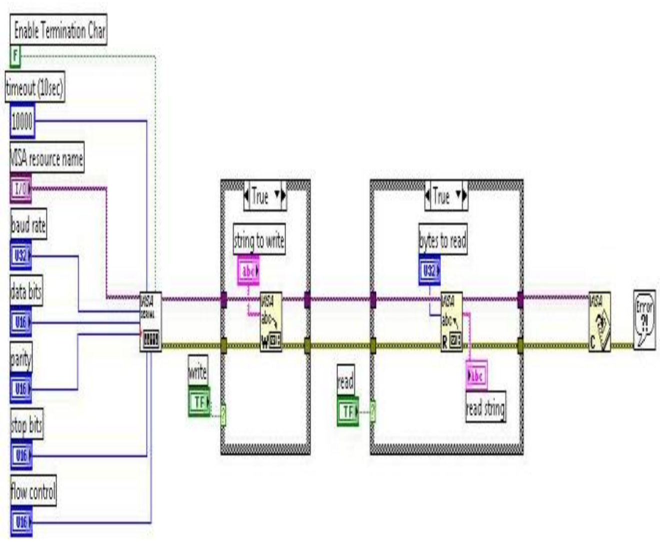

Fig. 4 Block Diagram of VISA

VII. Result

The processing of the algorithm is shown clearly. According to the amount of frequency obtained from the interface the direction is determined from the matches already loaded in it .This panel shows the signal obtained through the electrodes using VISA block. Then the signal is amplified and using recursive algorithm the corresponding direction is determined and the indication is displayed by glowing corresponding LED..

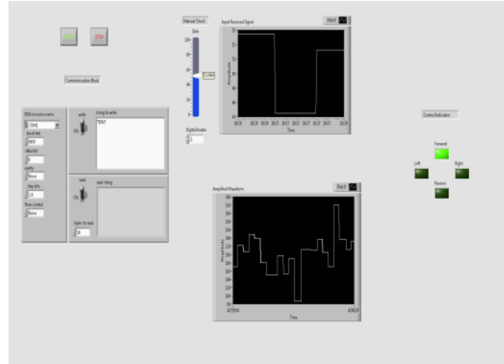

Fig.5 Front Panel Showing the direction Indicating Forward

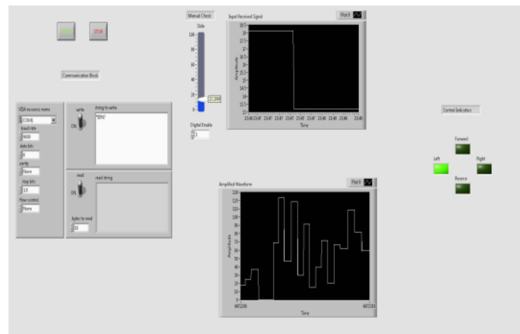

Fig. 6 Front Panel Showing the direction Indicating Right

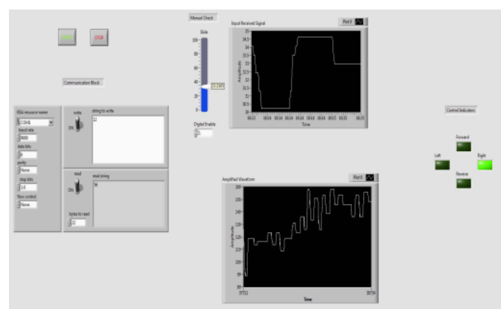

Fig.7 Front Panel Showing the direction Indicating Left

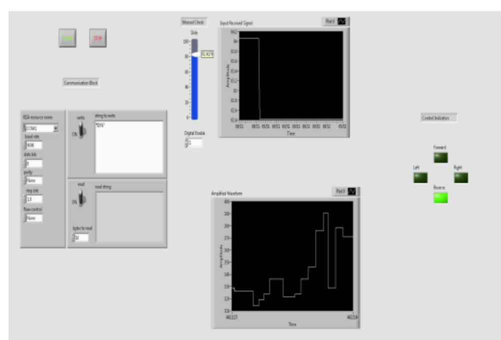

Fig.8 Front Panel Showing the direction Indicating Reverse

Hardware Implementation

The transmitter driver circuit is used for transmitting the acquired input signal from the electrodes, to the Lab View software. The signal is amplified and digitized for manipulation. The direction of the wheel chair is determined according to the frequency obtained as input using algorithm implemented in the Lab View software.The receiver circuit involves that of converting the digitally determined output in to analog and couple them to the motor mounted on the wheel. The sensor is mounted before the wheel for detecting the obstacle in the way so that we avoid skidding and accidents. Hardware implementation is in developing process.

VIII.CONCLUSION AND FUTURE WORK

Intensified training is needed for the users to use the electric wheelchair and is expensive .The design is possibly made in less cost so that it will be available for all people and the algorithm for signal analysis is suggested for improvement in future.

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