EEG based Machine Control

A. Kavitha Rajesh
Assistant professor
Department of Electronics and Communication Engineering
Er. Perumal Manimekalai College of Engineering,Hosur,Tamil Nadu,India

Abstract- **In the field of bio-medical, the brain interface is to create and adapt methods of human-computer interaction. This is BCI. A variety of application domains to compare and validate BCI interaction, including communication, environmental control, neural prosthetics and creative expression. EEG signals acts as a communication between men and machines. The BCI-based control system for robots using the EEG has been suggested for mobile robots and humanoids, and some other machines to control. In this project we do, the control interface to translate human intentions into appropriate motion commands for robotic systems. The experimental procedures consist of extraction of EEG signals, optimizing the exact signal, wireless transmission and machine control.**

Index Terms—Brain–computer interface (BCI), electroencephalograph (EEG), wireless communication, control robots.

I. INTRODUCTION

ONE of the most challenging goals of neural engineering is the development of Brain-Machine Interfaces (BMIs) [6]. Then a novel interfacing technique used between humans and machines was intensively studied based on neural responses to stimulation or thought, which is called brain–computer interface (BCI) [1], [2], [3], [4]. There exist diseases of the nervous system that gradually cause the body’s motor neurons to degenerate, Example: Amyotrophic Lateral Sclerosis (ALS). Eventually causes total paralysis. The affected individual becomes trapped in his own body, unable to communicate.

A Brain-Computer Interface (BCI) enables communication under such circumstances. Using data recorded from the brain, the BCI processes it, interprets the intention of the user, and acts on it. The BCI has a robust and flexible design that can be expanded in the future to encompass more complex communication schemes. An *electroencephalogram (EEG)* [7], [8] is a measure of the brain's voltage fluctuations as detected from brain signals. It is an approximation of the cumulative electrical activity of neurons. BCI research programs have began and encouraged new understanding of brain functions.

The advances in mechanics, electronics and computer science technology have allowed the development of machine control. In this proposal extracted EEG signal can transmit human intentions into machines as a form of appropriate command. The BCI methods using Electroencephalogy (EEG) have been extensively examined, because they are applicable to healthy subjects for general purpose. The various types of extraction of signals from brain are invasive techniques, ECOG (Electrocarticography), Functional MRI, EEG [16]. The best way for extraction of brain signals are EEG based method. The EEG-based BCI system for robots has been suggested in robotics and neural engineering fields because some elderly or disabled people can control robots naturally and intuitively by merely thinking while using this system. After extraction of EEG signals digital version of EEG can be optimized by suitable optimization algorithm. The algorithm used in this proposal is Fuzzy C Logic[13], [14]. After extraction of optimized signals, it is given to ARM processor for transmission. ARM processor [17] has a 16 resolution of ADC and it also has a inbuilt UART for transmitting and receiving data. The signal is transmitted from UART through wireless for controlling the machine in receiver side. The wireless transmission used in this proposal is ZIGBEE. The transmitted signal is received and it is given to PIC controller for machine control.

II. ELECTROENCEPHALOGRAPHY

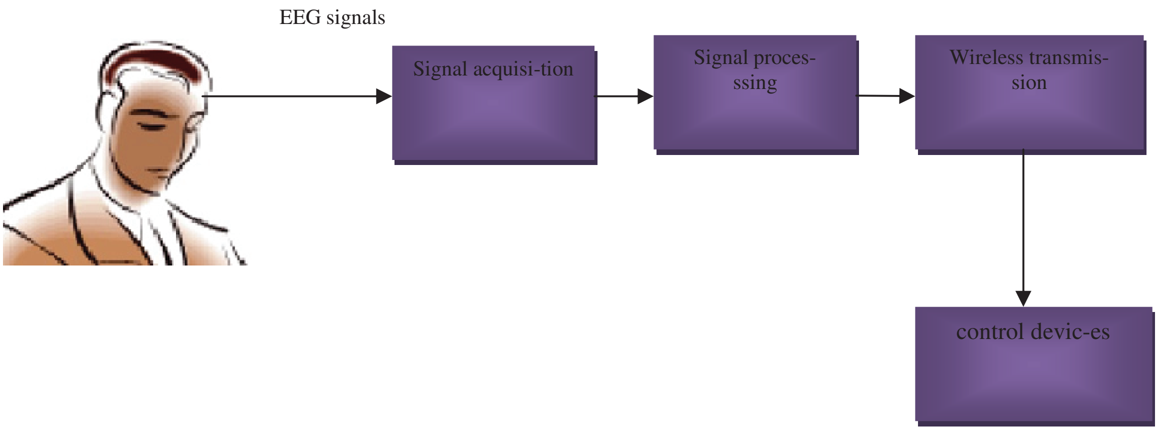
Electroencephalography (EEG) is the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain. In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a short period of time, usually 20–40 minutes, as recorded from multiple electrodes placed on the scalp. There are many types of materials used for manufacturing of electrodes which may be dry electrodes, nickel electrodes, Ag/Ag Cl. For this system electrodes used is Ag/Ag Cl which may be more effective than any other types of electrodes. Number of leads used for this system is only three electrodes. The two leads are placed on forehead and another lead which is ground is placed in the right side of the neck. Diagnostic applications generally focus on the spectral content of EEG, that is, the type of neural oscillations that can be observed in EEG signals. Despite limited spatial resolution, EEG continues to be a valuable tool for research and diagnosis, especially when millisecond-range temporal resolution (not possible with CT or MRI) is required.

III. OVERVIEW OF PREVIOUS METHODS:

payam aghaei pour et al, the number of electrodes used is 32 electrodes. The signals are obtained using a specially designed electrode cap and equipment, and send through a Bluetooth connection to a PC that processes it in real time. The signals were then mapped on two control signals and send through wireless connection to a mobile gaming device. *José del R. Millán et al,* Brain activity recorded noninvasively is sufficient to control a mobile robot if advanced robotics is used in combination with asynchronous electroencephalogram (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.

IV. BRAIN COMPUTER INTERFACE:

Brain-Computer Interface (BCI)[4], [5], technology is a new and fast evolving field that seeks direct interaction between the human neural system and machines, aiming to augment human capabilities by enabling people (especially disabled) to communicate and control devices by mere "thinking" or expressing intent. The increasing success of BCI systems is partially due to a better understanding of the dynamics of brain oscillations that generate EEG signals. In the brain, networks of neurons form feedback loops responsible for the oscillatory activity recorded in the EEG.



Normally the frequency of such oscillations becomes slower with increased synchronization. Sensorimotor activity such as motor movements or motor imagery (e.g. imagining hand/feet movement) changes the oscillatory patterns resulting in amplitude suppression (Event Related Desynchronization - ERD) or amplitude enhancement (Event Related Synchronization - ERS) on the Rolandic mu rhythm (7-13 Hz) and the central beta rhythms above 13 Hz. A second reason for the increased interest in BCI is the improved resolution and lower cost of recording equipment. Current research aims at developing systems that use dry electrodes instead of the cumbersome golden or Ag/AgCl electrodes, that require gel, glue and skin preparation. This technology, together with making the devices more mobile, will allow BCI systems to be available for controlling the machine, humanoids, etc for various commands through our thought.

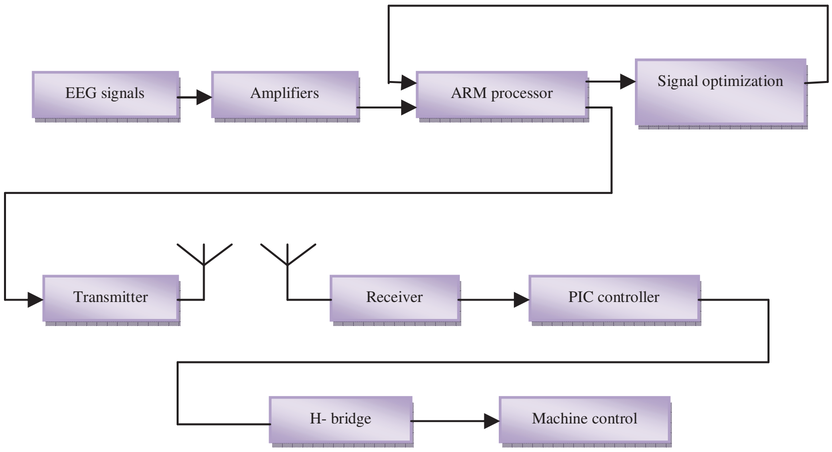
In the brain computer interface system is the, People speculated that Electro Encephalographic (EEG) activity or other measures of brain function might provide this new channel. BCI research programs have began and encouraged new understanding of brain functions. Immediate goal is to provide communication capabilities so that any subject can control the external world without using brain's normal output pathways of peripheral nerves and muscles. BCI's use EEG activity recorded at the signals. BCI operation depends on effective interaction between two adaptive controllers. Current BCI's have maximum information transfer rates.

In this BCI has consists of the four types of main components (fig1 shown in their). They are Signal Acquisition, Signal Processing, wireless transmission and Control Devices.

In this system the signal is extracted from the brain and it requires some amplification for strengthening the signal. This module works as an interface between the recording device and the computer used for the recording. Then the informative signal is extracted and it is transmitted and the machine is controlled.

V. EXPERIMENTAL SETUP:

In this an EEG based brain computer interface system is the proposed system has been implemented for making the people by combining the brain commands to the machine. Hence, the machine can be controlled by the brain commands (thoughts) which make the system move. The commands used in this proposal are right and left. The system is designed with an aim of natural and direct navigational control of the machine. Hence, our system employed thought-dependent control architecture that can perform right and left movements with respect to the appropriate user's intentions. The fig shows the schematic architecture of the proposal. This is the semi DSP system. Three electrodes are used, in this 2 are placed on the forehead and another one which is ground is placed near the right side of the neck for the user, the signal is extracted according to the thought through that device. The signals from the electrodes are nearly a milli volt it is amplified in the first stage. Output of the amplifier selection, the analog signal is formed. It is the first stage output in this system.



Architecture of this proposal

The output of the amplifier is given to the input of Analog to Digital Converter (ADC) [17]. It is inbuilt in the ARMLPC2148 processor. LPC2148 is a 64 pin IC with 8 to 40 kB of on-chip static RAM and 32 to 512 kB of on-chip flash program memory. It has 128 bit wide interface/accelerator enables high speed 60 MHz operation. One or two (LPC2148) 10-bit A/D converters provide a total of 6/14 analog inputs, with conversion times as low as 2.44 μs per channel. Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 k bit/s), SPI and SSP with buffering and variable data length capabilities. The LPC2148 has the operating voltage of 3.0 V to 3.6 V. So the milli volt is amplified to 3v and is digitize in the ARM processor. Digital EEG signal is optimized by suitable optimization algorithm. In this system Fuzzy C logic algorithm is used. The output is given to MATLAB for extracting the informative signal using Fuzzy C method. Then the ARM processor program is modified based on the optimized value for right and left commands. The signal is again given to the ARM processor for further process and then it is transmitted through ZIGBEE [15].

Types of wireless transmissions are IR, Bluetooth, WI-FI, ZIGBEE. IR light is electromagnetic radiation with longer wave lengths. Its operating speed is 11500 bits/sec and now it is extended to 4 mbps. Bluetooth is to exchanging a data over a short distance. It is a replaced model of RS232. Data transfer speed is 721 kbps. WI-FI, the transmission area depends on the size of the antenna. Data transfer speed is 11 mbps.

ZIGBEE is IEEE 802 standards for personal area network (PAN). The data transfer rate is 20 to 250 k bits/sec, and it is low cost. Then the signal is received and it is given to the PIC16F877A controller [18]. PIC16F877A has only 35 single-word instructions, and operating speed is DC – 20 MHz clock input, DC – 200 ns instruction cycle to process the signal. It has Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection.

The output from the controller is given to machine or robot. The motor in the machine requires 12v to run but the output from the controller is 3 to 5V. So it requires some methods to connect the controller and the machine. There are three methods opto- isolation, H-bridge, transistor logic. In opto isolation the output from the controller is given the led according to the light intensity the motor is controlled. Transistor logic works as a normal amplifier using transistor. H-Bridge is the concept of using relays. Through relays the motor is controlled to move left and right directions.

VI. RESULT AND CONCLUSION:

In this proposal three electrodes are used instead of 32 electrodes. The subjects controlled the vehicle by using their thoughts only up to 60% accuracy over controlling the target. By increasing the subjects more than 100 detection of optimized signal will be more accurate. Use of DSP rather than semi-DSP will lead the proposed system for disabled subjects. By use of DSP will increase the accuracy up to 80%.

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