Robot Interaction Using Brain Waves

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***Abstract*-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.Neural signals are everywhere just like mobile phones. Wepropose to use the neural signals to control a machine using for hands free, silent and effortless human-machine interaction. Until recently, devices for detecting neural signals have been costly, bulky and fragile. By the enhancement in the technology with the cheaper EEG sensors like Neurosky headset implementing low cost brain machine control is possible. The Neurosky headset safely measures brainwave signals and monitors the attention and relaxation level of students as they interact with math, memory, and pattern recognition applications.**

MindWave uses RF to transmit data to the system. Using the data send by neurosky headset machine will be interfaced with the help of Arduino microcontroller. Using this concept we will be controlling a robot.

I. INTRODUCTION

Like mobile phones, neural signals are ever present in our everyday lives. Given the recent availability of low-cost wireless electroencephalography (*EEG*) headsets programmable mobile phones capable of running sophisticated machine learning algorithms, we can now interface neural signals to phones to deliver new mobile computing paradigms—users on-the-go can simply “think” their way through all of their mobile applications. We propose the use of EEG device interfaced with an arduino board to wirelessly control a robot. The EEG device maps the electrical activity in brain and sends these signals to the microcontroller which in turn usesthese signals to control the robot’smovement.

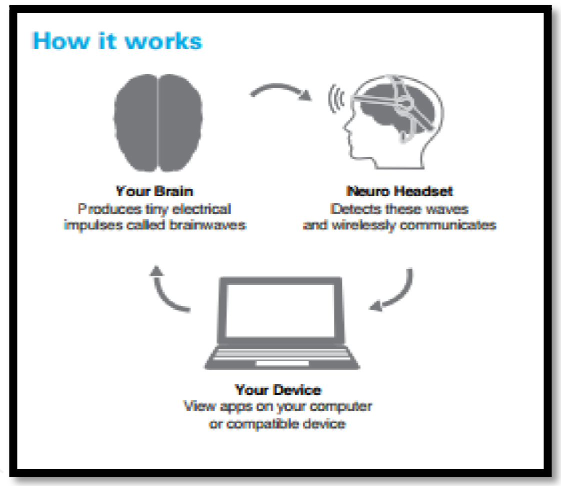

Fig 1 Basic mechanism of Brain-Machine interface

II. BRAIN MACHINE INTERFACE

Traditionally robots have been controlled by hand held remote controls. These remotes have limitations such as less battery backup, are bulky and cannot be used by the physically handicapped. All these demand for an alternate form of control system. Hence we put forward the concept of brain machine interface in providing hassle free environment for controlling robots.

Research grade EEG headsets are expensive (*e.g. tens of thousands of dollars*) but offer a much more robust signal then the cheaper variants a result there is a significant amount of noise in the data of cheaper headsets, requiring more sophisticated signal processing and machine learning techniques to classify neural events. Here we use a low cost EEG device from NeuroSky. However the cheaper headsets provide an encrypted wireless interface between the headset and the computer allowing for mobility but complicating the design of a clean brain machine interface. For robot control we will use eye blink, concentration and meditation levels of the person. These values are acquired using the EEG headset and are given to the RF Dongle. This dongle is connected to the arduino board and RF communication is established via USART. The parameters send by EEG headset and are processed accordingly.

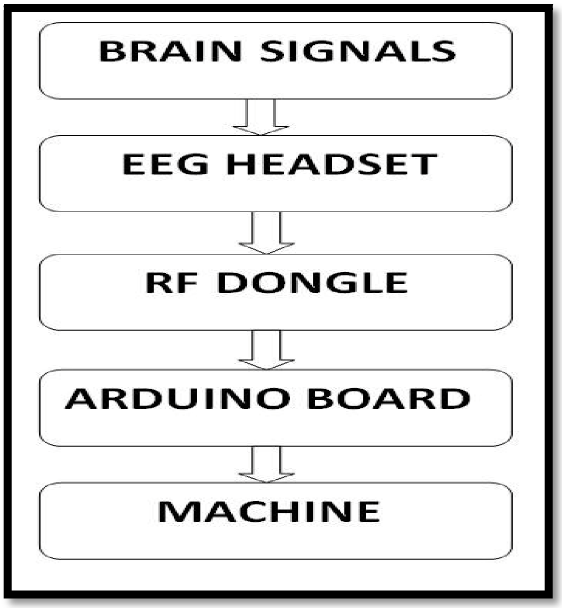

Fig.2 Flowchart

III. EEG HEADSET

Different brain states are the result of different patterns of neural interaction. These patterns lead to waves characterized by different amplitudes and frequencies. As examples, brainwaves between 12 and 30 hertz, Beta Waves, are associated with concentration, while waves between 8 and 12 hertz, Alpha Waves, and are associated with calm relaxation. Often overshadowing brainwaves, the contraction of muscles is also associated with unique wave patterns, called EMG. Isolating these EMG patterns is how NeuroSky devices detect eye blinks.The single sensor on FP1 provides a high degree of freedom; NeuroSky devices can measure multiple mental states simultaneously. The physics of brainwaves is virtually identical to the physics of sound waves where a single microphone can pick up the complexity of a concert. EEG is the recording of electrical activity of the brain from the scalp, producedby neurons firing in the brain voltages (*1–100 µV on the sca*lp). EEG doesn't read your thoughts, but it cantell your general state. For example, EEG can show if you are paying attention ormeditating. The tiny voltages are easily masked by electrical noise from muscles and ambient sources. EEG currents are measured in microvolts (*µV*), which are millionths of a volt:1µV = 0.001 mV = 10-6 VNoise from muscle and eye movement can be quite powerful compared tothis.

Fig 3. Electro Encephalographic Headset (EEG)

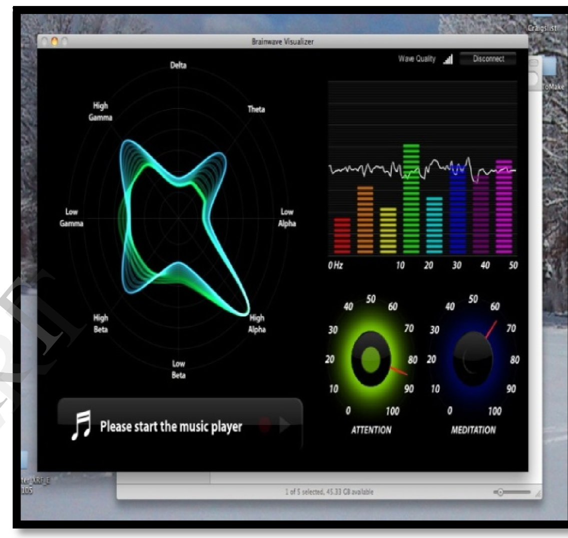

Fig 4. Data displaying attention & meditation level of the neural activity of brain

In normal buildings, the electrical main's current radiates a 50Hz or60Hz electromagnetic field. In a laboratory setting, EEG is usually measured in a room that has less interference. At home, the EEG unit must filter out the troublesome signals. The headset has a single electrode with a ground and reference. This means that there are two metallic things touching your head. The measuring electrode goes on the left side of your forehead. In the EEG lingo, this point is called Fp1. It's F for frontal, followed by p1 (*1, the first odd number, indicates10% to the left of your nose; 2, the first even number, indicates 10% to the right of your nose*). The other electrode, reference point, goes to your leftear (*A1*). The headset measures the voltage between these two electrodes.

IV. MICROCONTROLLER

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists and anyone interested in creating interactive objects or environments.

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (*based on Wiring*) and the Arduino development environment (*based on Processing*). Arduino projects can be stand-alone or they can communicate with software running on a computer (*e.g. Flash, Processing, MaxMSP*).

V. DESIGN CONSIDERATION

The basic circuit for interfacing EEG band to arduino board contains a RF dongle and an arduino board. The neural signals are analyzed by EEG headset and sent to the arduino board via RF dongle. These Signals are then processed by arduino board for controlling the motors. On concentrating the motors start to rotate, focusing more increases the speed of the motor. Decrease in the concentration level leads to Decrease in the speed of the motor and eventually it will stop.

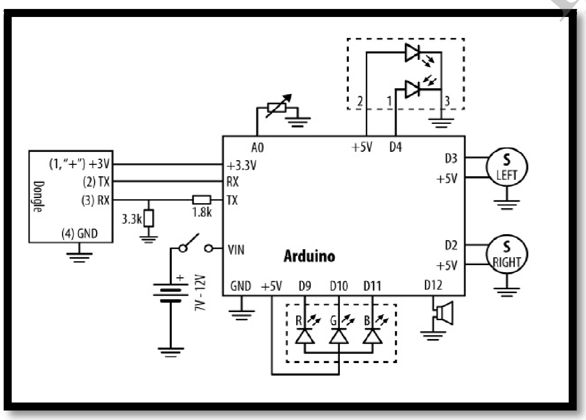

Fig.5 complete circuit diagram for Arduino based bot

VI. CONCLUSION

We have presented the evaluation of an initial prototype that brings together neural signals and a machine interface. One could argue that connecting the wireless EEG headset and Arduino is a simple engineering exercise.We believe that the use of the brain machine interfacecan help physically handicapped people, and we can also use this technology for making mind controlled-wheelchair. The advancements in the field of brain mapping opens door to numerous applications. Our motive is to create awareness in this field which will lead to more developments in this area. The available technology allows us to develop more devices working solely on the basis of mind controlling. This technology can be used to control functions in a mobile phone like dialing a call, opening different apps etc.We can use this for implementing home automation like switching on and off electronic appliances like television sets, music players, lights,etc.

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