ROBOTICS FUNCTIONED OVER BRAINWAVES

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Abstract— With growing technology the enhancements in gadgets is reaching great height. Every technology is seeking for less human interference and more of automation. How about everything happens automatically just by your thoughts. The mechanism is initiated to implant since 30 years and with growing conceptualization in it, various fundamentals are coming up. Brain consists of various parts and the three main segments are cerebrum, cerebellum and brain stem. Each thought generated in the brain has some energy associated with it. This energy is in the form of an electrical signal which can be detected. This signal generated is defined as electroencephalogram signal in terms of neurology. This electrical signal has some voltage associated with it and it can be detected using electrodes placed across the brain. These parts are the sites of the brain in the frontal portion along with central, parietal and occipital regions. There are many channels allied with these sites and different signals of different amplitude is received through this concept. This forms the basic foundations of Brain wave operated robotics. This is getting advance with time and it provides a very flexible medium to remove all the intermediates between the brain and human. A system is designed which is controlled using these EEG signals which are commanded as input. The tasks are assigned based on the various type of signals detected through these electrodes. These electrodes form the basis of the sensor detecting brain activities. Various types of sensors are introduced based on these fundamentals which give good resistance to noise and enhances the signals in a productive way. Signal detection initiates signal acquisition which is further processed using a bandpass filter and an instrumentation amplifier. This entirely constitutes the sensor. The signals detected are further processed using MATLAB and are interfaced with robotics using Arduino. The main aspect of this brain computer interface has been developed to introduce more accuracy to entire robotics and make the entire system more automatic without human intervention. Technologies are going up and many projects are developed like that of an automatic wheel chair which completely operates on brain waves.

Keywords— Amplitude, Arduino, Brain Computer Interface, Bandpass Filter, EEG Signals, Electrodes, Instrumentation Amplifier, Sensors.

I. INTRODUCTION

With introduction of interfacing with brain in 1970, brain-computer interfacing has now experienced a lot of development and is gaining a wide scope all over the globe. This brain-computer interface interacts with the parameters externally and the entire process is in real time. The brain signals can be defined in terms of voltage. These brain signals form the intermediate platform while interfacing brain and computer. These brain signals are further processed and assigned to get the desired output [1]. These brain signals which were introduced by Donchin completely relied on the potentials which were developed within the brain. To bring more development into this concept, visual potentials were also brought into impact along with brain potentials. This was done by Satter in the year 1992 [1]. Brain-computer interface was developed to endorse disabled people who found it difficult to convey things to others. If they are provided with communication methodologies which do not involve any kind of muscular motions they will be able to convey their feelings, and brain-computer interface have had a major part in this. This has been the boon to all disabled people and has enhanced technologies and electronics to a higher level. With the help of EEG signals [2], the disabled persons get the control of external parameters. The main three basic building blocks of this interfacing are: signal extraction, signal acquisition, processing and signal assigning. Advanced biosensors are used for signal extractions. Once the signal acquisition is done it needs to be classified so as to assign it to the tasks and for this appropriate classifier is used. For example, support vector machine is used in the following interfacing. In terms of visual brain-computer interface or the auditory brain-computer interface the classification done must be highly accurate which evokes steady state response. There are various brain features which can be used to enhance communication and they are cortical potential, event-related potential and sensorimotor rhythm. When the disable person is unable to use augmentative motion then these features will prove useful to them.

There are various categories into which the brain signal is classified. These classification is done based on the frequencies they possess. These signals are alpha, beta, gamma, theta rays. The different frequencies signified to these signals are: alpha ranges from 7-13 Hz, 12-20 Hz is ranged for beta waves. 20-45 Hz specified for gamma waves. Based on these frequencies the signals can be distinct to different categories. The neurons are in constant motion within the body and there is small amount of ionic current which flows through them. We place the electrodes on the scalp which measures this current. The electrodes are diversified as per the sensors and there is big list of sensors available for these purposes. Depending on the requirements and application of the system these sensors are selected. The characteristics which play major role in defining a BCI system are the brain signals, features extracted through it, commands assigned to output device, and the realization of design.

II. LITERATURE SURVEY

EEG signals are produced because of the potential which is possessed by the brain signals. Neurons consists of ionic current which defines this potentials into brain signals. This can be easily detected using the electrodes, which we are using across our scalp. It can be placed using 10/20 arrangements, or else if the project application and requirement is on small scale a strap of electrode on scalp also does the work. The first signal ever recorded of this type was in 1924. This was the first EEG signal. Further to

enhance this interfacing technology more sensors were developed. These sensors did fulfill the requirement of the hour. With introduction to this automation and technology came to a more fruitful level. Development to this is still going. This proved to be a blessing for many disabled people. With help of this interfacing they are now able to take care of their demands without worrying much about it. They do not have to involve any muscular motion to ask for anything. Their thoughts and brain signals do it for them.

The communication speed involved is high because the basic parameter of accuracy is well taken care of. The ultimate objective of this paper is to receive and extract the brain signals and appropriately characterize them so as to assign it further. This interfacing opens many doors to help the disabled people. It helps them to effectively handle the control of their movements through wheel chair and also operate many appliances which are robotic so as to convey their message. We are using noninvasive EEG to measure the electrical activity going on within the brain. Noninvasive signifies that the electrodes are removable and are used externally and not operated to study the signals internally. Hence it is very flexible to study more about it. Though it has many challenges involved it is gaining high attention all over. The basic challenges faced are the bandwidth related problems. Here the accuracy matters a lot because the ultimate output is entirely dependent on it. Error rate may be encountered in intervals. It is very important to signify the brain signals from the rest signals. Many activities such as eye movement, jaw movement has influence over brain signals and these activities add unwanted component into final brain signals. Hence to extract accurate ad concentrated brain signal it is most prominent to eliminate unwanted factors form the signals.

III. BASIC MECHANISM

The basic fundamentals while interfacing brain signal to computer is to extract brain signals and categorize them so as to assign it to the tasks.

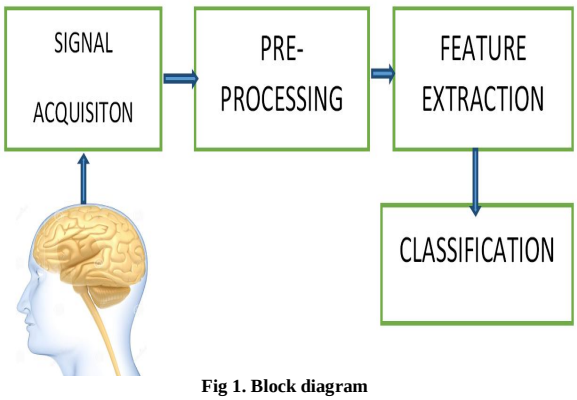

Fig 1. Block diagram

There are various type of sensors which can be implemented in detecting the brain signals. It varies form wet sensors to micro-technology sensors. Many other are the multimodality sensor and dry sensors. The basic signal acquisition step consist of extracting the features of brain signals. The electrodes are placed using 10/20 placement. These electrodes with the help of potentials identify the brain signals. Different categories of brain signals can be classified as meditation signal, attention signal, blink signal and many more. Each signal emits alpha waves, beta waves and theta waves. These signals are captured using **MATLAB.**

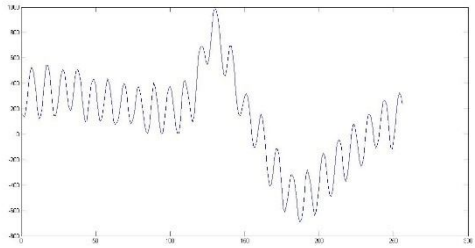

Fig2. Blink signal

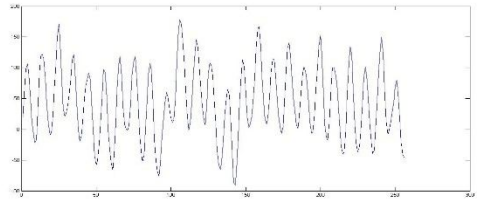

Fig 3. Concentration signal

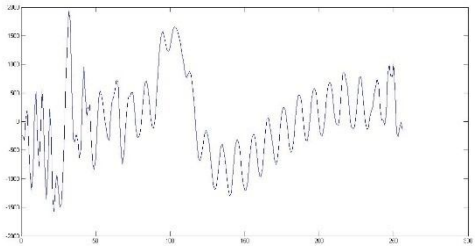

Fig 4. Meditation signal

These signals are characterized based on the amplitudes. MATLAB gives the ultimate output in the cycle and we can further plot the respective signals. These signals are further given a particular character which helps them in assigning to the tasks. These characters are serially passed to Arduino which operates as the intermediate between the robotic arm and MATLAB. Once the signal is extracted through the electrodes it is processed by MATLAB which extracts prime characteristics of the signal such as frequency and amplitudes based on these two basic parameters the entire work goes on.

We need an appropriate assignment to control the final output that is the robotic arm or any other application. Signal processing unit takes care of this dispensation which does the proper conversion of EEG signals into ones which control the ultimate objective. The basic classification of this processing is feature extraction and also its translation [2]. There are diversified techniques to extract features from the signal. They are subsampling of the signal, filtering of signals based on their frequency, selecting appropriate channels, scaling of these selected channels, decomposition of the frequencies and in the end post processing. This preprocessing plays such an essential role because it reduces the dimensionality of the signals and data. High pass filters are used to take care that no direct current is interfering with the channel in any way. The alternating current power, on the other hand, is suppressed by a low-pass filter. Logic control is implemented to enhance the accuracy while reducing the errors. The entire assignments are based on the different frequency threshold where the tasks are distributed according to the particular frequencies.

The Arduino is serially interfaced with the MATLAB. It consists of 6 channel and it is a 10 bit analog to digital converter. It will help in mapping all the input voltages

which range between 0-5 volts into the ones which have a range of 0-1023. This yields a useful resolution of around 9.009 volts i.e. 4.9 mV with respect to per unit. The time required to read an analog input is 100 microsecond. Therefore, the maximum rate is around 10000 second

IV. SENSOR MECHANISM

The signals which are detected by the sensor are very small in magnitude. To work with respect to these magnitudes we need to amplify it first. The first stage of the sensor consists of the instrumentation amplifier. This amplifier amplifies the signals received. The signal to noise ratio defined here is high. The basic fundamental of using instrumentation amplifier for this stage is high SNR ratio along with high CMRR. Because of high common mode rejection ratio, this is anytime preferred for such processing. It eliminates most of the common mode noise present in the signals. This is implemented using three operational amplifiers. It requires very accurate matching with these amplifiers to enhance its CMRR factor. Mostly, current feedback instrumentation amplifier is used for this purposes so as to overcome the problems arising in matching the resistors. High SNR suppresses many unwanted added components such as dc offsets, noise (flicker noise), low frequencies. These amplified signals are further passed to 7 KHz high pass filter. Once the voltage within the brain is detected by electrodes placed on skull they are amplified by instrumentation amplifier.

This EEG signal also consists of low-frequency voltages which are unwanted and in order to eliminate this we use a high-pass filter with a cut-off frequency of 7 KHz. In order to eliminate all the high-frequency component present in the signals, high pass filter is cascaded with a low pass filter. The cutoff frequency of this filter is 31 kHz. Power line noises also have huge impact on these signals. And it is very necessary to eliminate this and in order to implement this, we use a notch filter of cutoff frequency 50 Hz. Even if the system is initiated on battery this problem still remains. And adding notch filter to the process enhances the accuracy without increasing much of complexity. This filter is also known as band reject filter.

These factors cascaded and designed properly gives the ideal realization of EEG sensor. The sensor is important of all because it helps in getting the brain signals at the first place. It takes care that all the unwanted factors such as noise are eliminated and that the signal remaining can be easily processed to fulfill the objective. The sensors are though classified in many terms, it used as per the requirements. Hence small application sees small sensors whereas large application sees outsized usage of sensor fixed all over the skull. The output of the sensor is further processed in many ways to achieve the ultimate objective smoothly but it's taken that complication involved is reduced to a minimum. The flexibility is appreciable and hence the entire system stands through noninvasive brain EEG signals

V. RESULTS

With the help of the Fourier transform of the signal, the frequency spectrum of the signal is generated. The values resulted from this calculation gives the amplitude vs frequency estimation. The amplitude of signal varies with respect to time and hence it has its corresponding frequency spectrum. The MATLAB FFT gives the frequency component of the signal. This FFT exhibits the peaks of frequencies. These frequencies further signify the state of the brain whether it is concentration, attention or meditation. Lower frequencies signify the meditation state. The higher ones represent the state of meditation. There is threshold attached to these frequencies and based on these the further tasks are assigned.

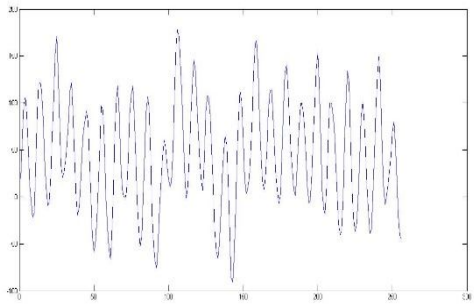

Fig.5

CONCLUSION

The main objective here is to revolutionize the technology by adding such enhanced automation. It's not only limited to disabled people but the application also has a wide scope for many other purposes. Its usages are exponentially rising in diversified domains. In this survey the basic implementation of brain wave operated robotic arm is discussed along with the incoming challenges and the solutions. This can prove to be a staunch start to the basic mechanism of brain-computer interfacing. It not only opens many doors to new technological opportunities but also gives us methodologies toe explore revolutionary techniques to enhance the reduction of human interface in all applications. In comparison to many other applications, the signal processing unit along with it translation is way more simplified. It is been easily implemented with the classifier without much of complication. The flexibility is appreciable and it also helps the user to know more about it. The way with the user is also friendly and you need not train yourself to adapt to its principles. The factor to be very considerate about here, is the accuracy and its reliability.

APPLICATION

This has emerged as the boon for disabled people. The very well platform is developed for them whereby they can communicate hassle free. They can also come in contact with the internet whereby they can have their requirements fulfilled by buying things and finding solutions without being dependent on anyone. They can also seek entertainment and education on their own. It has also found its position to control various applications installed on the computer. It has been taken automation to a very new dimension. Home automation being the most prominent of it. Opening and closing of doors and operating many other appliances have been its focus. The best part of this application has been the development of wheelchair. This has solved all the problems related to mobility of disabled people. The three basic application being the household automation, biomedical advancement and gaming controls. It has found a wide scope in biomedical applications. For many people who are totally paralyzed and they can't communicate except for moving their eyes and blinking, this system is going to be so much of worth.

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