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Wireless EEG Signal Acquisition and Device Control

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Abstract. Nowadays, technology grow up as in seconds. We want to grow up with the world also we see dreams but implementation is difficult for us. We want to imagine that if I want to do some work as my finger but we can't. Now stop our dreams and apply in science. Our mind is powerful, progressive and sensitive. Our mind produces waves, using this wave we do everything. In this paper we screening this wave using Brainsense machine and send it into controller and control the device like Robot, home appliances, etc. Mind produces the different types of wave like alpha, beta, theta, and delta. Every wave is different for adults and child. For controlling the device we want to concentrate or thinking about this direction. These signals are in microvolts so difficult for catching, filtering and amplifying that's way we use readymade machine.

Keywords: Electroencephalogram; MSP430, Brainsense

1.1 INTRODUCTION

There are different types of bio-medical signal like ECG, EOG, EEG, MEG. ECG (Electrocardiogram) is for heart bits. The eye movement can create micro potential, which is known as Electrooculogram (EOG) [1] signal. EEG (electroencephalography) [2] represents electrical activity of brain which can be measured using electrodes connected to scalp. These signals are transmitted, amplified and converted into control commands. Using this control commands computer or other machine is controlled. MEG (Magnetoencephalography) [3] is for recording the magnetic signal.

The human brain contains approximately 100 billion nerve cells called neurons. Neurons have the amazing ability to gather and transmit electrochemical signals. The Neurons have 3 basic parts, a cell body which has the necessary cells components, Axon which is like a long cable to carry nerve impulse and finally the Dendrites which is the nerve ending branches that connects to other cells to allow electrical transfers between cells. The generation of EEG potentials requires a neural source close to the inside surface of the skull that is coherent, which means all the neurons must be aligned similarly and act together electrically.Generally there are four wave groups (alpha, beta,

theta, and delta). The EEG rhythm and waveforms are varied by the position of electrode placements on certain parts of the brain (Fig.1).

Beta waves normally occur in the frequency range of 14-30Hz and sometimes even as high as 50Hz for intense activity. Beta waves activities are present when people are alert or anxious, with their eyes open.

Alpha wave occurs at a frequency between 7.5 and 13Hz. The alpha waves are produced when a person is in a conscious, relaxed state with eyes closed; the activity is suppressed when the eyes are

open. The amplitude of the alpha rhythm is largest and intensely occurs in the occipital region and can be best recorded at parietal and frontal regions of the scalp.

Delta waves have the largest amplitudes and the lowest frequency in less than 3.5Hz. It is normal rhythm for infants less than one year old and in adults in deep sleep. This wave can thus occur solely within the cortex, independent of the activities in lower regions of the brain.[4]

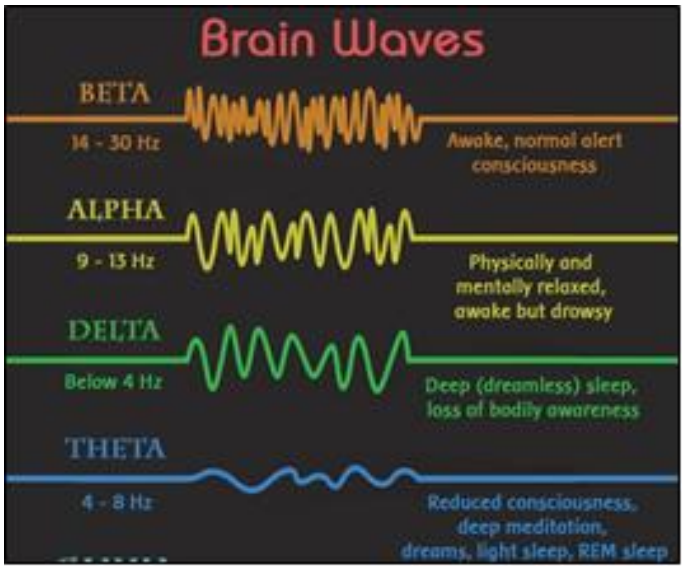

Fig.1 Brain waves

Theta potentials are large amplitude, low frequency between 3.5 and 7.5Hz waves. Theta is abnormal in alert adults but seen during sleep, and small children. Theta waves occur mainly in the parietal and temporal region.

1.2 HOW EEG WORKS

Here, instead of a central nervous system, there are decentralized nerve nets where sensory neurons communicate with motor neurons by electric signals. This

communication can be seen as a logic circuit where some action is done if signals from a certain group of input sensory neurons are present. This kind of activity, known as bio electro magnetism, already produces a measurable electromagnetic field. In the human nervous system the electrical signal of a single neuron is too small to be measured by an electrode on the scalp therefore, the measured activity comes from the summation of the activity of hundreds of neurons on the vicinity of the electrode. If the electric field is measured, the signal is called electroencephalogram (EEG). Therefore, according to the measure location and the measured signal, it is possible to understand until a certain degree what kind of activity occurs. Sometimes, a group of neurons fire more synchronously reflecting immediately in the measured signal as it becomes stronger and more synchronous to the firing frequency.

This is why these signals are seen as brainwaves and are categorized in different frequency bands. Each frequency band can correlate to a certain mental state for example; activity in the alpha frequency range (8-12Hz) is seen during relaxation whereas activity in the beta frequency range (15-20Hz) is present during high alertness and mental activity.

Besides the EEG clinical applications for diagnosis and monitoring, others exist like brain computer interfaces (BCI)] and EEG fundamentals. The last two rely on the fact that an individual can change certain EEG characteristics on demand. Brain computer interfaces allow its user to control a system using his EEG as an input. In EEG biofeedback a person's EEG is used as an input as well but the target is the person himself [5].

1.3 BLOCK DIAGRAM

We looked at aspects ranging from brain signal generation to end user applications. These aspects are depicted in Fig. 2 and include the following:

1) Personal traits, previous and current environmental stimuli, and knowledge on how EEG signals are generated and transmitted through biological tissue;
2) Capturing EEG signals from electrodes and low-power, miniaturized technology used for acquiring, amplifying, processing, and transmitting EEG signals;
3) Algorithms and methods used for EEG signal preprocessing, artifact handling, feature extraction, and feature interpretation;
4) Methods to process and present fusion of context-related brain activity [6]

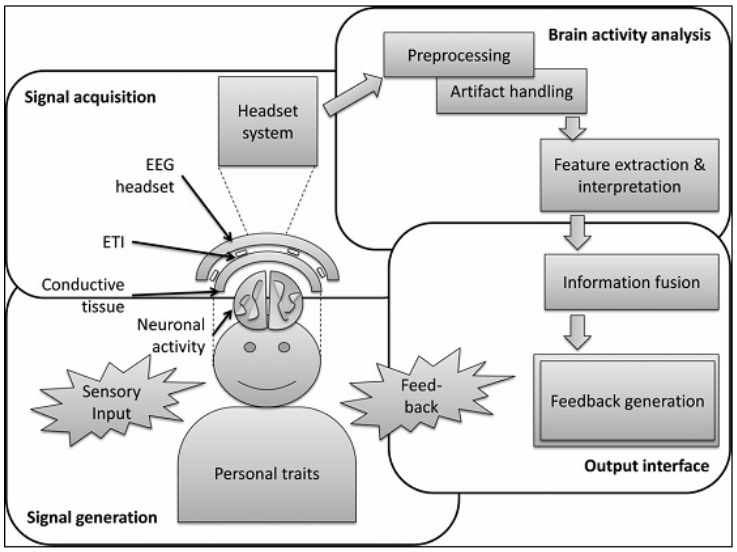

Fig.2 Aspects that should be considered when designing and developing intelligent wireless, wearable EEG solutions for daily life applications.

1.4 WIRELESS AND WEARABLE EEG SYSTEM DESIGNS

Here we present a number of existing systems and we discuss how the different systems may be useful in different application spaces. Since the number of existing devices is too large to be discussed exhaustively here, we have selected devices that are commercially available and that vary greatly in the way how design tradeoffs are made. They are depicted in Fig. 3.

Fig.3 Existing wearable wireless EEG devices.

Neurosky's [7] product range is based on a one-channel measurement platform with dry electrodes. The single measurement channel is typically positioned at the forehead, which allows for frontal recordings. Patient ground and reference are positioned at the ear clip. The dry electrode on the forehead is made of a stainless alloy. Data is wirelessly transmitted to a PC or a smartphone using Bluetooth (BT). Having the lowest price-tag of all products, it seems to target the low-end consumer market.

The Epoc (Emotive) [8] is amongst the most widely available and used devices. With 14 channels scattered around the head and low cost, it provides a flexible and versatile research platform. Data is wirelessly transmitted through a proprietary radio link. The system allows for 12-h continuous transmission. With a very attractive price-tag, the Epoc also targets the low-end consumer space. However, a substantially more expensive license is needed to get access to the raw EEG data and use the Epoc as a research vehicle.

Imec's headset [9] has four channels, based on an eight channel wireless acquisition platform. It uses dry Ag/AgCl coated electrodes (Biopac EL120) with pins to move away hair and touch the bare skin. To increase user comfort and provide sufficient force at each electrode, they are mounted within spring-loaded holders. A proprietary protocol is used for wireless transmission of the data. The battery allows for 20 h of continuous transmission. The system is designed around low-power and integrated electronics, allowing for system miniaturization for systems having low number of channels and flexibility in headset solution designs.

Quasar's [10] DSI 10/20 is an EEG headset with 21 channels. The aim of the system is an ambulatory EEG recording and it includes mechanical and electrical mechanisms to reduce motion artifacts. Data is wirelessly transmitted through a proprietary system which requires a USB dongle. It allows continuous EEG transmission for 24 h. The focus of this device seems to be on achieving the highest signal quality possible but with a high price-tag.

TABEL 1.

COMPARISON OF EEG MACHINES [7][8][10]

	NeuroSky	**E-motive**	**Brainsense**
Electrode	1	14	1
Reference	1	2	2
Baud rate	57,600	128000	115200
Connectivity	Bluetooth	Bluetooth	Bluetooth
Cost	12000/-	28000/-	6600/-

Brainsense A sleek, single-channel, wireless headset that monitors your brain activity and translates EEG into meaningful data you can understand.

Fig.4 Brainsense EEG Acquisition Module

Technical Specifications

- Uses the TGAM1 module, Dry Electrode and Ear clip electrode
- Automatic wireless pairing
- 6-hours battery run time
- Bluetooth v2.1 Class 2 (10 meters range).
- iOS and Android support

1.5 IMPLEMENTATION ON BRAINSENSE

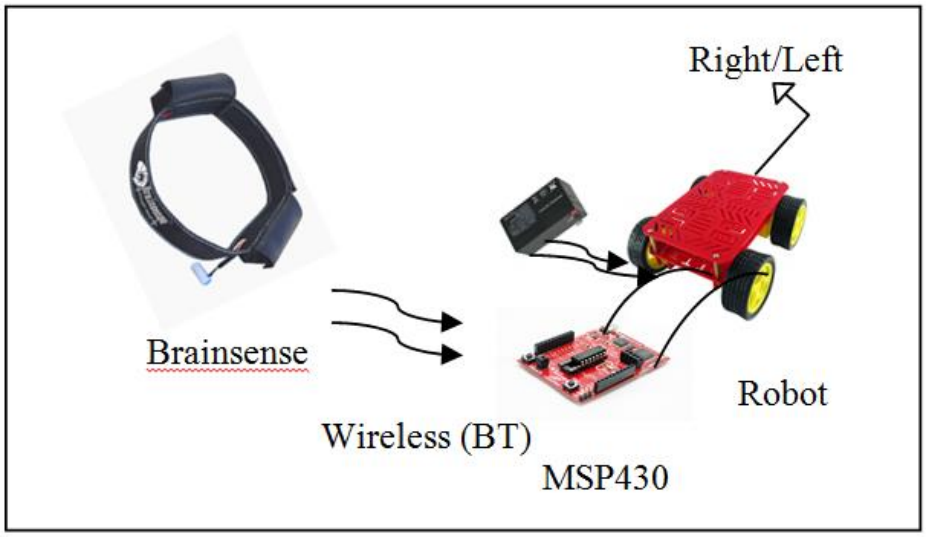

Fig.5 Process for Device controlling

As shown in fig.5 is the process for controlling the device. This is the hardware implementation of wireless EEG Acquisition and Device Control. Here mind waves reader machine is Brainscanse and it gives powerful waves detection which produce human mind. In this machine also include signal filtering, amplifying, noise removal and Bluetooth device therefore we easily connected with BCI system also. Here we record the signal and transmit into controller, controller will be detect the signal strength, signal voltage, signal frequency, etc. And through that it will decide that this signal is for which decision. It define with alpha, beta, theta, delta, and gamma waves.

1.6 Conclusion & Future Work

We concluded that if we want to do some work without touching device or without any stress we do with our mind power, our mind decision. Finally we achieve that Wireless Device Monitoring is possible with powerful thought. In future if someone does the further research it can be possible that wireless wheelchair system, home appliances device monitoring. Also the analysis of different waves when person is in deep sleep, at active mode, or at relax mode can be made by the acquired EEG signals.

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