# MIND WAVE BASED COMMUNICATION

Anil Pandeya, Ashish Kumar Jain
Department of Electronics and Electrical Engineering,
Dr. K.N. Modi University, Newai, Rajasthan, India.

Abstract: Electroencephalography (EEG) equipment is becoming more available on the public market, which enables more diverse research in a currently narrow field. The Brain-Computer Interface (BCI) community recognizes the need for systems that makes BCI more user-friendly, real-time, manageable and suited for people that are not forced to use them, like clinical patients, and those who are disabled. Thus, this project is an effort to seek such improvements, having a newly available market product to experiment with: a single channel brain wave reader. Our project uses smart phone app that uses brainwaves to connect android device with neurosky headset. The signals are then sent from the headset to your phone via Bluetooth, where they control the phone depending on your state of mind.

A GUI for the system lets you scroll vertically among your contacts list of the application. Two bars indicate your current level of "meditation" or "attention" in real time as your brainwaves is measured from the headset. These waves from the headset can be used to operate several functions in the android phone. The android phone will be completely operated with the help of these mind waves. Better attention will be required and some functions will be operated using the blinking of the eye.

Keywords: Android, Electroencephalography (EEG), Mindwave Headset, meditation, attention, brainwave, Brain-Computer Interface (BCI), neurosky headset

## 1: Introduction

### 1.1 Background

The brain has always fascinated humans, and particularly a German scientist named Hans Berger, who discovers electroencephalography (EEG) about 80 years ago. After this, new methods for exploring it have been found and we can categorize them into two main groups: invasive and non-invasive. An invasive approach requires physical implants of electrodes in humans or animals, making it possible to measure single neurons or very local field potentials.In EEG, brain-related electrical potentials are recorded from the scalp. Pairs of conductive electrodes made of silver, for example, are used to read this electricity. The difference in voltage between the electrodes are measured, and since the signal is weak (30-100µV) it has to be amplified. Current occurs when neurons communicate. The simplest event is called action potential, and is a discharge caused by fast opening and closing of $Na+$ and $K+$ ion channels in the neuron membrane.

### 1.2 Project purpose

The purpose of this project is to investigate and explore the possibilities that lie within the domain of Brain-Computer Interfaces, using consumer friendly equipment that have recently become available on the public market. The field of Brain-Computer Interfaces (BCI) is a driving force for utilizing electroencephalography technology (EEG), which is the process of recording brain activity from the scalp using electrodes.

BCI development is no longer constrained to just patients or for treatment; there is a shift of focus towards people with ordinary health as well. It is not just treatment in mind, but entertainment also. By taking BCI to the level of communication, the motivation for making more users friendly, faster, cheaper and public available systems will be totally different and become of a much higher priority. The motivating thought is that approaching this issue from an entertaining point of view could help getting BCIs to such standards faster.

1.3 Project Objectives

The main objectives of our project are listed below:

1. To operate android phone using brain wave signals.
2. To make communication easier with the differently able people.
3. To scroll and select a specified person present in the contact list of the mobile phone.

1.4 Project Scope

1. Can be used to serve paralyzed and disabled peoples.
2. It is a kind of Neurophone.
3. To serve as an adjunct test of brain death.

## 2. Literature Review

Android operating system is open source coding software. EEG based projects to control android based phones are rare. Projects done on EEG based android phone have been done to control robots for specific uses. Those robots were used for security and serve physically disabled people. Robotic arms and other mechanical robots are some common projects that have been done based on EEG. "NeuroPhone: Brain-Mobile Phone Interface using a Wireless EEG Headset" Andrew T. Campbell, Tanzeem Choudhury, Shaohan Hu, Hong Lu, Matthew K. Mukerjee , Mashfiqui Rabbi, and Rajeev D. S. Raizada Dartmouth College, Hanover, NH, USA. Furthermore, we are trying to make this project more advanced by enhancing some new features. We will be able to make phone calls using brain waves using our project. Those brain waves will also be used to control a robot which will be operated wirelessly.

## 3. Brain wave classification

The single dry sensor and reference pick up potential differences (voltages) on the skin at the forehead and the ear. The two are subtracted through common mode rejection to serve as a single EEG channel, and amplified 8000x to enhance the faint EEG signals. The signals are passed through analog and digital low and high pass filters to retain signals generally in the 1-50Hz range. After correcting for possible aliasing, these signals are ultimately
sampled at 128Hz or 512Hz.

Each second, the signal is analyzed in the time domain to detect and correct noise artifacts as much as possible, while retaining as much of the original signal as possible, using NeuroSky's proprietary algorithms. A standard FFT is performed on the filtered signal, and finally the signal is rechecked for noise and artifacts in the frequency domain, again using NeuroSky's proprietary algorithms.

For, and MindWave Mobile the formula for converting raw values to voltage is:

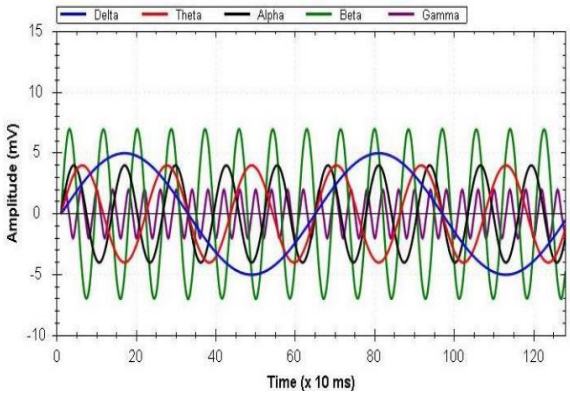
[ rawValue * (1.8/4096) ] / 2000

The Fourier Transformation and extraction of band powers is by far the most applied method for signal processing and analysis (Lotte et al., 2007). The algorithm is based on discrete Fourier transform (DFT) equation 4.1, and by applying that to the EEG signal it makes it possible to separate the EEG rhythms. Definition of the DFT:

$$Xk = \sum_{n=0}^{N-1} \quad xnexp(i2k(\frac{n}{N})) \quad \text{k=0,….,N-1} \qquad (4.2)$$

and the inverse of it:

$$xn = (\frac{1}{4}) \sum_{n=0}^{N-1} \quad Xkexp(i2k\Omega(\frac{n}{N}))$$



## 4. Working Principle

The mindwave mobile from neurosky headset first takes the brain waves from human scalp. It does so by taking brain waves from EEG sensor placed on the forehead and the ear-clip works as a filter to nullify the unnecessary signals coming from the brain.

The EEG signals as a whole cannot be manipulated to run the application so raw signals must be classified into different types (i.e alpha, delta, beta, gamma, theta). The mindwave performs the differentiation of different types of these waves by performing FFT with the help of an inbuilt program. Then the raw signal is amplified by 8000 times as the original signals are very weak or faint.

Then the low signal is converted into voltage form by using the formula;

V=raw value*(1.8/4096)/2000

Where 2000 is gain.

Then the mindwave mobile is paired to an android based mobile set using the inbuilt Bluetooth. Now the processed EEG signal can be used to operate the application we created. Once that application is accessed all the contacts stored in the phone memory is synchronized with the application created. Now we can scroll, call and cancel the call depending upon the nature of incoming EEG signal in the form of attention, meditation and blink.

## 5. Results and Outcomes

We have successfully built the application so that we can make useful operation of the Mind wave mobile headset using the different types of brain waves. The level of Attention, Meditation and Blink were used to operate the application on the android

phone.


## 6. Future Enhancements

1. Other applications such as music, photo gallery etc can also be operated.
2. Games and other advanced applications can be developed and can be operated through the mindwave mobile
3. The project will not be limited to only the android platform, but also to IOS, windows etc.
4. The project can be operated in other consoles other than just mobile phones such as PC, play stations and other electronic devices.

## 7. Conclusion

The project we have undertaken has helped us gain a better perspective on the various aspects to our course of study as well as practical knowledge of electronic equipment's and communication. We became more familiar with software analysis, designing, implementation, testing and maintenance concerned with our project.

The extensive capabilities of this system are what make it so interesting. From the convenience of a simple cell phone, a user is

able to control and operate the application through his/her brain waves. This project helps exclusively in the development of Brain computer Interface. This project will be very helpful who are disabled and have a case of autism. However, it is targeted to general people as well, so that they can experience to operate their cell phones using the brain waves.

The end product will have a simplistic design making it easier for users to interact with their cell phones. Also the project will broaden the electronics and communication market. The project has been completed with the guidance of our supervisor and other professors and the effort we put into it. Finally, we hope for the best results in the future of this project.

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