

SMART BUILDING

Using EEG Signal Controller

(First Controlling Method)

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ABSTRACT

At the root of all our thoughts, emotions and behaviours is the communication between neurons within our brains. Brainwaves are produced by synchronised electrical pulses from masses of neurons communicating with each other and they change according to what we're doing and feeling.

Brainwaves are detected using sensors placed on the scalp. such as the EEG sensor which record the human brain's electric field .

This work aims to study the possibility of controlling the smart building using Mind wave Mobile Headset to provide Easy way to control the whole building, specially for people who have physical impairment.

This paper describes part of an integrated project for implementation of smart building controlled by several ways, which is considered as a First Method to control the building.

Keywords : EEG signal, Mind wave, Android application, Smart building.

I. Introduction

In general a smart building is any structure that uses automated processes to automatically control the building's operations including heating, ventilation, air conditioning, lighting, security, entertainment audio & video systems, TVs, computers, camera systems and other systems that are capable of communicating with one another and can be controlled remotely from any room in the building, as well as remotely from any location in the world by phone or internet.

This work aims to use a new innovation “ Mind Wave Mobile Headset “ which is put on the head of a human and takes the mind signal, interoperated and converted it to an electrical signal used to control the whole building utilities through an Android application, as shown in Fig1.

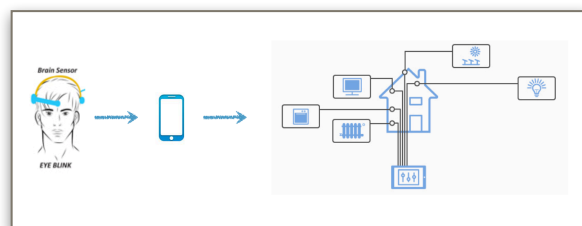


Figure1. Intelligent Building Diagram

This work is organized as follows: Section II covering the main concepts of the EEG system controller. Section III representing important information about Mindwave Mobile Headset. Then the Android Application is defined in section IV . Section V contains the practical part of Mindwave Mobile Headset and Android Application. Finally section VI drawing the major conclusions from this work.

II. EEG SYSTEM CONTROLLER

Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain. In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a period of time [1].

EEG sensor is the first recording of the human brain's electric field with amplitude $\sim 100 \mu\text{V}$ when measured on the scalp, and about 1-2 mV when measured on the surface of the brain. The bandwidth of this signal is from under 1 Hz to about 50 Hz.

Today, with all of this technology packed into a compact form factor that is the MindWave and the MindWave Mobile.

The MindWave and MindWave Mobile are all wireless devices used to record EEG signals. All devices utilize identical chips, also they use the same sensor technology[2].

A. Brainwaves

Brain is constantly producing electrical signals while it operates, as the cellular components of the brain

(neurons) communicate with each other. They produce a range of frequencies that scientists have found relate to particular mental states. For example, a sleeping person’s brain produces an abundance of delta waves, whereas an alert and awake person concentrating hard on something will produce far more beta waves.

The Mindwave headset picks up the brain’s electrical activity and divides the signal by frequency into various types of waves, allowing it to infer human mental state. The table1 gives a general synopsis of some of the commonly-recognized frequencies that tent to be generated by different type of activity in the brain [3]:

Table 1 Frequencies of Human Brainwave

Brainwave Type	Frequency range	Mental states and conditions
Delta	0.1Hz to 3Hz	Deep, dreamless sleep, non-REM sleep, unconscious
Theta	4Hz to 7Hz	Intuitive, creative, recall, fantasy, imaginary, dream
Alpha	8Hz to 12Hz	Relaxed, but not drowsy, tranquil, conscious
Low Beta	12Hz to 15Hz	Formerly SMR, relaxed yet focused, integrated
Midrange Beta	16Hz to 20Hz	Thinking, aware of self & surroundings
High Beta	21Hz to 30Hz	Alertness, agitation

The difference between these waves can be more easily understood in Fig2.

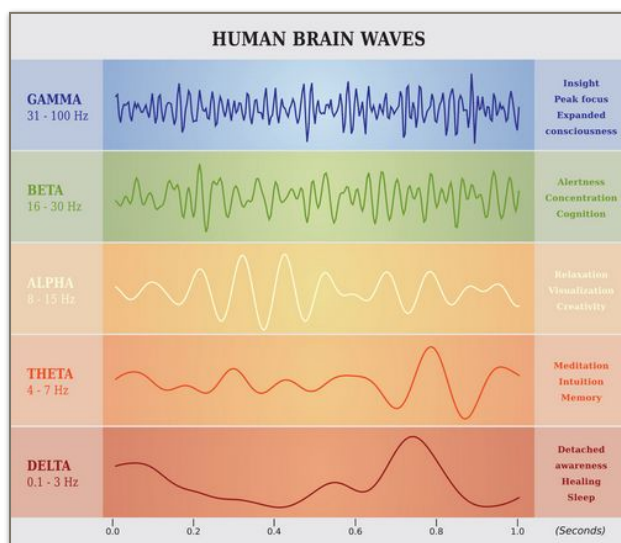


Figure2. Human Brain Waves

B. MindWave Mobile Technology

Brainwaves are tiny electrical impulses released when a neuron fires in the brain. NeuroSky’s brain-computer interface (BCI) works by monitoring these electrical impulses with a forehead sensor. The neural signals are input into ThinkGear chip, The measured electrical signals and calculated interpretations are then output as digital messages to the computer, or mobile device, allowing us to see the brainwaves on the screen, or use the brainwaves to affect the device’s behavior [2].

ThinkGear

ThinkGare should be included inside every EEG product that enable a device to interface with the wearer’s brainwaves. It includes the sensor that touches the forehead, the contact and reference points located in the ear clip, and the on-board chip that processes all of the data. Both the raw brainwaves and the eSense Meters (Attention and Meditation) are calculated on the ThinkGear chip [3].

eSense

eSense™ is an algorithm for characterizing mental states . To calculate eSense, the ThinkGear technology amplifies the raw brainwave signal and removes the ambient noise and muscle movement. The eSense algorithm is then applied to the remaining signal, resulting in the interpreted eSense meter values [3].

eSense Meter

The eSense meters are a way to show how effectively the user is engaging Attention (similar to concentration) or Meditation (similar to relaxation).

In many cases, people tend to be better at one eSense than the other, that means they must try different tactics until they are successful with one. Then they will be able to duplicate the action more easily with additional practice.

For each type of eSense (i.e. Attention, Meditation), the meter value is reported on a relative eSense scale of 1 to 100. The eSense Attention meter indicates the intensity of mental “focus” or “attention”. While the eSense Meditation meter indicates the level of a user’s mental “calmness” or “relaxation”.

III. Mindwave Mobile Headset

Mindwave Mobile is an EEG headset that safely measures and transfers the power spectrum (alpha waves, beta waves, etc) data via Bluetooth to wirelessly communicate with the device, and works with most modern operating systems

The MindWave Mobile headset, can be simply slipped on to be able to see human brainwaves change in real time. For example with the

Mindwave Mobile we can monitor the levels of attention, relaxation, meditation and eye blinks.

The Mindwave headset picks up the brain's electrical activity and divides the signal by frequency into various types of waves, allowing it to infer human mental state.

The Mindwave Mobile as shown in Fig3 is surprisingly simple consisting only of a headset, an ear-clip, and a sensor arm. The headset's reference and ground electrodes are on the ear clip, while the EEG electrode is on the sensor arm, resting on the forehead above the eye.

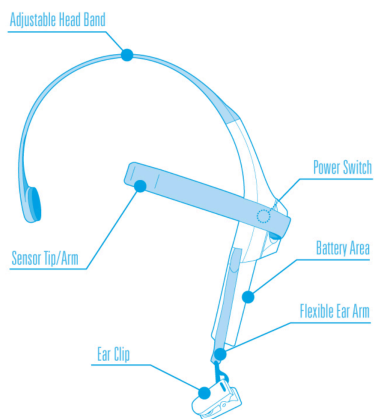


Figure3. EEG Headset Diagram

IV. Android Application

The Android application has been used in this work as an intermediary between the smart building controller and the mind wave mobile headset.

An Android app is a software application running on the Android platform. Because the Android platform is built for mobile devices, a typical Android app is designed for a smartphone or a tablet PC running on the Android OS [4].

An Android application is defined using one or more of Android's four core application components : Activity, Service, Broadcast Receiver and Content Provider [5].

Activity is an application component that provides a screen with which users can interact in order to do something. If an application has more than one activity, then one of them should be marked as the activity that is presented when the application is launched.

Service is an application component that can perform long-running operations in the background without a user interface.

Broadcast Receivers simply respond to broadcast messages from other applications or from the system.

Content Providers component supplies data from one application to others on request.

V. PRACTICAL PART “ Mindwave Mobile Headset and Android Application”

Mindwave Mobile headset shown in Fig4 as clarified in Section III, is a wireless device used to record the EEG signals, then it sends a corresponding data of the brain waves to the device connected with it via bluetooth connection.



Figure4. The MindWave Mobile headset

The headset uses eSense meters for Attention and Meditation. The meter value for each type of eSense is reported on a relative eSense scale of 1 to 100.

Given that the Attention can be controlled through a focus, two actions have been chosen in practical implementation of this work " single and double blinking " which they give different range of values on eSense scale.

The headset records low frequencies of single blinking and gives small values on eSense scale while higher frequency is recording when the Human blinks his eyes twice and the values will be higher on eSense scale.

Android application is designed to communicate with the headset and it acts as an intermediary between the Mindwave Mobile Headset and the smart building controller " The Arduino ". It takes advantage of these values in order to send commands to the Arduino.

Android mobile which contains this application, receives signals from the Mindwave Mobile Headset via bluetooth connection and It also sends orders to the Arduino via bluetooth connection.

The Interface of The Smart Building Android Application

This Application includes a set of buttons as shown in Fig5 that we can select one of them and change their status through the Mindwave Mobile Headset.



Figure5. The Interface of Android Application

The Android Application and Mindwave Mobile Headset Flow Chart

The flow chart in Fig6 clarifies how the Mindwave mobile headset and Android mobile contact with each other to send orders to the smart building controller.

If the user blinks his eyes once the mobile will change the focus to another button, and if the user blinks his eyes twice a certain button will be selected and the mobile will connect to the Arduino and sends data corresponding to this button (the letters).

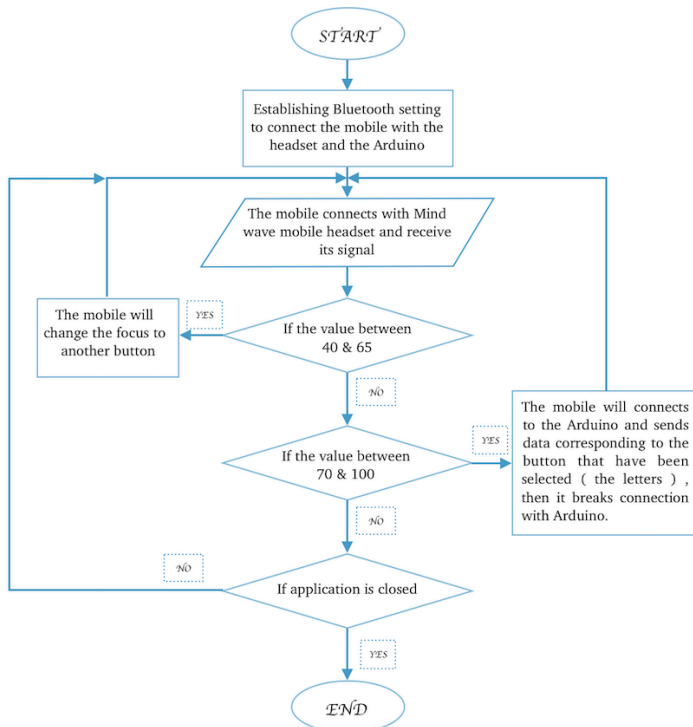


Figure6. Android Application Flow Chart

VI. Conclusion

Mindwave Mobile headset is a wireless device used to record the EEG signals, then it sends a corresponding data of the brain waves to the device connected with it via bluetooth connection.

This work aims to use the Mind Wave Mobile Headset to control the whole building utilities through an Android application.

The Android application is designed to communicate with the headset and it acts as an intermediary between the Mindwave Mobile Headset and the smart building controller " The Arduino ".

Two actions have been chosen in practical implementation of this work " single and double blinking " which they give different range of values on eSense scale of the Headset.

The Android application takes advantage of these values in order to send commands to the Arduino.

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