Thought Controlled Automation

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Abstract — *Brain computer interface (BCI) is a collaboration between a brain and a computer. Using BCI it is possible to use brain signals to direct some external activity, such as control of a cursor or some home appliance. This is useful for people who find it difficult to operate devices using normal muscular body parts. The proposed system, called Thought Controlled Automation, makes use of the concept of BCI and aims to control home appliances with the help of Human Attention and Meditation Levels which comes under non-invasive method of brain signal measurement. A NeuroSky Mindwave headset is used for capturing the brain waves. Inside the headset is a NeuroSky chip that gives the two values viz. attention and meditation values to an Arduino Mega controller. The Mega sends commands to an Arduino Uno and a Leonardo. The Uno controls a robot and a home appliance while the Leonardo controls the cursor on a PC.*

Keywords- Brain computer interface, home automation, brain signals, attention value, meditation value

I. INTRODUCTION

Technology has been one of the principal driving forces of the future. It is transforming our lives and shaping our future at rates unprecedented in history, with profound implications which we cannot even begin to see or understand. Advancements in technology have paved way for many scientific discoveries and have led to the development of many scientific applications that were unheard of earlier. Automation is one such application. It may be defined as the technique of making an apparatus, a process or a system operate automatically. The means for achieving automation includes mechanical, pneumatic, hydraulic, computers, electrical and electronics, usually in collaboration.

The last century in neuroscience research has provided us with insights into the working of the brain, and particularly, the electrical signals emitted by neurons firing in the brain. These signals, as described in this paper, can be used for the purpose of automation. This automation is called Thought Controlled Automation (TCA) or Brain Controlled Automation (BCA).

The proposed TCA system is a real-time automation system that controls operation of home appliances. A NeuroSky Mindwave headset is worn by the user. It captures the user's brainwaves. Inside the headset is a NeuroSky Think Gear Asic Module (TGAM) module. The TGAM processes the captured signal and outputs EEG frequency spectrums, EEG signal quality, raw EEG, and two NeuroSky eSense values: attention and meditation. Attention values indicate the degree of mental focus or 'attention' with values ranging from 0 to 100. This value increases when the user focuses on s specific thought or object, and decreases when the user is distracted. The meditation value shows the level of mental calmness or 'relaxation'. Its range is from 0 – 100. The value increases when the user relaxes the mind and decreases when he is stressed.

The TGAM module sends data to the Mega controller by Bluetooth. The Mega receives the data and sends commands to the Uno and the Leonardo. The Uno controls a robot and a bulb while the Leonardo is used to control the movement of the cursor on a PC.

II. LITERATURE REVIEW

Many systems have been proposed so far in the field of home automation and remote operation of appliances. However these systems have their own limitations. In [1], the authors proposed a voice controlled smart house system. The method involved use of voice commands to control the movement of a wheelchair. Finite Inductive Sequences (FIS) were used for assisting voice command recognition. The main problem with this method was the fact that the system depended on the pronunciation/accuracy of the words. Changes in the words or their pronunciation restricted the movement of the chair. [2] describes a BCI system to help disabled people input phone numbers just by gazing at the buttons. In [3] the authors proposed a method to control home appliances by movement of the eye. They used a blink sensor for eye

movement acquisition. The blink sensor produced a signal whenever the eye was closed. The processed signal was then used as an input for a microcontroller in order to control home appliances.

Visual Evoked Potentials (VEP) [3], Slow Cortical Potentials [4], P300 potentials, N400 potentials and Sensory Motor Rhythm (SMR) are some of the ways in which interaction between human brain and computer has been achieved. Wavelet-based feature extraction [5], Artificial Neural Network [6], Power Spectral Density [7], Band Power [8] and Adaptive Auto Regressive (AAR) [9] are some of the methods used for extracting and classifying features from brain signals.

III.   PROPOSED METHODOLOGY

3.1 Working description

- The basic structure of the proposed system consists of three microcontrollers, a headset, motor drivers, power supply and motors. The main aim of this project is to control appliances using brain waves.
- The user wears the headset, inside which is a TGAM module which captures the user's brain waves and sends two values viz. attention and meditation levels to an Arduino Mega microcontroller.
- The Mega sends commands, via Bluetooth, to two other controllers, one being the Uno and the other being a Leonardo.
- The Uno controls a robot and a bulb while the Leonardo controls a cursor on the PC.
- The system works in three different modes, each mode deals with controlling one appliance (robot, bulb and cursor).
- The bulb can be controlled by closing eyes for 1-2 seconds. Closing eyes for 2-4 seconds switches the system to robot controller mode while closing eyes for more than 4 seconds starts the mouse control mode.
- When the home automation mode is on, increasing the attention level to 70 switches on the bulb. In order to turn it off, the user has to bring his attention level to 70 once again. Another device, say a fan, could be connected using a second relay. It switches on when the meditation level goes above 70. Once on, it could be switched off by attaining a meditation level of 70 once again.
- In the cursor/mouse control mode, if the attention level is below 25, the cursor moves left; if it is between 25 and 50, the cursor moves right; if it is between 50 and 75, the cursor moves up; and when it goes above 75, the cursor moves down.
- For the robot control mode, both attention and meditation levels are needed. The attention value controls the forward movement of the robot, while the meditation level controls its spin.

3.2 Block diagram of proposed system
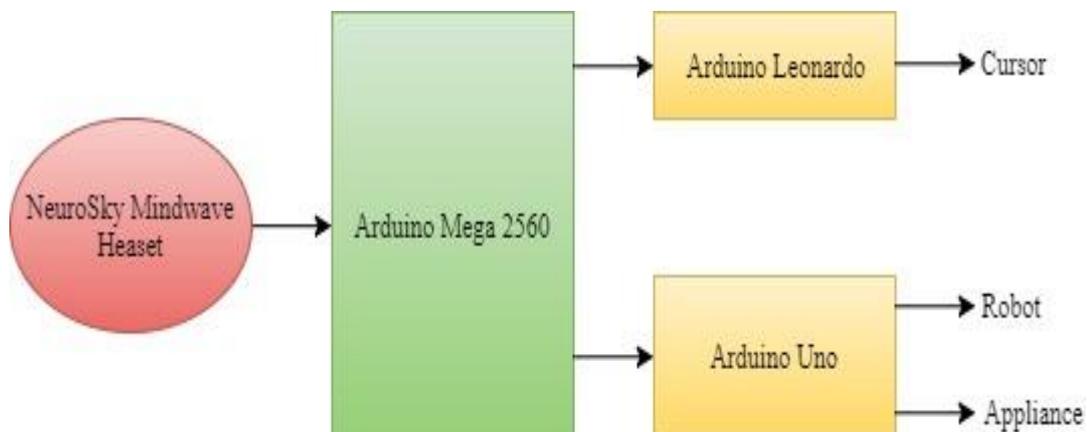
Figure 1. Main Block Diagram

The Mega is the brain of the entire system. It receives data from the mindwave headset and sends commands accordingly to the Uno and the Leonardo. The Leonardo constitutes the cursor control mode while the Uno controls a robot and an appliance.

3.3 Software description

The programming is done using Arduino programming language. Arduino IDE is used as the programming environment. Three different libraries are used- brain library, IR library and serial communication library.

IV. EXPERIMENTAL RESULTS

The home automation mode consists of Arduino Uno controlling the operation of a bulb. Attention value of 70 or more is needed for switching the bulb on or off. This value may be obtained by strongly concentrating on a particular thought or object. Strong emotions also yield such high attention values.

The Uno also controls the robot in robot control mode. Attention values are used for moving the robot forward while meditation values are used for moving the robot left or right.

The Leonardo is used in the cursor control mode. Here different movements of the cursor is achieved by changing the attention levels. Movements in left, right, upward and downward directions are achieved by attaining attention values below 25, between 25 and 50, between 50 and 75, and above 75 respectively.
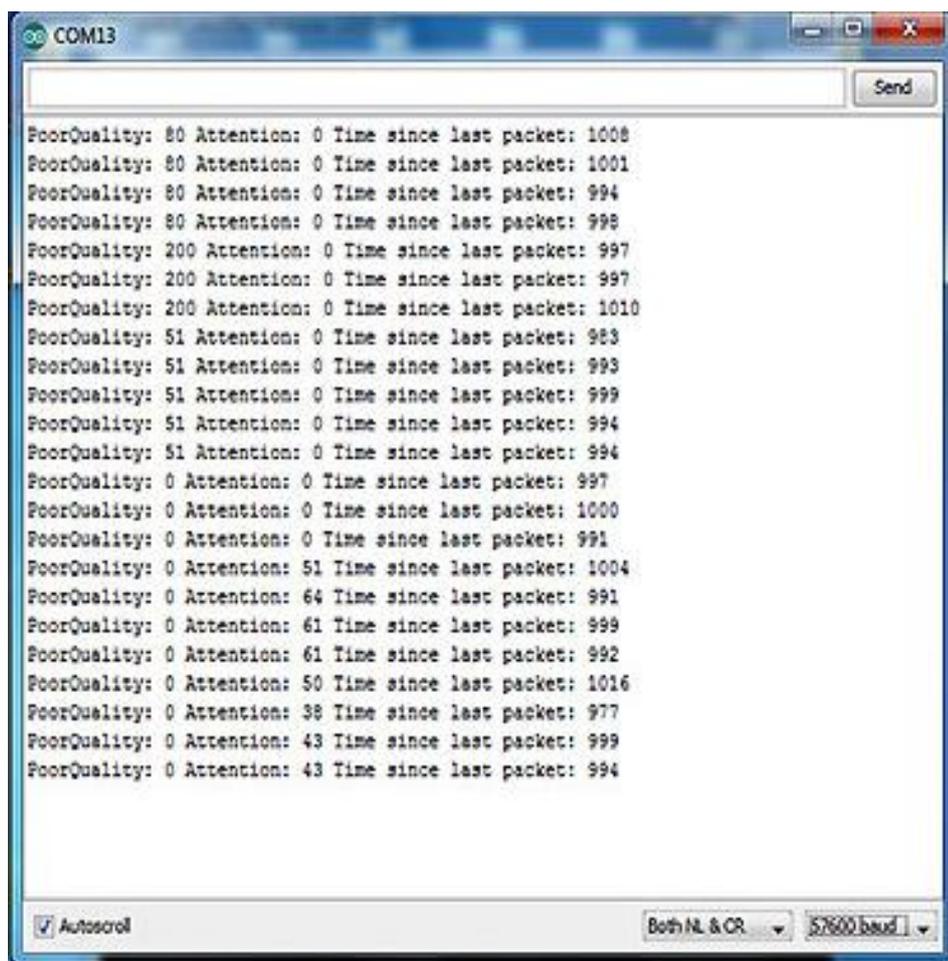
Figure 2. Attention values received from the headset

V. CONCLUSION

The proposed system consists of three different modes. In first mode, user is able to control the movement of the cursor on a PC. For this mode A Leonardo controller is interfaced with the Mega controller board. In the second mode, user is able to control a robot using his brain waves. For this, an Uno controller is interfaced with the Mega controller board. The Uno is also used in the third mode, called home automation mode, wherein the user can switch a bulb on or off using his brain waves only. The system can be modified to control other home appliances as well. This system is useful for people with special needs, people who find it difficult to perform day to day activities using their normal muscular body parts. The

robot control mode proposed in this paper can be further developed to control a wheelchair using brain waves only. Using advance technologies, it could also be used in autonomous cars. The home automation feature could be extended to a wide range of appliances, thereby paving a way for smart home automation systems. The cursor control mode is useful for gaming purposes.

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