Robot Controlled by Mind Wave

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Abstract—The mind wave controlling robot system is based on brain-computer interfaces(BCIs). We have used the Neurosky mind wave mobile (EEG Sensor) to detect the electric signals from the mind according to the signals which are transmitted and received by the neurons from the mind. Then we have recognised some of the patterns from our brain like attention level and while we blink. We have processed these signals and used them as command in our system then with the help of microcontroller we have taken the input from our android application which will process the data after fetching it from the EEG Sensor. Then the processed command is recognised by the microcontroller and microcontroller will then take the action to move the robot. We have used only the attention level and the blink strength. If the attention level is above 50% then the system will start moving and to change the command we have to use the blink pattern which is based on the force blink and the normal blink the robot which we are moving here can move forward, backward ,right and left.

Keywords—Brain-computer interface, neurosky mind wave sensor, EEG,Arduino, Robot.

I. INTRODUCTION

Human brain consists of millions of interconnected neurons. The patterns of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also generate a unique electrical signal. The control commands will be transmitted to the robotic module which is the vehicle section. With this entire system, we can move a robot according to the human thoughts and it can be turned by blink thoughts and it can be turned by blink muscle contraction. Electroencephalography (EEG) is the measurement of electrical activity in the living brain. Mind wave sensors are not used in clinical use, but are used in the Brain Control Interface (BCI) and neuro feedback . The BCI is a direct communication pathway between the brain and an external device to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time . To control the robot, EEG and Eye-Blinking signals are needed. In this system we have a tendency to use simple unipolar electrode to record EEG signal from the forehead . We have got the signal attention. In addition, we also extract the eye-blinking signals. Therefore, attention and eye-blinking signals are collected as the management signals through a Bluetooth interface and therefore they electrically interface in the robot. And thus the robot will be controlled.

II. Literature Survey

Controlling electrical devices with human brainwaves

Keerthana, et al. (2010) of VIT University developed a way of switching electrical appliances on and off using brainwaves. The project uses a Neurosky mind wave Mobile for brainwave sensing and transmission. The system flow of this project starts with the mind wave Mobile. Raw brainwave data are fed into the mind wave Mobile and put through a series of processing algorithms to make it suitable for microcontroller use. The resulting translated data is fed into a microcontroller that has an electrical appliance connected to it via a relay. Using brainwaves, the user is able to turn the electrical appliance on and off. Apart from the switching on and off of the electrical appliance, this project also tested the mind wave Mobile's accuracy in terms of translating brainwave data into usable ones. A series of tests for varying intensities of Beta and Gamma waves was made and the mind wave Mobile managed to pass all of them. This project did not use other features of the mind wave Mobile such as blink detection. Limitations of this project include the max transmission range of Bluetooth and the limited range of brainwave-related data that the mind wave Mobile can sense. The mind wave Mobile is probably the most affordable EEG headset available to student developers, albeit having a less robust and comprehensive feature set.

PC-based hands-free short messaging system through facial movements using Emotive EPOC

Manuel Adrian Aclan and his team (2012) at De La Salle University Philippines developed a short messaging system using Emotiv's super-expensive $800 EPOC headset. The main goal of this project is to give people with motor disabilities a hands-free way of communicating via GSM. It works similar to Stephen Hawking's computer system where an infrared sensor mounted on his eyeglasses scans for any muscle movement in his cheek. Hawking's computer goes through a list of characters and the tensing of his cheek muscle serves as a way of selecting a specific character. While this method requires a ton of patience, it works given Hawking's severe motor limitations. Emotiv's EPOC headset is able to detect specific facial movements, giving the developer access to a wide range of possible controls. Specific facial movements are used for up, down, left and right directions. Upon the completion of a message, it is sent to the recipient via the GSM module. While this project is primarily aimed towards people with motor handicaps, it can also be used by anyone who wishes to have a hands free way of communicating with others. The biggest limitation of this project is its cost. While Emotiv's EPOC headset can detect a larger range of brainwaves and facial movements, it is extremely expensive and therefore inaccessible to most student-developers. It costs $800 and taking into consideration shipping costs and other expenses, it could very well surpass the $1000 mark for only the EEG headset.

Bluetooth Remote-Controlled Car

Hector Dominguez (2014) developed a Bluetooth remote-controlled RC car for his summer study's final project. The main components of Dominguez' project include an ATmega1284, an L293D motor controller, an HC-05 Bluetooth module, 9V DC motors, a 5V regulator, 9V batteries and a car chassis. On the software side, he used AVR Studio 6, the Android SDK and Eclipse. Dominguez's project makes use of a Bluetooth module to send and receive signals to and from the Android application that serves as the remote controller of the RC car. The project specifically uses PWM signals to drive the DC motors on the RC car. The Android application utilized Android Bluetooth API and was made with Java and XML.

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Mobile-controlled wheelchair

Roger Achkar and his team (2015) developed a smart phone-controlled wheelchair with an auto-movement feature that allows you to save a predefined path that the wheelchair will take. The wheelchair has two DC motors attached to it with two relays attached to each. One relay operates the DC motor it is connected to and the second one switches the motor's phase to go forward or backward. An IP cam is mounted on the wheelchair, which connects wirelessly to a router connected to the Arduino board. The mounted IP adds video monitoring to the wheelchair that can be used by the wheelchair administrator to monitor the current location of the patient. The Android application made for this project also connects to the same router. As mentioned before, one of the main features of this electric wheelchair is its auto-movement. It basically allows you to save a pre-defined path for the wheelchair to take, which requires you to measure the time needed for the wheelchair to get from the source location to its destination and the turns it would have to take along the way. Limitations of this project include the lack of an obstacle-sensing feature that would make its auto-movement more effective. Also, motor-handicapped people with no limbs have no way of using the wheelchair as it requires them to use a smart phone to control it. This wheelchair is essentially limited to patients with fully-functional hands.

Android-controlled monitoring toy car via WIFI

Rosevir Ceballos and his team (2016) developed an Android-controlled RC car with video streaming via Wireless Fidelity (WIFI) and an Android application to control the RC car. It basically is an RC car with an IP camera and a router mounted on it that can be controlled through an Android smart phone application. The Android app they developed makes clever use of a smart phone's accelerometer and gyroscope by using it as the steering mechanism of the RC car. Apart from being able to stream directly to the Android application, Ceballos' project is also able to save video to an SD card attached to the IP camera. The IP camera also features night vision and the ability to be panned through the Android application. However, a major limitation in Ceballos' project was the motorcycle lead-acid battery they used to power their car. It could only power the system continuously for short periods of time before requiring to be charged again. Using other types of batteries more suited for RC cars such as lithium polymer ones william prove battery life. Another limitation is the max distance between the smart phone controller and the RC car itself – it is limited to the max transmission range of WIFI.

III. PROPOSED SYSTEM

Project Concept Planning

The researchers got together for several brainstorming sessions on what the overall concept behind this project would be – trying to come up with new and creative ways of integrating new technology into traditional wheelchairs. Both being superhero fans, they ultimately drew inspiration from Tony Stark's Iron Man suit in Iron Man 3, where he used a device worn around his head that enabled him to call upon his suit using only his brain. From that, the idea for this project was conceived.

Electroencephalography (EEG)- Electroencephalography or EEG is a method of recording the brain's electrical activity. EEG is done by placing electrodes on the subject's scalp. It measures voltage fluctuations within the neurons of the brain. EEG used to be confined to medical institutions, but the development of cheaper, more consumer-friendly EEG devices have put it in the mainstream market.

Electro-oculography- Electro-oculography or EOG is a technique for recording movements of the eye. EOG uses the electrical changes due to muscle-related movements in the ocular region to detect events such as blinks.

Bluetooth- Bluetooth is a global wireless communication standard for connected devices wirelessly over a certain distance. At present, there are about 8.2 billion Bluetooth devices in use worldwide. Bluetooth devices, depending on the class, can transmit up to 100m. However, the most common transmission distance for Bluetooth devices is 10m.

Microcontroller- A microcontroller is a very small computer on a single integrated circuit. It has a processor, a memory module and programmable input and output ports. Microcontrollers are typically used in embedded systems that have specific and dedicated functions.

HC-06 Bluetooth Module- The HC-06 Bluetooth module is one of the most common Bluetooth modules used by hobbyists and professionals alike. It is a serial port protocol Bluetooth module that only acts as a slave. HC-06 modules can transmit up to 10m.

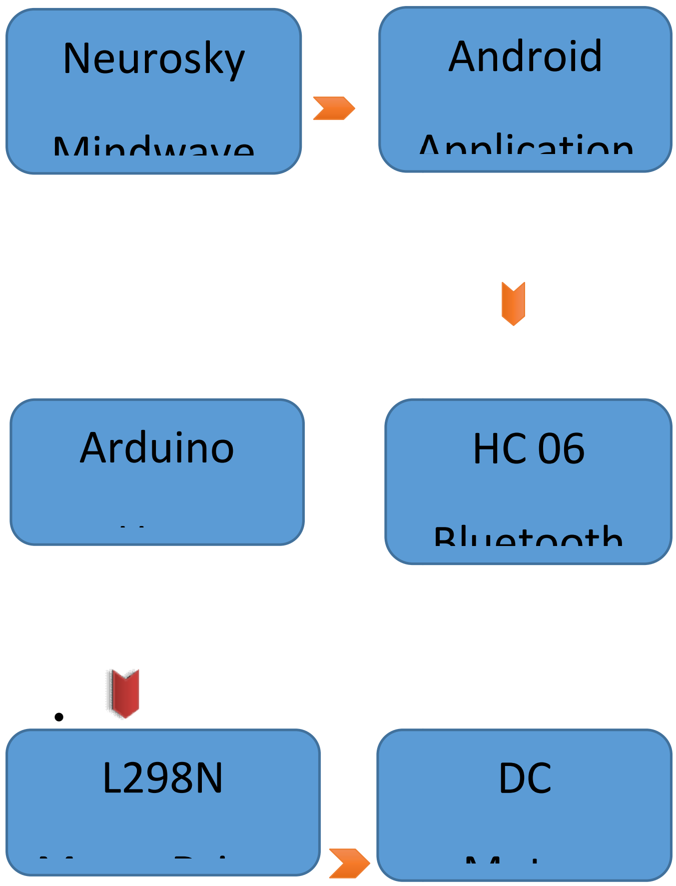
Arduino Uno. The Arduino Uno is one of the most, if not the most, popular microcontrollers around. It is based on the ATmega238p. The Uno has fourteen digital input/output pins with six of those doubling as PWM outputs.

L298N Motor Driver. The L298N Motor Driver enables the control of DC motors by amplifying the low-current signal from the Arduino into a higher-current signal suitable for motor control.

Neurosky Mind wave Mobile. Neurosky's mind wave Mobile is an Electroencephalography or EEG headset that measures and transmits brainwave data via Bluetooth. It can monitor attention and meditation levels as well as detect blinks. The mind wave Mobile is one of the most affordable Brain-Computer Interfaces available.

Attention eSense Meter. A value based on the user's beta brainwaves that is calculated by Neurosky's proprietary algorithm. Attention is associated with the focusing of a single thought by the user.

Meditation eSense Meter. A value based on the user's alpha brainwaves that is calculated by Neurosky's proprietary algorithm. Meditation indicates the level of mental calmness and relaxation.



Software Development-

The software was created with the goal of creating a way to operate the robot that is as simple and straightforward for the user while staying within the boundaries of the very limited controls the mind wave Mobile affords us. The researchers came up with a sequential operation loop composed of four different modes, each representing a state of the wheelchair. The modes are as follows: standby, command, focus, and running. After both the mind wave Mobile and the Arduino's Bluetooth module establish connection with the Android application, the Android application begins fetching the signal quality value, which can be not detected, poor, medium, or good. The signal quality will be not detected when the user is not wearing the mind wave Mobile, poor if almost no contact is made by the forehead skin with the dry sensor, medium if partial contact is made by the forehead skin with the dry sensor, and good if the dry sensor makes firm contact with the forehead. The signal quality has a value from 0-255 with 0 being the best and 255 being the worst. The range of values that each signal quality value is based upon has not been revealed by Neurosky. As an added safety precaution, when the signal quality value is not good, a stop command will be sent to the robot, preventing any unwanted motion. Once the signal quality value turns into good, the Android application begins listening for any incoming force blink data from the mind wave Mobile. At this point, normal blinks or blinks

whose blink strength values are below the threshold value of 90 are discarded. When a force blink or a blink whose blink strength value is above the threshold value of 90 is detected, the Android application begins cycling direction values – forward, reverse, left, and right for 10 seconds with a 2-second interval in between changing the direction value. This 10-second direction-cycle window is known as command mode. During command mode, the Android application listens for two consecutive blinks, otherwise known as a double blink event, from the user. When it detects a double blink event, the cycling of directions stops and whatever direction is shown in the cycle at the moment of the double blink event will become the chosen direction. For blinks to be considered consecutive, the time elapsed between two blink events must be equal to or less than 400 milliseconds. When a direction has been chosen, the Android applications shifts to focus mode where it starts listening to any incoming attention data from the mind wave Mobile. Attention values are outputted by the mind wave Mobile once every 1 second and once it goes to 50 or more, the Android application switches to running mode where it sends a command to the Arduino based on the direction chosen earlier. Each direction has a respective Bluetooth command that will be transmitted to and interpreted by the Arduino residing on the robot. Outside of focus mode, the attention listener process is set to null to reduce the amount of work the Android application has to do simultaneously. Similar to command mode, the user exits running mode by blinking consecutively to go back to standby mode. From then on, the whole operation loop is repeated should the user want to move the miniature wheelchair once again. The speed is kept at a constant throughout operation when the robot is running. This is due to accuracy and control-issues that are innate to the brainwave detection in the mind wave Mobile. Because of this, the constant speed can also be thought of as a safety feature for the user.

Hardware Development-

The mind wave Mobile and the HC-06 Bluetooth module will connect to the Android application simultaneously. It starts with the Neurosky mind wave Mobile, which is worn around the user's head, that picks up brainwave-related data and processes it before wirelessly transmitting it through its own built-in Bluetooth module to the Android Application. The Android application acts as a middleman between the mind wave Mobile and the

Arduino, the microcontroller that resides in the robot itself. In addition to acting as a middleman, the Android application can also be considered as a safety precaution for the user. Because data from the mind wave Mobile is not directly transmitted to the Arduino, the Android application can weed out unwanted data, ensuring that only relevant information is sent to the Arduino. By moving most of the processing to the Android application, this will also reduce the amount of Hardware System Flow processing that the Arduino has to do, thereby making it more efficient. Using Neurosky's Android SDK, the mind wave Mobile and the Android application will then be interfaced, allowing the transmission and reception of EEG and EOG data. The resulting data received by the Android application will then be wirelessly transmitted to the HC-06 Bluetooth module, which is connected to the Arduino. The Arduino, in turn, passes the data to the L298N motor driver. The L298N Motor driver has 4 DC motors connected to it and is responsible for both its speed and direction-control. Depending on the data passed on by the Arduino, the L298N then sends subsequent commands to the DC motors, allowing the movement of the miniature wheelchair.

WORKING

• Force blinking once triggers the command mode.

• Once the direction cycles, blinking consecutively at least twice selects the direction and triggers focus mode.

• Focusing on something gets focus level up to at least 50 to get the robot running

• Once the attention level reaches the threshold value of 50, running mode will be triggered and the robot will start running based on whatever direction has been choosed earlier.

• To stop running mode, blink consecutively at least two times.

• When want to run it again, force blink once to trigger the operation cycle once again.

IV.CONCLUSION

While this project allowed for the movement of the robot prototype, it is by no means perfect. Current EEG and brainwave technology, while effective to a certain extent, is nowhere near perfect. Blink detection is still not 100% accurate, an issue that will most likely be solved as blink detection technology gets better and better. As for brainwave detection, the inconsistencies and fluctuations in brainwave data can mostly be attributed to humans' inability to have complete control over their brainwaves. Algorithms that calculate usable values from raw brainwave data can get better, but until human beings learn how to control and manipulate individual brainwave frequencies, complete and absolute control of brainwaves will remain impossible. Mind wave-Mobile-related issues like hardware bugs that cause it to suddenly stop functioning at times also contribute to the various aforementioned problems that the researchers have no control over. This project does hold promise though for the future of EEG and brain wave related products. Brainwave technology will undoubtedly get better over time and we are very confident that the day will come when they can be effectively integrated into everyday products.

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