Triggering a FES for foot drop patients based on eye blink detection

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Abstract: Patients with ulnar mononeuropathy survive with flatfoot or drop foot resulting from weakness of the ankle dorsiflexiors. This proposed device attempts to detect the mono channel involuntary eye blink with use of neurosky mind wave device. This signal also using for control to resume patients independent-walking ability by stimulating the peroneal nerve by triggering an FES.

Introduction: Mononeuropathy is a neurodegrerative condition which results in loss of sensation, movement and other nerve dysfunctions. If the neuropathy affects the peroneal nerve, it causes the dropping of the forefoot and the condition is regarded as the FD. This etiology is termed as peroneal mononeuropathy. FD may also be caused due to muscular weakness or the paralysis of the anterior muscles of the lower portion of the leg. FD has also been associated with the damage of the peroneal nerve due to swelling or injury. The damage may either slow or prevent the nerve signals to reach the forefoot muscles. Since the movement of the foot play an important role in gait of a person, FD causes an abnormality in the gait pattern of the individual. The occurrence of FD has been found to be much higher in patients suffering with spinal upper motor neuron (UMN) pathology [3]. The patients suffering from this condition usually have to drag their foot along the ground, which makes them vulnerable to fall down and sustain physical injuries. This condition may be corrected to a certain extent by using ankle-foot orthosis (AFO). The orthosis is a plastic support to keep the ankle at a straightened position to improve the gait pattern. Even though the AFO improve the condition of the FD patients, it lacks the control. Therefore, functional electrical stimulator (FES) has been used widely to restore motor function in individual suffering from FD [4]. More than 80% of the patients who are suffering from peroneal and ulnar mononeuropathy have been found to be eligible for FES based device. Eye blinks and lateral eye movements are prominent in EEG signals which are obtained by placing electrodes in the frontal region of the brain. This paper presents a machine learning approach to detect eye blinks from EEG data and map them as intents to trigger the peroneal nerve by the FES from the EOG signal.

Electroencephalography (EEG) refers to the measuring of electrical activity around the scalp which results from the flow of current through the neurons inside the brain [1].Though the main purpose of EEG devices is to detect neuronal activity inside the brain [2], they also capture electrical activity that occurs due to movement of the muscles called electromyogram (EMG) and movements of eyes called electrooculogram (EOG) [3]. The movements of the eyes generate electric signals which could be detected in electrodes placed in the frontal regions of the scalp.
Electrooculogram

There is a constant potential difference that exists
between the retina and the foveal sclera of the eye known as *corneo-retinal potential (CRP)*. This helps in generating a large-amplitude current field with the movement of eyeballs in both lateral and vertical directions [8-9], which can be detected by neurosky (mindwave) from this we can get EEG signal.eye blink signal id getting from the EEG signal by using of aurdino and bluesmirf .aurdino is interface with computer to show the signal of eye blink.

Block diagram
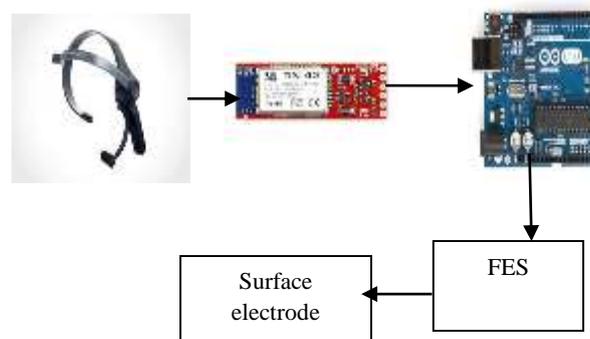
Method

This proposed device consists of 3 major parts: (1) voluntary blink conditioning module, (2) control signal generating module, and (3) electrical stimulator module. Fig. 1 is the schematic diagram of the device.
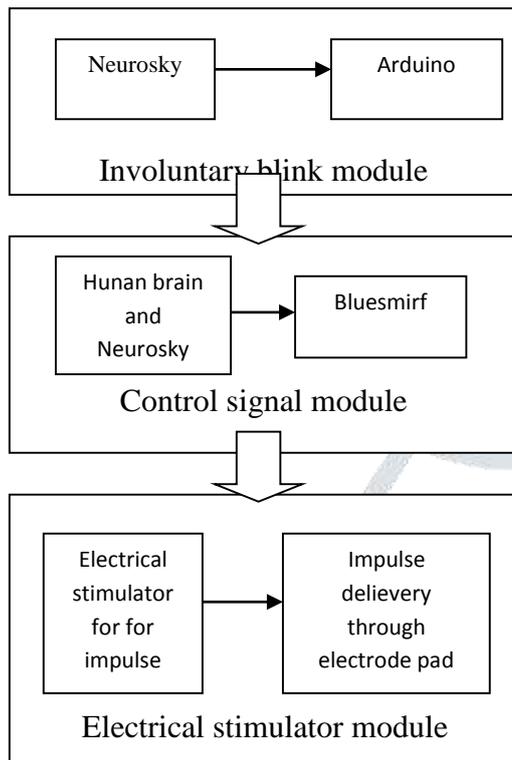

fig : Overview of the EOG-based FES triggering device

Involuntary eye blink conditioning module Eye blink results in the contraction of set of muscles. The EEG generated from the set of muscles during eyeblink may be recorded using neurosky mindwave. The duration of the eye blink usually lasts for a fraction of a second .Eyeblinks have been categorized as reflex blink(reflex action),voluntary blink (decision of the volunteer) and involuntary(controlled by the brain).

In first module we can see add two device Neurosky and Arduino.The MindWave headset takes decades of laboratory EEG technology research and puts it in your hands. It safely measures brainwave signals and monitors the attention and relaxation level of students as they interact with math, memory, and pattern recognition applications. Arduino use is based on the C/C++ language and requires very little else to get started. All the details or regular microprocessor development such as processor clock speed, programming speed, clock sources, etc. They are all initialized by the Arduino core. With this in mind, the Arduino system will still be able to perform much of the required tasks with no problem at all. The simplicity of using the microprocessor peripherals combined with the C language along with the sample code provided provides for very quick interface to the MindSet. Th e user is encouraged to extend the Arduino code by appendingcode after the indicated section where the packet has been checked for a valid check sum. after, the user may use the eSense values to do one of many things possible. Some of which is to control the brightness of an LED, the height of an object, etc.e bulk of the code is used for parsing the packet data. For further information, see the Mind- Set Communication Protocol document in the MindSet Development tools (MDT).

In block modem tool

We need to connect the Bluetooth modems to devices that can send and receive serial signals. These are TTL-level serial signals, make sure you don't confuse that with RS-232! Voltages should be between 3.3V and 5V. There are loads of options here, for this tutorial we'll use an Arduino.

Instead of connecting the Bluetooth modem to the Arduino's lone hardware UART, we'll use SoftwareSerial and connect the modem's RX and TX pins to any of the Arduino's free digital pins. This will help to avoid bus contention and will make sure the Bluetooth modem doesn't receive any spurious data during a sketch upload. Here's the connections we'll make for the example code later in this tutorial:
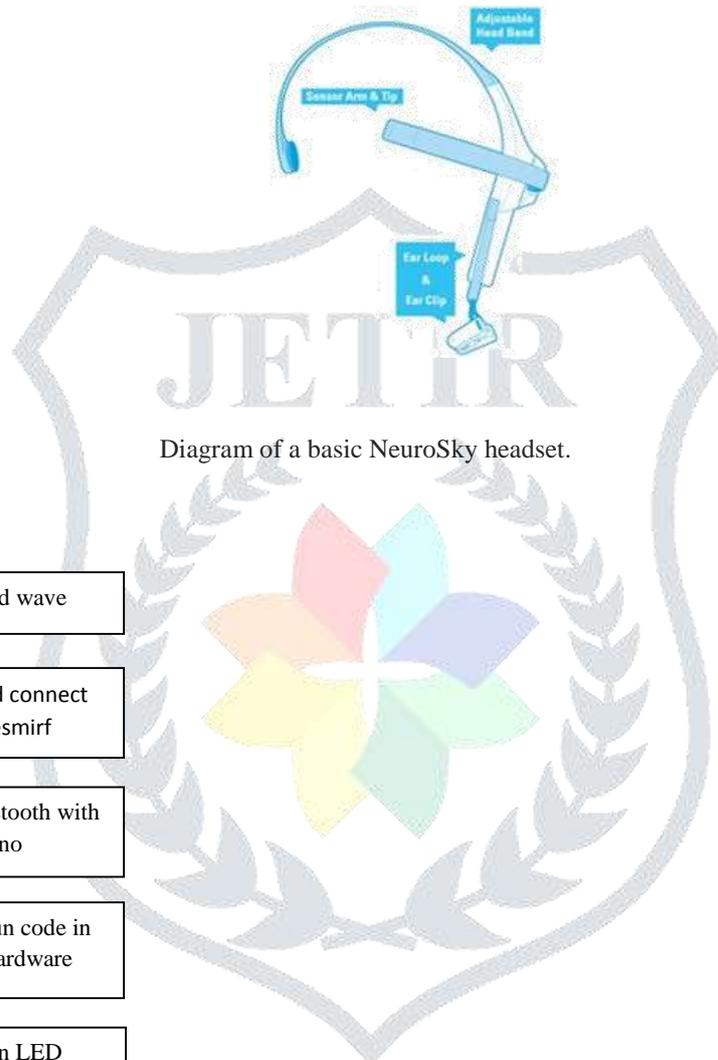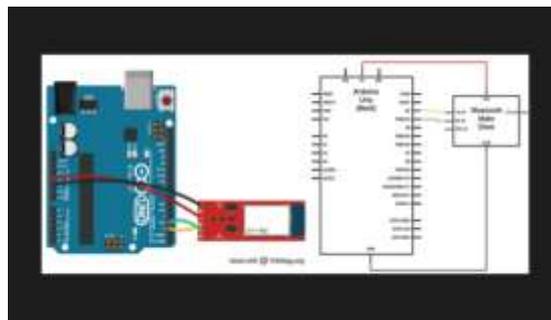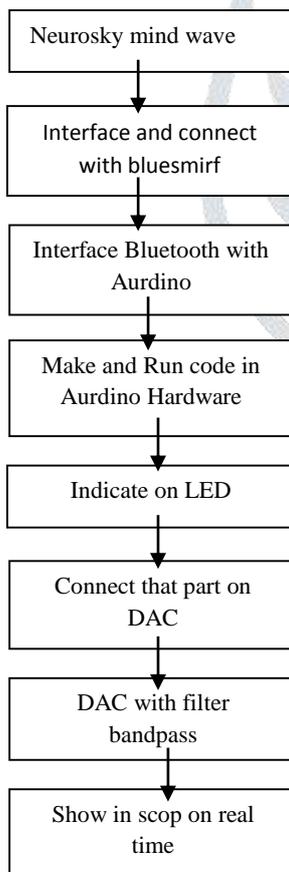
Diagram of a basic NeuroSky headset.

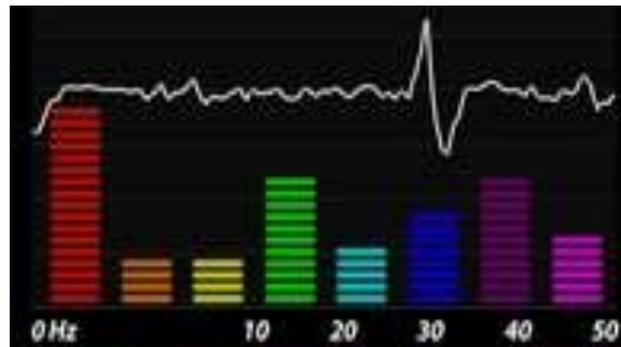**Propose Flow chart**

RESULT

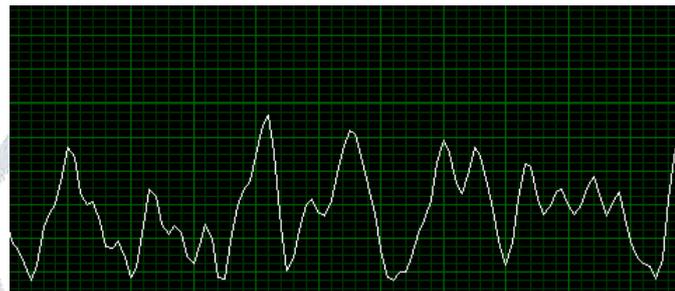Fig : Raw Brainwaves and Power Spectrum
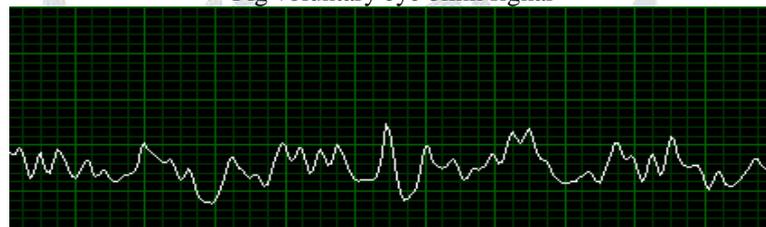

Fig voluntary eye blink signal

Fig involuntary eye blink

CONCLUSION

Combining the discovery of EOG signals in the brain hemisphere, electronics, and advances in rehabilitation, our device provides a novel method for rehabilitation for stroke survivors. In testing, we were able to process EEG signals for real-time hand control with accuracy consistent with previous studies. Recent evidence suggests that substracting EOG devices induces neural plasticity and improve and fetch eog signal for FES. Signal acquisition, signal processing, and mechanical control methods are established Using ARDUNIO UNO(ATMEGA 328).when EEG value is range between 170 to 50 and when arise between this than eog value detected and it inducate on 13 number LED. i would also work for voluntary and non-voluntary signal.

REFERANCES

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[2]. F. Lotte, "Study of Electroencephalographic Signal Processing and Classification Techniques towards the use of Brain-Computer Interfaces in Virtual Reality Applications," *Ph.D. thesis, National Institute of Applied Sciences of Rennes*, France, 2008.
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