Methodology for NeuroSky Based System to Detect Objective Pain in Human Body

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Abstract—The goal of this dissertation is to develop methods that are capable of classifying different categories of electroencephalography (EEG) signal to help in the evaluation and treatment of neurological diseases to detect pain level in the human body. In order to have a broad understanding of classification, this chapter mainly provides an overview of classification including its concept, structure and commonly used methods of EEG signal classification.

Keywords-*ThinkGear,NueroSky EEG Sensor,Battery,MindWave Headset,Andriod Application.*

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I. INTRODUCTION

EEG signals to identify pain and characterize it giving the human pain an objective assessment. Research into such modalities has started during the early years of this decade. Medical researchers have confronted this problem of pain identification from human brain. The research involved brain responses to external pain called stimuli. The technology used by most of the researches in US universities and UK universities are Functional Magnetic Resonance Imaging (FMRI). The cost incurred was huge, but the results were encouraging.

Electroencephalogram (EEG) is an economically viable solution [1-13] to monitor brain activity. In the last few years researchers started looking towards this option and trying to figure out a link between pains sensing part of human brain i.e. somatosensory cerebral cortex, the pain center of the brain. Recently European Union has funded a project for brain responses specifically related to the perception of pain in humans with hybrid sensors such as FMRI and EEG.

II. PROBLEM STATEMENT

Pain killer is a cure for pain, but when it comes to the intensity of pain the physician have to rely only on the condition told by the patient. The patient's inability to describe exact condition or the exaggerations about the condition leads to over doze of medicine that has harm effects in human body.

If the physicians have a quantitative method to measure the exact pain he/she will be in better position to prescribe a cure. If the patient's immunity level is very down the pain killer's extra doze may be the poisonous. To overcome all the above situations and keeping in mind budgetary conditions a research was conducted to develop an EEG based system to detect pain in human body.

III. SOLUTION METHODOLOGY

Here we are proposing a novel method based on a simple random sampling technique and least square support vector machine (SRS-LS-SVM) is introduced to classify epileptic EEG signals. This approach is also tested to identify different categories of mental imagery tasks EEG signals in BCI applications.

This Brain-Computer Interface (BCI) device [14] turns your brainwaves into actions, unlocking new worlds of interactivity. The MindWave reports the wearer's mental state in the form of NeuroSky's proprietary Attention and Meditation eSense algorithms, along with raw wave and information about the brainwave frequency bands. The NeuroSky MindWave can be used with supported video games, research software, or a number of other applications for an enhanced user experience.

MindWave Product Contents

- MindWave headset
- MindWave Wireless USB Adapter
- MindWave Application Disc sleeve / Quick Start Guide
- MindWave Application Disc, containing:
- MindWave User Guide
- MindWave Wireless drivers
- MindWave Manager
- ThinkGear Connector (TGC)
- CogniScore Connector (CSC)

The MindWave headset requires AAA battery to operate. To install or replace the battery, slide open the battery cover. Remove any existing battery within and replace with a new AAA battery.

Power: To power on the MindWave, slide the switch to the ON position. To turn the MindWave off, slide the switch back to the OFF position. While the MindWave is powered on, the LED light on the side of the headset will be turned on. If the MindWave has a low battery, the LED light will flash to indicate low battery status.

LED Light: The Mind Wave's LED light has two colors: red and blue. Refer to the chart to see what state the MindWave is in.

The MindWave is more than your average headset. It has the ability to use your brainwaves for exciting new applications.

1. Orient the MindWave with the forehead Sensor Arm on your left hand side. Rotate the Sensor Arm from its base by about 90 degrees. It can be rotated slightly more if necessary to get proper fit and comfort.

2. The overhead band of the MindWave is adjustable and can be extended to fit various sizes. Put-on the MindWave. If the sensor does not make contact with the forehead or if the fit is not comfortable, remove the MindWave to readjust the overhead band and the forehead Sensor Arm. The forehead Sensor Arm is flexible and should arch inwards.

3. Allow the rubber ear hoop to rest behind your left ear, and then clip the ear clip onto your earlobe.

4. Make sure the two metal contacts on the inside of both sides of the ear clip make skin contact with your earlobe or ear. Move any hair or obstructions (such as jewelry) out of the way. Readjust the ear clip as necessary to make proper contact with the skin of your ear. You may need to squeeze the ear clip against your ear for a few moments.

5. Adjust the forehead Sensor Arm of the headset so that the Sensor Tip makes contact with the skin of your forehead. This Sensor Tip must maintain steady skin contact in order to properly measure your brainwaves. The Sensor Tip should be comfortable, yet stay firmly in position. Keep hair away from the sensor – the sensor must be able to directly contact the skin at all times. Make up, dead skin, or debris can interfere with the connection. Scratch or wipe the obstruction away if you have trouble obtaining a clean signal.

6. This is how the MindWave should look when properly worn. During usage, if you are not receiving a signal, repeat the steps above to make minor adjustments to ensure the sensor and contacts have proper skin contact.

A. NeuroSky Technology Overview

Brainwaves the last century of neuroscience research has greatly increased our knowledge about the brain and particularly, the electrical signals emitted by neurons □ring in the brain. The patterns and frequencies of these electrical signals can be measured by placing a sensor on the scalp. The Mind Tools line of headset [14-15] products contain NeuroSky ThinkGear technology, which measures the analog electrical signals, commonly referred to as brainwaves, and processes them into digital signals. The ThinkGear technology then makes those measurements and signals available to games and applications. The table below gives a general synopsis of some of the commonly-recognized frequencies that tend to be generated by different types of activity in the brain.

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

B. ThinkGear

ThinkGear is the technology inside every NeuroSky product or partner product that enables a device to interface with the wearers' 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.

C. eSense

eSense is a NeuroSky's proprietary algorithm for characterizing mental states. To calculate eSense, the NeuroSky 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. Please note that eSense meter values do not describe an exact number, but instead describe ranges of activity.

Maintenance

• Clean the Mind Wave's sensor and ear contacts with alcohol or a damp cloth periodically to ensure the best signal quality. Use a soft cloth to clean the MindWave casing.

• For travel and storage, gently push the sensor arm up until it is aligned with the top of the headset. Be careful not

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to overextend the maximum range of the boom by adjusting it beyond the natural stopping point.

• Do not expose the MindWave to temperatures above 140°F (60°C)

• Dropping or throwing the MindWave may cause damage to the MindWave.

• Remove the battery from the MindWave when not in use for extended periods of time.

IV. RESULTS AND DISCUSSION

The final output of this project is to get the pain levels more accurately with the NeuroSky device. From which we can get the clear picture of the pain bands for a particular subject and from the correlation and Euclidian results, he/she will be clearer about the pain signal.

The data collected from the headset during the needle test on the finger clearly demonstrate NeuroSky's suitability as a minimally invasive means of measuring the pain level of a subject. This study show that the pain outputted by the headset clearly indicate when a subject undergoes a in some physical pain.

Fig 1: Apply Needle to feel pain

Fig 2: Result before feeling tensed & pain

Fig 3: Result after feeling tensed & pain

Fig 4: Login Screen for Android App

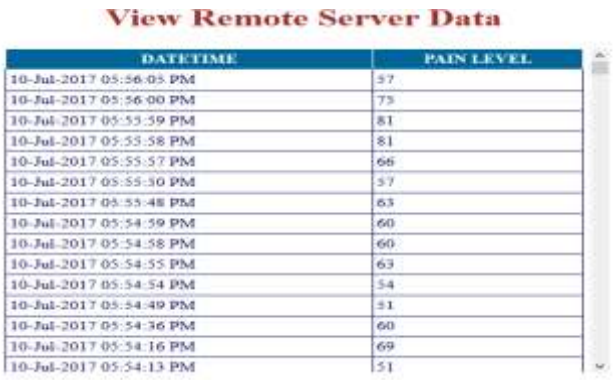

Fig 5: Checking Pain Level in Android App

From the Android Application we can monitor the pain levels of the patient for every minute by logging to the Application with username and password. Before that we need to create an account to login. After Login to Application to the application we can see the pain level w.r.to date and time in terms of db.

V. CONCLUSION AND FUTURE WORK

In this paper, we aimed to understand the brainwave activity captured by the affordable devices NeuroSky Mindset and investigate how the attention and meditation values correlates in regards to different objects which are known and both unknown. We also aimed to understand the activities by reading those values when they are focused or relaxed. BCI is a new emerging area to explore which is now extends from patients rehabilitation to other area of research such as game, user experience and understanding cognitive behavior for human settings. We developed an application to store the brainwave data and visualize and analyze it for investigating the attention and meditation levels of participants.

During our study we noticed that when the users are feeling bored, there is a decrease level of attention values. The attention value is lower than normal value below 60 for bored, distracted participants. It may raise the difference

between unknown answers that decrease the level of attention as user can't focus what to think for answer that question. Other possibility could be the participants lose the focus because they do not understand the questionnaire formulation.

However, we can draws the conclusion that relaxation levels are consistent in our study. The level was high when focus level was as high as 93 when the level of attention was almost 20. More research will give clear option in this area as the devices generates Big data so we have the opportunity to analyze and synchronize data from multiple users at the same time to see the correlation about the Different brainwaves.

The data we gathered from the users we analyzed it visually in two different imputed files by using the JSFiddle. The data from the same time stamp with different users can be a future work to

Implement systems where the data can be synchronized in a single file and analyze it. The video streaming we captured in the camera we didn't implement it in our application. This option includes with some static images where known and unknown objects also mention to the users not to look at certain objects and how it generate their brain activities can be a future object to investigate.

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