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Brain-Based Computer Interfaces Using Eeg Sensor

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Abstract:

Electroencephalography (EEG)-based brain-computer interfaces (BCIs), particularly those using motor-imagery (MI) data, have the potential to become groundbreaking technologies in both clinical and entertainment settings. MI data is generated when a subject imagines the movement of a limb. This paper reviews state-of-the-art signal processing techniques for MI EEG-based BCIs, with a particular focus on the feature extraction, feature selection and classification techniques used. It also summarizes the main applications of EEG-based BCIs, particularly those based on MI data, and finally presents a detailed discussion of the most prevalent challenges impeding the development and commercialization of EEG-based BCIs

Keywords: EEG- Electroencephalography, BCI - brain-computer interfaces, IM – imaginary data

1. INTRODUCTION

A complete picture of the brain structure will provide new insights into how the human brain functions and may facilitate new treatments and drug discovery for brain disorders. Recent advances in intact brain imaging, such as the CLARITY and MAP (Magnified Analysis of the Proteome) tissue clearing techniques, make it possible to collect large volumetric images of brain tissue at cellular and sub-cellular resolutions. The high throughput and high-resolution brain imagery, however, poses a challenge for efficient processing and analysis. We have developed an automated dense axonal fibber tracing pipeline that can track long-range fibbers and construct 3D connectivity maps, which include not only the vertices and edges of a network graph, but also the 3D location information associated with each fibres track.

In addition to typical graph analysis, we are interested in identifying long-range neuron fibres connections and fibres crossings, both of which could reveal informative patterns when analyzed at cellular resolution and at long range (≥ 1 mm). Brain graphs offer a framework to represent the structural or functional topology at multiple levels. A number of software tools exist for analysing topology of brain networks using graph theory. Few are designed for high throughput dense and long-range neuron analysis at the cellular level, which is critical for understanding brain circuits and for comparing healthy and diseased brains.

Mind reading and remote communication have their unique fingerprint in numerous fields such as educational, self-regulation, production, marketing, security as well as games and entertainment. It creates a mutual understanding between users and the surrounding systems. This paper shows the application areas that could benefit from brain waves in facilitating or achieving their goals. We also discuss major usability and technical challenges that face brain signals utilization in various components of BCI system. Different solutions that aim to limit and decrease their effects have also been reviewed.

2. LITERATURE SURVEY

2.1 THE NIH BRAIN INITIATIVE

In 2014, the National Institutes of Health (NIH) began funding an ambitious research program, the Brain Research through Advancing Innovative Neuro technologies (BRAIN) Initiative, with the singular focus of advancing our understanding of brain circuits though development and application of breakthrough neuro technologies. As we approach the halfway mark of this 10-year effort aimed at revolutionizing our understanding of information processing in the human brain, it is timely to review the progress and the future trajectory of BRAIN Initiative research. Throughout history, new tools have driven scientific revolutions in multiple disciplines [1].

Unraveling how the human brain processes information and supports a diverse spectrum of behaviours requires such a scientific revolution and an arsenal of next generation tools to be deployed by neuroscientists across the basic, translational, and clinical landscapes. Capturing the full record of neural activity or what has been called a “brain activity map” across spatial and temporal domains is a daunting technological challenge that needs to be met to achieve a more complete understanding of fundamental and pathological brain processes [2]. Launched on April 2, 2013, the key goal of the Brain Research through Advancing Innovative Neuro technologies (BRAIN) Initiative is to develop innovative technologies to interrogate how the brain’s cells and circuits interact at the speed of thought and, ultimately, to reveal the complex links between brain function and behavior.

In addition to these spatial scales, there are temporal scales, as brain circuits are not static but continually change as a result of neural activity, developmental stage, and aging. Despite this complexity, the technologies emerging from the BRAIN Initiative are opening new doors to decipher how the brain records, processes, uses, stores, and retrieves vast quantities of information. They have the potential to facilitate a quantum leap toward understanding brain function and its disruption in disease.

Making circuit abnormalities the basis of diagnostics and the normalization of circuit function the target of future intervention in neuro/mental/substance-abuse disorders.

3. EXISTING SYSTEM

Brain computer interfaces (BCIs) have enabled individuals to control devices, such as spellers, robotic arms, drones, and wheelchairs, but often these BCI applications are restricted to research laboratories. With the advent of virtual reality (VR) systems and the Internet of Things (IoT) we can couple these technologies to offer real-time control of a user’s virtual and physical environment. Likewise, BCI applications are often single-use with user’s having no control outside of the restrictions placed upon the applications at the time of creation. Therefore, there is a need to create a tool that allows users the exibility to create and modularize aspects of BCI applications for control of IoT devices and VR environments. Using a popular video game engine, Unity, and coupling it with BCI2000, we can create diverse applications that give the end-user additional autonomy during the task at hand. We demonstrate the validity of controlling a Unity-based VR environment and several commercial IoT devices via direct neural interfacing processed through BCI2000.

3.1 EEG-INTERNET OF THINGS

A Brain-Computer Interface (BCI) acquires brain signals, analyzes and translates them into commands that are relayed to actuation devices for carrying out desired actions. With the widespread connectivity of everyday devices realized by the advent of the Internet of Things (IoT), BCI can empower individuals to directly control objects such as smart home appliances or assistive robots, directly via their thoughts.

Moreover, pre-processing brain signals and the subsequent feature engineering are both time-consuming and highly reliant on human domain expertise. To address the aforementioned issues, in this paper, we propose a unified deep learning-based framework that enables effective human-thing cognitive interactivity in order to bridge individuals and IoT objects.

3.2 MATERIALS AND METHODS

Signals from both EEG and ECoG devices can be recorded, analyzed, and utilized using a popular software package BCI2000 allows for the acquisition of neural recordings from a wide-range of 3rd party systems, formatting and sending that raw data to pre-built or custom signal processing modules, creating a control signal based upon the signal used and the application to be sent to, and finally, the creation of an application to be presented.

4. PROPOSED SYSTEM

The main findings of this survey highlights three major development trends of BCI, which are EEG, IoT, and cloud computing. Using the EEG (Electro Encephalogram) sensor we are going to visualize the brain Function with the help of Arduino TFT controller. The information of the authorized person is stored in the AWC cloud system. The TFT controller is used to sense whether the brain is Alive or dead. When the brain dead the stored information in the cloud will be transfer automatically to the trusted person.

4.1 BLOCK DIAGRAM

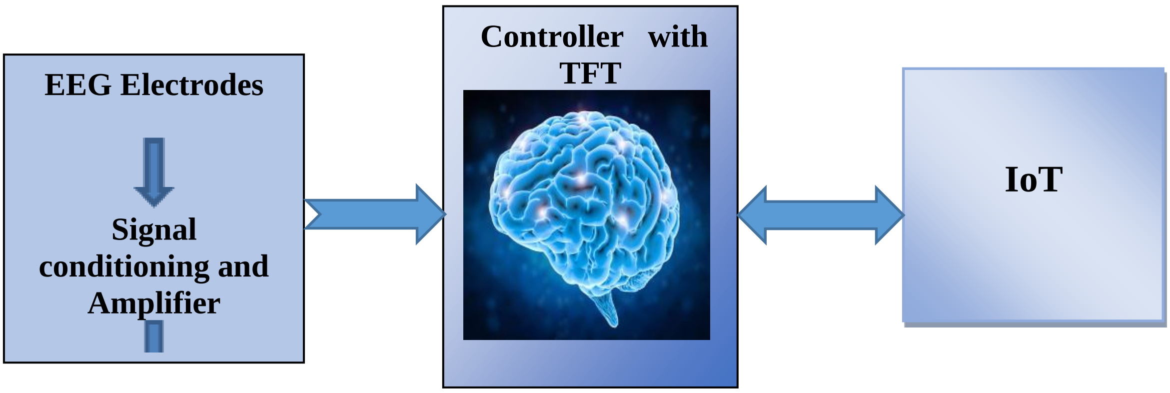

Figure 4.1: BLOCK DIAGRAM OF PROPOSED SYSTEM

4.2 MODULES DESCRIPTION

Sensors Architecture

Serial Communication System & Sensor Monitoring

Sending Mail & Storage

4.2.1 SENSORS ARCHITECTURE

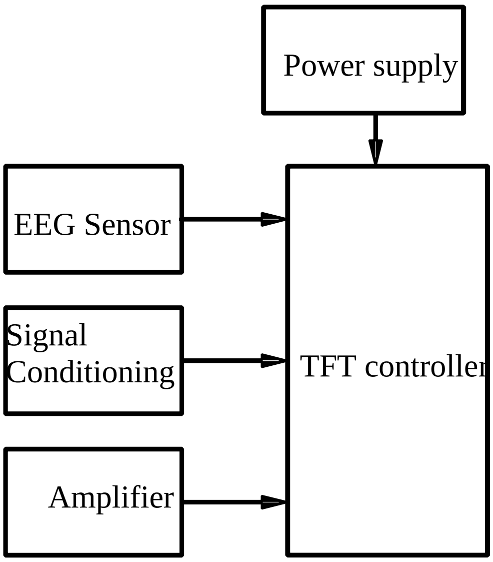

Figure 4.2: SENSORS ARCITECTURE

Power supply is used to supply the overall power to the sensors and TFT controller. An electroencephalogram (EEG) is a test used to evaluate the electrical activity in the brain. Brain cells communicate with each other through electrical impulses. Signal conditioning is a process of data acquisition, and an instrument called a signal conditioner is used to perform this process.

4.2.2 SERIAL COMMUNICATION SYSTEM & SENSORS MONITORING

In this Module, the communication takes place into Data Analytical and Cloud.

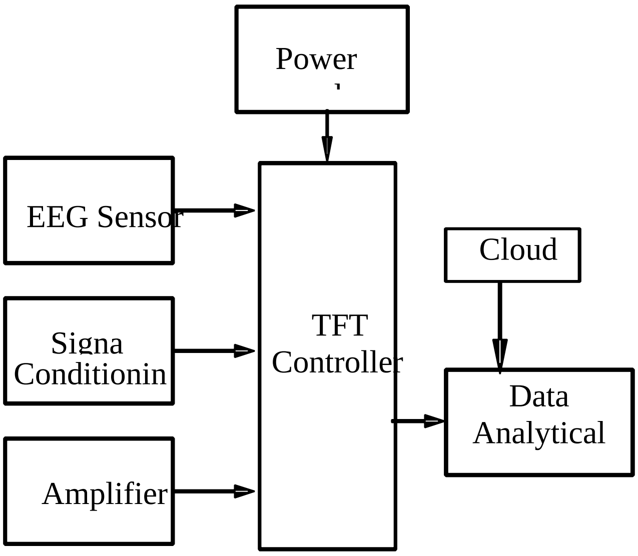

Figure 4.3: SERIAL COMMUNICATION SYSTEM & SENSORS MONITORING

4.2.3 SENDING MAIL & STORAGE

Computer has Dotnet application, which has Database. The Database is used to store the sensor values from the microcontroller. The Sensor values send to required mail using dotnet application.

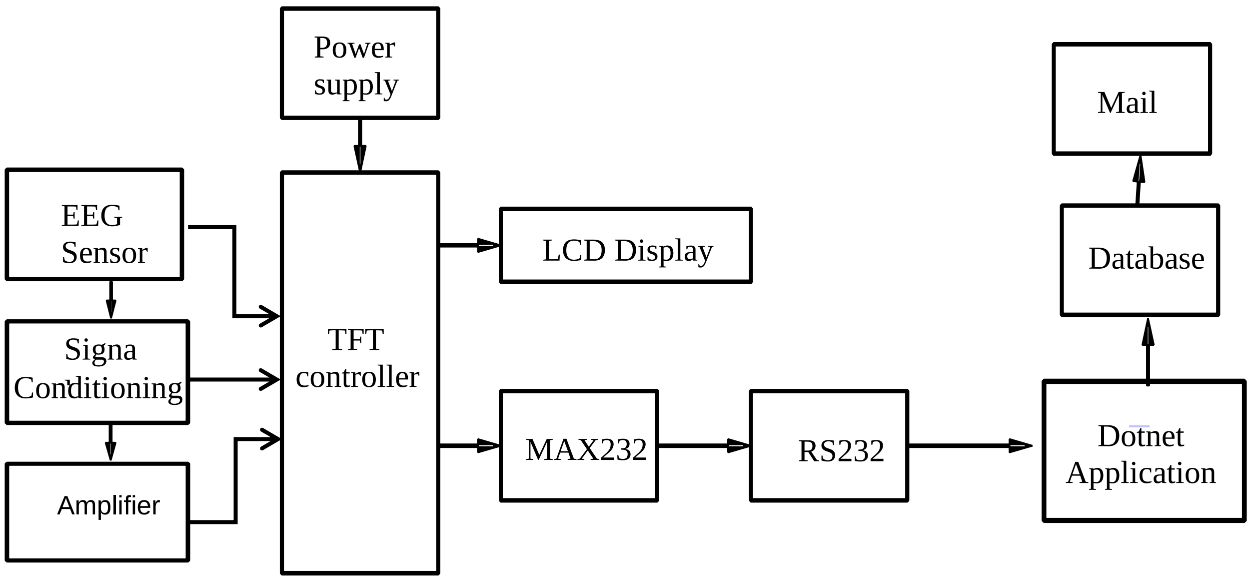

Figure 4.4 SENDING MAIL & STORAGE

5. HARDWARE REQUIREMENTS

5.1 EEG SENSOR

Electroencephalogram (EEG) sensors require conductive gel to ensure low-impedance electrical contact between the sensor and skin. The measured input-referred noise, over 1-100 Hz frequency range, is 2µvrms at 0.2mm sensor distance, and 17µvrms at 3.2mm distance. Experiments coupling the sensor to human scalp through hair and to chest through clothing produce clear EEG recorded Signals.

Figure 5.1.2: EEG SENSOR

Right leg electrode serves as the reference. The Arduino TFT screen is a backlit TFT LCD screen with a micro SD card slot in the back.

5.2 ARDUINO UNO

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases.

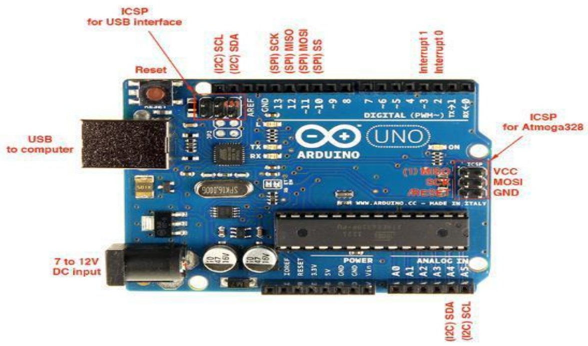

Figure 5.3: ARDUINO UNO BOARD

6. RESULTS AND IMPLEMENTATION

The manner of extension of the work presented in this report for development of future work is also presented. Here, firstly the EEG headset with sensor is connected to the microprocessor ARDUINO board and connected to the ESP8266 which is interconnected to the TFT Touchscreen.

Figure 6.1: DEVICE BEFORE ACTIVATION

The above figure shows the hardware kit of the project after connection and before activation. Firstly, the EEG headset sensors the EEG signal from the brain with the electrodes present in the headset and it checks whether it is alive or dead. After sensing, if the result comes it is normal, and then it will be displayed on the touch screen.

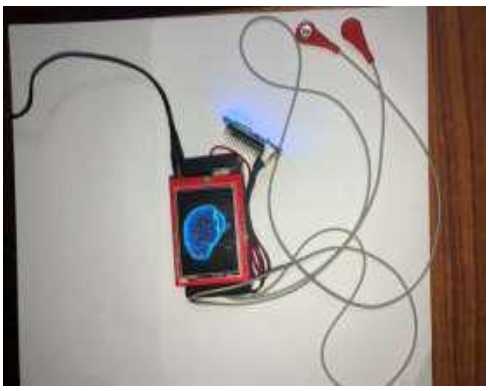

Figure 6.2: DEVICE AFTER ACTIVATION

The above figure shows the result after it gets activated and for few seconds it checks for the EEG signal. If we want in Software application, then we can check the status of the brain in ARDUINO IDE using the cable connected to hardware kit and the device is to be installed into the system/laptop in which Arduino software has been installed.

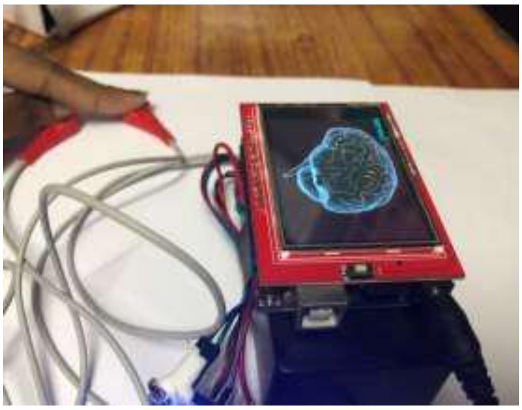

Figure 6.3: DEVICE WITH OUTPUT (NORMAL)

From the above figure, it is confirmed that after the EEG signal gets received, it checks for the state of the brain whether it is normal (alive).

Figure 6.4: DEVICE WITH OUTPUT (ABNORMAL/ BRAIN DEAD)

From the above figure, after getting the signal and checks for the status, if it is abnormal it shows the message on the touch panel as Brain dead.

7. CONCLUSION AND FUTURE ENHANCEMENT

7.1 CONCLUSION

We described a cloud-based system for performing large-scale brain connectivity analysis using Apache Accumulate and D4M. We demonstrated that our approach can achieve fast data query and extraction for graph analytics and visualization.

Indexing of sub volumes is simple and logical with geo hashing-based binary tree encoding, which supports a Google Map-like viewer with multiple zoom levels. There are many avenues for future work.

First, we would like to enhance the web GUI by making it more interactive and user friendly. Further, we intend to scale up to process much larger datasets (terabytes and above) with the goal of one day being able to perform such analysis on the human brain. We are currently exploring the use of Graphology to perform graph analytics directly inside accumulate. We are also exploring the use of a poly store database such as Big DAWG as a data viewer showing the original data and a zoomed-in view of 4 neighboring sub volumes extracted using binary tree encoding management solution that closely matches data sources with data management technology.

7.2 FUTURE ENHANCEMENT

At collecting the data from the sensors and updates it to the main server in the hospital. So, this process occurs irrespective of the presence of the doctor or the patient's relative beside the patient. The doctor can advise the patient to take any treatment by analyzing the patient's health condition. The medical evaluation process can be made easier by this project using IOT technology and the patient can live a carefree life.

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