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Brain Neural Network Controlled CAR - A Review

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ABSTRACT

The idea of having the power to control physical objects with your mind has been a fantasy of many people ever since, a car with an onboard computer that will interpret EEG (electroencephalography) readings from a headset worn by the user, and, depending on the type of brain activity detected, either move the car forward, backward, left, or right. Commercially available headsets make it possible for the field to broaden its view. This system is used in automotive sector for various actions in steering, throttling, vehicle maneuver and accident reporting.

1.INTRODUCTION

1.1 DEFINITION AND SCOPE

Control a car by interpreting signals sent from the human mind as well as facial expressions. Brain computer interface seems to be narrowly focused on the medical applications, but a much broader applicability of BCI exists than just medical uses. This project aims to expand into the realm of alternative uses for BCI by applying it to everyday activities. As more is understood about the brain and how it works, the more its power will want to be harnessed. Manipulating physical objects just by thinking is the ultimate goal for this area of interface. As a group of electrical and computer engineers the prospect of this is too enticing to pass up, therefore a mind-controlled car was the perfect choice. The ability to apply this project to people who no longer and move their arms and legs was also a driving factor, just byreplacing the remote for the car with the joystick.

This paper considers the development of a brain driven car, which would be of great help to the physically disabled people. Since these cars will rely only on what the individual is thinking they will hence not require any physical movement on the part of the individual. The car integrates signals from a variety of sensors like video, weather monitor, anti-collision etc. it also has an automatic navigation system in case of emergency. The car works on the asynchronous mechanism of artificial intelligence.

Scope: Automobiles, Aid for the disabled, Gadgets, Mental relaxation.

Figure 1 Brain Control Car Germany

1.2 IMPLEMENTATION IN AUTOMOBILE INDUSTRIES.

At the Freie University Berlin, Germany, Raul Rojas an AI professor have demonstrated how brain interface can drive an actual car. The project uses the Emotiv neuroheadset that feeds the commands received from the driver to the drive-by-wire system installed on the vehicle. The thoughts control the engine, breaks, and steering. While nifty the BrainDriver application is still a demonstration and not road worth because there is a two to three second delay in the response time. But the researchers say that future applications could be an autonomous cab ride, where a passenger could decide which route to take when more than one possibility exist.

The Vienna Convention on Road Traffic in 1968 states that:

•Every moving vehicle or combination of vehicles shall have a driver.

•Every driver shall at all times be able to control his vehicle.

Cars will not change from being driven by a human to being driven by a computer from one day to the other. These changes will be subtle; however, they have already begun. In the past, pressing the brake pedal in a car meant transferring the physical force to the brake shoes.The interface (brake - pedal) stayed the same, but the actual movement of the brake shoes changed to computer control. More advanced drive assistance systems like Adaptive Cruise Control (ACC) regulate the car's speed by regulating gas and brake. These new tech. cars will not need any driver actuation, but will actuate the vehicle control mechanism, i.e. the steering mechanism, throttle, brakes, sidelights, headlights, A.C., etc.The main aim is to study of a functioning car that will respond to a user's brain activity and react accordingly, interpreting signals sent from the human mind as well as facial expressions, which help humans to drive car without any physical control and Aid the disable persons.This system is used in automotive sector for various actions in steering, throttling, vehicle maneuver and accident reporting, and for various gadgets making our life easier.

2.BASIC OF BRAIN NEURAL NETWORK

2.1BRAIN NEURAL NETWORK

Neural Network is a series of interconnected neurons whose activation defines a recognizable linear pathway.

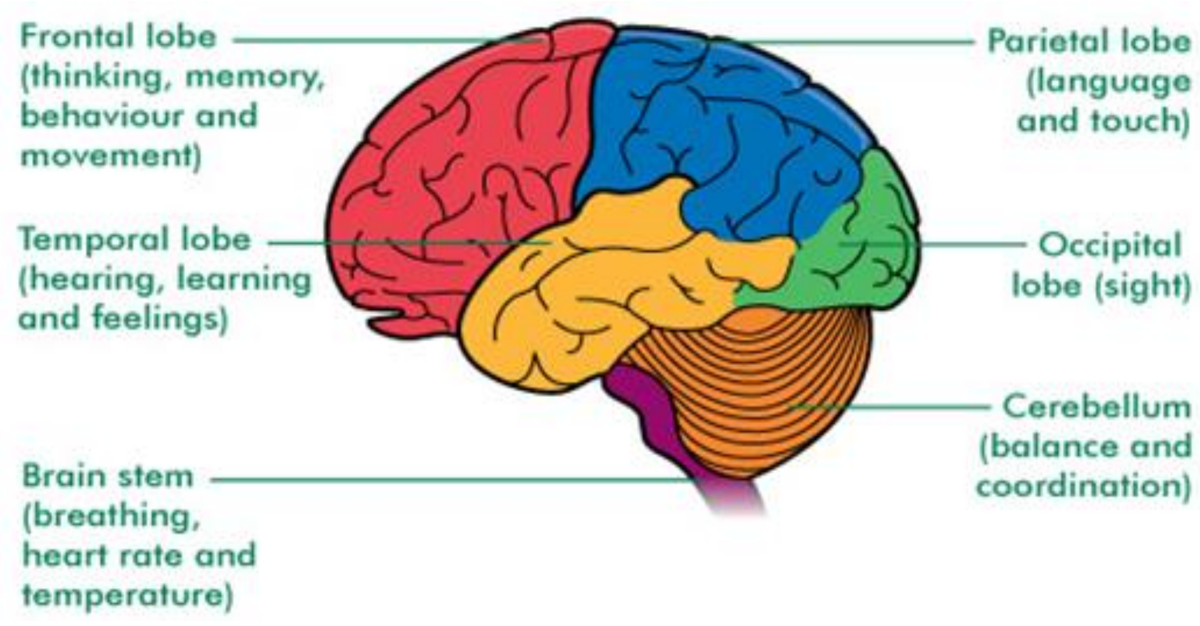

Figure 2 Brain Parts

The FRONTAL LOBE: Planning, Language, Expression and Speech contains the Motor cortex area involved in movements (movement, conscious thought, and controls voluntary movement of body parts),At the front of the brain are the frontal lobes, and the part lying just behind the forehead is called the prefrontal cortex. Often called the executive control center, these lobes deal with planning and thinking. They comprise the rational and executive control center of the brain, monitoring higher-order thinking, directing problem solving, and regulating the excesses of the emotional system.

PARIETAL LOBE: Touch, Taste contains the Somatosensory cortex areas (receives and processes sensory signals from the body) Near the top are the parietal lobes, which deal mainly with spatial orientation, calculation, and certain types of recognition.

OCCIPITAL LOBE visual area (contains the visual cortex) receives and processes signals from the retinas of the eyes, At the back are the paired occipital lobes, which are used almost exclusively for visual processing.

TEMPORAL LOBE: Language Reception. Above the ears rest the temporal lobes, which deal with sound, music, face and object recognition, and some parts of long-term memory. They also house the speech centers, although this is usually on the left side only.

CEREBELLUM: Balance and coordination. The cerebellum (Latin for "little brain") is a two-hemisphere structure located just below the rear part of the cerebrum, right behind the brain stem. The surface area of the entire cerebellum is about the same as that of one of the cerebral hemispheres.The cerebellum also is known to be involved in the mental rehearsal of motor tasks, which also can improve performance and make it more skilled. A person whose cerebellum is damaged slows down and simplifies movement, and would have difficulty with finely tuned motion, such as catching a ball or completing a handshake.

- Every time you think particular about one thing, a specific part of brain activates.
- As we know that brain works on electrical signal transmitting from one neurons to others.
- So, this electrical signal can be measured using some magnetic sensors.

2.2BRAIN WAVES

Brainwaves are detected using sensors placed on the scalp. They are divided into bandwidths to describe their functions (below) but are best thought of as a continuous spectrum of consciousness; from slow, loud and functional - to fast, subtle, and complex. It is a handy analogy to think of brainwaves as musical notes - the low frequency waves are like a deeply penetrating drum beat, while the higher frequency brainwaves are more like a subtle high-pitched flute. Like a symphony, the higher and lower frequencies link and cohere with each other through harmonics.

These waves that are produced from the volume communication between neurons can be classified into; Delta, Theta, Alpha, Beta, and Gamma waves. There are also Mu waves but for control car these are irrelevant. The table below describes the frequency of each wave and what state of mind each occurs at.

Table 1 Brain waves

Wave Type	Location	Frequency (Hz)	States of Mind
Delta	Frontal cortex	0 - 4 high amplitude	Asleep
Theta	Locations not related to task being preformed	4 - 8	Drowsiness, Idling, Arousal
Alpha	Posterior regions, either side of the brain	8 – 13	Relaxed, eyes are closed
Beta	Either sides of the brain but mostly in frontal region	13 – 30	Alert, working, anxious, busy
Gamma	Somatosensory cortex	30 – 100	Cross modal sensory processing

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3. DEVICE AND SENSORS

3.1 HEADSET

The Emotiv headset is the key to the entire system, being what obtains and transmits the neuro-signals. The EmotivTM EPOC is a high resolution, multi-channel, portable system which has been designed for practical research applications. License our Testbench™ software to receive raw EEG data from the Neuroheadset and our proprietary software toolkit that exposes our APIs and detection libraries: Mental Commands, Performance Metrics & Emotional States and Facial Expressions.This image represents the sensor locations as seen when looking down from above onto the user's head. Each circle represents one sensor and its approximate location when wearing the headset.

The EPOC headset has sixteen electrodes to measure the potential difference across the skull. However, there

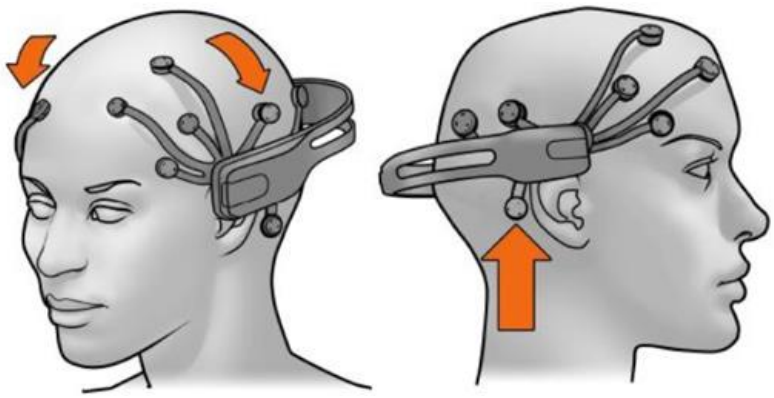

Figure 3 Headset

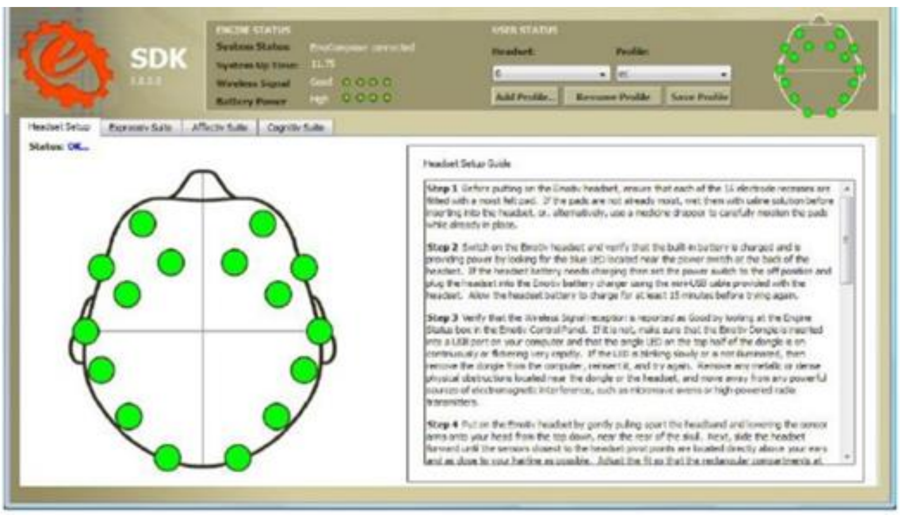

Figure 4 Sensor Map

is no official reference for the user wearing the headset so the electrodes are actually paired up, and the difference between a pair is used as the measured signal. Once the headset is connected via the wireless USB receiver the headset setup panel is displayed. The main function of this panel is to display the contact quality feedback for the neuroheadset's EEG sensors.

3.2 EYEBALL TRACKING

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As the eye moves, the cursor on the screen also moves and is also brightened when the driver concentrates on one particular point in his environment. The sensors, which are placed at the front and rear ends of the car, send a live feedback of the environment to the computer. The steering wheel is turned through a specific angle by electromechanical actuators. The angle of turn is calibrated from the distance moved by the dot on the screen.

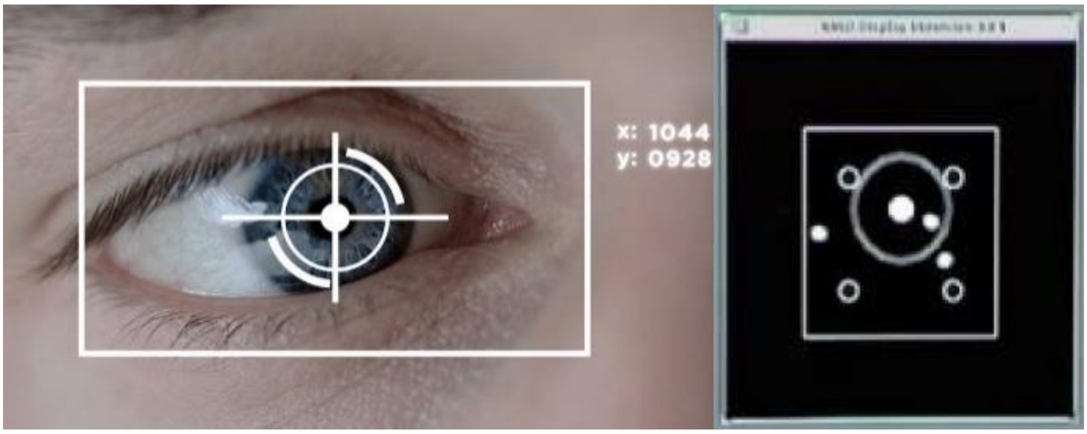

Figure 5 Eyeball Tracking

3.3 FACIAL RECOGNIZATION

This uses the signals measured by the Emotiv EPOC to interpret driver facial expressions in real-time. It provides a natural enhancement to interaction by providing computer more data for precision movement. Artificial intelligence can now respond to users naturally, in ways only humans have been able to until now. And also use for security purpose.

Figure 6 Facial Reorganization

3.4 CENTRAL PROCESSING UNIT

Central processing unit collect all information and do computation for output signal. One-board CPU is used to compute the data and link neural control with vehicle's motion control system. EEG (Electroencephalography) is essentially the recording of electrical activity across the scalp, measuring the voltage fluctuations resulting from ionic current flows within the brain. These ionic current flows are maintained by neurons which obtain their charge from membrane transport proteins that act as simple pumps transporting ions across the cells membrane. So, the way the headset picks up readings is that when one neuron releases a large number of ions, these ions can push against other neurons, which push against others and so on. This is known as volume communication, and when that wave reaches the electrodes on the EEG detector they can exert a force on the metal inside each electrode. This difference in pushing or pulling on the metal between two electrodes is recorded as the EEG reading.

3.5 DATA ACQUISITION SYSTEM

Software use for data acquisition is Emotive TestbenchTM.Real-time display of the Emotiv headset data stream, including EEG, contact quality, FFT, gyro (if fitted – custom option), wireless packet acquisition/loss display, marker events, headset battery level. Record and replay files in binary EEGLAB format. Define and insert timed markers into the data stream, including on-screen buttons and defined serial port events. Markers are stored in EEG data file. TestBench™ Collect following data from headset,

1. EEG display includes

•ALL or selected channels can be displayed

•Automatic or manual scaling (chart recorder mode)

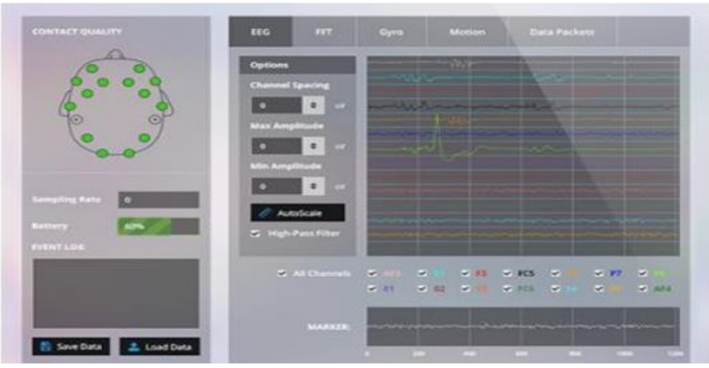

Figure 7 EEG Display

2. Gyro Display

•X and Y defection

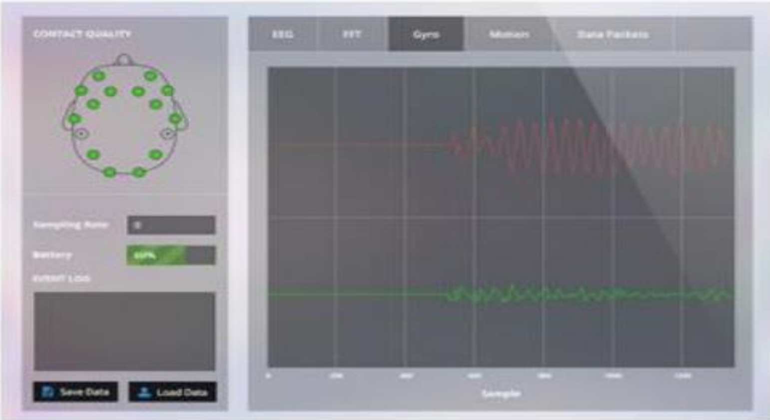

Figure 8 Gyro Display

• 5 second rolling time window (chart recorder mode)

4. SYSTEMS WORKING

Brain-computer interface is a direct communication pathway between the brain and an external electronic device. The goals of BCI are often directed at assisting or augmenting human cognitive or sensory motor functions. Recently neural interface devices have become available on the market for gaming and other virtual uses.

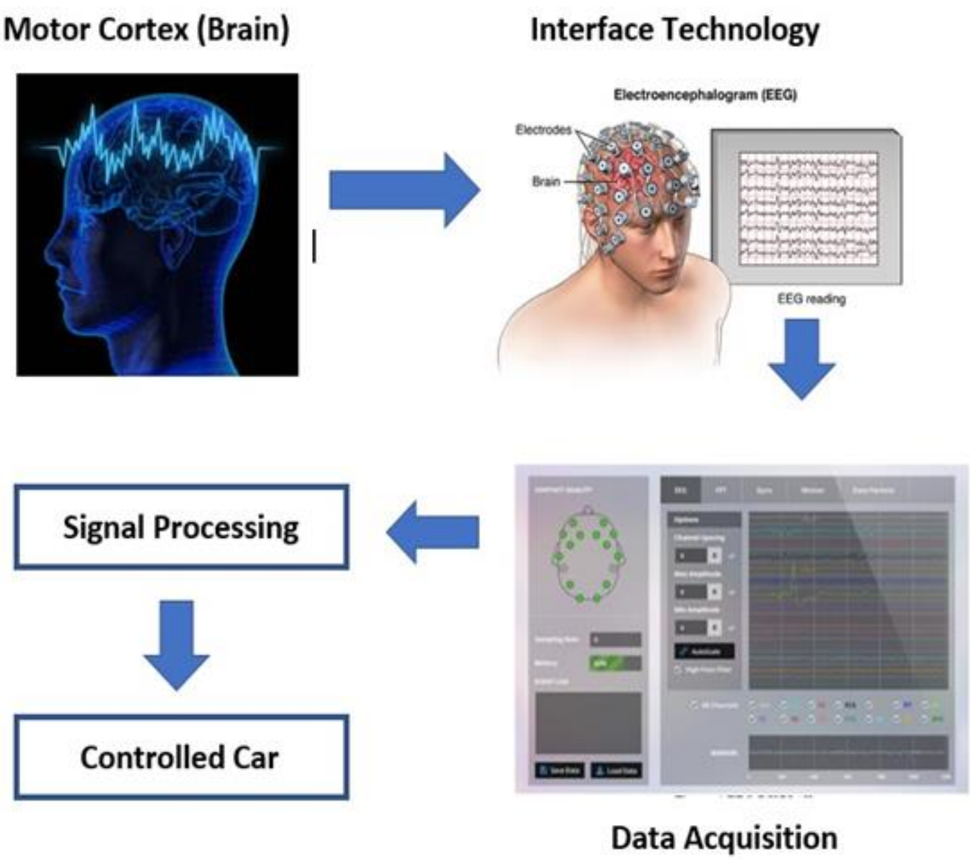

Figure 9 Block Diagram of working

The headset contains one sensor on the frontal lobe to collect multiple mental states. Record and replay files in binary EEGLAB format.Neurosky, a company who offers one of these headsets gathers raw EEG data to use with applications on iOS and Android platforms. As the company puts it "the physics of brain waves is virtually identical to the physics of sound waves where a single microphone can pick up the complexity of the concert." Another company who is in the same market is Emotiv, the headset this project utilizes. This headset contains 14 different sensors that are divided up into 7 pairs, which makes it better for reading the cognitive thoughts of a person.

The Emotiv EPOC EEG Neuroheadset has 14 saline felt based electrode sensor receivers. Each sensor is ideally mapped and conveniently placed in the 14 different areas and lobes of the brain for optimal measurements. All of these 14 lobes and areas are divided into specific regional areas each has different functional aspects. Their headset contains one sensor on the frontal lobe to collect multiple mental states The goals of BCI are often directed at assisting or augmenting human cognitive or sensory motor functions.

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5. VEHICLE CONTROL MODEL

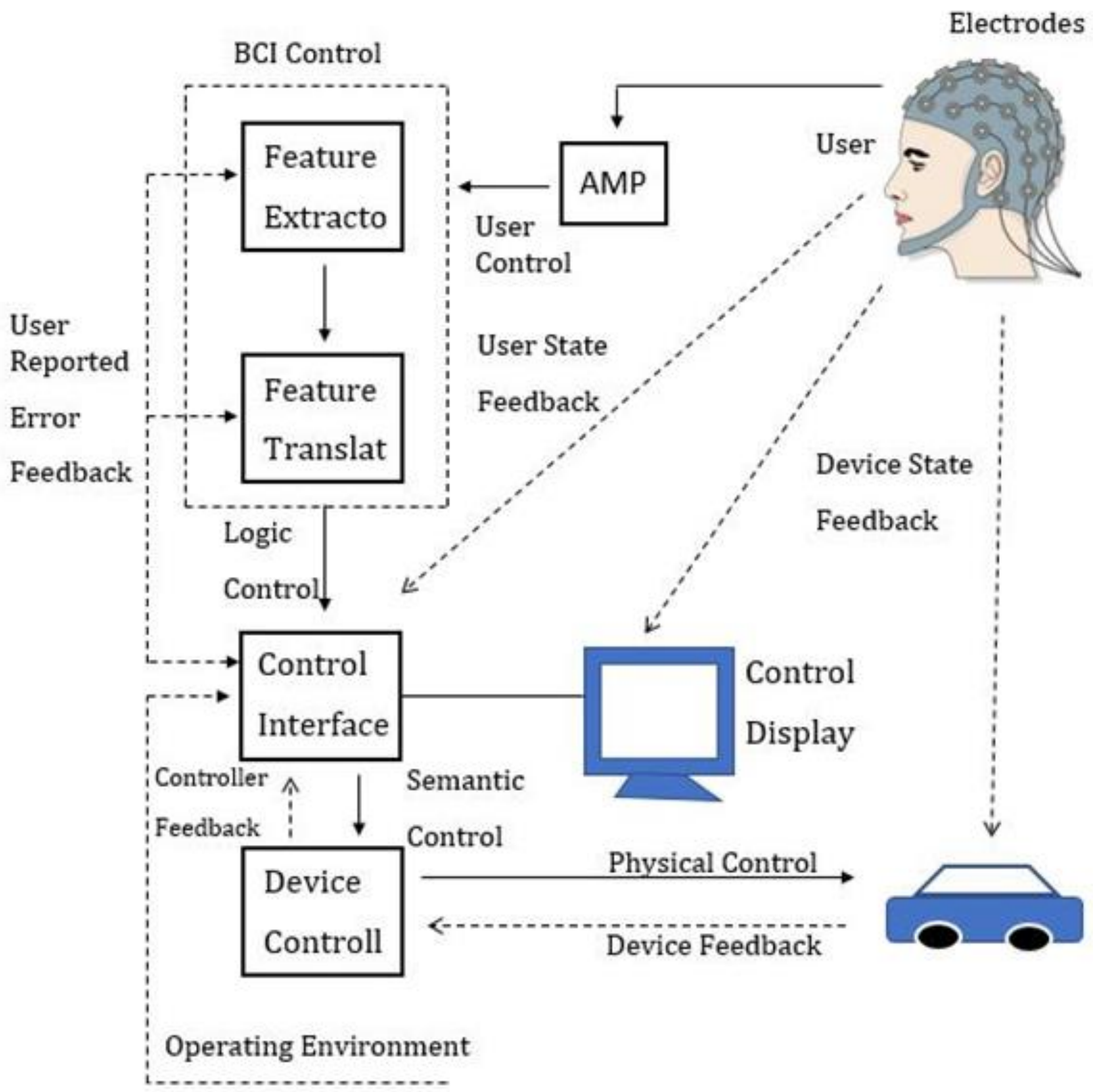

Figure 10 Vehicle control Model

The control panel uses a virtual CUBE to display an animated representation of the detection output. This cube is used to assist the user in visualizing the intended action during the training process. In order to enable the detection, each chosen action, plus the neutral action, must be trained. As the engine refines the signatures for each of the actions, detections become more precise and easier to perform. Emokey give output to vehicle to go right, left, forward, backward or stop. To convey these instructions from the motherboard to the Arduino board the Emokey program will be used action with a command. The figure below shows a preliminary mapping for the car. The commands forward, backward, left, and right are triggered by push, rotate right, wink left, and wink right respectively.

6. CONCLUSIONS

Thus, we can conclude the following results from the above synopsis that:

When the above requirements are satisfied and if this car becomes cost effective then we shall witness a revolutionary change in the society where the demarcation between the abler and the disabled vanishes. Thus, the integration of bioelectronics with automotive systems is essential to develop efficient and

- Useful technology if learnt to use and implement properly.
- It is still slower than our 2.4GHz mouse as it is a still younger technology. So, more research and implementation required as it reaction time is 3 to 2 secs, which is very slow for driving condition in urban areas.
- This Technology can be a very useful technology for the disabled, as the paralyzed people, having lost control over their body, still retain a full control over a car with use of their brain.
- Neuro-controlled headsets can prove useful in driving and perform actions directly from the brain and not via the limbs, and thus are speedy in response.
- They require minimal or no training for an average person and thus are readyto use whenever put on, even for first usage.
- They can thus also be used as an S.O.S device that signals nearby hospital, police station, as well as our home when in distress automatically in unwanted situations. They can also prove to be a useful safety tool for its users.

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