MANTECH Publications
Journal of Internet of Things and Information Technology
Volume 2, Issue 3, September-December, 2019

Real Time IOT Management by Mind Reading

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Abstract

The convergence of modern technologies (especially machine learning) have unleashed a new era in the field of computer science and BCI. It can provide a way for physically disabled people to use computers. But there are close to none ways by which a normal person can get hold of such systems with a limited budget. Our project is primarily focused on using an EEG headset which is available and affordable to a normal person (less than $100) to provide a solution by which users can control a computer interface by mere thinking. We use an EEG headset from Neurosky which costs about $99. The headset is normally used for keeping track of the mental calmness of a person (hobbyist purpose). We have tweaked the output from the headset and uses its single channel raw EEG data together with its other sensor data's (eSense datas) to provide the brain computer interface.

Keywords: *Mind Reading, EEG headset,*

INTRODUCTION

A brain–computer interface (BCI), sometimes called a mind machine interface (MMI), direct neural interface (DNI), or brain– machine interface (BMI), is a direct communication pathway between an enhanced or wired brain and an external device. BCIs are often directed at researching, mapping, assisting, augmenting, or repairing human cognitive or sensory-motor functions. Research on BCIs began in the 1970s at the University of California, Los Angeles (UCLA) under a grant from the National Science

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Foundation, followed by a contract from DARPA.

The field of BCI research and development has since focused primarily on neuroprosthetics applications that aim at restoring damaged hearing, sight and movement. Thanks to the remarkable cortical plasticity of the brain, signals from implanted prostheses can, after adaptation, be handled by the brain like natural sensor or effector channels. Following years of animal experimentation, the first neuroprosthetic devices implanted in humans appeared in the mid-1990s.

In This project, we use Neurosky. NeuroSky technology allows for low-cost EEG-linked research and products by using inexpensive dry sensors; older EEGs require the application of a conductive gel between the sensors and the head. The systems also include built-in electrical “noise” reduction software/hardware, and utilize embedded (chip level) solutions for signal processing. This Project uses Neurosky to control the movement of mouse pointer.

RELATED WORKS

The development of electroencephalography (EEG) technology can be traced back to the 1920’s, but it wasn’t until recently that we figured out a way to use neurofeedback to control electronic devices. Nowadays, we can use brain computer interfaces (BCI’s) to control everything from prosthetic limbs, to robotic arms, cars, and even things as simple as your computer’s cursor. In the past couple years, BCI technology has expanded in leaps and bounds. Not only are sensor technologies becoming more advanced, but companies like Emotive and NeuroSky are working to make BCI headsets more affordable and available to consumers. Software development kits are available for most major EEG headsets, which means developers everywhere can tinker with the technology and help to expand its uses.

A. Mindset

To give you a sense of chronology, we’ll take a step back and start with some of the earliest consumer applications of BCI. About five years ago, NeuroSky created the MindSet, the first affordable EEG headset. Up until this point, dry sensor technology wasn’t easily accessible or easy to use. It shipped with an early version of NeuroBoy, a game where you use thoughts to trigger telekinetic powers to manipulate objects and accomplish tasks. NeuroSky has since released a

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newer EEG headset called the MindWave, which despite looking newer, is essentially the same technology without headphones.

B. Mindflex

Back in 2009, NeuroSky partnered with Mattel to make Mind Flex — a game where players are tasked with moving a ball through an obstacle course using nothing more than their thoughts. The game was a huge commercial success, and surely helped to put NeuroSky on the map. Today the company's chips are used in a number of different EEG headsets, and they have rapidly growing app store filled with games from developers who have taken advantage of the company's free SDK.

C. Emotiv Epoc

About a year ago, Emotive released its own take on the EEG headset. Using an array of 14 different sensors and two 2 gyroscopes, it can pick up four different mental states, 13 conscious thoughts, a range of different facial expressions, and head movement in any direction. Like NeuroSky, it also has a software development kit — the only difference is that this one isn't free. Although we haven't used it first hand, its list of features suggests that it's the most advanced EEG headset available to consumers.

D. Swarm Extreme

With bikes, cars, and skateboards all covered, it seems that it was only a matter of time before someone took brainwave control to the skies. A couple students at Northeastern University College of Computer and Information Science have done just that, and built a program that allows them to fly the popular AR. Drone Parrot via BCI. With nothing more than their brainwaves, these guys can remotely control the flight path of one or multiple quadcopter drones. If this catches on, perhaps that the days of the boxy two-joystick controller with a long antenna will soon be behind us.

BACKGROUND INFORMATION

A. Electroencephalography

Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain. It is typically noninvasive, with the electrodes placed along the scalp, although invasive electrodes are sometimes used in specific applications. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain. In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity

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over a period of time, as recorded from multiple electrodes placed on the scalp. Diagnostic applications generally focus on the spectral content of EEG, that is, the type of neural oscillations (popularly called "brain waves") that can be observed in EEG signals. EEG is most often used to diagnose epilepsy, which causes abnormalities in EEG readings. It is also used to diagnose sleep disorders, coma, encephalopathies, and brain death. EEG used to be a first-line method of diagnosis for tumors, stroke and other focal brain disorders, but this use has decreased with the advent of high-resolution anatomical imaging techniques such as magnetic resonance imaging (MRI) and computed tomography (CT).

Despite limited spatial resolution, EEG continues to be a valuable tool for research and diagnosis, especially when millisecond-range temporal resolution (not possible with CT or MRI) is required. Derivatives of the EEG technique include evoked potentials (EP), which involves averaging the EEG activity time-locked to the presentation of a stimulus of some sort (visual, somatosensory, or auditory). Event-related potentials (ERPs) refer to averaged EEG responses that are time-locked to more complex processing of stimuli; this technique is used in cognitive science, cognitive psychology, and psycho physiological research.

In 1875, Richard Caton (1842–1926), a physician practicing in Liverpool, presented his findings about electrical phenomena of the exposed cerebral hemispheres of rabbits and monkeys in the British Medical Journal. In 1890, Polish physiologist Adolf Beck published an investigation of spontaneous electrical activity of the brain of rabbits and dogs that included rhythmic oscillations altered by light. Beck started experiments on the electrical brain activity of animals. Beck placed electrodes directly on the surface of brain to test for sensory stimulation. His observation of fluctuating brain activity lead to the conclusion of brain waves.In 1912, Ukrainian physiologist Vladimir Vladimirovich PravdichNeminsky published the first animal EEG and the evoked potential of the mammalian (dog).

In 1914, Napoleon Cybulski and Jelenska-Macieszyna photographed EEG recordings of experimentally induced seizures. German physiologist and psychiatrist Hans Berger (1873–1941) recorded the first human EEG in 1924. Expanding on work previously conducted on animals by Richard Caton and others, Berger also invented the electroencephalogram (giving

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the device its name), an invention described "as one of the most surprising, remarkable, and momentous developments in the history of clinical neurology". His discoveries were first confirmed by British scientists Edgar Douglas Adrian and B. H. C. Matthews in 1934 and developed by them.

In 1934, Fisher and Lowenback first demonstrated epileptiform spikes. In 1935 Gibbs, Davis and Lennox described interictal spike waves and the three cycles/s pattern of clinical absence seizures, which began the field of clinical electroencephalography. Subsequently, in 1936 Gibbs and Jasper reported the interictal spike as the focal signature of epilepsy. The same year, the first EEG laboratory opened at Massachusetts General Hospital. Franklin Offner (1911–1999), professor of biophysics at Northwestern University developed a prototype of the EEG that incorporated a piezoelectric inkwriter called a Crystograph (the whole device was typically known as the Offner Dynograph). In 1947, The American EEG Society was founded and the first International EEG congress was held. In 1953 Aserinsky and Kleitman described REM sleep. In the 1950s, William Grey Walter developed an adjunct to EEG called EEG topography, which allowed for the mapping of electrical activity across the surface of the brain. This enjoyed a brief period of popularity in the 1980s and seemed especially promising for psychiatry. It was never accepted by neurologists and remains primarily a research tool.

A few paralyzed patients could soon be using a wireless brain-computer interface able to stream their thought commands as quickly as a home Internet connection. A wireless brain interface uses the head-worn transmitter, shown. After more than a decade of engineering work, researchers at Brown University and a Utah company, Blackrock Microsystems, have commercialized a wireless device that can be attached to a person's skull and transmit via radio thought commands collected from a brain implant. Blackrock says it will seek clearance for the system from the U.S. Food and Drug Administration, so that the mental remote control can be tested in volunteers, possibly as soon as this year. The device was developed by a consortium, called BrainGate, which is based at Brown and was among the first to place implants in 3 the brains of paralyzed people and show that electrical signals emitted by neurons inside the cortex could be recorded, then

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used to steer a wheelchair or direct a robotic arm (see “Implanting Hope”). A major limit to these provocative experiments has been that patients can only use the prosthetic with the help of a crew of laboratory assistants. The brain signals are collected through a cable screwed into a port on their skull, then fed along wires to a bulky rack of signal processors. “Using this in the home setting is inconceivable or impractical when you are tethered to a bunch of electronics,” says Arto Nurmikko, the Brown professor of engineering who led the design and fabrication of the wireless system. The new interface does away with much of that wiring by processing brain data inside a device about the size of an automobile gas cap. It is attached to the skull and wired to electrodes inside the brain. Inside the device is a processor to amplify the faint electrical spikes emitted by neurons, circuits to digitize the information, and a radio to beam it a distance of a few meters to a receiver.

There, the information is available as a control signal; say to move a cursor across a computer screen. The device transmits data out of the brain at rate of 48 megabits per second, about as fast as a residential Internet connection, says Nurmikko. It uses about 30 milliwatts of power—a fraction of what a smartphone uses—and is powered by a battery. Scientists have prototyped wireless brain-computer interfaces before, and some simpler transmitters have been sold for animal research. “But there’s just no such thing as a device that has this many inputs and spits out megabits and megabits of data. It’s fundamentally a new kind of device,” says Cindy Chestek, an assistant professor of biomedical engineering at the University of Michigan. Although the implant can transmit the equivalent of about 200 DVDs’ worth of data a day, that’s not much information compared to what the brain generates in executing even the simplest movement. Of the billions of neurons in the human cortex, scientists have never directly measured more than 200 or so simultaneously. “You and I are using our brains as petabyte machines,” says Nurmikko. “By that standard, 100 megabits per second is going to look very modest.” Blackrock has begun selling the wireless processor, which it calls “Cereplex-W” and costs about $15,000, to research labs that study primates. Tests in humans could happen quickly, says Florian Solzbacher, a University of Utah professor who is the owner and president of Blackrock. The Brown scientists have plans to try it on paralyzed patients, but haven’t yet done so. Currently, a half

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dozen or so paralyzed people, including some in the late stages of ALS, are taking part in BrainGate trials using the older technology.

In those studies, underway in Boston and California, the implant that makes contact with the brain is a small array of needle-like electrodes carved from silicon. Also sold by Blackrock, it is commonly called the Utah array. To establish a brain-machine interface, that array is pushed into the tissue of the cerebral motor cortex, where its tips record the firing patterns from 100 neurons or more at once. Those tiny blasts of electricity, scientists have found, can be decoded into a fairly precise readout of what movement an animal, or a person, is intending. Decoding those signals has permitted hundreds of monkeys, as well as a growing number of paralyzed volunteers, to control a computer mouse, or manipulate objects with a robotic arm, sometimes with surprising dexterity (see “The Thought Experiment”).

But the Brain Gate technology will never turn into actual medicine until it’s greatly simplified and made more reliable. The head-mounted wireless module is a step toward that goal. Eventually, scientists say, all the electronics will have to be implanted completely inside the body, with no wires reaching through the skin, since that can lead to infections. Last year, the Brown researchers reported testing a prototype of a fully implanted interface, with the electronics housed inside a titanium can that can be sealed under the scalp. That device is not yet commercialized.

B. Delta Wave

Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain. It is typically noninvasive, with the electrodes placed along the scalp, although invasive electrodes are sometimes used in specific applications. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain.

"Delta waves" were first described in the 1930s by W. Grey Walter, who improved upon Dr. Hans Berger's electroencephalograph machine (EEG) to detect alpha and delta waves. Delta waves can be quantified using Quantitative electroencephalography using freely available toolboxes, such as, EEGLAB or the Neurophysiological Biomarker Toolbox (NBT). Delta waves, like all brain waves, can be detected by electroencephalography (EEG). Delta

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waves were originally defined as having a frequency between 1-4 Hz, although more recent classifications put the boundaries at between 0.5 and 2 Hz. They are the slowest and highest amplitude classically described brainwaves, although recent studies have described slower (<0. Hz) oscillations. Delta waves begin to appear in stage 3 sleep, but by stage 4 nearly all spectral activity is dominated by delta waves. Stage 3 sleep is defined as having less than 50% delta wave activity, while stage 4 sleep has more than 50% delta wave activity. These stages have recently been combined and are now collectively referred to as stage N3 slow-wave sleep. During N3 SWS, delta waves account for 20% or more of the EEG record during this stage. Delta waves occur in all mammals, and potentially all animals as well. Delta waves are often associated with another EEG phenomenon, the K-complex. K-Complexes have been shown to immediately precede delta waves in slow wave sleep. Delta waves have also been classified according to the location of the activity into frontal (FIRDA), temporal (TIRDA), and occipital (OIRDA) intermittent delta activity.

C. Theta Wave

Theta waves generate the theta rhythm, a neural oscillatory pattern in electroencephalography (EEG) signals, recorded either from inside the brain or from electrodes glued to the scalp. Two types of theta rhythm have been described. The 4 "hippocampal theta rhythm" is a strong oscillation that can be observed in the hippocampus and other brain structures in numerous species of mammals including rodents, rabbits, dogs, cats, bats, and marsupials. "Cortical theta rhythms" are lowfrequency components of scalp EEG, usually recorded from humans. Theta rhythms can be quantified using Quantitative electroencephalography (qEEG) using freely available toolboxes, such as, EEGLAB or the Neurophysiological Biomarker Toolbox (NBT). In rats, the most frequently studied species, theta wave rhythmicity is easily observed in the hippocampus, but can also be detected in numerous other cortical and subcortical brain structures. Hippocampal theta waves, with a frequency range of 6–10 Hz, appears when a rat is engaged in active motor behavior such as walking or exploratory sniffing, and also during REM sleep. Theta waves with a lower frequency range, usually around 6–7 Hz, are sometimes observed when a rat is motionless but alert. When a rat is eating, grooming, or sleeping, the hippocampal EEG usually shows a non-rhythmic pattern known as Large irregular activity

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or LIA. The hippocampal theta rhythm depends critically on projections from the medial septal area, which in turn receives input from the hypothalamus and several brainstem areas. Hippocampal theta rhythms in other species differ in some respects from those in rats. In cats and rabbits, the frequency range is lower (around 4–6 Hz), and theta is less strongly associated with movement than in rats. In bats, theta appears in short bursts associated with echolocation. In humans, hippocampal theta rhythm has been observed and linked to memory formationand navigation. The function of the hippocampal theta rhythm is not clearly understood. Green and Arduini, in the first major study of this phenomenon, noted that hippocampal theta usually occurs together with desynchronized EEG in the neocortex, and proposed that it is related to arousal. Vanderwolf and his colleagues, noting the strong relationship between theta and motor behavior, have argued that it is related to sensorimotor processing. Another school, led by John O'Keefe, have suggested that theta is part of the mechanism animals use to keep track of their location within the environment. Another theory links the theta rhythm to mechanisms of learning and memory (Hasselmo, 2005). These different theories have since been combined, as it has been shown that the firing patterns can support both navigation and memory[4] Cortical theta rhythms observed in human scalp EEG are a different phenomenon, with no clear relationship to the hippocampus. In human EEG studies, the term theta refers to frequency components in the 4– 7 Hz range, regardless of their source. Cortical theta is observed frequently in young children. In older children and adults, it tends to appear during meditative, drowsy, hypnotic or sleeping states, but not during the deepest stages of sleep. Several types of brain pathology can give rise to abnormally strong or persistent cortical theta waves. Although there were a few earlier hints, the first clear description of regular slow oscillations in the hippocampal EEG came from a paper written in German by Jung and Kornmüller (1938). They were not able to follow up on these initial observations, and it was not until 1954 that further information became available, in a very thorough study by John D. Green and Arnaldo Arduini that mapped out the basic properties of hippocampal oscillations in cats, rabbits, and monkeys (Green and Arduini, 1954). Their findings provoked widespread interest, in part because they related hippocampal activity to arousal, which was at that time the hottest topic in

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neuroscience. Green and Arduini described an inverse relationship between hippocampal and cortical activity patterns, with hippocampal rhythmicity occurring alongside desynchronized activity in the cortex, whereas an irregular hippocampal activity pattern was correlated with the appearance of large slow waves in the cortical EEG. Over the following decade came an outpouring of experiments examining the pharmacology and physiology of theta. By 1965, Charles Stumpf was able to write a lengthy review of "Drug action on the electrical activity of the hippocampus" citing hundreds of publications (Stumpf, 1965), and in 1964 John Green, who served as the leader of the field during this period, was able to write an extensive and detailed review of hippocampal electrophysiology (Green, 1964). A major contribution came from a group of investigators working in Vienna, including Stumpf and Wolfgang Petsche, who established the critical role of the medial septum in controlling hippocampal electrical activity, and worked out some of the pathways by which it exerts its influence.

D. Alpha Waves

Alpha waves are neural oscillations in the frequency range of 7.5–12.5 Hz arising from synchronous and coherent (in phase or constructive) electrical activity of thalamic pacemaker cells in humans. They are also called Berger's wave in memory of the founder of EEG. Alpha waves are one type of brain waves detected either by electroencephalography (EEG) or magnetoencephalography (MEG) and predominantly originate from the occipital lobe during wakeful relaxation with closed eyes. Alpha waves are reduced with open eyes, drowsiness and sleep. Historically, they were thought to represent the activity of the visual cortex in an idle state.

More recent papers have argued that they inhibit areas of the cortex not in use, or alternatively that they play an active role in network coordination and communication. Occipital alpha waves during periods of eyes closed are the strongest EEG brain signals. Alpha waves can be quantified using Quantitative electroencephalography using freely available toolboxes, such as, EEGLAB or the Neurophysiological Biomarker Toolbox. An alpha-like variant called mu (μ) can be found over the motor cortex (central scalp) that is reduced with movement, or the intention to move. Alpha waves seem not to appear until three years of age.

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Alpha waves were discovered by German neurologist Hans Berger, most famous for his invention of the EEG. Alpha waves were among the first waves documented by Berger, along with beta waves, and he displayed an interest in "alpha blockage", the process by which alpha waves decrease and beta waves increase upon a subject opening their eyes. This distinction earned the alpha wave the alternate title of "Berger's 5 Wave". Berger took a cue from Ukrainian physiologist Pravdich-Neminski, who used a string galvanometer to create a photograph of the electrical activity of a dog's brain.

Using similar techniques, Berger confirmed the existence of electrical activity in the human brain. He first did this by presenting a stimulus to hospital patients with skull damage and measuring the electrical activity in their brains. Later he ceased the stimulus method and began measuring the natural rhythmic electrical cycles in the brain. The first natural rhythm he documented was what would become known as the alpha wave. Berger was very thorough and meticulous in his data gathering, but despite his brilliance, he did not feel confident enough to publish his discoveries until at least five years after he had made them. In 1929, he published his first findings on alpha waves in the journal Archiv für Psychiatrie. He was originally met with derision for his EEG technique and his subsequent alpha and brain wave discoveries.

His technique and findings did not gain widespread acceptance in the psychological community until 1937, when he gained the approval of the famous physiologist Lord Adrian, who took a particular interest in alpha waves. Alpha waves again gained recognition in the early 1960s and 1970s with the creation of a biofeedback theory relating to brain waves (see below). Such biofeedback, referred to as a kind of neuro feedback, relating to alpha waves is the conscious elicitation of alpha brainwaves by a subject. Two different researchers in the United States explored this concept through unrelated experiments. Dr. Joe Kamiya, of the University of Chicago, discovered that some individuals had the conscious ability to recognize when they were creating alpha waves, and could increase their alpha activity. These individuals were motivated through a reward system from Kamiya.

The second progenitor of biofeedback is Dr. Barry Sherman, from the University of California, Los Angeles. He was working with monitoring brain waves in cats and

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found that, when the cats were trained to withhold motor movement, they released SMR, or mu, waves, a wave similar to alpha waves. Using a reward system, he further trained these cats to enter this state more easily. Later, he was approached by the United States Air Force to test the effects of a jet fuel that was known to cause seizures in humans. Sterman tested the effects of this fuel on the previously-trained cats, and discovered that they had a higher resistance to seizures than non-trained cats. Alpha wave biofeedback has gained interest for having some successes in humans for seizure suppression and for treatment of depression.

Some researchers posit that there are at least two forms of alpha waves, which may have different functions in the wakesleep cycle. Alpha waves are present at different stages of the wake-sleep cycle. The most widely researched is during the relaxed mental state, where the subject is at rest with eyes closed, but is not tired or asleep. This alpha activity is centered in the occipital lobe, and is presumed to originate there, although there has been recent speculation that it instead has a thalamic origin. This wave begins appearing at around four months, and is initially a frequency of 4 waves per second. The mature alpha wave, at 10 waves per second, is firmly established by age 3.

The second occurrence of alpha wave activity is during REM sleep. As opposed to the awake form of alpha activity, this form is located in a frontal-central location in the brain.

The purpose of alpha activity during REM sleep has yet to be fully understood. Currently, there are arguments that alpha patterns are a normal part of REM sleep, and for the notion that it indicates a semi-arousal period. It has been suggested that this alpha activity is inversely related to REM sleep pressure. It has long been believed that alpha waves indicate a wakeful period during sleep.[citation needed] This has been attributed to studies where subjects report non-refreshing sleep and have EEG records reporting high levels of alpha intrusion into sleep. This occurrence is known as alpha wave intrusion. However, it is possible that these explanations may be misleading, as they only focus on alpha waves being generated from the occipital lobe.

E. Beta Waves

Beta wave, or beta rhythm, is the term used to designate the frequency range of human brain activity between 12.5 and 30

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Hz (12.5 to 30 transitions or cycles per second). Beta waves can be split into three sections: Low Beta Waves (12.5–16 Hz, "Beta 1 power"); Beta Waves (16.5–20 Hz, "Beta 2 power"); and High Beta Waves (20.5–28 Hz, "Beta 3 power"). Beta states are the states associated with normal waking consciousness.

Beta waves were discovered and named by the German psychiatrist Hans Berger, who invented electroencephalography (EEG) in 1924 as a method of recording electrical brain activity from the human scalp. Berger termed the larger amplitude, slower frequency waves that appeared over the posterior scalp when the subject's eye were closed alpha waves. The smaller amplitude, faster frequency waves that replaced alpha waves when the subject opened his or her eyes were then termed beta waves.

Low amplitude beta waves with multiple and varying frequencies are often associated with active, busy or anxious thinking and active concentration. Over the motor cortex beta waves are associated with the muscle contractions that happen in isotonic movements and are suppressed prior to and during movement changes. Bursts of beta activity are associated with a strengthening of sensory feedback in static motor control and reduced when there is movement change. Beta activity is increased when movement has to be resisted or voluntarily suppressed. The artificial induction of increased beta waves over the motor cortex by a form of electrical stimulation called Transcranial alternating-current stimulation consistent with its link to isotonic contraction produces a slowing of motor movements.

F. Gamma Waves

A gamma wave is a pattern of neural oscillation in humans with a frequency between 25 and 100 Hz,though 40 Hz is typical. According to a popular theory, gamma waves may be implicated in creating the unity of conscious perception (the 6 binding problem). However, there is no agreement on the theory; as a researcher suggests: Whether or not gamma wave activity is related to subjective awareness is a very difficult question which cannot be answered with certainty at the present time although invasive electrodes are sometimes used in specific applications. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain.

Gamma waves were initially ignored before the development of digital electroencephalography as analog

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electroencephalography is restricted to recording and measuring rhythms that are usually less than 25 Hz.One of the earliest reports on them was in 1964 using recordings of the electrical activity of electrodes implanted in the visual cortex of awake monkeys.

THE PROPOSED SYSTEM

The main idea of the current work is to use a wireless EEG headset such as the one designed by NeuroSky as a remote control for the mouse cursor of personal computers and the computer applications.

A. EEG Data

The PhysioNetEEG dataset [25] is used in this work. It consists of more than 20 one or two minutes-duration EEG records obtained from 10 healthy subjects. Subjects were asked to execute and imagine different tasks while 64 channels of EEG signals were recorded from the electrode that were fitted along the scalp. In the records of the dataset that are related to the current research, each subject performed the following tasks:

• One-minute baseline run with eyes open.

• One-minute baseline run with eyes closed.

B. Bluetooth Interface

The NeuroSky natively supports Bluetooth communications. All the data recorded are sent through it’s Bluetooth interface. After initial pairing the data is sent seamlessly. As all the device now support Bluetooth the proposed system can be used with minor modification in the any mobile device. The primary and only objective of this interface connection and sharing of data.

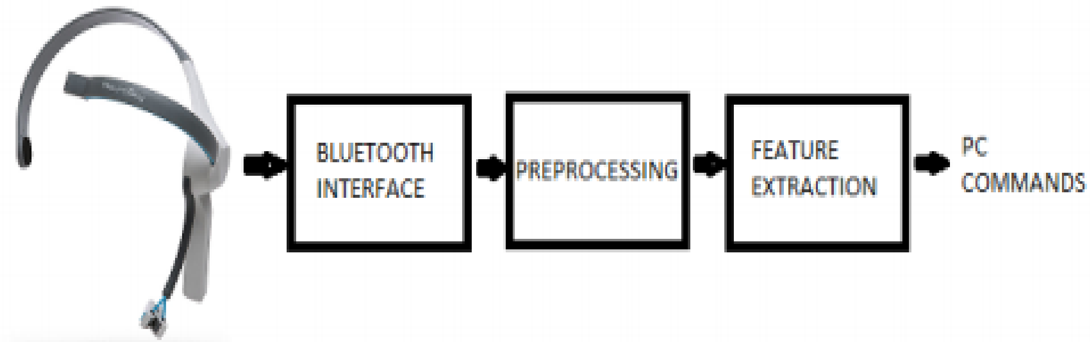

Fig. 1 A block diagram for the suggested system

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C. Preprocessing

The data received from Neurosky headset is analyzed and required information like attention level, blink strength are modulated and converted into a format which can be used within our desktop app.

D. Feature Extraction

The preprocessed data from the Neurosky headset is used by desktop application and feature like blink strength and attention level are used for performing different mouse movements.

E. PC Commands

We have set the desktop application to identify blinking frequency and blink strength. Different ways in which you can communicate through our system are:

• Blink once to select

• Blink twice in 3 seconds to double click.

• Blink once can rotate our response circle

• Once the response circle is activated blink again to select the direction

• Once direction is selected the cursor moves along tha direction till the user blinks again.

ACKNOWLEDGEMENT

God, we thank you for all the blessing bestowed upon us during course of this project. This Project is funded by CERD. Our entire department especially HOD Dr Surekha Mariam Varghese was very supportive and our guide Prof Eldo P Elias helped with all our doubt. We thank all of them for their help and support.

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