

# A General Purpose Brain Computer Interface Technology

Harshitha.B.S<sup>1</sup>, Maithra.S.T<sup>2</sup>, Mamatha.T.S<sup>3</sup>, Dr K.S Jagadeesh Gowda<sup>4</sup>

U.G. Student, Department of Computer science & Engineering, Sri Krishna Institute of Technology, Bangalore, India <sup>12</sup>

Assistant Professor, Department of Computer science & Engineering, Sri Krishna Institute of Technology,  
Bangalore, India <sup>3</sup>

Professor, Department of Computer science & Engineering, Sri Krishna Institute of Technology,  
Bangalore, India <sup>4</sup>

**ABSTRACT:** 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 flexibility 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.

**KEYWORDS:** Brain computer interface, virtual reality, internet of things, unity, sensor motor rhythms

## I. INTRODUCTION

Brain-computer interfaces (BCIs) are devices that display and decode brain interest and create control signals to govern virtual or physical items. With the arrival of commercial-grade virtual reality (VR) devices, graphical processing units (GPUs), the internet of things (IOT), and advanced robotics, that outside application can without problems be a videogame, healing virtual revel in, or home devices including espresso pots and televisions. customers can have interaction with both the physical and digital world and to any tool with get right of entry to internet, through BCIs. BCI research and devices are normally utilized in each healthful and scientific populations. even as healthy individuals can utilize BCI for recreational programs, disabled individuals can use BCI for rehabilitation or assistive gadgets. those people with a motor impairment would specially locate IOT packages useful internal their personal domestic via being able to control their private gadgets. Likewise, having BCI generation that blessings the wholesome populace ought to generate public interest within the subject to develop it further. Good sized advances in the underlying neurophysiologic studies has been attained in the beyond several years and we are able to now harness that to construct complementary applications.

By appearing an imagined act consisting of the opening/final of a hand, dorsiflexion of the foot, or protrusion/retraction of the tongue we will report fluctuations inside the sensor motor cortex. In conventional BCI research users are given a particular undertaking utilizing one, or numerous, of the neurological manage strategies. numerous examples of BCI correctly using those signals encompass controlling drones, robotic arms, virtual avatars, video games, and wheelchairs. A crucial issue of the BCI feedback mechanism is the visible stimulus furnished to the user to give them an illustration in their development at some point of the project. This kind of feedback offered to the person might also alter their overall performance on a given BCI mission. Many advances have been made from each a neuro scientific and an engineering angle with regards to BCI, however little has been carried out from a human-device interaction point of view. If BCI performance is project-dependent and the mission presented to the person does no longer

encourage or incentivize them to perform well, there is room for development. A device is needed that users can create not most effective devices and programs that offer healing blessings and enhancements inside the fine of existence, however programs that humans are without problems the usage of long term. with the aid of combining a sport engine for content material introduction, various application programming interfaces (APIs) for the control of outside IOT devices, and digital/augmented truth libraries for immersive experiences, users can create the next era of smooth-to-use BCI applications for each studies and personal use. Brain computer interfaces (BCIs) have enabled individuals to manipulate gadgets including spellers, robot hands, drones, and wheelchairs, but frequently those BCI packages are confined to research laboratories. With the arrival of digital reality (VR) structures and the internet of things (IOT) we can couple these technology to offer real-time control of a person's digital and bodily surroundings. Likewise, BCI applications are regularly unmarried-use with user's having no manipulate outside of the regulations located upon the programs on the time of advent. therefore, there is a need to create a device that lets in customers the flexibility to create and modularize elements of BCI applications for manage of IOT gadgets and VR environments. the use of a popular video game engine, team spirit, and coupling it with BCI2000, we are able to create numerous programs that give the cease-consumer extra autonomy for the duration of the venture handy.

## II. RELATED WORK

Christopher G. Coogan et al has carried out a work on brain-computer interface manipulate in a digital truth surroundings. in keeping with this studies brain-computer interfaces (BCIs)[1] have enabled people to control gadgets inclusive of spellers, robot arms, drones, and wheelchairs, but frequently these BCI applications are confined to investigate laboratories. With the arrival of digital truth systems and the net of factors we can couple those technology to provide real-time manipulate of a person's virtual and physical environment. Likewise, BCI programs are often single-use with consumer's having no manipulate outdoor of the restrictions placed upon the applications on the time of creation. therefore, there's a need to create a device that allows users the ability to create and modularize components of BCI programs for control of IOT gadgets and VR environments. the usage of a famous video game engine, harmony, and coupling it with BCI2000, we will create diverse packages that give the end-consumer extra autonomy for the duration of the challenge handy.

Sunil Kalagi et al has proposed a piece on mind laptop Interface structures the usage of Non-Invasive Electroencephalogram sign. in line with this systems based on brain pc Interface (BCI) have been developed from the past three decades for supporting locked-in country sufferers. Researchers throughout the globe are growing new strategies to boom the BCI accuracy. The wide variety of experimental measurements of mind hobby has been finished using human manipulate instructions. the primary characteristic of BCI is to transform and transmit human intentions into suitable movement commands for the wheelchairs, robots, gadgets, and so on. BCI allows improving the great of life of disabled patients and allowing them to engage with their surroundings. since the BCI indicators are non-desk bound, the primary demanding situations within the non-invasive BCI machine are to as it should be stumble on and classify the indicators. This paper reviews the state of art of BCI and techniques used for function extraction and type the use of electroencephalogram (EEG) and highlight the need of model idea.

The electroencephalogram (EEG)[2] represents the electrical pastime of the mind recorded with the aid of setting numerous electrodes at the scalp. A brain computer interface (BCI), additionally called a brain mind interface (BMI), is a hardware and software communications device that allows humans to have interaction with their surroundings, without the involvement of peripheral nerves and muscular tissues, by the use of control indicators generated from electroencephalographic interest.

Dr. E. GraceMaryKanaga et al has executed a research on Experimental Investigations on Classifiers for mind laptop Interface. in step with this brain sign based totally authentication system is surprisingly new while as compared to different forms of biometric statistics. This paper is primarily based on brain-laptop Interface technique using Electroencephalography (EEG) signals to authenticate a machine for paralyzed humans. Brain computer interface (BCI) is an instantaneous communication among pc(s) and the human brain. it's far a machine that allows the external tool manage by the use of the alerts measured from the mind. BCI measures brain pastime and by the manner, those exclusive brain indicators are translated into manipulate alerts. An electroencephalograph (EEG)[3] might read the ones mind waves the use of non-invasive electrodes that document the alerts. The precise styles can be used as a password or biometric identity. whilst we carry out intellectual duties like picturing a shape or acting an event, our mind generates precise neuronal electric indicators. people are asked to carry out a few events for precise period and their signals are

obtained. these received indicators are pre-processed, and the vital time area and frequency area capabilities are extracted and given to the classifiers for training. these categorized alerts are used for authentication reason.

even as textual passwords are the most typically used approach for consumer authentication in pc systems, the usage of textual passwords for consumer identity has several 9aaf3f374c58e8c9dcdd1ebf10256fa5 boundaries: passwords have low entropy in exercise are regularly difficult to recall, and are liable to "shoulder surfing", or remark by way of nearby 0.33 parties.

Melody M. Moore et al has proposed a piece on actual-international packages for mind-computer Interface era. according to this most of the present BCI programs were designed largely for schooling and demonstration functions. Our aim is to investigate approaches of transitioning BCI manage abilities learned in education to real-international scenarios. Our research explores some of the problems and demanding situations of combining BCI outputs with human-pc interface paradigms so that you can acquire most desirable interplay. We make use of a spread of application domain names to examine and validate BCI interactions[4], including communicate, environmental manage, neural prosthetics, and innovative expression. The intention of this research is to improve great of existence for people with extreme disabilities. the general purpose of the GSU BrainLab is to determine which paradigms of human-laptop interplay are most efficient for direct manipulate of a computer using brain signals. We goal to provide a substantial first-class-of-existence improvement to users with extreme disabilities as well as reading ways to make use of BCIs for capable-bodied users.

The BrainLab presently has ongoing initiatives in several BCI and assistive-era areas: person interface manage paradigms, problem schooling and biofeedback, innovative expression, and satisfactory-of-life applications such as assistive communicate and environmental manage. The goal of this studies is to explore the field human-laptop interactions and to pick out possibilities for exchange paradigms of navigating a laptop display the usage of mind indicators, in addition to traditional 2-D spatial navigation (together with cursor movement managed via a mouse). One option for increasing accuracy and decreasing mistakes is logical manage, that is motion between targets induced by way of a discrete manipulate sign. We carried out logical manage with alerts from a neurotrophic-electrode that were implanted within the cortex of a patient.

GerwinSchalk et al has accomplished a piece on A fashionable-purpose brain computer Interface (BCI) machine. consistent with this Many laboratories have began to develop brain computer interface (BCI) systems that provide verbal exchange and manipulate talents to people with intense motor disabilities. similarly development and awareness of practical applications depends on systematic opinions and comparisons of various brain signals, recording methods, processing algorithms, output formats, and operating protocols. but, the typical BCI gadget is designed especially for one specific BCI method and is, consequently, now not acceptable to the systematic research which might be vital for persisted progress. In response to this trouble, we've advanced a documented fashionable-reason BCI studies and development platform referred to as BCI2000[5]. BCI2000 can comprise by myself or in aggregate any mind indicators, signal processing techniques, output gadgets, and running protocols. This record is meant to describe to investigators, biomedical engineers, and computer scientists the standards that the BCI2000 system is primarily based upon and offers examples of successful BCI implementations the use of this machine. so far, we've used BCI2000 to create BCI systems for a diffusion of brain signals, processing strategies, and applications. Han Yuan et al has proposed a piece on mind-pc Interfaces the use of Sensorimotor Rhythms. Many research during the last decades have proven that human beings can use brain signals to carry their cause to a laptop the use of brain-computer interfaces(BCIs). BCI systems extract specific functions of brain interest and translate them into control alerts that power an output. recently, a category of BCIs that are built at the rhythmic pastime recorded over the sensorimotor cortex, i.e., the sensorimotor rhythm (SMR), has attracted massive interest most of the BCIs that use non-invasive neural recordings, e.g., electroencephalography (EEG), and feature validated the capability of multidimensional prosthesis control. Brain computer interface (BCI), provides a brand new output channel for mind signals to communicate or manipulate outside devices without the usage of neuromuscular pathways. A BCI recognizes the intent of the person through electrophysiological or other alerts of the brain. In real time, neural recordings are used to decode on going interest and translate in to output commands that accomplish the desire of the user.

### III. TECHNICAL OVERVIEW

Brain Computer interfaces (BCIs) are gadgets that display and decode brain hobby and create manage alerts to control digital or bodily items. With the arrival of industrial-grade virtual reality (VR) gadgets, graphical processing units

(GPUs), the internet of things (IOT), and advanced robotics, that outside software can effortlessly be a videogame, healing digital experience, or home gadgets along with espresso pots and televisions. customers can interact with both the bodily and digital world and to any tool with get admission to the net, thru BCIs. BCI research and gadgets are generally utilized in both wholesome and scientific populations. even as healthful individuals can utilize BCI for leisure programs, disabled individuals can use BCI for rehabilitation or assistive devices. the ones people with a motor impairment would specially find IoT packages beneficial interior their very own domestic by being able to manage their private devices.

**Electroencephalography**

There are various techniques of recording neurophysiological signals, every having their pros and cons. For healthful topics the most customarily used neural sign acquisition device would be the electroencephalogram (EEG). The benefits of using EEG is that it's far non-invasive, has incredible temporal decision, and is more value effective. then again, electrocardiography (ECG) operate very similarly to EEG except that the electrodes are placed at once onto the cortical floor. This increases the overall signal to noise (SNR) ratio and permits higher frequencies to be recorded, but also calls for surgical implantation and is therefore most effective to be had to the medical populace. There are a couple of categories of neurological manage strategies that may be integrated into mind laptop interfaces including sensorimotor rhythms (SMR), steady-state visible evoked potentials (SSVEP), and the P300 evoked response, all of which might be without problems discernable using an EEG. SMR alerts are elicited thru the act of motor imagination (MI). with the aid of appearing an imagined act which includes the hole/closing of a hand, dorsiflexion of the foot, or protrusion/retraction of the tongue we will file fluctuations within the sensorimotor cortex. in the case of MI of the hand, an occasion related desynchronization synchronization may be seen at the contra/ipsilateral cortex within the frequency band of eight-thirteen Hz. A essential factor of the BCI comments mechanism is the visible stimulus furnished to the consumer to give them an illustration in their development at some stage in the venture.

**Unity**

Unity is one of the most popular recreation engines, with over 700 million users, and is used mainly to create video video games for numerous structures along with cellular gadgets, net browsers, pcs and Macs. aside from game creation, currently solidarity is being applied to create videos, educational fabric, and neuroscientific programs. Except being beneficial in traditional display screen primarily based online game layout, local virtual and augmented truth guide had been brought to communicate with numerous VR hardware gadgets. moreover, it makes use of C as a dynamic scripting language for manage of its various belongings. Regarding routing the signals from BCI2000 into solidarity, the scripting element permits us to create user datagram protocol (UDP) community connections to examine and write facts streams. Likewise, we can take the indicators we receive from BCI2000 and port them to different IoT devices related to a neighborhood or far off network.

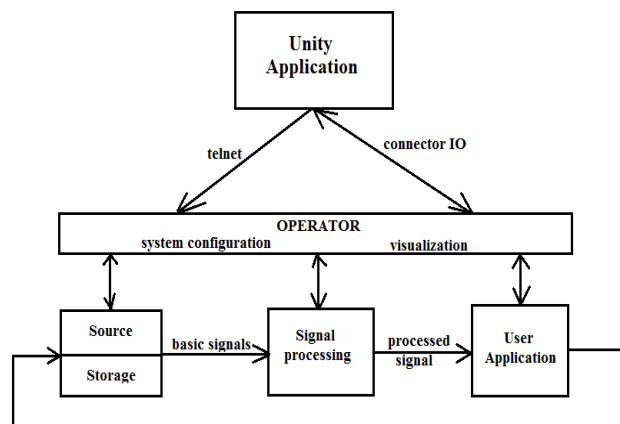


Fig.1 Unity Integration

As referred to inside the preceding section concerning the telnet connection at the operator layer, whilst the unity software is properly configured it'll open BCI2000's operator module and will pass in a consumer-defined argument on what IP/port to connect to. those connections remain open at some stage in the length of the experiment and permit cohesion to pass statistics into the operator module including which sign supply and processing modules to apply, as well as diverse parameters. of BCI2000's parameters which can be important for the usage of a third celebration utility layer are the Connector enter cope with and Connector Output deal with, which takes as an argument an additional IP cope with and port variety. by setting those arguments to a specific IP/port combination, studying and writing country variable values to and from BCI2000 for use by the signal processing module can be finished.

**BCI2000**

Signals from each EEG and ECG devices may be recorded, analysed, and utilized the use of a famous software program bundle, BCI2000. BCI2000 allows for the purchase of neural recordings from a wide-variety of 3rd birthday celebration systems, formatting and sending that uncooked statistics to pre-built or custom sign processing modules, growing a manipulate signal primarily based upon the signal used and the software to be sent to, and finally, the introduction of an application to be offered to the end-consumer. because of the modular nature of BCI2000 each module connects to each different via a network protocol. Upon initialization of every module an IP cope with and port variety are assigned and records can be passed backward and forward. local BCI2000 use allows an experimenter to pass commands to the Operator module via command line arguments, shell scripting, batch documents, or a graphical user interface (GUI). in the historical past, a telnet connection is created, which users make use of by using writing instructions without delay to the operator module. those instructions decide the community parameters, flags to run a couple of BCI2000 instances, wherein to course specific alerts, and specify variables to be created and triggered all through unique obligations within the application layer.

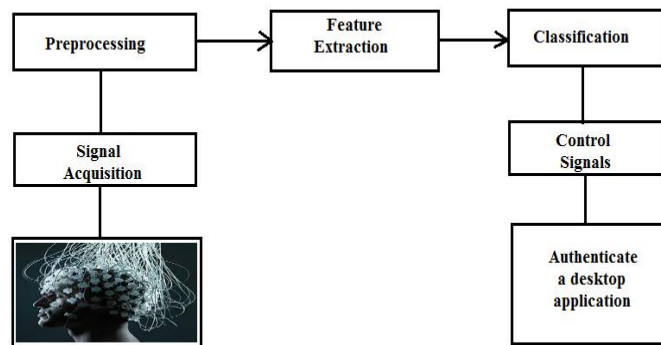


Fig 3 Framework For BCI Based Authentication System

To begin strolling an experiment in BCI2000, the user inputs parameters into the operator layer as a chain of commands. those inputs decide what form of sign acquisition device is to be used, what filtering pipeline, and what application the user will interact with, together with concern-particular parameters along with subject and undertaking facts. The supply module is responsible for speaking with the purchase hardware. The sign processing module gets the output from the supply module and creates a control sign to ship to the software layer primarily based upon the filter and task.

Due to BCI2000's modularity of additives, supplanting the underlying utility layer simplest requires forwarding signals into an external software, in our case, Unity3D. whilst BCI2000 is a essential tool for BCI research, its software layer is on the whole designed for experimental use in laboratory settings. As for visible remarks it's often suited for display on a computer reveal with simple pix. By having third birthday party graphical software program communicate and complement the native BCI2000 modules, we gain the capability to create lots more tricky and complex BCI packages, much like how BCPy2000 uses numerous python scripts to speak with BCI2000.



#### IV.RESULT ANALYSIS

As may be seen performing MI-primarily based BCI obligations in VR does no longer affect one's potential to perform the venture. throughout each studies and 31 subjects assessed, suggest differences have been no longer visible among groups, indicating 1) sign transmission from BCI2000 to harmony and back once more did no longer introduce any great latency, and a couple of) that users completed no worse while in an immersive, digital truth, BCI test, indicating that that the immersion effect of a digital surroundings does now not hinder performance.

even as not statistically good sized, an thrilling trend which can offer extra records. There seems to be an growth in overall performance even as switching from the manipulate stimulus to the VR stimulus within the group that has already had some experience with the SMR-primarily based BCI assignment within the beyond. over again, switching from the control stimulus to the VR stimulus shows a similar growth in performance, no longer visible in both observe 1 and have a look at 2's individuals going from a VR to a manipulate stimulus. whilst not giant, it seems to be consistent at some point of both research.

Even as this software layer has been constructed for use with BCI2000, there are no technical limitations as to why it couldn't be used together with different BCI systems because the analyzing and writing of information is carried out using easy TCP/UDP communication. Likewise, instance scenes encompass guide for the Philips Hue and Roku API, but there are not any technical boundaries to amplify beyond this as they handiest require HTTP requests.

#### V. CONCLUSION

By using broadly available software program applications and network calls it's miles viable to route BCI manage alerts into numerous applications together with sport engines, virtual reality gadgets, and private domestic gadgets. these gadgets can be controlled, and environments traversed, the usage of a mixture of BCI control and physical enter. This significantly expands the capability for creating complex BCI packages and growing a fashionable to speak with virtual and outside items/devices. The work presented right here describes the creation, implementation, and evaluation of a team spirit recreation engine based totally software layer for BCI2000.. If user's want to build their personal BCI applications, or construct upon posted templates, an smooth interface permits them the freedom to edit every individual element from the visual stimuli to the manipulate indicators of interest.

we're trying to do an offline evaluation on BCI based Authentication gadget the use of EEG signals inside the place that calls for high safety and extensively utilized for paralyzed persons to authenticate a desktop software. The advantages of this device over a few of the present authentication technologies include changeability, shoulder-browsing resistance, and safety in opposition to robbery and user non-compliance. If the recording and processing of mind signals may be correct and repeatable, this technique might come to be a possible and beneficial form of authentication. the important thing to transferring BCI generation beyond the demonstration degree is to determine which techniques of interaction are the best and to comprise these into actual-international applications. all the programs and interaction strategies defined had been tested with mind-sign emulation and offline facts, that's sufficient for assuring accurate functionality but no longer enough to attract conclusions approximately the efficacy of the person interface paradigms.

#### REFERENCES

- [1]Christopher G. Coogan et al, "mind-computer interface manipulate in a digital fact surroundings and programs for the internet of factors IEEE 2018.
- [2] Sunil Kalagi et al, "mind laptop Interface structures the usage of NonInvasive Electroencephalogram signal: A Literature overview", IEEE 2017.
- [3] Dr. E. Grace Mary Kanaga et al, "An Experimental Investigations on Classifiers for mind laptop Interface (BCI) based Authentication", IEEE 2015.
- [4] Melody M. Moore et al, "actual-global applications for brain-pc Interface generation", IEEE 2013.
- [5] GerwinSchalk et al, "BCI2000: A popular-reason brain-computer Interface (BCI) device", IEEE 2014.
- [6] Han Yuan et al, "mind-laptop Interfaces using Sensorimotor Rhythms: current kingdom and future perspectives", IEEE 2016.