**“BRAIN GATE”**

**A**

**Seminar Report**

***Submitted***

**In Department of** **Computer Science &**

**Engineering**

**Bachelor of Technology**

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**Submitted To:**  **Submitted By:**

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**ABSTRACT**

The mind-to-movement system that allows a quadriplegic man to control a computer using only his thoughts is a scientific milestone. It was reached, in large part, through the brain gate system. This system has become a boon to the paralyzed. Brain Gate is a brain implant system developed by the bio-tech company Cyber kinetics in 2003 in conjunction with the Department of Neuroscience at Brown University. The device was designed to help those who have lost control of their limbs, or other bodily functions, such as patients with spinal cord injury. The computer chip, which is implanted into the brain monitors brain activity in the patient and converts the intention of the user into computer commands. Cyber kinetics describes that "such applications may include novel communications interfaces for motor impaired patients, as well as the monitoring and treatment of certain diseases which manifest themselves in patterns of brain activity, such as epilepsy and depression.

" Currently the chip uses 100 hair-thin electrodes that sense the electro-magnetic signature of neurons firing in specific areas of the brain, for example, the area that controls arm movement. The activities are translated into electrically charged signals and are then sent and decoded using a program, which can move either a robotic arm or a computer cursor. According to the Cyber kinetics' website, three patients have been implanted with the Brain Gate system. The company has confirmed that one patient (Matt Nagle ) has a spinal cord injury, while another has advanced ALS. Brain Gate pathway to control a computer with thought, just as individuals who have the ability to move their hands, use a mouse.

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10. **INTRODUCTION**
    1. **BRAIN GATE**

Brain Gate was developed by the bio-tech company Cyberkinetics in 2003 in Conjunction with

the department of Neuroscience Brown University.

The device was designed to help those who have lost control of their limbs or other body

function. The computer chip which is implanted into the brain, monitors brain activity in the

patient and convert the intension of the user into computer hands. Currently the chip used 100

hair-thin electrodes that hear neurons firing in specific area of the brain. For e.g.: the area that

control the arm movement .the activity is translated into eclectically charged signals and are

then set and decoded using a program thus moving the arm. According to the Cyberkinetics

website, 2 patients have been implanted with the Brain Gate.

The Brain Gate System is based on Cyber kinetics" platform technologies to sense, transmit,

analyze and apply the language of neurons. The System consists of a sensor that is implanted

on the motor cortex of the brain and a device that analyzes brain signals. The principle of

operation behind the Brain Gate System is that with intact brain function, brain signals are

generated even though they are not sent to the arms, hands and legs. The signals are

interpreted and translated into cursor movements, offering the user an alternate "Brain Gate

pathway" to control a computer with thought, just as individuals who have the ability to move

their hands use a mouse.

The 'Brain Gate' contains tiny spikes that will extend down about one millemetre into the brain

after being implanted beneath the skull,monitoring the activity from a small group of neurons.It

will now be possible for a patient with spinal cord injury to produce brain signals that relay the

intention of moving the paralyzed limbs,as signals to an implanted sensor,which is then output

as electronic impulses. These impulses enable the user to operate mechanical devices with the

help of a computer cursor.

* 1. **BRAIN**

The brain is the center of the nervous system in all vertebrate and most invertebrate animals—

only a few invertebrates such as sponges, jellyfish, adult sea squirts and starfish do not have

one, even if diffuse neural tissue is present. It is located in the head, usually close to the

primary sensory organs for such senses as vision, hearing, balance, taste, and smell. The brain

of a vertebrate is the most complex organ of its body. In a typical human the cerebral cortex

(the largest part) is estimated to contain 15–33 billion neurons,[1] each connected by synapses

to several thousand other neurons. These neurons communicate with one another by means of

long protoplasmic fibers called axons, which carry trains of signal pulses called action potentials

to distant parts of the brain or body targeting specific recipient cells.

Physiologically, the function of the brain is to exert centralized control over the other organs of

the body. The brain acts on the rest of the body both by generating patterns of muscle activity

and by driving secretion of chemicals called hormones. This centralized control allows rapid and

coordinated responses to changes in the environment. Some basic types of responsiveness such

as reflexes can be mediated by the spinal cord or peripheral ganglia, but sophisticated

purposeful control of behavior based on complex sensory input requires the informationintegrating

capabilities of a centralized brain.



**FIGURE 1.1 FIGURE 1.2**

1. **BLOCK DIAGRAM AND ITS EXPLAINATION**
   1. **BLOCK DIAGRAM**

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**FIGURE 2.1**

****

**FIGURE 2.2**

* 1. **BLOCK DIAGRAM DESCRIPTION**

**NEUROPROSTHETIC DEVICE:**

A neuroprosthetic device known as Braingate converts brain activity into computer commands.

A sensor is implanted on the brain, and electrodes are hooked up to wires that travel to a

pedestal on the scalp. From there, a fiber optic cable carries the brain activity data to a nearby

computer.

**PRINCIPLE:**

"The principle of operation of the BrainGate Neural Interface System is that with intact brain

function, neural signals are generated even though they are not sent to the arms, hands and

legs. These signals are interpreted by the System and a cursor is shown to the user on a

computer screen that provides an alternate "BrainGate pathway". The user can use that cursor

to control the computer, Just as a mouse is used.”

BrainGate is a brain implant system developed by the bio-tech company Cyberkinetics in 2003

in conjunction with the Department of Neuroscience at Brown University. The device was

designed to help those who have lost control of their limbs, or other bodily functions, such as

patients with amyotrophic lateral sclerosis (ALS) or spinal cord injury. The computer chip, which

is implanted into the patient and converts the intention of the user into computer commands.

The system consists of a sensor that is Implanted on the motor cortex of the brain (Pedestal)

and a Brain Gate Neural Interface Device that analyzes the brain signal. The principle is that the

intact brain functions, brain signals are generated even though they are not sent to the arms,

hands and legs. The signals are interpreted and translated into cursor movements, offering the

user an alternate ”BRAIN GATE PATHWAY” to control a computer with thought, just as

individuals who have the ability to move their hands.

1. **BRAIN CONTROL MOTOR FUNCTION**
   1. **How does the brain control motor function**?

The brain is "hardwired" with connections, which are made by billions of neurons that make

electricity whenever they are stimulated. The electrical patterns are called brain waves.

Neurons act like the wires and gates in a computer, gathering and transmitting electrochemical

signals over distances as far as several feet. The brain encodes information not by relying on

single neurons, but by spreading it across large populations of neurons, and by rapidly adapting

to new circumstances.

Motor neurons carry signals from the central nervous system to the muscles, skin and

glands of the body, while sensory neurons carry signals from those outer parts of the body to

the central nervous system. Receptors sense things like chemicals, light, and sound and encode

this information into electrochemical signals transmitted by the sensory neurons. And

interneurons tie everything together by connecting the various neurons within the brain and

spinal cord. The part of the brain that controls motor skills is located at the ear of the frontal

lobe.

How does this communication happen? Muscles in the body's limbs contain

embedded sensors called muscle spindles that measure the length and speed of the muscles as

they stretch and contract as you move. They're just not being sent to the arms, hands and

legs.A technique called neurofeedback uses connecting sensors on the scalp to translate brain

waves into information a person can learn from. The sensors register different frequencies of

the signals produced in the brain. These changes in brain wave patterns indicate whether

someone is concentrating or suppressing his impulses, or whether he is relaxed or tense.

1. **HARDWARE COMPONENTS AND SOFTWARE TOOLS**
   1. **HARDWARE COMPONENTS USED:**

THE CHIP

THE CONNECTOR

THE CONVERTER AND

THE COMPUTER

* + 1. **THE CHIP:**

A 4-millimeter square silicon chip studded with 100 hair-thin, microelectrodes is embedded in

brain primary motor cortex.

The chip, about the size of a baby aspirin, contains 100 electrode sensors, each thinner than a

human hair. The sensors detect tiny electrical signals generated when a user imagines, for

example, that he's moving the cursor, its manufacturer says.



**FIGURE 4.1**

Though paralyzed, a quadriplegic still has the ability to generate such signals -- they just don't

get past the damaged portion of the spinal cord. With BrainGate, the signals instead travel

through a wire that comes out of the skull and connects to a computer, Cybernetics says.

BrainGate uses technology similar to cochlear implants that help deaf people hear and deepbrain

simulators that treat Parkinson's disease. Those devices cost $15,000 to $25,000.

BrainGate will be "at least that expensive, and perhaps more," Surgenor said.

* + 1. **THE CONNECTOR:**

It is attached firmly to the skull of the patient and it passes the signals received by the chip to

the converter.

Most handicapped people are satisfied if they can get a rudimentary connection to the

outside world. BrainGate enables them to achieve far more than that. By controlling the

computer cursor, patients can access Internet information, TV entertainment, and control lights

and appliances – with just their thoughts.

And as this amazing technology advances, researchers believe it could enable brain

signals to bypass damaged nerve tissues and restore mobility to paralyzed limbs. "The goal of

BrainGate is to develop a fast, reliable, and unobtrusive connection between the brain of a

severely disabled person and a personal computer” said Cyberkinetics President Tim Surgenor.

BrainGate may sound like science fiction, but its not. The device is smaller than a dime

and contains 100 wires smaller than human hairs which connect with the portion of the brain

that controls motor activity. The wires detect when neurons are fired and sends those signals

through a tiny connector mounted on the skull to a computer.



**FIGURE 4.2**

* + 1. **THE CONVERTER:**

The signal travels to a shoebox-sized amplifier where it's converted to Digital data and bounced

by fiber-optic cable to a computer.



**FIGURE 4.3**

* + 1. **THE COMPUTER:**

Brain Gate learns to associate patterns of brain activity with particular imagined movements -

up, down, left, right - and to connect those movements to a cursor.

A brain-computer interface uses electrophysiological signals to control remote devices. Most

current BCIs are not invasive. They consist of electrodes applied to the scalp of an individual or

worn in an electrode cap such as the one shown in 1-1 (Left). These electrodes pick up the

brainâ„¢s electrical activity (at the microvolt level) and carry it into amplifiers such as the ones

shown in 1-1 (Right). These amplifiers amplify the signal approximately ten thousand times and

then pass the signal via an analog to digital converter to a computer for processing. The

computer processes the EEG signal and uses it in order to accomplish tasks such as

communication and environmental control. BCIs are slow in comparison with normal human

actions, because of the complexity and noisiness of the signals used, as well as the time

necessary to complete recognition and signal processing.

The phrase brain-computer interface (BCI) when taken literally means to interface an

individuals electrophysiological signals with a computer. A true BCI only uses signals from the

brain and as such must treat eye and muscle movements as artifacts or noise. On the other

hand, a system that uses eye, muscle, or other body potentials mixed with EEG signals, is a

brain-body actuated system.



**FIGURE 4.4**

* 1. **SOFTWARE BEHIND BRAINGATE :**

Software Behind BRAINGATE System uses algorithms and pattern-matching techniques to

facilitate communication. The algorithms are written in C, JAVA and MATLAB. . Signal

processing software algorithms analyze the electrical activity of neurons and translate it into

control signals for use in various computer-based applications**.**

1. **WORKING**
   1. **WORKING:**

Embedded down into the cortex are hundred thin platinum tipped electrodes – each a

millimeter long and only 90 microns at the base . These pick up the brain’s electrical signals

which are then transmitted to EEG through wires connected to each individual electrode.

Operation of the BCI system is not simply listening the EEG of user in a way that let’s tap this

EEG in and listen what happens. The user usually generates some sort of mental activity pattern

that is later detected and classified**.**

* + 1. **PREPROCESSING:**

The raw EEG signal requires some preprocessing before the feature extraction. This

preprocessing includes removing unnecessary frequency bands, averaging the current brain

activity level, transforming the measured scalp potentials to cortex potentials and denoising.

* + 1. **DETECTION:**

The detection of the input from the user and them translating it into an action could be

considered as key part of any BCI system. This detection means to try to find out these mental

tasks from the EEG signal. It can be done in time-domain, e.g. by comparing amplitudes of the

EEG and in frequency-domain. This involves usually digital signal processing for sampling and

band pass filtering the signal, then calculating these time -or frequency domain features and

then classifying them. These classification algorithms include simple comparison of amplitudes

linear and non-linear equations and artificial neural networks. By constant feedback from user

to the system and vice versa, both partners gradually learn more from each other and improve

the overall performance.

* + 1. **CONTROL:**

The final part consists of applying the will of the user to the used application. The user chooses

an action by controlling his brain activity, which is then detected and classified to corresponding

action. Feedback is provided to user by audio-visual means e.g. when typing with virtual

keyboard, letter appears to the message box etc.

* + 1. **TRAINING:**

The training is the part where the user *adapts* to the BCI system. This training begins

with very simple exercises where the user is familiarized with mental activity which is used to

relay the information to the computer. Motivation, frustration, fatigue, etc. apply also here and

their effect should be taken into consideration when planning the training procedures.

**Frequency bands of the EEG :**

**Band** Frequen-cy [Hz] Amplit--ude [\_V] Location

**Alpha (**\_**)** 8-12 10 -150 Occipital/Parietal regions

**μ-rhythm** 9-11 varies Precentral/Postcentral regions

**Beta (**\_**)** 14 -30 25 typically frontal regions

**Theta (**\_**)** 4-7 varies varies

**Delta (**\_**)** <3 varies varies

**TABLE 5.1.1 6**

1. **DEVICES USED FOR BRAIN GATE SYTEM**

The BrainGate system is a neuromotor prosthetic device consisting of an array of one hundred

silicon microelectrodes, each of which is 1mm long and thinner than a human hair. The

electrodes are arranged less than half a millimetre apart on the array, which is attached to a

13cm-long cable ribbon cable connecting it to a computer.

The device, which has been implanted in motor cortex, detects electrical activity that is

associated with the planning of movements, and transmits them to a series of computers. The

signals are translated by the computers, which then produce an output that controls the

movements of the prosthesis, and also of a cursor on a computer screen.



**FIGURE 6.1.1**

While the results prove that it is possible to record brain signals that carry multi-dimensional

information about movement even year after the trauma and exhibit the most complex

functions to date that anyone has been able to perform using a BCI, they are still far from being

practical for commercial use due to the fact that the presented results are preliminary, and the

safety and effectiveness of the device have not been established.



**FIGURE 6.1.2**

The neural interface system consists of a baby aspirin-sized square of silicon sensor which

contains 100 hair-thin electrodes used to monitor brain signals which are processed by

computer software in order to control external devices. The sensor is implanted into the motor

cortex, a part of the brain that directs movement. The implanted microelectrode array and

associated neural recording hardware used in the BrainGate research are manufactured by

BlackRock Microsystems LLC.

1. **BRAIN - COMPUTER INTERFACE**

**7.1 WHAT IS BRAIN COMPUTER INTERFACE???**

A brain-computer interface uses electrophysiological signals to control remote devices. Most

current BCIs are not invasive. They consist of electrodes applied to the scalp of an individual or

worn in an electrode cap such as the one shown in 1-1 (Left). These electrodes pick up the

brainâ„¢s electrical activity (at the microvolt level) and carry it into amplifiers such as the ones

shown in 1-1 (Right). These amplifiers amplify the signal approximately ten thousand times and

then pass the signal via an analog to digital converter to a computer for processing. The

computer processes theEEG signal and uses it in order to accomplish tasks such as

communication and environmental control. BCIs are slow in comparison with normal human

actions, because of the complexity and noisiness of the signals used, as well as the time

necessary to complete recognition and signal processing.

The phrase brain-computer interface (BCI) when taken literally means to interface an

individuals electrophysiological signals with a computer. A true BCI only uses signals from the

brain and as such must treat eye and muscle movements as artifacts or noise. On the other

hand, a system that uses eye, muscle, or other body potentials mixed with EEG signals, is a

brain-body actuated system.

Scheme of an EEG-based Brain Computer Interface with on-line feedback. The EEG is recorded

from the head surface, signal processing techniques are used to extract features. These

features are classified, the output is displayed on a computer screen. This feedback should help

the subject to control its EEG patterns.

The BCI system uses oscillatory electroencephalogram (EEG) signals, recorded during specific

mental activity, as input and provides a control option by its output. The obtained output

signals are presently evaluated for different purposes, such as cursor control, selection of

letters or words, or control of prosthesis. People who are paralyzed or have other severe

movement disorders need alternative methods for communication and control. Currently

available augmentative communication methods require some muscle control. Whether they

use one muscle group to supply the function normally provided by another (e.g., use

extraocular muscles to drive a speech synthesizer) .Thus, they may not be useful for those who

are totally paralyzed (e.g., by amyotrophic lateral sclerosis (ALS) or brainstem stroke) or have

other severe motor disabilities. These individuals need an alternative communication channel

that does not depend on muscle control. The current and the most important application of a

BCI is the restoration of communication channel for patients with locked-in-syndrome.

**7.2 STRUCTURE OF BRAIN-COMPUTER INTERFACE**

The common structure of a Brain-Computer Interface is the following :

1) Signal Acquisition: the EEG signals are obtained from the brain through invasive or noninvasive

methods (for example, electrodes).

2) Signal Pre-Processing: once the signals are acquired, it is necessary to clean them.



**FIGURE 7.2**

3) Signal Classification: once the signals are cleaned, they will be processed and classified to

find out which kind of mental task the subject is performing.

4) Computer Interaction: once the signals are classified, they will be used by an appropriate

algorithm for the development of a certain application.

**7.3BRAIN-COMPUTER INTERFACE ARCHITECTURE**

The processing unit is subdivided into a preprocessing unit, responsible for artefact detection,

and a feature extraction and recognition unit that identifies the command sent by the user to

the BCI. The output subsystem generates an action associated to this command. This action

constitutes a feedback to the user who can modulate her mental activity so as to produce those

EEG patterns that make the BCI accomplish her intents.

**7.4APPLICATIONS OF BRAIN-COMPUTER INTERFACE**

Brain-Computer Interface (BCI) is a system that acquires and analyzes neural signals with the

goal of creating a communication channel directly between the brain and the computer. Such a

channel potentially has multiple uses. The current and the most important application of a BCI

is the restoration of communication channel for patients with locked-in-syndrome.

1) Patients with conditions causing severe communication disorders:

Advanced Amyotrophic Lateral Sclerosis (ALS)

* Autism
* Cerebral Palsy
* Head Trauma
* Spinal Injury

The output signals are evaluated for different purpose such as cursor control, selection of

letters or words.

2) Military Uses:

The Air Force is interested in using brain-body actuated control to make faster responses

possible for fighter pilots. While brain-body actuated control is not a true BCI, it may still

provide motivations for why a BCI could prove useful in the future.A combination of EEG signals

and artifacts (eye movement, body movement, etc.) combine to create a signal that can be

used to fly a virtual plane.

3) Bioengineering Applications:

Assist devices for the disabled. Control of prosthetic aids.

4) Control of Brain-operated wheelchair.

5) Multimedia & Virtual Reality Applications:

* Virtual Keyboards
* Manipulating devices such as television set, radio, etc.
* Ability to control video games and to have video games react to actual EEG signals.

1. **BIO FEEDBACK**

**8.1 DEFINITION OF BIO FEEDBACK:**

The definition of the biofeedback is biological information which is returned to the source that

created it, so that source can understand it and have control over it. This biofeedback in BCI

systems is usually provided by visually, e.g. the user sees cursor moving up or down or letter

being selected from the alphabet**.**

****

**FIGURE 8.1**

Operation of the BCI system is not simply listening the EEG of user in a way that lets tap

this EEG in and listen what happens. The user usually generates some sort of mental activity

pattern that is later detected and classified.

Signals recorded in this way have been used to power muscle implants and restore partial

movement in an experimental volunteer. Although they are easy to wear, non-invasive implants

produce poor signal resolution because the skull dampens signals, dispersing and blurring the

electromagnetic waves created by the neurons. Although the waves can still be detected it is

more difficult to determine the area of the brain that created them or the actions of individual

neurons.

**8.2 EEG( Electro Encephalo Graph):**

Electroencephalography (EEG) is the most studied potential non-invasive interface, mainly due

to its fine temporal resolution, ease of use, portability and low set-up cost. But as well as the

technology's susceptibility to noise, another substantial barrier to using EEG as a brain–

computer interface is the extensive training required before users can work the technology. For

example, in experiments beginning in the mid-1990s, Niels Birbaumer at the University of

Tübingen in Germany trained severely paralyses people to self-regulate the slow cortical

potentials in their EEG to such an extent that these signals could be used as a binary signal to

control a computer cursor.[32] (Birbaumer had earlier trained epileptics to prevent impending

fits by controlling this low voltage wave.) The experiment saw ten patients trained to move a

computer cursor by controlling their brainwaves. The process was slow, requiring more than an

hour for patients to write 100 characters with the cursor, while training often took many

months.

Another research parameter is the type of oscillatory activity that is measured. Birbaumer's

later research with Jonathan Wolpaw at New York State University has focused on developing

technology that would allow users to choose the brain signals they found easiest to operate a

BCI, including mu and beta rhythms.

A further parameter is the method of feedback used and this is shown in studies of P300

signals. Patterns of P300 waves are generated involuntarily (stimulus-feedback) when people

see something they recognize and may allow BCIs to decode categories of thoughts without

training patients first. By contrast, the biofeedback methods described above require learning

to control brainwaves so the resulting brain activity can be detected**.**

While an EEG based brain-computer interface has been pursued extensively by a number of

research labs, recent advancements made by Bin He and his team at the University of

Minnesota suggest the potential of an EEG based brain-computer interface to accomplish tasks

close to invasive brain-computer interface. Using advanced functional neuroimaging including

BOLD functional MRI and EEG source imaging, Bin He and co-workers identified the co-variation

and co-localization of electrophysiological and hemodynamic signals induced by motor

imagination.[35] Refined by a neuroimaging approach and by a training protocol, Bin He and coworkers

demonstrated the ability of a non-invasive EEG based brain-computer interface to

control the flight of a virtual helicopter in 3-dimensional space, based upon motor imagination.

In addition to a brain-computer interface based on brain waves, as recorded from scalp EEG

electrodes, Bin He and co-workers explored a virtual EEG signal-based brain-computer interface

by first solving the EEG inverse problem and then used the resulting virtual EEG for braincomputer

interface tasks. Well-controlled studies suggested the merits of such a source analysis

based brain-computer interface.

**8.3 A BOON TO THE PARALYZED -BRAIN GATE NEURAL INTERFACE SYSTEM:**

The first patient, Matthew Nagle, a 25-year-old Massachusetts man with a severe spinal cord

injury, has been paralyzed from the neck down since 2001. Nagle is unable to move his arms

and legs after he was stabbed in the neck. During 57 sessions, at New England Sinai Hospital

and Rehabilitation Center, Nagle learned to open simulated e-mail, draw circular shapes using a

paint program on the computer and play a simple videogame, "neural Pong," using only his

thoughts. He could change the channel and adjust the volume on a television, even while

conversing. He was ultimately able to open and close the fingers of a prosthetic hand and use a

robotic limb to grasp and move objects. to open and close the fingers of a prosthetic hand and

use a robotic limb to grasp and move objects. Despite a decline in neural signals after few

months, Nagle remained an active participant in the trial and continued to aid the clinical team

in producing valuable feedback concerning the BrainGate` technology.



**FIGURE 8.3**

**8.4 NAGLE’S STATEMENT:**

“I can't put it into words. It's just—I use my brain. I just thought it. I said, "Cursor go up to the

top right." And it did, and now I can control it all over the screen. It will give me a sense of

independence.”

**8.5 OTHER APPLICATIONS:**

****

**FIGURE 8.5.1**

Rats implanted with BCIs in Theodore Berger's experiments.Several laboratories have managed

to record signals from monkey and rat cerebral cortexes in order to operate BCIs to carry out

movement. Monkeys have navigated computer cursors on screen and commanded robotic

arms to perform simple tasks simply by thinking about the task and without any motor output.

Other research on cats has decoded visual signals.

Garrett Stanley's recordings of cat vision using a BCI implanted in the lateral geniculate nucleus

(top row: original image; bottom row: recording) in 1999, researchers led by Garrett Stanley

ater approaches by connecting directly to the part of the brain that controls hand gestures.

Harvard University decoded neuronal firings to reproduce images seen by cats. The team used

an array of electrodes embedded in the thalamus (which integrates all of the brain’s sensory

input) of sharp-eyed cats. Researchers targeted 177 brain cells in the thalamus lateral

geniculate nucleus area, which decodes signals from the retina. The cats were shown eight

short movies, and their neuron firings were recorded. Using mathematical filters, the

researchers decoded the signals to generate movies of what the cats saw and were able to

reconstruct recognisable scenes and moving objects.



**FIGURE 8.5.2**

In the 1980s, Apostolos Georgopoulos at Johns Hopkins University found a mathematical

relationship between the (based on a cosine function). He also found that dispersed groups of

neurons in different areas of the brain collectively controlled motor commands but was only

able to record the firings of neurons in one area at a time because of technical limitations

imposed by his equipment.

There has been rapid development in BCIs since the mid-1990s. Several groups have been able

to capture complex brain motor centre signals using recordingsfrom neural ensembles (groups

of neurons) and use these to control external devices, including research groups led by Richard

Andersen, John Donoghue, Phillip Kennedy, Miguel Nicolelis, and Andrew Schwartz.



**FIGURE 8.5.3**

**Diagram of the BCI developed by Miguel Nicolelis and collegues for use on Rhesus monkeys**

Later experiments by Nicolelis using rhesus monkeys, succeeded in closing the feedback loop

and reproduced monkey reaching and grasping movements in a robot arm. With their deeply

cleft and furrowed brains, rhesus monkeys are considered to be better models for human

neurophysiology than owl monkeys. The monkeys were trained to reach and grasp objects on a

computer screen by manipulating a joystick while corresponding movements by a robot arm

were hidden.The monkeys were later shown the robot directly and learned to control it by

viewing its movements. The BCI used velocity predictions to control reaching movements and

simultaneously predicted hand gripping force.

Other labs that develop BCIs and algorithms that decode neuron signals include John Donoghue

from Brown University, Andrew Schwartz from the University of Pittsburgh and Richard

Andersen from Caltech. These researchers were able to produce working BCIs even though they

recorded signals from far fewer neurons than Nicolelis (15–30 neurons versus 50–200 neurons).

Donoghue's group reported training rhesus monkeys to use a BCI to track visual targets on a

computer screen with or without assistance of a joystick (closed-loop BCI).[10] Schwartzss's

group created a BCI for three-dimensional tracking in virtual reality and also reproduced BCI

Control in a robotic arm.

1. **APPLICATIONS**

**APPLICATIONS:**

• Navigate Internet

• Play Computer Games

• Turn Lights On and Off

• Control Television

• Control Robotic Arm



**FIGURE 9**

This technology is well supported by the latest fields of

* Biomedical Instrumentation,
* Microelectronics, signal processing,
* Artificial Neural Networks and Robotics which has overwhelming developments.
* Hope these systems will be effectively implemented for many Biomedical applications.

1. **ADVANTAGES**

**ADVANTAGES:**

The brain crate system is based on cyber kinetics platform technology to sense, transmit

analyze and apply the language of neurons.

The Brain Gate Neural Interface System is being designed to one day allow the interface with a

computer and / or even faster than, what is possible with the hands of a person. The Brain Gate

System may offer substantial improvement over existing technologies.

Currently available assistive device has significant limitations for both the pers and caregiver.

For example, even simple switches must be adjusted frequent that can be time consuming. In

addition, these devices are often obtrusive and user from being able to simultaneously use the

device and at the same time contact or carry on conversations with others.

Potential advantages of the Brain Gate System over other muscle driven or brain computer

interface approaches include :

* its potential to interface with a compute weeks or months of training; its potential to be

used in an interactive environment users ability to operate the device is not affected by

their speech.

* eye movement noise.
* The ability to provide significantly more usefulness and utility than other approaches by

connecting directly to the part of the brain that controls hand gestures.

1. **DISADVANTAGES**

**DISADVANTAGES:**

The U.S. Food means that it has been approved for pre-market clinical trials. There are no

estimates on cost or insurance at this time and Drug Administration (FDA) has not approved the

Brain Gate Non Interface System for general use.But has been approved for IDE status.

**Sources**:

The Brain Gate System is an investigational device in the United States, and is status

(Investigational Device Exemption). In the United States, this investigate can only be used in

pre-marketing clinical trials approved by the FDA.

1. **CONCLUSION**

**CONCLUSION:**

The idea of moving robots or prosthetic devices not by manual control, but by mere

“thinking” (i.e., the brain activity of human subjects) has been a fascinated approach. Medical

cures are unavailable for many forms of neural and muscular paralysis. The enormity of the

deficits caused by paralysis is a strong motivation to pursue BMI solutions. So this idea helps

many patients to control the prosthetic devices of their own by simply thinking about the task.

This technology is well supported by the latest fields of BiomedicalInstrumentation,

Microelectronics, signal processing, Artificial Neural Networks and Robotics which has

overwhelming developments. Hope these systems will be effectively implemented for many

Biomedical applications.

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