A

Seminar report

On

BrainGate

Submitted in partial fulfillment of the requirement for the award of degree
Of Computer Science

SUBMITTED TO:

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Preface

I have made this report file on the topic **BrainGate**, I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the prepration of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

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INTRODUCTION:

BrainGate is a brain implant system developed by the bio-tech company, Cyber kinetics in conjunction with the Department of Neuroscience at Brown University. The development of the braingate system brain-computer interface is to enable those with severe paralysis and other neurological conditions to live more productively and independently. 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. Currently the chip uses about 100 hair-thin electrodes that sense the electro-magnetic signature of neurons firing in specific areas of the brain.

The activity is translated into electrically charged signals and is then sent and decoded using a program, which can move a robotic arm, a computer cursor, or even a wheelchair. Scientists are developing the brain gate systems underlying core technology in the neuroport system to enable improved diagnosis and treatment for a number of neurological conditions, such as epilepsy and brain trauma. Brain gate will be the first human device that has been designed to record, filter, and amplify multiple channels of simultaneously recorded neural activity at a very high spatial and temporal resolution. When a person becomes paralyzed, neural signal from the brain no longer reach their designated site of termination. However, the brain continues to send out these signals although they do not reach their destination. It is these signals that the brain gate system picks up and they must be present in order for the system to work.

It is found that people with long-standing, severe paralysis can generate signals in the area of the brain responsible for voluntary movement and these signals can be detected, recorded, routed out of the brain to a computer and converted into actions enabling a paralyzed patient to perform basic tasks. Scientists are to implant tiny computer chips in the brains of paralyzed patients which could 'read their thoughts'. Brain gate consists of a surgically implanted sensor that records the activity of dozens of brain cells simultaneously. The system also decodes these signals in real time to control a computer or other external devices. The brain gate technology platform was designed to take advantage of the fact that many patients with motor impairment have an intact brain that can produce movement commands allowing the brain gate system to create an output signal directly from the brain, bypassing the route through the nerves to the muscles that cannot be used in paralyzed people.

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WORKING

Basic requirements

The basic elements of BrainGate

1. The chip: A four-millimeter square silicon chip studded with about 100 hair-thin microelectrodes is embedded in the primary motor cortex-the region of the brain responsible for controlling movement.
2. The connector: When somebody thinks ,move cursor up and left his cortical neurons fire in a distinctive pattern the signal is transmitted through the pedestal plug attached to the skull.
3. The converter: The signal travels to an amplifier where it is converted to optical data and bounced by fiber optic cable to a computer.
4. 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.

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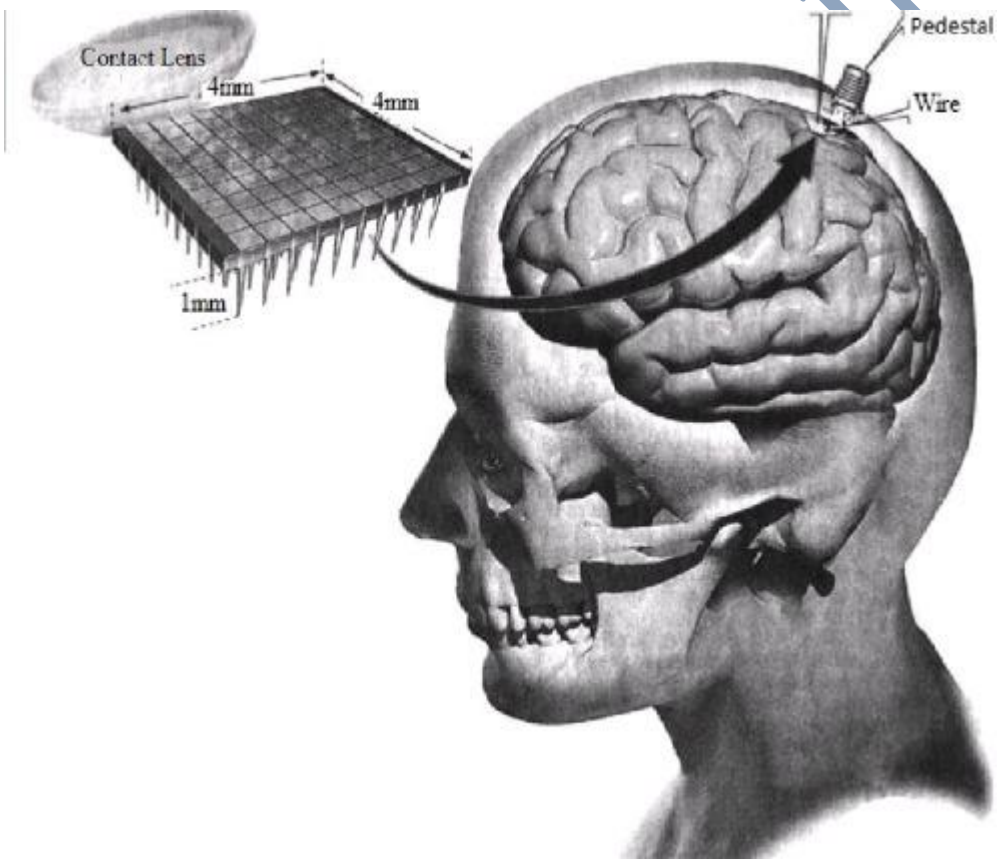

Fig 2: A silicon chip implanted in the brain cortex through pedestal

Brains behind BrainGate:

The person thinks of moving the computer cursor. Electrodes on the silicon chip implanted into the persons brain detect neural activity from an array of neural impulses in the brains motor cortex.The impulses transfer from the chip to a pedestal protruding from the scalp through connection wires.The pedestal, filters out unwanted signals or noise, and then transfers the signal to an amplifier.The signal is captured by acquisition system and is sent through a fiber optic cable to a computer.The computer then translates the signal into an action, causing the cursor to move.

The brain gate system is a neuromotor prosthetic device consisting of an array of one hundred silicon micro-electrodes; each electrode 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 BrainGate neural interface system is a proprietary, investigational Brain-Computer Interface(BCI) that consists of an internal sensor to detect brain cell activity and external processors that convert these brain signals into a computer-mediated output under the person's own control.The sensor is implanted on the surface of the area of the brain responsible for voluntary movement, the motor cortex. The electrodes penetrate about 1 mm into the surface of the brain where they pick up electrical signals known as neural spiking, the language of the brain from nearby neurons and transmit them through thin gold wires to a titanium pedestal that protrudes about an inch above the patient's scalp. An external cable connects the pedestal to computers, signal processors and monitors. The technology is able to sense the electrical activity of many individual neurons at one time the data is transmitted fro the neurons in the brain to computers where it is analyzed and the thoughts are used to control an external device. even 20 and 200 times a second and they work in teams.

The reason a BCI works at all is because of the way our brains function. Our brains are filled with neurons, individual nerve cells connected to one another by dendrites and axons. Every time we think, move, feel or remember something, our neurons are at work. That work is carried out by small electric signals that zip from neuron to neuron as fast as 250 mph .The signals are generated by differences in electric potential carried by ions on the membrane of each neuron.

Although the paths the signals take are insulated by something called myelin, some of the electric signal escapes. Scientists can detect those signals, interpret what they mean and use them to direct a device of some kind. It can also work the other way around. For example, researchers could figure out what signals are sent to the brain by the optic nerve when someone sees the color red. They could rig a camera that would send those exact signals into someone's brain whenever the camera saw red, allowing a blind person to "see" without eyes.

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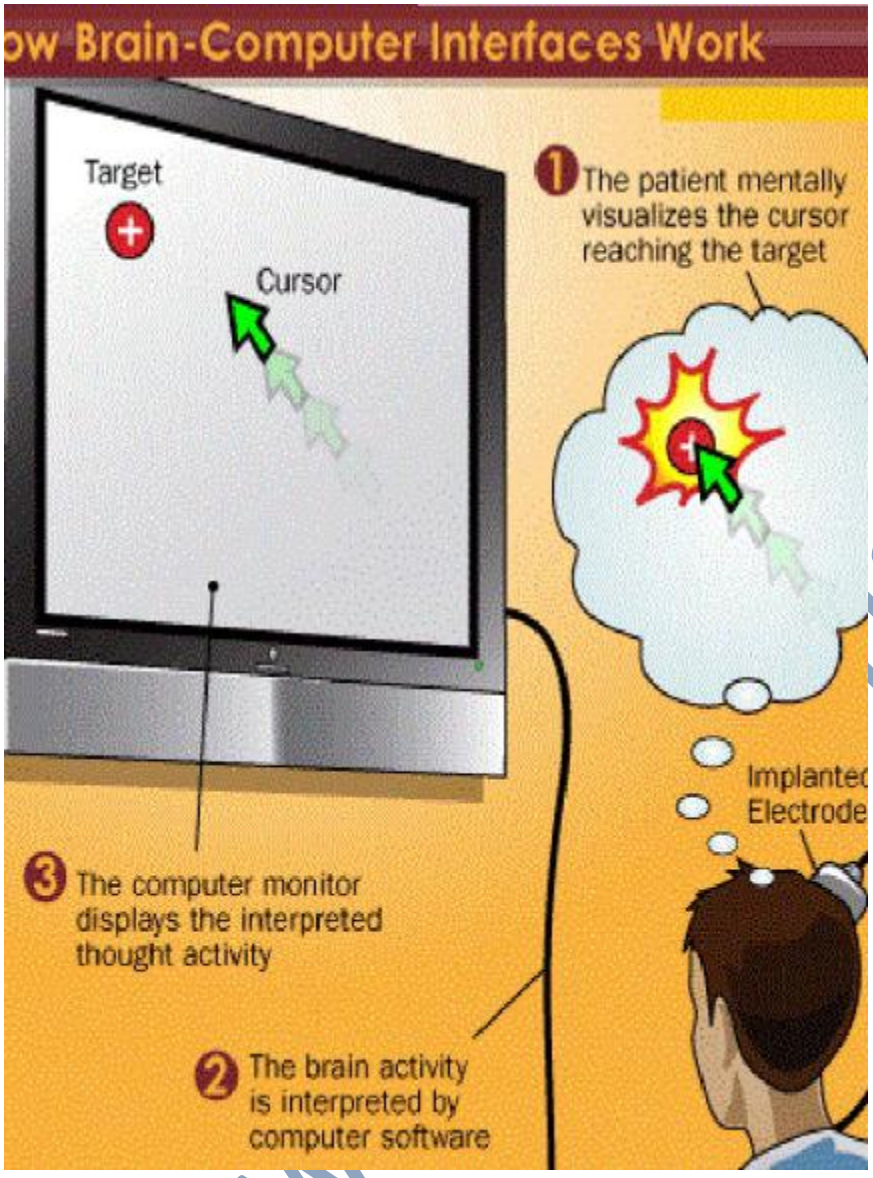

Fig 3: Basic working principle of the Brain Gate

Basically there are two methods to sense the signals sent by the neurons:

1.ECoG: Invasive method.

2.EEG : Non invasive method

ECoG – Electrocorticography:

This measures the electrical activity of the brain taken from beneath the skull. Here the electrodes are embedded in a thin plastic pad that is placed above the cortex, beneath the duramater. ECoG is a very promising intermediate BCI(Brain computer interface) modality because it has higher spatial resolution, better signal-to-noise ratio, wider frequency range,and

lesser training requirements than scalp-recorded EEG(Electroencephalography), and at the same time has lower technical difficulty, lower clinical risk, and probably superior long-term stability than intracortical single-neuron recording. This feature profile and recent evidence of the high level of control with minimal training requirements shows potential for real world application for people with motor disabilities. To get a higher-resolution signal, scientists can implant electrodes directly into the gray matter of the brainitself, or on the surface of the brain, beneath the skull. This allows for much more direct reception of electric signals and allows electrode placement in the specific area of the brain where the appropriate signals are generated. This approach has many problems, however. It requires invasive surgery to implant the electrodes, and devices left in the brain long-term tend to cause the formation of scar tissue in the gray matter. This scar tissue ultimately blocks signals.

EEG – Electroencephalography

The easiest and least invasive method is a set of electrodes — a device known as an electroencephalograph (EEG) — attached to the scalp. The electrodes can read brain signals. However, the skull blocks a lot of the electrical signal, and it distorts what does get through.

It is the most studied potential non-invasive interface, mainly due to its fine temporal resolution, ease of use, portability and low set-up cost. A substantial barrier to using EEG as a brain-computer interface is the extensive training required before users can work the technology.Signals recorded in this way have been used to power muscle implants and restore partial movement in an experimental volunteer. 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.

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FEATURES

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 amyotrophic lateral sclerosis (ALS) or 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.

Currently the chip uses 100 hair-thin electrodes that sense the electromagnetic signature of neurons firing in specific areas of the brain, for example, the area that controls arm movement. The activity is 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 Cyberkineticsâ„¢ 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, whilst another has advanced ALS.

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APPLICATIONS

1. The brain gate neural interface system is an investigational medical device that is being developed to improve the quality of life for physically disabled people by allowing them to quickly and reliably control a wide range of devices by thought, including computers, environmental controls, robotics and medical devices.
2. One of the most exciting areas of BCI research is the development of devices that can be controlled by thoughts. Some of the applications of this technology may seem frivolous, such as the ability to control a video game by thought. If you think a remote control is convenient, imagine changing channels with your mind.
3. Once the basic mechanism of converting thoughts to computerized or robotic action is perfected, the potential uses for the technology are almost limitless. Instead of a robotic hand, disabled users could have robotic braces attached to their own limbs, allowing them to move and directly interact with the environment. This could even be accomplished without the "robotic" part of the device. Signals could be sent to the appropriate motor control nerves in the hands, bypassing a damaged section of the spinal cord and allowing actual movement of the subject's own hands.
4. Cyberkinetics is also developing products to allow for robotic control, such as a thought-controlled wheelchair. Next generation products may be able to provide an individual with the ability to control devices that allow breathing, bladder and bowel movements.
5. The brain gate system has allowed people with paralysis to operate a computer in order to read e-mail, control a wheelchair and operate a robotic hand.
6. The system will connect the brain gate sensor with functional electrical stimulation (FES) system, which uses electrical impulses to trigger muscle and limb movement. The first version will allow users to make simple movements that could be used to perform tasks such as eating or drinking using their own arms and hands and under the natural control of their own brains. The initial version of this FES system would use arm supports. Later versions, however, wont require supports and will allow users to do activities that require more dexterity, such as using cell phones or remote controls.
7. The device can be used in an interactive environment; activity surrounding the patient will not affect the accuracy of the device.

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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 userâ„¢s ability to operate the device is not affected by their speech, eye movement noise; and 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.

DISADVANTAGES:

- The switches must be frequently adjusted which is a time consuming process. As the device is perfected this will not been issue.
- There is also a worry that devices such as this will “normalize” society.
- The Brain Gate Neural Interface System has not been approved by the FDA, but has beenapproved for IDE status, which means that it has been approved for pre-market clinical trials.
- Limitation in information transform rate. The latest technology is 20 bits/min.

CURRENT WORK PROGRESS

Brain Gate is currently recruiting patients with a range of neuromuscular and neuron-degenerativeconditions for pilot clinical trials being conducted under an Investigational Device Exemption (IDE)in the United States.

Cyber kinetics hopes to refine the Brain Gate in the next two years to develop awireless device doesn’t have a plug, making it safer and less visible.

And once the basics of brainmapping are worked out, there is potential for a wide variety of further applications

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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 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.

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