ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

Brain Gate Technology

Manjunatha .V[1]

II MCA Department of Computer Application, Adhiyamaan College of Engineering, Hosur- 635 109, Tamilnadu, India[1]

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. The Brain Gate System is based on Cyber kinetics platform technology to sense, transmit, analyze and apply the language of neurons. 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 millimetre 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. Matthew Nagle,a 25-year-old Massachusetts man with a severe spinal cord injury,has been paralyzed from the neck down since 2001.After taking part in a clinical trial of this system,he has opened e-mail,switched TV channels,turned on lights.He even moved a robotic hand from his wheelchair. This marks the first time that neural movement signals have been recorded and decoded in a human with spinal cord injury.The system is also the first to allow a human to control his surrounding environment using his mind.

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. Other sensors in the skin respond to stretching and pressure. Even if paralysis or disease damages the part of the brain that processes movement, the brain still makes neural signals. They're just not being sent to the arms, hands and legs.

- → A technique called neuron feedback 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

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) **Vol.2, Special Issue 1, March 2014**

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

NEURON PROSTHETIC DEVICE:

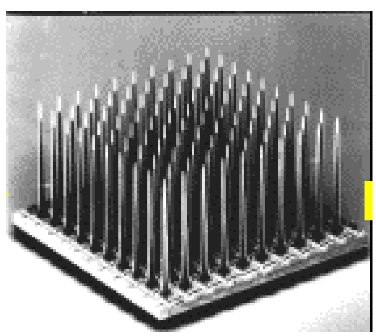
Neuron prosthetic device known as Brain gate converts brain activity into computer commands. A sensor is implanted on the brain, and electrodes are hooked up to wires that travel to a pedestal on the scalp. From there, a fiber optic cable carries the brain activity data to a nearby computer.

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."

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

NUERO CHIP:

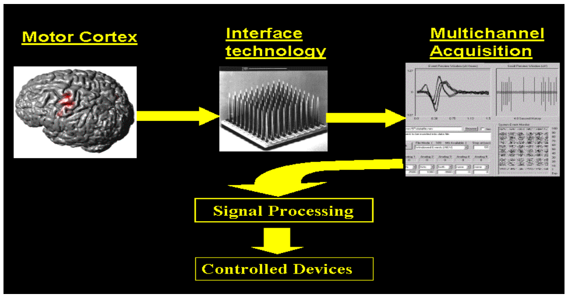


Currently the chip uses 100 hair-thin electrodes that 'hear' neurons firing in specific areas of the brain, for example, the area that controls arm movement. The activity is translated into electrically charged signals and is then sent and decoded using a program, which can move either a robotic arm or a computer cursor. According to the Cyberkinetics' 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. In addition to real-time analysis of neuron patterns to relay movement, the Brain gate array is also capable of recording electrical data for later analysis. A potential use of this feature would be for a neurologist to study seizure patterns in a patient with epilepsy.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering
(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)
Organized by
Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014



WORKING:

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.

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. Frequency bands of the EEG:

.

Band	Frequency [Hz]	Amplitude [_V]	Locations
Alpha (_)	8-12	10 -150	Occipital/Parietal regions
µ-rhythm	9-11	varies	Pre central/Post central regions
Beta (_)	14 -30	25	typically frontal regions
Theta (_)	4-7	varies	varies
Delta (_)	<3	varies	varies

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.

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.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

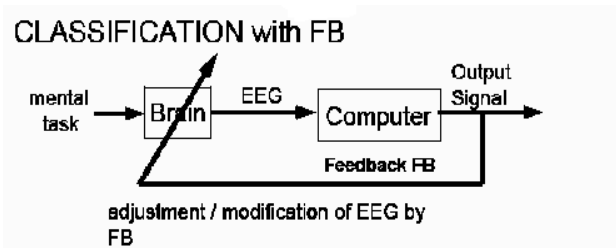
Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

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

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.



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.

OTHER APPLICATIONS:

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

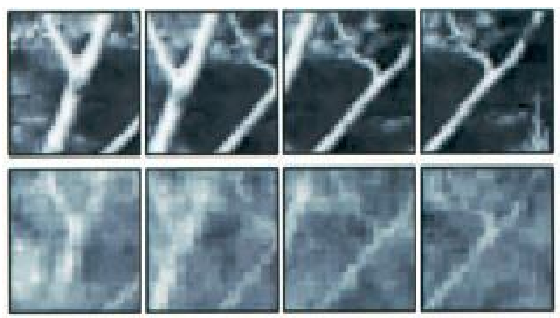
Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

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.

In 1999, researchers led by Garrett Stanley at 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.



There has been rapid development in BCIs since the mid-1990s.[5] Several groups have been able to capture complex brain motor centre signals using recordings from 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.

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

Later experiments by Nicolle's 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).

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 Bio-medical applications.