

Brain-Robot Interfaces via EEG and RFID Technology in Control of Medical Robots and Neuro Robotic Prosthetics by Noninvasive Technique

Saranya SA¹, K.Mahendran², Rebekah Francis³, Amrutha.A⁴

Assistant Professor, Department of Electronics and Communication Engineering, CK Engineering College, Cuddalore,
India¹

Assistant Professor, Department of Electronics and Communication Engineering, CK Engineering College, Cuddalore,
India²

Assistant Professor, Department of Electronics and Communication Engineering, CK Engineering College, Cuddalore,
India³

Assistant Professor, Department of Electronics and Communication Engineering, CK Engineering College, Cuddalore,
India⁴

ABSTRACT: -Brain-robot interface (BRI) has been a growing field of innovative research and development in cognitive neuroscience and brain bioimaging processing technologies. In this paper we endeavor to explore how medical robotics and neurorobotic prosthetics can be controlled by Brain-Robot Interfaces and RFID (Radio Frequency Identification) technologies, directly using brain signals obtained non-invasively from the scalp through electroencephalography (EEG) in order to assist disabled patients to ameliorate their everyday lives. There is a general consensus that computational visualizations and interfaces are proliferating in every aspect of medical practice, prompted from the current trends in telemedicine. The main focus of the study is on architectures of Brain-robot interfaces for communication and control using one specific modality, namely electroencephalography (EEG), alpha (a) wave-based BRI with an emphasis on biosignal processing aspects.

KEYWORDS: Brain-Robot Interfaces, EEG, Radio Frequency Identification, neurorobotic prosthetics.

I. INTRODUCTION

The main motivation for the application of such scientific methods is the development of an alternative communication and control means for severely disabled people, focusing in replacing total voluntary muscle control using robotic prosthetics. The substantial goal is to demonstrate that an EEG-based brain-robot interface can be used for sophisticated robotic interaction with the environment, involving not only navigation as in previous applications but also manipulation and transport of objects. Visualization of brain electrical activity and BRI technology, by their intimate connection with the wonder of human thought processes, are a fascinating research field, that has demonstrated the unprecedented ability of direct information transfer from the brain to medical robots or robotic prosthetics. Inclusion of a BRI in a multimodal interface thus results in a net gain of information transfer capability that alters the standards in medical robotics.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

II. ROBOTIC RFID SYSTEMS

Robots are the newest option for retailers seeking to capture inventory data. Tesco announced in June it is trialing an indoor robotics mapping and analytics system in the fashion departments of five of its U.K. stores. The solution is from Silicon Valley company RFspot, which reports that six other retailers globally are carrying out similar pilots. The RFspot robots roam through each store’s clothing department. Onboard RFID readers perform inventory counts by reading each garment’s passive ultrahigh-frequency EPC Gen 2 tag, much the way an employee would with a handheld. The RFspot robot is fitted with multiple antenna arrays to enable tags to be read from six inches to 12 feet above the floor. RFspot says the robot is seven times faster than a human using a handheld. While robots have some clear advantages over store associates when it comes to conducting inventory, they also have some disadvantages. One is cost. Another is having a clunky machine roaming the aisles while people are shopping. Some retailers might prefer to use robots at night, when stores are closed. This would mean updating inventory only after hours or having employees take inventory during working hours. Also, the inventory accuracy of robotic data collection is not yet clear.

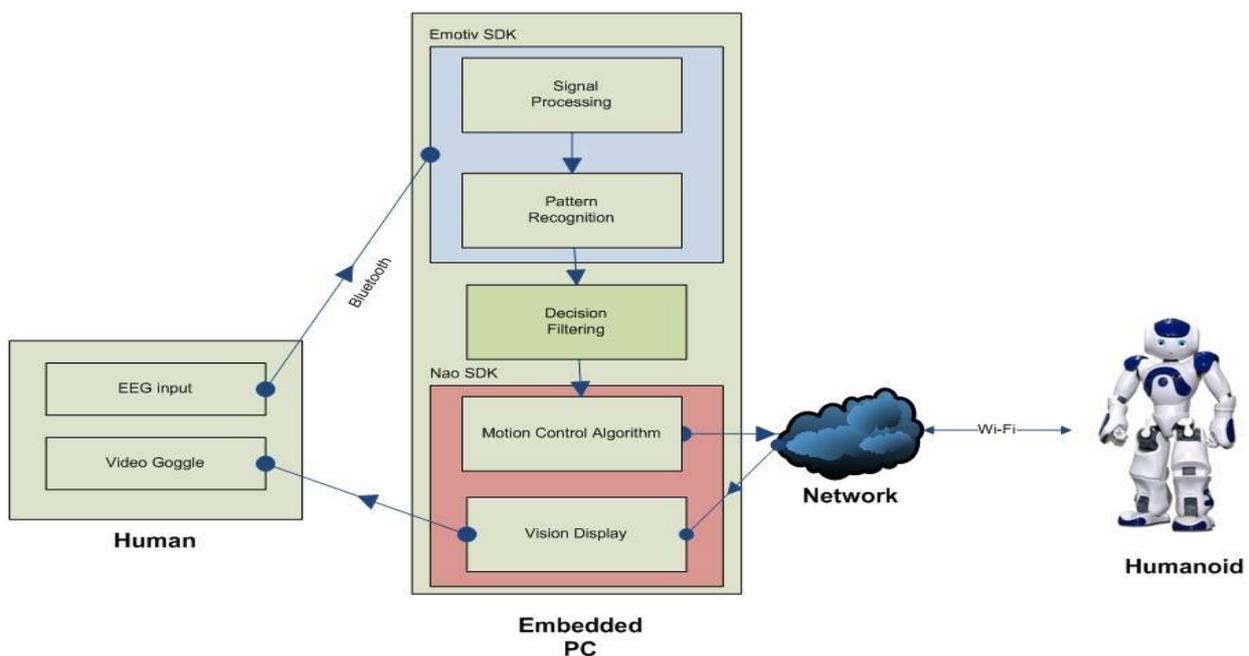


Fig 1. shows the processing of EEG signals from the human brain to the humanoid robot

Tesco and others are aiming to determine more about these factors from the robotics trial. Retailers deploying RFID systems have been debating which approach will win out. Long-term, RFID Journal believes a fixed RFID infrastructure will likely become an integral part of store systems, hidden from view but constantly monitoring inventory in real time. Lower infrastructure costs, the ability to add readers during renovations or new construction, and improvements in the technology will all contribute to this trend. But during the next five years, and perhaps much longer, retailers will use handhelds and robotic solutions. Handhelds are a good option for smaller stores, where a single associate can update inventory once or twice a day in less than an hour. The cost of paying a store associate for an hour will likely remain lower than the cost of setting up a fixed infrastructure. In larger stores, with tens of thousands of tagged items, handhelds will consume too much time and labor to be practical. Retailers will opt for robots or fixed infrastructure, or perhaps a combination of the two. They might use overhead fixed readers to continuously monitor areas of the store that generate the most profit, while using robots to inventory other areas each evening. The bottom line is that today there is no one right choice for all retailers. Each company should explore all

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

three options and determine which will be most costeffective, while considering the best longterm data-capture strategy to meet its needs.

II. METHODOLOGY

The Human Brain All of it happens in the brain. The brain is undoubtedly the most complex organ found among the carbon-based life forms. So complex it is that we have only vague information about how it works. The average human brain weights around 1400 grams. The most relevant part of brain concerning BCI's is the cerebral cortex. The cerebral cortex can be divided into two hemispheres. The hemispheres are connected with each other via corpus callosum. Each hemisphere can be divided into four lobes. They are called frontal, parietal, occipital and temporal lobes. Cerebral cortex is responsible for many higher order functions like problem solving, language comprehension and processing of complex visual information. The cerebral cortex can be divided into several areas, which are responsible of different functions.

Cortical Area	Function
Auditory Association Area	Processing of auditory information
Auditory Cortex	Detection of sound quality (loudness, tone)
Speech Center (Broca's area)	Speech production and articulation
Prefrontal Cortex	Problem solving, emotion, complex thought
Motor Association Cortex	Coordination of complex movement
Primary Motor Cortex	Initiation of voluntary movement
Primary Somatosensory Cortex	Receives tactile information from the body
Sensory Association Area	Processing of multisensory information
Visual Association Area	Complex processing of visual information
Wernicke's Area	Language comprehension

Table1: Cortical areas of the Brain and their function

A. Main Principle

Main principle behind this interface is the bioelectrical activity of nerves and muscles. It is now well established that the human body, which is composed of living tissues, can be considered as a power station generating multiple electrical signals with two internal sources, namely muscles and nerves. We know that brain is the most important part of human body. It controls all the emotions and functions of the human body. The brain is composed of millions of neurons. These neurons work together in complex logic and produce thought and signals that control our bodies. When the neuron fires, or activates, there is a voltage change across the cell, (~100mv) which can be read through a variety of devices. When we want to make a voluntary action, the command generates from the frontal lobe. Signals are generated on the surface of the brain. These electric signals are different in magnitude and frequency. By monitoring and analysing these signals we can understand the working of brain. When we imagine ourselves doing something, small signals generate from different areas of the brain. These signals are not large enough to travel down the spine and cause actual movement. These small signals are, however, measurable. A neuron depolarizes to generate an impulse; this action causes small changes in the electric field around the neuron. These changes are measured as 0 (no impulse) or 1 (impulse generated) by the electrodes. We can

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

control the brain functions by artificially producing these signals and sending them to respective parts. This is through stimulation of that part of the brain, which is responsible for a particular function using implanted electrodes.

B. Electroencephalography

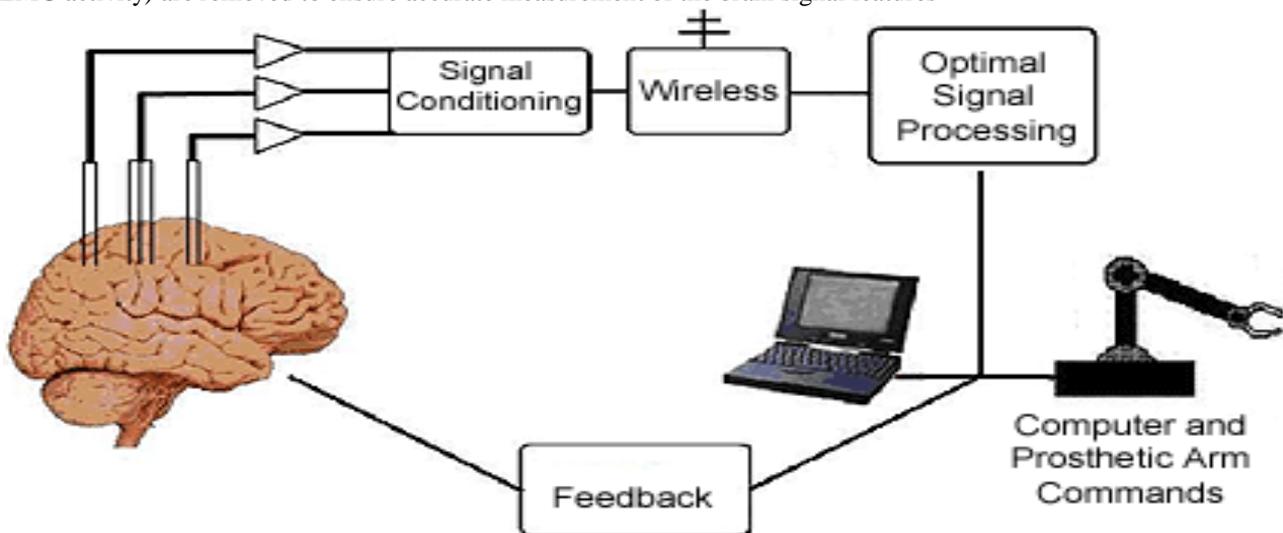
Electroencephalography (EEG) is a method used in measuring the electrical activity of the brain. The brain generates rhythmical potentials which originate in the individual neurons of the brain. These potentials get summated as millions of cell discharge synchronously and appear as a surface waveform, the recording of which is known as the electroencephalogram. The neurons, like other cells of the body, are electrically polarized at rest. The interior of the neuron is at a potential of about -70mV relative to the exterior. When a neuron is exposed to a stimulus above a certain threshold, a nerve impulse, seen as a change in membrane potential, is generated which spreads in the cell resulting in the depolarization of the cell. Shortly afterwards, repolarization occurs. The EEG signal can be picked up with electrodes either from scalp or directly from the cerebral cortex. As the neurons in our brain communicate with each other by firing

III. BLOCK DIAGRAM

Figure (b): General Approach of BCI Any BCI, regardless of its recording methods or applications, consists of four essential elements, as described by Wolpaw: 1. Signal acquisition 2. Feature extraction 3. Feature translations 4. Device output

1. Signal Acquisition Signal acquisition is the measurement of the neurophysiologic state of the brain. In BCI operation, the recording interface (i.e., electrodes, for electrophysiological BCI systems) tracks neural information reflecting a person's intent embedded in the on-going brain activity. As discussed in the last section, the most common electrophysiological signals employed for BCI systems include: EEG recorded by electrodes on the scalp; ECoG recorded by electrodes placed beneath the skull and over the cortical surface; and local field potentials (LFPs) and neuronal action potentials (spikes) recorded by microelectrodes within brain tissue. The brain electrical signals used for BCI operation are acquired by the electrodes, amplified, and digitized.

2. Feature Extractions The signal-processing stage of BCI operation occurs in two steps. The first step, feature extraction, extracts signal features that encode the intent the electrophysiological features extracted should have strong correlations with the user's intent. The signal features extracted can be in the time domain or the frequency-domain. The most common signal features used in current BCI systems include: amplitudes or latencies of event-evoked potentials (e.g., P300), frequency power spectra (e.g., sensorimotor rhythms), or firing rates of individual cortical neurons. An algorithm filters the digitized data and extracts the features that will be used to control the BCI. In this step, confounding artefacts (such as 60-Hz noise or EMG activity) are removed to ensure accurate measurement of the brain signal features



Experimental results

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

3. Feature Translations

The second step of signal processing is accomplished by the translation algorithm, which converts the extracted signal features into device commands. Brain lelectrophysiological features or parameters are translated into commands that will produce output such as letter selection, cursor movement, control of a robot arm, or operation of another assistive device. A translation algorithm must be dynamic to accommodate and adapt to the continuing changes of the signal features and to ensure that the possible range of the specific signal features from the user covers the full range of device control.

4. Device Output The signal features thus extracted and translated provide the output to operate an external device. The output might be used to operate a spelling program on a computer screen through letter selection, to move a cursor on a computer screen], to drive a wheelchair or other assistive devices to manipulate a robotic arm, or even to control movement of a paralysed arm through a neuroprosthesis. At present, the most commonly used output device is the computer screen, and it is used for communication.

IV. CONCLUSION

The Brain Computer Interface has proved to be boon to the disabled persons by providing them independent environment not by manual control but by mere “thinking”. Brain-computer interfaces and their potential applications engender great excitement. However, it must be stressed that in their present state, it remains to be seen how far, and in what direction, applications for BCIs will develop. Hope these systems will be effectively implemented for many Biomedical applications.

REFERENCES

- [1] Talairach J, Tournoux P (1988). Co-planar Stereotaxic Atlas of the Human Brain, New York: Thieme.
- [2] Mazziotta JC, Toga AW, Evans AC, and Fox P, Lancaster J (1995) a Probabilistic Atlas of the Human Brain: Theory and Rationale for its Development, Neuroimaging 2: 89-101.
- [3] Altenmuller, E.O., W. Gruhn and D. Parlitz et al. (1997), “Music Learning Produces Changes in Brain Activation Patterns: A Longitudinal DC-EEG-study Unit”, International Journal of Arts Medicine, Vol. 5, pp. 28-34.
- [4] Raz, N., U. Linden Berger, K.M. Rodrigue, K.M. Kennedy, D. Head and A. Williamson (2005), “Regional Brain Changes in Aging Healthy Adults: General Trends, Individual Differences and Modifiers”, Cerebral Cortex, Vol. 15(11), pp. 1676-1689.
- [5] Rossi, S., C. Miniussi, P. Pasqualetti, C. Babiloni, P.M. Rossini and S.F. Cappa (2004), “Age-related Functional Changes of Prefrontal Cortex in Long-term Memory: A Repetitive Trans cranial Magnetic Stimulation Study”, Journal of Neuroscience, Vol. 24(36), pp. 7939-7944.
- [6] Thomaе, H. (1970), “Theory of Aging and Cognitive Theory of Personality”, Human Development 13, pp.1
- [7] Sowell, E.R., B.S. Peterson, P.M. Thompson, S.E. Welcome, A.L. Henkenius and A.W. Toga (2003), “Mapping Cortical Change across the Human Life Span”, Nature Neuroscience, Vol. 6(3), pp. 309-315.
- [8] Jung T-P, Makeig S, Humphries C, Lee TW, McKeown MJ, Iragui V, and Sejnowski TJ, "Removing Electroencephalographic Artifacts by Blind Source Separation," Psychophysiology, 37:163-78, 2000 .
- [9] Jung T-P, Makeig S, Westerfield W, Townsend J, Courchesne E, and Sejnowski TJ, "Removal of eye activity visual event-related potentials in normal and clinical subjects," Clinical Neurophysiology 111:1745-58, 2000 .