International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 1 Volume No.7 January - February – 2023
DOI:10.46647/ijetms.2023.v07i01.033 ISSN: 2581-4621

Design and Implementation of a Smart Prosthetic Hand

Kavyanjali R. (1DS19EC060), Mo Imran (1DS19EC080),
Nalliboyina Yuva Raja Phani Kumar (1DS19EC085), Maria Dayana L.N. (1DS20EC420),
[2]Dr. Pavithra G., [3]Dr. Sindhu Shree M., [4]Dr. T.C.Manjunath, [5]Aditya T.G., [6]Sandeep K.V.,
[7]Rajashekar M. Koyyeda, [8]Dr. Suhasini V.K., [9]Dr. Vijayakumar K.N.
[1]Second year BE (ECE) students, Dept. of Electronics & Communication Engg., Dayananda Sagar College of Engineering, Bangalore, Karnataka
[2]Associate Professor, ECE Dept., Dayananda Sagar College of Engineering, Bangalore
[3]Assistant Professor, ECE Dept., Dayananda Sagar College of Engineering, Bangalore
[4]Professor & HOD, ECE Dept., Dayananda Sagar College of Engineering, Bangalore
[5]Second year BE (CSE) Student, PES University, Bangalore
[6]Assistant Professor, Electronics & Telecommunication Engg. Dept., DSCE, Bangalore
[7]Assistant Professor, EEE Dept., Tatyasaheb Kore Inst. of Engg. & Tech., Kolhapur, Maharashtra
[8]Prof. & Head, Mechanical Engg. Dept., DJ Sanghvi College of Engg., Mumbai
[9]Principal & Prof., Dept. of MCA, Bharati Vidyapeeth's Inst. of Mgmt. & Info. Tech., Mumbai

Abstract
An overview of the design and use of a Smart Prosthetic Hand is provided in this study. This study presents an overview of computational methods for brain, gesture, and voice signals to operate a robotic arm. There are several hundred million neurons in the human brain. A prosthetic arm powered by a Brain-Computer Interface (BCI) based on electroencephalograms (EEG) is a non-invasive approach that can be a powerful aid for persons with severe disabilities in their daily lives, particularly to let them use their arm voluntarily. The brain's EEG data is recorded by the Brainsense headset and processed by a microprocessor to move the prosthetic hand via controlling servo motors. Additionally, a glove controller that replicates the gestures is used. The method entails using flex sensors to control the arm's movements. The voice control system was created so that voice commands could be sent through Bluetooth to control prosthetic arms. With the aid of a microcontroller, all actions can be monitored by a user interface. This prosthetic arm can help patients who have amputees below the elbow. This essay's main objective is to enable people with physical disabilities to become less dependent on others for their everyday needs. This model would be very helpful in both the real world, especially for those with disabilities who are unable to use their hands, and in the classroom when employed by college students pursuing robotics as a subject. The work given here is a mini-project that is taken up as a part of the curriculum completed by electronics and communication engineering students in the second year of the electronics & communication engineering department at Dayananda Sagar College of Engineering in Bangalore.
Keywords
Robotic arm, Electroencephalogram, Brain-Computer Interface, Brainsense headset, Bluetooth, Voice control, flex sensors

1. Introduction
The inspiration for this idea came from persons with disabilities, stroke patients who have motor deficits, war veterans who lost their arms, and individuals who are unable to control their hands and arms. According to recent surveys by the World Health Organization (WHO), half of all people worldwide live with some sort of disability, which affects around 15% of the population [1]. There are around 5 million crippled persons in India. In the world, there are approximately 10 million amputees, 30% of whom have lost one arm [2]. The three main causes of limb loss are illnesses, birth abnormalities, and traumatic events. Other common causes are injuries sustained in motor vehicle and cruiser accidents [3]. One of the most coveted robotic and prosthetic accomplishments, as well as one of the most challenging engineering goals ever, is to replicate the human hand [4]. Hand

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 1 Volume No.7 January - February – 2023
DOI:10.46647/ijetms.2023.v07i01.033 ISSN: 2581-4621

gestures are a common form of human contact and are effective in HCI [5]. The prevalence of amputees and patients with limb impairment is rising overall for a variety of political, economic, scientific, and demographic reasons. Although artificial limbs have been around for a while, their use and interaction with the environment are not very natural. They call for invasive surgical intervention [6].

The fundamental objective of such intricate treatments is to redistribute nerves so that amputees may operate their prosthetic devices simply by thinking about what they wish to do [7]. Robots are employed not just in industries but also in everyday life. A robotic arm is a sort of mechanical arm that performs tasks akin to those of a human arm and is typically programmable. To complete jobs, robotic arms are used in a variety of sizes and configurations [8]. This project's main objective is to support physically disabled people in their daily lives. Here, the robot picks up and places any thing to assist the impaired person in becoming independent. For users to benefit in freedom, self-realization, and social inclusion, assistive robot efficiency must therefore be improved at several levels [9]. The invention of electroencephalography (EEG) and Hans Berger's discovery of the electrical activity of the human brain are at the foundation of the history of brain-computer interfaces (BCI) [10]. Berger was the first to use an EEG to capture human brain activity in 1924. Using his or her brain activity, a person can communicate with an automated system like a robot or prosthesis through a BCI, which is a non-muscular communication channel. There are many uses for BCI systems, including controlling a wheelchair prosthesis or a cursor on a screen, as well as multimedia and virtual reality [11].

Acquisition is a representation of one of a BCI system's most crucial elements. The most used acquisition method is EEG, which offers an affordable and transportable acquisition solution [29]. The EEG method relies on scalp electrodes being placed to the subject to record brainwaves. EEG signals have low-level amplitudes of the order of microvolts and oscillate between 1 Hz and 100 Hz in frequency. Specific properties are extracted and linked to various patient brain activity states as well as directives for apps that have been built [12].

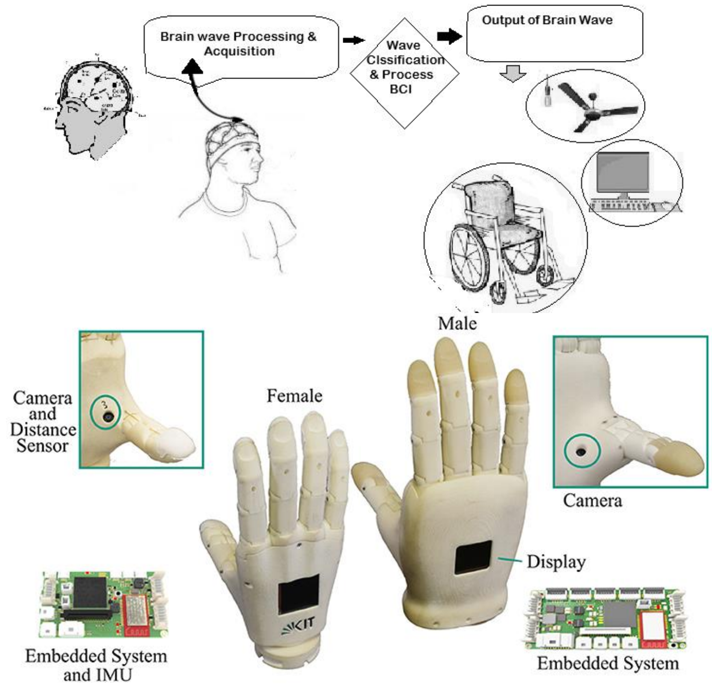

Fig.1: Applications of BCI interface prototype that is going to be developed in our project

Fig. 1 gives the prototype of the prosthetic hand that is going to be developed in our project. Although speech recognition algorithms have been developed for a while, they recently gained prominence as a result of significant advancements in voice recognition performance and resilience, which enable cutting-edge machine learning methods [28]. Many elderly assistance robots can be operated with

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 1 Volume No.7 January - February – 2023
DOI:10.46647/ijetms.2023.v07i01.033 ISSN: 2581-4621

joysticks, tablets, PCs, etc. [13], but some people may find it difficult to use them; in this case, a voice-controlled robot can be used to solve the problem. To process the user's voice through distant servers, the majority of modern speech control systems, including those found in smartphones and home automation, need an internet connection. Due to autonomy and safety considerations, it is ideal for an assistive technology to work without an internet connection [14].

This has a significant impact on the use cases that may be developed with voice recognition devices. In this project, we use a robotic arm to carry out the intended action while transmitting voice commands through Bluetooth to a preprogrammed controller [15]. Glove-based techniques that assess hand and arm joint angles and spatial position are among the most widely used methods[16]. The use of this gesture recognition technology has become more widespread in a short period of time. The flex sensors are an effective tool for identifying and detecting human body motions due to their moderately low cost and relatively small size [17]. The primary goal of gesture recognition in this work is to identify a specific hand motion and deliver an appropriate instruction to a robotic system for action execution [18].

2. Objectives & Scopes

The goal of our initiative is to assist people with disabilities in living a normal life and carrying out their everyday tasks more effectively and efficiently without the assistance of others [27]. It mostly aids those who have lost their hands as a result of conflict, those who are paralysed, and those who have lost control of their limbs. Without requiring any brain surgery, BCIs convey the subject's thoughts, which have been converted into control signals by brain electrical activity, for external use [30]. This aids the individual who need support. With the help of this technology, a completely dependent person can become somewhat autonomous, which will benefit both their physical and mental health [26]. The project's specific objective was to make controlling assistive robots more natural and to have them carry out various duties more quickly and efficiently via voice instructions [25]. To accurately duplicate only a few of the motions available with the human hand, it is best to design for a very simple prosthetic hand [24]. Designing a highly complicated prosthesis that could imitate every hand gesture possible would be challenging and unnecessary. However, the prosthesis must be made to allow the hand's selected articulations to appear as natural as feasible [21].

The prosthesis would need to be made with strength, stability of motion, and long-lasting elements, taking into account the necessity for a sturdy design since it may be used in daily life. Aside from needing to be too sophisticated in terms of machine operations, the parts would also need to be designed to allow for simple machining. The major goal is to create a trustworthy, affordable prosthetic arm control circuit. Additionally, it is necessary to create a smart prosthetic arm that can do complicated navigational tasks (select and put objects in a realistic environment) for persons with disabilities. This arm would employ signals from the brain that were recorded and processed [20]. The design of the prosthetic hand mimics the gestures and responds appropriately. voice instructions can be used to control the hand [22]. Additionally, based on the signals analysed, to automate the home and send a warning message to family members in the event of an emergency, as well as the GPS location of the person using the prosthetic hand [23].

3. Conclusions and Next Steps

The work presented in this paper gives a small indepth information about the prosthetic hand which we are going to develop in our project work. Prosthetics is one of the many applications for Human Robot Interaction (HRI). In order to obtain EEG data from the brain utilising the brain's electrodes and take appropriate action, this project develops and implements a comprehensive technique. The speech recognition module will effectively capture the data by responding to vocal commands.

References

[1] Chinbat, “Prosthetic Arm Control by Human Brain,” IEEE International Symposium on

DOI:10.46647/ijetms.2023.v07i01.033 ISSN: 2581-4621

Computer, Consumer and Control (IS3C), 2018.
[2] T. Beyrouthy, "EEG Mind Controlled Smart Prosthetic Arm," A Comprehensive Study Advances in Science, Technology and Engineering Systems, 2017.
[3] Andrews, "Low-Cost Robotic Arm for differently abled using Voice Recognition," Proceedings of the Third IEEE International Conference on Trends in Electronics and Informatics (ICOEI 2019), 2019.
[4] Juan Pablo, "Voice Controlled Prosthetic Hand with Predefined Grasps and Movements," VII Latin American Congress on Biomedical Engineering CLAIB, 2016.
[5] Dr.Sandeep, "Robotic arm control using gesture and voice", IEEE International Journal of Computer, Information Technology & Bioinformatics (IJCITB).
[6] Guoxin, "The Prosthetic Arm: A Dramatic Improvement For The Limb Amputation From The Humerus," IEEE 4th International Conference on advanced Robotics and Mechatronics, 2019.
[7] D. sharma, "Enhanced Framework for Active Prosthetic Arm," IEEE International Conference om Advanced communication and applied informatics., 2022.
A. P. Naik, "Arduino based Voice controlled Robotic Arm," IEEE International Conference on advanced Robotics, 2017.
[8] Shobhan, "Implementation of Pick & Place Robotic Arm for Warehouse Products Management," IEEE International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA), 2021.
[9] Nirsandh G; Preetha S; Sabeer yaccob. "Arthroplasty Advancement: Remodification Design of Total Hip Replacement". International Research Journal on Advanced Science Hub, 2, 6, 2020, 105-108. doi: 10.47392/irjash.2020.45
[10] Muniyandy Elangovan; Mohamed Yousuf; Mohamed Nauman; Mohammed Nayeem. "Design and Development of Delivery Robot for Commercial Purpose". International Research Journal on Advanced Science Hub, 4, 07, 2022, 192-197. doi: 10.47392/irjash.2022.047
[11] Gayathri N Shenoy; Chithu Rajan; Shibi Varghese; Vignesh M.V; ShanmugaPriya M; Priya S; Aparna George. "STERILOID: Room Sanitization Robot". International Research Journal on Advanced Science Hub, 2, 8, 2020, 100-104. doi: 10.47392/irjash.2020.101
[12] R. Devi Priya, R. Sivaraj, Ajith Abraham, T. Pravin, P. Sivasankar and N. Anitha. "Multi-Objective Particle Swarm Optimization Based Preprocessing of Multi-Class Extremely Imbalanced Datasets". International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems Vol. 30, No. 05, pp. 735-755 (2022). Doi: 10.1142/S0218488522500209
[13] Saha, "Progress in brain computer interface, challenges and opportunities," Frontiers in systems Neuro science., 25th Feb. 2021.
[14] J. R. Wolpaw, "Brain–computer interfaces as new brain output pathways," Wadsworth Center, Laboratory of Nervous System Disorders, New York State Department of Health and State University of New York, Albany, Mar 5 2007.
[15] J. kaur, "A review on analysis of EEG signals," IEEE International Conference on Advances in Computer Engineering and Applications (ICACEA), 2015.
[16] Ujwal, "Voice Control Based Prosthetic Human Arm," International Research Journal of Engineering and Technology (IRJET), 07, July 2019..
[17] Z. X. P. Wang, "Design of a voice control 6DoF grasping robotic arm based on ultrasonic sensor, computer vision and Alexa voice assistance," IEEE 10th International Conference on Information Technology in Medicine and Education, 2019.
[18] Poirier, "Voice Control Interface Prototype for Assistive Robots for People Living with Upper Limb Disabilities"," IEEE 16th International Conference on Rehabilitation Robotics (ICORR) Toronto, 2019.
[19] P. Iyer, "Hand Gesture Controlled Robot," IEEE 9th International Conference on Emerging Trends in Engineering and Technology - Signal and Information Processing (ICETET-SIP-19), 2019.
A. B. Bakri, "Wireless Hand Gesture Controlled Robotic Arm Via NRF24L01 Transceiver","

DOI:10.46647/ijetms.2023.v07i01.033 ISSN: 2581-4621

Proceedings of 2016 IEEE Conference on Latest trends in Robotics., 2016.
[20] P. Atre, "Efficient and Feasible Gesture Controlled Robotic Arm," IEEE International Conference on ent Computing and Control Systems (ICICCS), 10 March 2019.
[21] Rajanbabu, "Material Handling Using Pick and Place Robot," IEEE International Conference on Smart Structures and Systems (ICSSS), 2020.
[22] Sonawanc, "Motion Control of Robotic Arm for Micro-Positioning in Industrial Application"," IEEE International Conference on Advances in Communication and Computing Technology (ICACCT), 2018.
[23] M. Fattah, "Gesture controlled prosthetic arm," IEEE 3rd International Conference for Convergence in technology, 2018.
[24] M. k. Doga Akcinar, "Speaker Dependent Voice Controlled Robotic Arm," IEEE International Symposium on Innovations in Intelligent Systems and Applications (INISTA), 2018.
[25] R. Dhotre, "Gesture controlled home automation," International journal of Scientific and Engineering Research, vol. 8, no. 9, 2017.
A. S. Aishwarya Patil, "Haptic Robotic Arm Using Voice & Gesture Recognition," Journal of Advanced Research in Computer and Communication Engineering, vol. 2, no. 3, Mar 2013.
[26] Kanash, "Design and Implementation of Voice Controlled Robotic ARM," IEEE International Conference on Communication & Information Technology (ICICT)., 2021.
[27] Sihombing, "Robotic Arm Controlling Based on Fingers and Hand Gesture", IEEE International Conference on Mechanical, Electronics, Computer, and Industrial Technology (MECnIT), 2020.
[28] Gunapriya, "A review of Arduino based hand gesturec ontrolled robot using IoT," IEEE International Conference on Artificial Intelligence and Smart Systems (ICAIS), 2022.
[29] J. Islam, "ntegration of Home Assistance with a Gesture Controlled Robotic Arm," IEEE Region 10 Symposium (TENSYMP)., 2020.
[30] K. K. Ang, "EEG-based Strategies to Detect Motor Imagery for Control and Rehabilitation,"IEEE proceedinds on Transactions on Neural Systems and Rehabilitation Engineering, 2016.
[31] Ashwal, "" Stress Effect on Attention Level Detection Using Neurosky Mindwave Headset," International Biomedical Instrumentation and Technology Conference (IBITeC), 2021.
[32] Lakshmi Gandan, "EEG Based Brain Controlled Mobile Arm Pick and Place robot," International Journal of Engineering Trends and Technology (IJETT), vol. 45, 8 Mar 2017.
[33] Katona, "Evaluation of the Neuro Sky Mind Flex EEG headset brain waves data," IEEE International Symposium on Applied Machine Intelligence and Informatics (SAMI), 2021.
[34] M. Borghetti, E. Sardini and M. Serpellon, "Evaluation of bend sensors for limb motion monitoring," IEEE International Workshop on Medical Measurement and Applications (MEMEA), 2014.