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BRAIN CONTROLLED ROBOTIC ARM

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ABSTRACT

This project explores the development of a brain-controlled robotic arm using brain wave sensing and Arduino, aiming to assist individuals with motor impairments. By leveraging a brain computer interface (BCI) and electroencephalogram (EEG) technology, brain signals are captured and translated into motion commands for the robotic arm. The EEG headset detects various brainwave patterns, such as alpha, beta, and gamma waves, which are associated with different cognitive states like focus or relaxation. Arduino is used as the central processing unit, receiving brainwave signals and converting them into electrical outputs that control the motors of the robotic arm. These outputs allow the robotic arm to perform simple tasks such as grasping, lifting, and releasing objects, based on the user's mental concentration or relaxation levels. The system provides a cost-effective and accessible solution for individuals with disabilities, enabling them to control assistive devices through non-invasive brainwave detection. Future enhancements could include machine learning algorithms to improve signal accuracy and responsiveness, allowing for more complex movements and personalized control. This research contributes to the fields of assistive technology and human machine interaction by demonstrating the feasibility of robotic control through brainwave sensing and Arduino-based platforms.

1.INTRODUCTION

1.1 Introduction

Controlling a computer with one's mind may sound like science fiction, but brain-computer interfaces currently exist, and innovative research is rapidly expanding the level of control that is achievable. Researchers, psychologists, artists, and others have been experimenting with noninvasive brain- computer interfaces that read brain signals with an electroencephalogram (EEG). EEG-based brain- computer interfaces use sensors placed on the head to detect brainwaves and feed them into a computer as input. EEG-based interfaces are being used for a wide range of applications. Clinical psychologists employ brain interfaces to treat a number of conditions, including attention deficit hyperactivity disorder (ADHD), epilepsy, and alcoholism. Researchers are creating brain-interfaces to aid disabled users who are unable to use typical computer interfaces. ROBOTS have been not only widely used in industry, but also gradually entering into human life. Assistive robots can provide support for disabled people in daily and professional life, thus creating a growing demand for them. In general, healthy users can operate the robots with a conventional input device such as a keyboard, a mouse, or a joystick. These devices are, however, difficult to use for elderly or disabled individuals. The brain-controlled robot basically works on the principle of capturing the brain wave signals utilizing it for the movement of robot. Two main classes of brain-controlled robots to assist disabilities are brain-controlled manipulators and mobile robots.

One representative work of braincontrolled manipulators is the manipulator used within the ftiend system developed by Graser which is able to show the brain-controlled capabilities of robots out of a controlled laboratory situation. Brain-controlled mobile robots can be divided into two categories according to their operational modes. One category is called “direct control by the BCI,” which means that the BCI translates EEG signals into motion commands to control robots directly. The basic idea of BCI is to translate user produced patterns of brain activity into corresponding commands. Although some BCI systems do not include all components and others group two or three components into one algorithm, most systems can be conceptually divided into signal acquisition, preprocessing, feature extraction, and classification The brain signals that are widely used to develop EEG-based BCIs include P300 potentials, which are a positive potential deflection on the ongoing brain activity at a latency of roughly 300ms after the random occurrence of a desired target stimulus from non target stimuli the stimuli can be in visual, auditory, or tactile modality SSVEP, which are visually evoked by a stimulus modulated at a fixed frequency and occur as an increase in EEG activity at the stimulus frequency and the event-related de synchronization (ERD) and event-related synchronization (ERS), which are induced by performing mental tasks, such as motor imagery, mental arithmetic, or mental rotation.

1.2 Objective of the project

Design and Build Working of Robotic ARM handling with Android application. The device employs electroencephalography (EEG) data acquired from the scalp to classify the user's intention, brain signals, and control the robotic arm's movement.

1.3 Existing System

The system is based on android application controlled for remote operation. In this method, robotic arm is designed and developed with a soft catching gripper. This system has 8 independent commands for Robotic ARM open and close, wrist up and down, Pick and Place and Start and Stop. By using Android microcontroller, the robot has performed the task perfectly according to the program that being made.

1.4 Proposed System

BCIs Brain computer interface are systems that can bypass conventional channels of communication to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. This system describes about EEG based brain controlled pick and place robot. The robotic arm is controlled through egg sensor. The key lies in the mapping of the EEG signal to the robotic arm to achieve the objective. This system demonstrates the application for disabled people and Industry automation.

1.5 Block Diagram

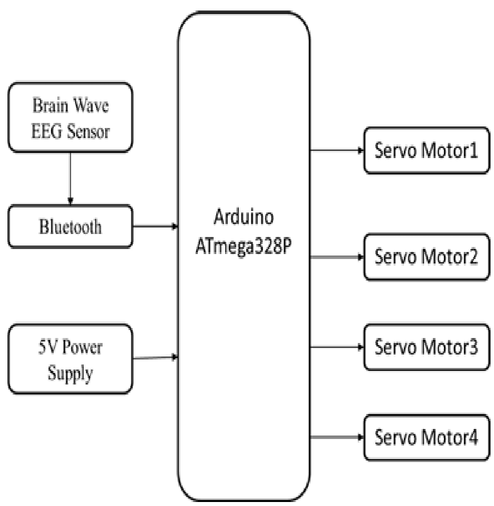

Fig 1.1 Block Diagram

Block Diagram Components:

1. EEG Sensor (Brain Wave Sensor):

• Captures electrical signals generated by brain activity.

• Converts brain wave data into digital signals (e.g., attention, relaxation).

2. Arduino Microcontroller:

• Processes the digital brain wave signals received from the EEG sensor.

• Maps specific brain wave patterns (e.g., focus or thought commands) to corresponding actions for the robotic arm.

• Generates control signals based on the classified brain wave patterns.

3. Robotic Arm (Servo Motors):

• Receives control signals from Arduino.

• Executes the required movements such as lifting, rotating, or grasping, based on the brain wave commands.

4. Power Supply:

• Provides the necessary voltage for the Arduino, EEG sensor, and robotic arm motors.

2.LITERATURE SURVEY

1. Nicolelis, M. A. L. et al. (2003)

Title: *Chronic, multisite, multielectrode recordings in macaque monkeys during behavioral tasks*
Journal: Journal of Neuroscience Methods
Summary: Nicolelis pioneered the concept of direct cortical control of robotic limbs using neural signals. This study showed how cortical signals could be recorded to predict hand movements.

Contribution: Introduced real-time control of robotic limbs using brain signals.

2. Hochberg, L. R. et al. (2006)

Title: *Neuronal ensemble control of prosthetic devices by a human with tetraplegia*
Journal: Nature
Summary: Demonstrated that a tetraplegic patient could control a robotic arm using a brain-computer interface based on intracortical recordings.
Contribution: Landmark human trial validating invasive BCI for robotic limb control.

3. Lebedev, M. A., & Nicolelis, M. A. (2006)

Title: *Brain–machine interfaces: past, present and future*
Journal: Trends in Neurosciences
Summary: A comprehensive review of the evolution and state of BCIs for robotic control.
Contribution: Established foundational knowledge for invasive and non-invasive BCIs.

4. Pfurtscheller, G., & Neuper, C. (2001)

Title: *Motor imagery and direct brain-computer communication*
Journal: Proceedings of the IEEE
Summary: Focused on EEG-based BCI systems using motor imagery for controlling external devices.
Contribution: Key work in non-invasive BCI using EEG signals.

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5. Leuthardt, E. C. et al. (2004)

Title: *A brain–computer interface using electrocorticographic signals in humans*
Journal: Journal of Neural Engineering
Summary: Showed ECoG (Electrocorticography) as a middle ground between EEG and intracortical methods.
Contribution: Demonstrated high-resolution control using semi-invasive BCI.

3. WORKING METHODOLOGY

3.1 Working Principle

• **EEG Signal Acquisition:**

A brainwave sensor (such as NeuroSky MindWave or OpenBCI) captures electrical activity from the brain. • Signal Processing: The EEG sensor processes brain signals and extracts relevant features (e.g., attention levels or specific brainwave patterns).

• **Data Transmission:** The processed signals are transmitted to an Arduino via Bluetooth or a wired connection.

• **Arduino Control:** The Arduino interprets the received signals and converts them into commands for the robotic arm.

• **Robotic Arm Movement:** Based on the brainwave input, the robotic arm performs pickand-place actions using servo motors.

3.2 RESULT

Fig 3.1 Result

ADVANTAGES AND APPLICATIONS

Advantages:

1.Enhanced Mobility: Restores or enhances mobility for individuals with paralysis, amputation, or motor disorders.

2. Intuitive Control: Allows users to control the arm with their thoughts, providing a natural and intuitive interface.

3. Increased Independence: Enables users to perform daily tasks and activities with greater autonomy.

4. Improved Quality of Life:

Enhances overall quality of life for individuals with disabilities or motor impairments. **Applications :**

1.Assistive Technology: Helping individuals with paralysis, amputation, or motor disorders perform daily tasks.

2. Neuroscience Research: Studying brain function, motor control, and neural plasticity.

3. Space Exploration: Potentially assisting astronauts in space missions.

4. Medical Surgery: Possibly enhancing surgical precision and control. 5. Disaster Response: Assisting in search and rescue operations.

4. CONCLUSION

These preliminary results revealed conclusions converted in future possible improvements for presented controlling paradigms. Comparing the two proposed paradigms, we notice a major difference for selection events in terms of accuracy. This difference might appear due to the user's fatigue when using the EOG-based system. Also, the difference is seen for average values. Most of the subjects presented an increase in the selection accuracy of over 7.5% in case of the EOGEEG paradigm. One of the subjects presented an accuracy rate increase of over 10%, two of them of over 14% and a single one presented a decrease in the accuracy rate of 3%. Considering commands for gripper closure, we conclude there is a difference between maximum accuracy rates and also for average rates. It seems that using eye closure events (through EEG signals), subjects achieved a higher accuracy rate. From the answers given by subjects, we conclude that the EOGEEG-based paradigm was preferred by subjects; results also confirmed this fact. They argued that this combination was less tiring. Future work is related to refining developed algorithms, in order to increase recognition accuracy rates. Current system will evolve in an synchronous one, allowing the user to select a desired object at will. Some new tests will be conducted in order to finally choose the best paradigm for our project, considering also the fact that many objects for selection will be added in the next applications, and also new commands will be integrated

5. FUTURE SCOPE

1. The future scope of robotic arm handling with button mechanisms holds significant potential across various industries due to its versatility, precision, and the growing demand for automation. The combination of robotic arms and button mechanisms is expected to expand in multiple directions. Here are some key future trends and possibilities:

2. Advancements in Haptic Feedback and User Control

3. Industry 4.0 and Manufacturing

4. Flexible Automation in Logistics and Warehousing

5. Artificial Intelligence and Robot Autonomy

6. Miniaturization and Consumer Applications

7. Environmental Impact and Sustainability

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