Aditiya Subba, 2026, 14:3
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

Hand Gesture Robotic Arm

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Abstract- The field of robots is now moving ahead rapidly. Robots are machines that perform physical tasks under the direction and control of humans. Many robots have been built to do dangerous jobs that humans can't do on their own, and the robot arm is one of them. This research proposed a model and implementation of a robotic arm for controlled use with human hand and finger gestures. The movement mechanism of the robot arm is controlled by flexible sensors and fuzzy logic. Gyroscopes and human hand motions control the angle of the robotic arm. The input and output operations of the sensors, hand movement, and other controlling mechanisms are processed by means of fuzzy logic.

Keywords: Microcontroller ATmega328P, Robotic arm, Hand gestures.

I. INTRODUCTION

Robots are used for numerous purposes like cleaning and industries, etc. Robots can be either autonomous, semi-autonomous, or remotely controlled. A complicated robot comprises hardware and software. Software gives the required intelligence signal to machinery for performing various jobs. Users send signals about their robots' movements, such as move ahead, reverse, stop, rotate, and up/down movement of arms for pick & place actions. They are carrying out delicate surgeries or working with experts. Everything is becoming complex due to technology. They can perform hazardous & repetitive jobs efficiently & speedily. It can save the pattern of operation inside its memory unit and replay when required. Robots can be classified into two broad categories viz. service robots and industrial robots. The robots are easy to control and very efficient. For designing this complex system, we require the roboticarm which works according to the gestures of the human hand and fingers. In our work, the gesture detection will be done using the visual camera which will detect the gestures of the human hand and record it in the form of an image. This image will be processed further and then its output will be viewed using the hardware model which is the robotic arm.

II. LITERATURE REVIEW

In [1], a basic mechanical arm was developed that is mainly programmable and has capabilities similar to a human arm. In [2], a wireless mobile robot arm was built that could perform pick-and-place operations under the command of wireless PS2 controller. The Arduino Mega board was used as the framework during the development process, and there had been an analysis of speed, range, and lifting power capacity in order to establish how capable it is. As it was stated before, the focus in [3] was on developing a robot that is able to sense the presence of any human activity and perform its duties accordingly. Let us develop a robot glove in which sensors will be installed for the detection of hand motion and transformation of these actions into electrical signals.

III. METHODOLOGY

The hand gesture robotic arm involves the creation of an apparatus which seeks to interpret hand movements by human beings and convert them to the operation of the robotic arm. This involves placing a glove or other wearable devices with flex sensors and accelerometers. Such gadgets help in detection of bending of hands and the orientation at which hand movements are made. This information

is then sent to the microcontroller through various means of communication such as Bluetooth.

After this, the data is processed in the microcontroller to create some commands. This information in form of command is then sent through wireless channels such as Bluetooth, to the robotic arm section of the apparatus. Here, the data is interpreted to issue commands to rotate the servo motors thus enabling joint movement of the robotic arm to replicate human gestures. Calibration of movements is done for accuracy.

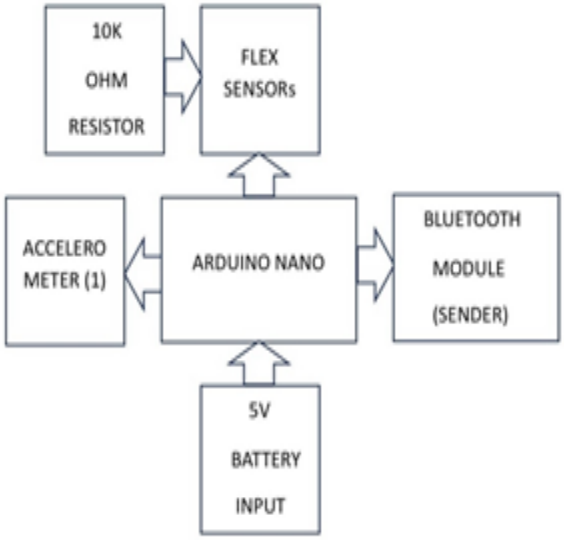

Figure 1: Block Diagram for Smart Glove

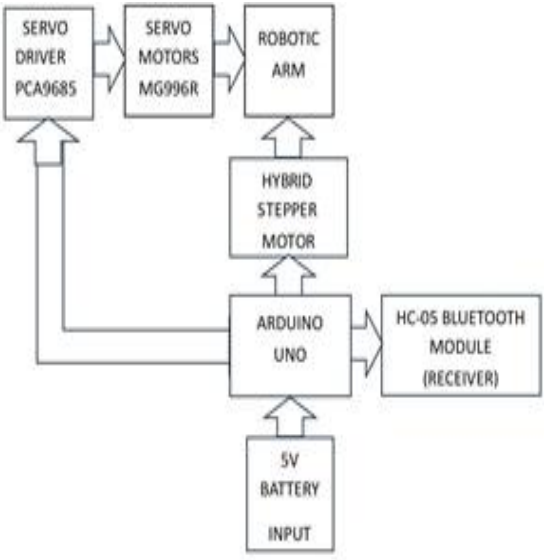

Figure 2: Block Diagram for Robotic Arm

V. SUMMERY TABLE OF ALL THE JOURNAL

SLNo	Title of the paper/Author	Technology used	Key finding	Gap
1	Gesture Controlled Robotic Arm Using IoT/Gaurav Kamat, Harsh Kaushik, Praveen Kumar Singh, RajneshKumar Singh,	Arduino ATmega328P, Servo motors, accelerometer sensors, RF communication modules, Wi-Fi module ESP8266,	Gesture and joystick control make robotic systems easier to operate.	Existing systems still face signal interference and response delay issues.
2	Robotic arm using hand gesture with AI/Ms.Jagruti Rane, Mr Om. Wadikar, Dr. Anuradha, S. Deshpande, Ms.Rutuja Sawant	Arduino microcontroller, Flexible sensors, gyroscope sensors, Bluetooth Module, Camera, microprocessor	The robotic arm successfully performed tasks such as writing, , pick-and-place operations, and gesture replication.	NN and ANN machine learning models are difficult to understand and implement.
3	IOT BASED GESTURE CONTROLLED ROBOTIC ARM FOR SURGERY/NOUFIYA N, RESHMA R NAIR, SALEEJA S, SHIJINA N S, INDU V NAIR	ESP32, ESP8266, ESP32CAM, MPU 6050, BUCK CONVERTER, FLEX SENSOR	The robotic arm successfully followed human hand gestures such as arm swing, palm movement, and grasping	Network latency and internet dependency can affect real-time surgical performance.
4	Implementation of a Human Hand Gesture Controlled Robotic Arm/E. Satheesh Kumar, Chepakam Indhu Reddy, Kasuvu Praveen Kumar, Amudala Yamin, KVinay	Arduino Uno, Wifi Module, LCD display, Servo Motor, Transformer	Integration of IoT and robotics improved automation efficiency and reduced manual effort.	Real-time latency reduction is still a challenge in remote robotic control systems.
5	Hand Gesture Controlled Robot Using Arduino/Suryarajsinh T. Vala	Arduino Uno, Accelerometer, RF Modules, Motor Driver	Arduino Uno, Accelerometer, RF Modes	No camera or vision-based feedback system is included for complex operations.

VI. FEATURE SCOPE

There is an immense scope for hand gesture robotic arms in the future due to development in artificial intelligence, machine learning, Internet of Things (IoT), and sensors. Future developments would make such robotic arms smart, precise, and user-friendly that are capable of detecting complex hand gestures and learning user behaviors automatically. Such robotic arms would prove to be extremely useful in the field of healthcare where they could help doctors, help in rehabilitation activities, and help people to control prosthetic arms using hand movements. Future developments would also make these robotic arms valuable assets for various industries as well as automation activities. It can also involve integration of VR, AR, and BCI to make robotic arms operate remotely and control them by thinking. Moreover, further advancements in the field of wireless.

VII. RESULT

Hand gesture control system of the robotic arm was developed successfully whereby movements of the robotic arm were controlled using hand gestures. Signals of movements of the hands were detected by sensors and transferred to the microcontroller for processing. Movements of the robotic arm due to the different hand gestures such as up, down, left, right, and gripper movements were accomplished

with very little delay. The communication between the gloves and robotic arm through wireless means was successful too.

Accuracy, flexibility, and ease of controlling the robot arm was successfully achieved through the developed system as opposed to other systems used to control the robotic arm. Servo motor controls movement of the robotic arm was accurate due to the hand gestures made by the users. From the development of this technology, it can be observed that human hand gestures can reduce efforts of people.

VIII. CONCLUSION

The project successfully demonstrates a real-time IoT-based gesture-controlled robotic arm. The integration of Arduino, MPU6050, flex sensors, and ESP8266 enables accurate gesture detection and wireless robotic control.

This major project enhances understanding of robotics, embedded systems, IoT communication, control systems, and automation technologies. The system provides a foundation for future AI-based smart robotic systems.

The project 'Robotic Arm Using Hand Gesture with Arduino UNO' successfully demonstrates how natural human gestures can be used to control robotic arms. By using flex sensors, MPU6050, Arduino UNO, and servo motors, the system provides real-time, user-friendly control.

This project not only enhances the learning of embedded systems and robotics but also opens opportunities in prosthetics, industrial automation, defence, and healthcare. With future improvements, it can become a highly impactful and widely adopted

REFERENCE

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