International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IoT Based Human Hand

Bhoomika Banajger [1], Gourav Yelameli [2], Pallavi Mopagar [3], Vidyashree Pujeri [4], Anandraddi Naduvinmani [5]

[1 2 3 4] Dept. of Electronics and Communication Engineering, S. G. Balekundri Institute of Technology, Belagavi, Karnataka, India.

[5] Assistant Proferssor, Dept. of Electronics and Communication Engineering, S. G. Balekundri Institute of Technology, Belagavi, Karnataka, India.

ABSTRACT

An IoT-based human hand refers to a system that integrates the human hand with Internet of Things (IoT) technology. The system involves the use of sensors and devices that can detect and measure different aspects of hand movements and gestures, such as motion, position, and force. The data collected from these sensors can be transmitted wirelessly to a central computer or mobile device for processing and analysis. The IoT-based human hand has numerous potential applications, including virtual reality and gaming, medical rehabilitation, and human-robot interaction. The system can also be used to monitor and track hand movements for security and surveillance purposes. The integration of IoT technology into the human hand opens up a range of possibilities for improving human-machine interaction and enhancing the capabilities of the human body.

Keywords—IoT, Sensors, Gestures, Human-Robot interactions.

Introduction

The recent days have seen robotics reach such a level that robots are being used in day-to-day tasks. Hence, real time controlling and automation is important to increase the human robot interaction levels [1]. They are also shown to have a positive effect on human psychology. A hand gesture controlled robotic arm is a type of robotic system that is designed to be controlled through the use of hand gestures. These gestures are typically captured by sensors or other types of input devices, which are then interpreted by software algorithms to generate commands for the robotic arm. The introduction of a hand gesture controlled robotic arm can provide a number of benefits in various applications, such as allowing for more intuitive and natural human-robot interaction, reducing the need for physical controls or buttons, and enabling the use of the robotic arm in situations where traditional controls may not be practical. There are a wide range of possible applications for hand gesture controlled robotic arms, including manufacturing, assembly, inspection, and even healthcare and rehabilitation. These systems can be used in a variety of settings, including industrial environments, research labs, and hospitals [2]. Overall, the introduction of a hand gesture controlled robotic arm can enable more efficient and effective automation of tasks and processes, and has the potential to revolutionize the way humans interact with robots in the future.

The Internet of Things (IoT) has revolutionized the way we interact with technology, transforming everyday objects into smart devices that are connected to the internet. One area where IoT has shown great promise is in the field of human-machine interaction, particularly in the context of human hand-based applications. The human hand is a complex and dexterous organ that plays a crucial role in our daily activities, ranging from simple tasks like grasping objects to more intricate tasks like playing musical instruments or performing surgery. With the advancements in IoT technologies, human hand-based applications have gained significant attention due to their potential to enhance human capabilities, improve healthcare outcomes, and enable new opportunities in various domains, including smart homes, healthcare, robotics, gaming, and virtual reality. IoT-based human hand applications involve the integration of smart devices, sensors, and communication technologies with the human hand to enable remote monitoring, control, and feedback, creating a seamless interaction between humans and machines.

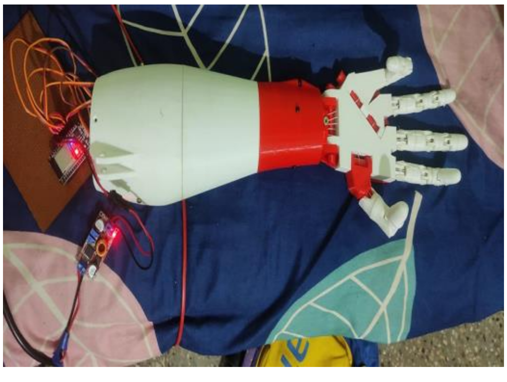

Fig 2. Robotic Arm

In this conference paper, we aim to explore the current state-of-the-art in IoT-based human hand applications, including the latest research and advancements in the field. We will discuss the challenges, opportunities, and potential use cases of IoT-based human hand applications, along with their implications for various domains. Furthermore, we will delve into the technical aspects, such as the design considerations, communication protocols, and sensor technologies employed in IoT-based human hand applications. We will also highlight the ethical, privacy, and security concerns associated with the integration of IoT with the human hand and propose possible solutions.

Overall, this paper aims to provide a comprehensive overview of the state-of-the-art in IoT-based human hand applications, highlighting their potential to transform various domains and open new avenues for research and innovation. We hope that this paper will inspire further research and discussion on this emerging field and contribute to the advancement of IoT technologies for human-machine interaction.

LITERATURE REVIEW

The current study builds upon a significant body of research that has investigated the effects of topic of the study on relevant outcome variables. In this literature review, we will summarize and analyze the key findings from previous studies in this area, highlighting the most important and relevant findings to inform the present study.

In study [3], The labor deficit has grown increasingly pronounced as a result of a dropping birthrate and an ageing population. In light of this, using remote robot operation to replace human work have gained traction. In this study, a real-time gesture-based human-robot interaction application for senior care employing a Kinect sensor is suggested. Robotic teleoperation using gestures makes it possible to swiftly identify senior patient needs and situations, such as abrupt falls and abnormalities. The iRobot Create robot that was used in this study is a well-known mobile robot for indoor use. It can recognize the gestures of raising the right hand, raising the left hand, waving the right hand, and waving the left hand to control the robot's forward, backward, right, and left movements, respectively. According to experimental findings.

In study [4], Since the global pandemic outbreak, work-from-for remotely managing and monitoring applications have developed quickly. We have been inspired by this to create a remotely controlled Robotic arm that can be utilized in applications where interacting with humans in hazardous environments is risky (such as in isolation rooms for COVID patients). As a result, a robotic arm, which technicians can control from a distance to lessen their direct interaction with the dangerous environment, has been developed as a B-rover. It has a variety of uses, including the ability of the Robotic Arm to gather samples from patients and a health monitoring system for tracking the patient's health problems.

In study [5], Wireless operations are required in many businesses, particularly in risky or hazardous environments. In some businesses, it is required to handle a small number of jobs with very high demands. In such instances, wireless activities are more efficient since temperature cannot be measured by hand. This study focuses on the design of a hand gesture controlled robotic arm utilizing a microcontroller and wireless sensor networks. Simulations are being run, and the hardware prototype has been successfully implemented in accordance with the specifications listed above.

In study [6], - In this study, we highlighted how human efforts may be decreased by implementing the robotic arm. Since automation has been adopted in many areas, the need for robots is expanding on a daily basis. We considered many current technologies and worked in the realm of robotic arms and IoT. After reviewing all of the existing technology, we can claim that it opens up a new door for technology that can be employed to complete a new project. It also addresses the extent of current technology and its sphere of applications designed using the 3D rendering software SolidWorks and then manufactured using additive and subtractive methods.

METHODOLOGY

Our goal is to develop a hand gesture controlled robotic arm that allows the user to easily and intuitively control the robot using natural hand gestures, without the need for specialized training or complex interfaces. Human machine interface is used to control robotic arm. To make this device simple as well as cheap so it can be produced and used for number of purposes. In this project user is also able to control motions by wearing controller glove and performing predefined gestures.

The hand gesture controlled robotic arm system connected to STM-32 microcontroller with all the sensor and transceiver to establish the connection and control the arm with flex sensor and accelerometer though LoRa transceiver. The first goal is to convert the hand and finger movements to readable electrical signals. This is done by the aid of flex sensor, gyroscope and accelerometer

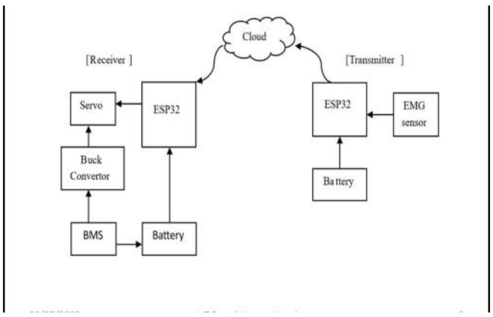

Fig 2. Block diagram of Robotic arm

Flex sensor and MPU-6050 are connected to the STM32 as showed in the STM32 operate from a 2.0 to 3.6V power supply and the voltage is an analogue value given by the flex sensor are analog and cannot precisely be determined by a digital circuit. This is where we configure the ADC of STM-32. This ADC is a 10 channel 12 -bit ADC. Here the term 10 channel implies that there are 10 ADC pins using which we can measure analogue voltage. MPU-6050 is a Micro Electro-mechanical system (MEMS), it consists of a three-axis accelerometer and three-axis gyroscope.

The first step is to design the robotic arm and determine its specifications, such as the size, weight capacity, range of motion, and control system. The design should take into account the intended application and environment. Once the design is finalized, the robotic arm can be built using appropriate materials and components. The IoT sensors and connectivity hardware can also be integrated into the design.

The IoT sensors and connectivity hardware can be integrated into the robotic arm, allowing it to send and receive data to and from other devices and systems. This can be done using various IoT protocols, such as MQTT, CoAP, or HTTP. The data collected by the IoT sensors can be analyzed in real-time using various data analytics tools, such as machine learning algorithms, to identify patterns and optimize the performance of the robotic arm.

Fig 3. Requirements of Robotic Arm

The IoT connectivity allows for remote control and monitoring of the robotic arm from anywhere, using various devices such as smartphones, tablets, or laptops. This allows for increased flexibility and reduces the need for human intervention. Regular maintenance and updates are necessary to ensure the optimal performance and longevity of the robotic arm system. The IoT connectivity allows for predictive maintenance, detecting potential issues before they cause major problems and allowing for proactive maintenance.

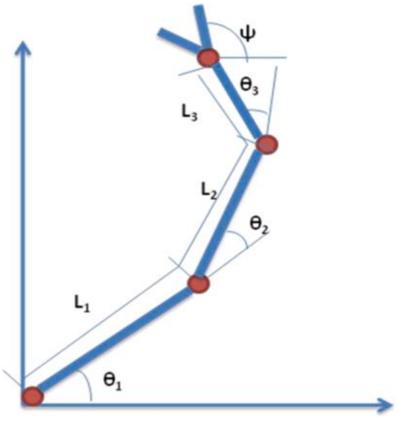

Fig 4. Three degree of freedom in 2D manipulator with orientation.

A two-dimensional manipulator with orientation has three degrees of freedom, which can be defined as follows:

1. Translation along the x-axis: The manipulator can move horizontally along the x-axis in the plane
2. Translation along the y-axis: The manipulator can move vertically along the y-axis in the plane.
3. Rotation about the z-axis: The manipulator can rotate about the z-axis, which is perpendicular to the plane of motion.

These three degrees of freedom allow the manipulator to position and orient itself in the two-dimensional plane, which is useful for tasks such as pick-and-place operations, assembly, and inspection. The orientation of the manipulator can be important in such tasks because it determines the angle at which it approaches the object or surface being manipulated.

RESULT AND DISCUSSION

The use of IoT in robotic arm systems can result in increased efficiency, improved performance, and reduced downtime, leading to significant cost savings and increased productivity for businesses. IoT-enabled robotic arm systems can be programmed to perform tasks more efficiently and accurately, resulting in increased productivity.

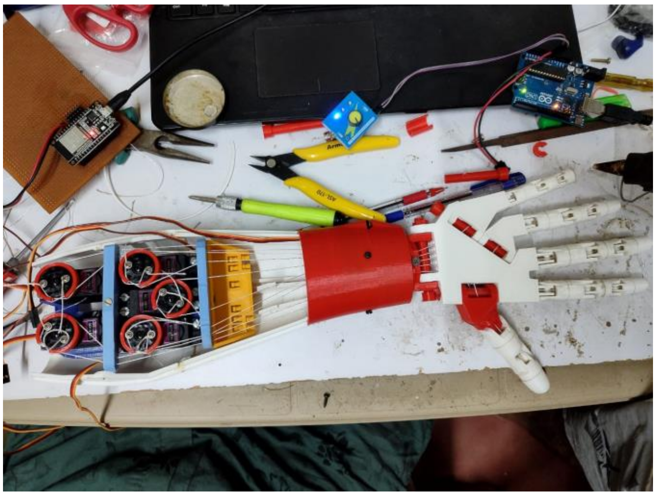

Fig 5. Robotic arm

Fig 6. Slider Setting

In the context of an IoT-based human hand project, it is possible that a slider setting could be used to control or adjust various parameters related to the operation of the hand. For example, a slider could be used to adjust the strength or speed of the hand's movements, or to select different grip patterns or finger configurations.

Comparison of simulated and actual readings obtained from the designed robot for IoT application.

Table 1: Slider Switch Position

1	2	3
0%	0%	0%
25%	0%	0%
50%	0%	0%
75%	0%	0%

100%	**0%**	**0%**
0%	**25%**	**0%**
0%	**50%**	**0%**
0%	**75%**	**0%**
0%	**100%**	**0%**
0%	**0%**	**25%**
0%	**0%**	**50%**
0%	**0%**	**75%**
0%	**0%**	**100%**

Table 2: Simulation Output

1(in Degrees)	2(in Degrees)	3(in Degrees)
0	**0**	**0**
45	**0**	**0**
90	**0**	**0**
135	**0**	**0**
180	**0**	**0**
0	**45**	**0**
0	**90**	**0**
0	**135**	**0**
0	**180**	**0**
0	**0**	**45**
0	**0**	**90**
0	**0**	**135**
0	**0**	**180**

Table 3: Actual Output

1(in Degrees)	2(in Degrees)	3(in Degrees)
0	**0**	**0**
42	**0**	**0**
87	**0**	**0**
132	**0**	**0**
176	**0**	**0**
0	**42**	**0**
0	**87**	**0**
0	**132**	**0**
0	**176**	**0**
0	**0**	**42**
0	**0**	**87**
0	**0**	**132**
0	**0**	**176**

Table 1, 2 and 3 presents the results of testing the robot arm's simulated output and actual output at different slider positions. Initially, when all sliders are at the null position, both simulated and actual outputs are at the null position. When slider 1 is varied by 25% of 180◦ with sliders 2 and 3 kept at the initial position, the simulated output is 45◦, and the actual output is 42◦. Similarly, when slider 1 is changed by 50%, the simulated output is 90◦, and the actual output is 87◦. The same testing is carried out with sliders 2 and 3 at 0◦, and the results are tabulated in Table 2. Further testing is done by keeping sliders 1 and 3 at 0◦, and similar trends in simulated and actual outputs are observed. The variations in the actual readings range from 2◦ to 4◦, and it is noted that the actual output variations are smaller than the simulated output. This is attributed to factors such as the weight of the arm itself and small variations in the PWM signal produced, which contribute to the small variation in the servo motor's angular displacement during the maximum degree change of 180◦.

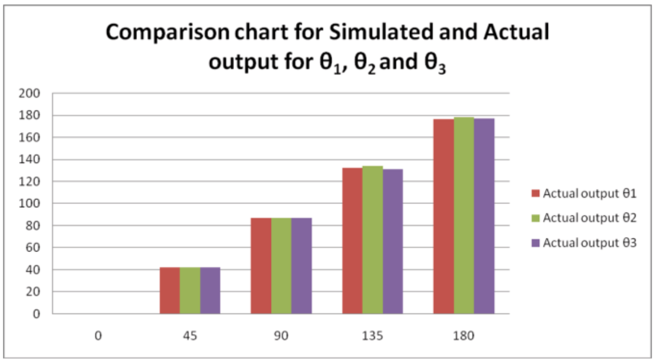

Fig 7. Comparison Chart for the simulated and actual output

Figure 7 depicts the graphical representation of the comparison chart. To assess its repeatability, the robot arm was directed to move to the same position multiple times, with at least five repetitions, while monitoring for any variations. The experiment was conducted at three different locations to obtain more accurate results. Remarkably, it was observed that the end effector consistently returned to the exact coordinate with a repeatability of within ±0.95 mm.

CONCLUSION

In conclusion, hand gesture controlled robotic arms are a type of robotics technology that use hand gestures as a means of control. The suitability of hand gesture controlled robotic arms for a particular application will depend on the specific needs and goals of the application, as well as the resources and budget available. Overall, hand gesture controlled robotic arms represent a promising and rapidly developing technology that has the potential to revolutionize a wide range of industries and applications. Robotic arms are versatile and precise machines that can be used for a wide range of applications, including manufacturing, assembly, pick-and-place operations, and inspection. They have revolutionized the way many industries operate by increasing efficiency, accuracy, and safety while reducing costs.

With advancements in technology, such as the integration of IoT, robotic arm systems have become even more powerful and useful. IoT-enabled robotic arm systems can be remotely monitored and controlled, perform tasks more efficiently and accurately, predict maintenance needs, and integrate with other systems.

FUTURE SCOPE

The future scope of this project can be controlling the arm from a distant location with the help of camera and high range wireless transmission modules. By this we can still accurately perform the task and the arm can be fixed to a rover which moves wirelessly and performs the task. This will be very useful in bomb diffusion applications. The future of robotic arm technology looks promising, with continued developments in artificial intelligence, machine learning, and automation. As these technologies continue to evolve, robotic arm systems will become even more sophisticated and capable, allowing for even greater levels of efficiency, productivity, and innovation.

Acknowledgment

We thank Mr. Anandraddi Naduvinmani for their expertise and assistance in arranging and writing the manuscript. We also thank Mr. Shankargouda Patil for guiding us.

We express our gratitude to Dr. Suresh Akkole, HOD, ECE dept. SGBIT and Dr. B. R. Patagundi, principal, SGBIT, Belagavi for funding our paper.

REFERENCES

[1] https://www.google.com/search?q=human+robot+interaction&oq=human+robot+interaction+&aqs=chrome..69i57j0i512l9.9951j0j7&sourceid=chrome&ie=UTF-8

[2] https://arxiv.org/abs/2102.00928

[3] Kareemullah, H., et al. "Robotic Arm controlled using IoT application." *Computers and Electrical Engineering* 105 (2023): 108539.

[4] Prabhu, R. Raja, and R. Sreevidya. "Design of robotic arm based on hand gesture control system using wireless sensor networks." *International Research Journal of Engineering and Technology,(IRJET)* 4.3 (2017): 617-621.

[5] Kaushik, Gaurav Kamat1Harsh, and Kumar Singh1 RajneshKumar Singh. "Review Paper on Gesture Controlled Robotic Arm Using IoT."

[6] Hsu, Roy Chaoming, et al. "Real-time interaction system of human-robot with hand gestures." *2020 IEEE Eurasia Conference on IOT, Communication and Engineering (ECICE)*. IEEE, 2020.