

Research Paper

Development Of A Wireless Gesture-Controlled Assistive Robot For Disabled And Elderly Individuals

¹Dr. M. V. Sruthi,²K M Abubakar Siddiqui,³Sayyad Murthujavali,⁴Doola Prasanth,⁵Koyitakula Kiran

¹Professor, Department of Electronics and Communication Engineering, Dr. K.V. Subba Reddy Institute of Technology

^{2,3,4,5}B. Tech Student, Department of Electronics and Communication Engineering, Dr. K.V. Subba Reddy Institute of Technology

ABSTRACT

Assistive robotics has become a vital research domain aimed at improving the quality of life for disabled and elderly individuals by enhancing independence and reducing reliance on caregivers. This study presents the design and implementation of a wireless gesture-controlled robot that enables intuitive and contactless control for individuals with limited mobility. Using gesture detection sensors such as accelerometers, gyroscopes, or IMU modules integrated with microcontrollers, the system interprets hand or wrist movements and wirelessly transmits commands to the robot through RF, Bluetooth, or Wi-Fi communication. The robot executes corresponding functions such as movement, object retrieval, and navigation assistance. The system is designed with low-cost components, user-friendly operation, and high reliability to support everyday tasks. The robot improves accessibility by eliminating complex interfaces and providing natural gesture-based interaction. This research contributes to the development of smart assistive technologies that enhance autonomy, safety, and comfort for disabled and elderly users.

Keywords: Assistive robotics, Gesture-controlled robot, Wireless communication, IMU sensors, Accelerometer and gyroscope, Microcontroller-based system, Human–robot interaction, RF/Bluetooth/Wi-Fi communication, Disabled and elderly assistance, Smart assistive technology.

I. INTRODUCTION

As global populations age and disability rates increase, the need for assistive technologies that support independence and mobility becomes increasingly essential. Conventional robotic control interfaces, such as joysticks or mobile applications, pose challenges for users with limited physical ability or cognitive difficulty. Gesture recognition offers a natural and intuitive mode of interaction that mimics human communication methods. Wireless gesture-controlled robots combine sensing, embedded processing, and communication technologies to enable seamless and effortless control. Recent advancements in microcontrollers, wearable sensors, and wireless modules have made such systems cost-effective and highly functional. This project focuses on developing a wireless gesture-controlled robot that offers practical assistance for disabled and elderly individuals in daily tasks, enhancing their quality of life through smart, reliable, and accessible robotic technology.

II. Related Words

Assistive robotics has gained significant attention in recent years as researchers aim to develop intelligent systems that improve the independence and daily living conditions of elderly and disabled individuals. Gesture-based control has emerged as a natural and intuitive interaction method that eliminates the need for complex interfaces such as keyboards or

touchscreens. By using wearable sensors such as accelerometers, gyroscopes, and inertial measurement units (IMUs), human hand movements can be accurately detected and translated into commands for robotic systems. These technologies enable seamless human–robot interaction, allowing users to control robotic devices through simple hand gestures and body movements. Several studies have demonstrated the effectiveness of IMU-based gesture recognition systems for controlling machines and robotic platforms in various applications, including assistive technologies and human–machine interfaces [1], [6], [14].

Wireless communication technologies further enhance the flexibility and usability of gesture-controlled systems by enabling remote operation and real-time data transmission. Communication modules such as RF, Bluetooth, and Wi-Fi are commonly integrated with microcontrollers to transmit gesture commands from wearable devices to robots. This approach allows robots to perform various actions such as navigation, object manipulation, and environmental monitoring. Researchers have developed multiple gesture-controlled robotic platforms that demonstrate reliable performance in tasks such as robotic arm control, path planning, and teleoperation. These systems highlight the advantages of wireless gesture interfaces in improving control accuracy and user convenience in robotic applications [2], [3], [12], [13].

Recent advancements in machine learning and intelligent signal processing techniques have further improved the accuracy and adaptability of gesture recognition systems. Deep learning models and classification algorithms can analyze sensor data patterns and recognize complex gestures with higher precision. Such approaches are particularly useful in domestic service robots and assistive systems where reliable gesture interpretation is critical for safe operation. Intelligent gesture classification models have been applied in service robots and rehabilitation robots to support users with mobility limitations and assist them in performing daily activities. These developments demonstrate the growing potential of smart assistive robotics in healthcare and home automation environments [5], [8], [11].

In addition, the integration of Internet of Things (IoT) technologies and wearable devices has expanded the scope of gesture-controlled robotic systems. IoT-based gesture recognition frameworks allow multiple smart devices and robots to be controlled within interconnected environments. Advanced research has also explored the use of ROS-based robotic systems, wearable IMU sensors, and camera-based motion tracking to enhance gesture recognition accuracy and enable long-range human-robot interaction. These technologies contribute to the development of more intelligent, adaptive, and scalable robotic systems capable of supporting real-

world assistive applications for elderly and disabled individuals [7], [9], [10], [15].

III. PROPOSED MODEL

The proposed system focuses on the development of a wireless gesture-controlled assistive robot designed to support disabled and elderly individuals in performing everyday tasks independently. The system operates by detecting hand or wrist gestures using wearable motion sensors such as an accelerometer, gyroscope, or an Inertial Measurement Unit (IMU). These sensors are connected to a microcontroller that continuously reads motion data and interprets the user's gestures. Each predefined gesture corresponds to a specific command, such as moving the robot forward, backward, left, or right, or performing additional assistive actions. The gesture signals are processed in real time to ensure accurate and responsive control of the robotic system.

The system is composed of two major modules: the gesture sensing transmitter unit and the robot control receiver unit. In the transmitter unit, the wearable sensor module detects the user's hand movements and sends the processed gesture commands through a wireless communication module such as RF, Bluetooth, or Wi-Fi. The receiver unit, mounted on the robot, contains a microcontroller that receives these commands and translates them into control signals for the robot's motors and actuators. A motor driver module is used to regulate the speed and direction of the

robot's movement, allowing smooth navigation in indoor environments such as homes or healthcare facilities.

The assistive robot is designed to perform essential support functions including navigation assistance, object retrieval, and basic mobility support. By interpreting simple hand gestures, the robot can move toward a location, carry small objects, or assist users in accessing items that are otherwise difficult to reach. This gesture-based interaction eliminates the need for complex interfaces like keyboards, mobile applications, or voice commands, making the system highly suitable for elderly individuals or users with limited physical abilities.

Furthermore, the proposed model emphasizes low-cost implementation, reliability, and ease of use. The system uses affordable electronic components and simple wireless communication protocols to make the technology accessible for real-world deployment. The design also focuses on energy efficiency and stable communication to ensure continuous operation in assistive environments. By combining gesture recognition, wireless communication, and robotic mobility, the proposed model provides a practical assistive solution that enhances independence, safety, and comfort for disabled and elderly individuals in their daily lives.

IV. PROPOSED SYSTEM

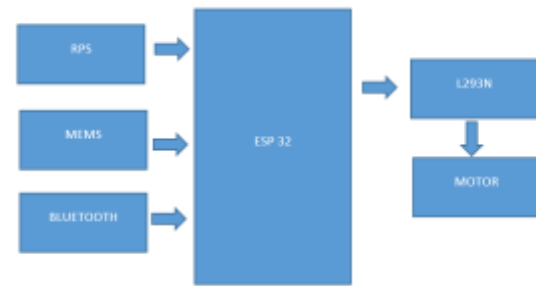


Fig.1.Block diagram

The diagram represents the block diagram of the wireless gesture-controlled assistive robot system. The ESP32 microcontroller acts as the central processing unit that coordinates all sensing, communication, and control operations. On the input side, the system receives signals from three main modules: the RPS (Power Supply), MEMS sensor, and Bluetooth module. The regulated power supply provides the necessary electrical power to operate the ESP32 and the connected components. The MEMS sensor, which typically includes an accelerometer and gyroscope, detects the user's hand or wrist gestures. These motion signals represent different control commands such as forward, backward, left, or right movement. The Bluetooth module enables wireless communication between the gesture sensing device and the robot, allowing the gesture data to be transmitted without physical connections.

Once the ESP32 receives the gesture signals from the MEMS sensor through the Bluetooth communication channel, it processes the data and determines the corresponding movement command. The ESP32 then sends control signals to the L293N motor driver module. The L293N

acts as an interface between the low-power control signals of the microcontroller and the higher-power requirements of the motors. It controls the direction and speed of the motors by regulating the voltage and current supplied to them.

Finally, the DC motor module executes the movement commands generated by the ESP32 through the motor driver. Depending on the interpreted gesture, the motors rotate in specific directions to move the robot forward, backward, or turn left or right. This integrated operation of sensing, wireless communication, processing, and motor control allows the robot to respond instantly to the user's gestures. As a result, the system provides a simple, intuitive, and contactless control mechanism, making it highly suitable for assisting disabled and elderly individuals in performing everyday mobility and assistance tasks.



Fig.2. ESP32-D0WDQ6 chip

V. RESULTS AND DESCUSSIONS

The proposed Wireless Gesture-Controlled Assistive Robot for Disabled and Elderly Individuals improves assistive mobility and human-robot interaction by integrating

gesture sensing, wireless communication, embedded processing, and robotic motion control. The system continuously monitors the hand or wrist movements of the user using a MEMS-based motion sensing module connected to the ESP32 controller. The MEMS sensor detects motion parameters such as tilt, acceleration, and orientation of the user's hand. These gesture signals are transmitted wirelessly through the Bluetooth communication module to the ESP32 controller, which processes the received data and interprets the gestures as robot movement commands. Based on the recognized gestures, the robot performs corresponding actions such as forward movement, backward movement, left turn, or right turn. This gesture-based interaction eliminates the need for physical contact with control devices and provides a convenient interface for users with limited mobility.

The specifications of the components used in the proposed system are presented in **Table 1**. The ESP32 microcontroller acts as the central processing unit responsible for receiving gesture signals, processing sensor data, and controlling the robotic movement. The MEMS sensor is used to detect hand gestures by measuring acceleration and angular motion of the user's wrist. The Bluetooth module enables wireless communication between the gesture sensing unit and the robot controller. The L293N motor driver module serves as the interface between the ESP32 controller and the DC motors, enabling control of motor direction and speed. The DC motors are responsible

for driving the robot's movement in different directions, while the regulated power supply ensures stable power delivery to all electronic components.

TABLE 1: SYSTEM COMPONENT SPECIFICATION

SI.NO	Components	Specifications
1	ESP32	Operating Voltage: 3.3V, Wi-Fi and Bluetooth enabled microcontroller
2	RPS (Regulated Power Supply)	Provides stable power supply for system components
3	MEMS Sensor (Accelerometer/Gyroscope)	Detects hand gestures and motion orientation
4	Bluetooth Module	Enables wireless communication between controller and robot
5	L293N Motor Driver	Controls direction and speed of DC motors
6	DC Motors	Provides mechanical movement for the robot
7	Robot Chassis	Mechanical structure supporting motors and electronics
8	Battery	Provides portable power supply for the robot system

The hardware implementation integrates the ESP32 controller with the MEMS sensor, Bluetooth communication module, motor driver, and DC motors to achieve gesture-based robotic control. During system operation, the MEMS sensor continuously detects the orientation and movement of the user's hand. These motion signals are interpreted as predefined gesture commands and transmitted wirelessly through the Bluetooth module to the ESP32 controller. The ESP32 processes the received data and determines the appropriate control action for the robot. Based on the processed commands, the controller sends control signals to the L293N motor driver module, which regulates the voltage and current supplied to the motors. The L293N motor driver plays an important

role in enabling smooth robotic motion. It allows the ESP32 controller to control the direction and speed of the DC motors while protecting the microcontroller from high current loads. Depending on the detected gesture, the motor driver activates the motors in specific directions, allowing the robot to move forward, backward, or rotate. The robot chassis and motor assembly provide stable mechanical support for movement, enabling the robot to navigate indoor environments such as homes, hospitals, or care centers.

The experimental results demonstrate that the proposed gesture-controlled assistive robot successfully responds to user hand gestures and performs the corresponding motion actions. The MEMS sensor accurately detects gesture movements, and the Bluetooth communication module reliably transmits gesture data to the ESP32 controller. The system processes gesture commands with minimal delay, enabling real-time robotic response. The motor driver and DC motors effectively translate the control signals into mechanical movement, allowing smooth and responsive navigation of the robot.

Overall, the implementation of the proposed system enhances assistive robotics by providing an intuitive and wireless gesture-based control mechanism. The integration of MEMS sensors, embedded processing, and wireless communication enables disabled and elderly individuals to interact with robotic systems easily and safely. The system demonstrates reliable performance,

low implementation cost, and user-friendly operation, making it suitable for practical assistive applications in healthcare environments, smart homes, and rehabilitation systems.

VI. CONCLUSION AND FUTURE SCOPE

Conclusion:

The development of a wireless gesture-controlled robot offers an impactful solution for improving the independence and quality of life of disabled and elderly individuals. Through intuitive gesture-based interfaces and reliable wireless communication, the robot assists users in navigation and task execution without requiring complex controls. Literature findings emphasize the relevance of gesture recognition in assistive technologies and validate its effectiveness for mobility-restricted users. The proposed system integrates wearable IMU sensors, embedded processing, and wireless communication into a robust and accessible assistive robot. Future advancements may incorporate AI-based gesture prediction, obstacle detection, voice support, and IoT monitoring to further enhance safety and user experience.

Future Scope:

The proposed wireless gesture-controlled assistive robot provides a foundation for developing advanced assistive robotic systems for disabled and elderly individuals. In the future, the system can be enhanced by integrating advanced gesture recognition algorithms and machine learning techniques to improve the accuracy and reliability of

gesture interpretation. By analyzing larger gesture datasets and using intelligent classification models, the robot can recognize more complex hand movements and adapt to different users. This improvement will allow the system to provide more personalized assistance and reduce errors in gesture detection during real-time operation.

Further improvements can be made by integrating additional sensors and perception modules such as cameras, ultrasonic sensors, and obstacle detection systems. These enhancements will enable the robot to navigate autonomously in complex environments while avoiding obstacles and ensuring safe movement. Vision-based object recognition can also be incorporated to allow the robot to identify and retrieve specific items requested by the user. Such features will significantly enhance the robot's ability to perform daily assistance tasks in home and healthcare environments.

Another potential future development involves incorporating Internet of Things (IoT) connectivity and cloud-based monitoring systems. With IoT integration, the robot can communicate with smart home devices and remote monitoring platforms to provide enhanced support for elderly care. Caregivers or family members could remotely monitor the robot's activity, receive alerts, and provide assistance when required. This connectivity would enable the robot to become part of a larger smart healthcare ecosystem designed to support

independent living for elderly and disabled individuals.

Additionally, future versions of the system could focus on improving portability, energy efficiency, and mechanical design. The robot can be designed with lightweight materials, improved battery management systems, and compact electronic modules to increase operational time and mobility. Integration of voice control, mobile application interfaces, and advanced human-robot interaction techniques could further enhance usability. With these improvements, the gesture-controlled assistive robot can evolve into a more intelligent, autonomous, and multifunctional assistive platform capable of providing reliable support in real-world healthcare and rehabilitation environments.

VII. REFERENCES

- [1]. M. Kim, J. Lee, and H. Kim, "IMU sensor-based hand gesture recognition for human-machine interfaces," *Sensors*, vol. 19, no. 18, pp. 1–18, 2019.
DOI: <https://doi.org/10.3390/s19183827>
- [2]. A. Vysocký and P. Novák, "Hand gesture interface for robot path definition in collaborative environments," *Sensors*, vol. 23, no. 9, pp. 1–16, 2023.
DOI: <https://doi.org/10.3390/s23094219>
- [3]. Z. Yu, Y. Zhang, and L. Wang, "Gesture-controlled robotic arm for agricultural harvesting," *Micromachines*, vol. 15, no. 7, pp. 1–17, 2024.
DOI: <https://doi.org/10.3390/mi15070918>
- [4]. H. Choi and J. Kim, "Hand-guiding gesture-based telemanipulation with

- wearable IMU sensors,” *Mathematics*, vol. 11, no. 16, pp. 1–15, 2023.
DOI: <https://doi.org/10.3390/math11163514>
- [5]. A. D. Segal et al., “A gesture-controlled rehabilitation robot to improve assistive therapy,” *IEEE Access*, vol. 8, pp. 141240–141252, 2020.
DOI: <https://doi.org/10.1109/ACCESS.2020.3013419>
- [6]. C. Zhu and W. Sheng, “Wearable sensor-based hand gesture recognition for human-robot interaction,” *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 41, no. 6, pp. 1064–1073, 2011.
DOI: <https://doi.org/10.1109/TSMCA.2010.2093883>
- [7]. V. Sideridis, A. Zacharakis, G. Tzagkarakis, and M. Papadopoulou, “GestureKeeper: Gesture recognition for controlling devices in IoT environments,” 2019.
DOI: <https://doi.org/10.48550/arXiv.1903.06643>
- [8]. K. Suri and R. Gupta, “Classification of hand gestures from wearable IMUs using deep neural networks,” 2020.
DOI: <https://doi.org/10.48550/arXiv.2005.00410>
- [9]. N. A. Bhuiyan, M. N. Huq, S. H. Chowdhury, and R. Mangharam, “A bimanual gesture interface for ROS-based mobile manipulators using TinyML,” 2025.
DOI: <https://doi.org/10.48550/arXiv.2509.19521>
- [10]. C. Zhang et al., “HiSync: Spatio-temporally aligning hand motion from wearable IMU and on-robot camera for long-range human-robot interaction,” 2026.
DOI: <https://doi.org/10.48550/arXiv.2603.11809>
- [11]. H. M. R. T. Bandara et al., “An intelligent gesture classification model for domestic service robots,” *IEEE Access*, vol. 8, pp. 1–12, 2020.
DOI: <https://doi.org/10.1109/ACCESS.2020.2987596>
- [12]. M. I. Kurpath et al., “IMU and potentiometer-based controller for robotic arm teleoperation,” *Robotics and Autonomous Systems*, vol. 175, pp. 104675, 2024.
DOI: <https://doi.org/10.1016/j.robot.2024.104675>
- [13]. G. Angelidis et al., “Gesture-controlled robotic arm for small assembly lines,” *Machines*, vol. 13, no. 3, pp. 1–18, 2025.
DOI: <https://doi.org/10.3390/machines13030182>
- [14]. G. G. Samatas et al., “Inertial measurement units in mobile robots: A comparative study,” *Journal of Sensor and Actuator Networks*, vol. 6, no. 1, pp. 1–25, 2022.
DOI: <https://doi.org/10.3390/jsan6010017>
- [15]. Mahesh Ganji. (2025). Enhancing Oracle Cloud HR Reporting Through AI-Driven Automation. *Journal of Science & Technology*, 10(6), 28–36.
<https://doi.org/10.46243/jst.2025.v10.i06.pp>

- 28-36
- [16]. Todupunuri, A. (2023). The Role of Artificial Intelligence in Enhancing Cybersecurity Measures in Online Banking Using AI. *International Journal of Enhanced Research in Management & Computer Applications*, 12(01), 103–108. <https://doi.org/10.55948/ijermca.2023.01015>
- [17]. The Future of Conversational AI in Banking: A Case Study on Virtual Assistants and Chatbots*: Exploring the Impact of AI-Powered Virtual Assistants on Customer Service Efficiency and Satisfaction. (2024). *International Research Journal of Economics and Management Studies*, 3(10). <https://doi.org/10.56472/25835238/irjems-v3i10p124>
- [18]. Todupunuri, A. (2025). Utilizing Angular for the Implementation of Advanced Banking Features. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.5283395>
- [19]. Sushma Babburi. (2025). Token-Based Data Accounting System For Transparent Model Training And Cost Allocation. *American Journal of AI Cyber Computing Management*, 5(4), 463–474. <https://doi.org/10.64751/ajaccm.2025.v5.n4>. pp463-474
- [20]. Snigdha Gaddam. (2025). SOFTWARE STACK PREPARED FOR AI TRANSITIONING FROM MODULES TO MODELS. *American Journal of AI Cyber Computing Management*, 5(4), 451–462. <https://doi.org/10.64751/ajaccm.2025.v5.n4>. pp451-462
- [21]. Gaddam, S. INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING.
- [22]. Bajarang Bhagwat, V. (2023). Optimizing Payroll to General Ledger Reconciliation: Identifying Discrepancies and Enhancing Financial Accuracy. *JOURNAL OF ADVANCE AND FUTURE RESEARCH*, 1(4). <https://doi.org/10.56975/jaaf.v1i4.501636>
- [23]. Suhasnadh Reddy Veluru, Sai Teja Erukude, and Viswa Chaitanya Marella. 2025. Multimodal Detection of Fake Reviews using BERT and ResNet-50. In 2025 4th International Conference on Innovative Mechanisms for Industry Applications (ICIMIA). IEEE, 877–882.
- [24]. Doragacharla, V. R. (2026). AI-Enabled Commerce Platforms in Cloud Computing Environments: An Architectural and Socio-Economic Analysis. *Journal of Computational Analysis & Applications*, 35(1).
- [25]. Jay Bharat Mehta. (2025). AUTONOMOUS PATCH VALIDATION FOR ZERO-DAY EXPLOITS IN ENTERPRISE CLOUDS. *International Journal of Applied Mathematics*, 38(4s), 1270–1285. <https://doi.org/10.12732/ijam.v38i4s.685>
- [26]. Reddy, S. K. (2025). Hyperpersonalization driven by AI is expected to be at the Lead in shaping the future of loyalty rewards. *Journal of Emerging Technologies and Innovative Research*.

- [27]. Reddy, S. K. R. Developing a Modular AI Framework to Enhance Scalability and Personalization in Next-Generation Reward Platforms.
- [28]. Poojari, R. (2026). Privacy-Preserving Generative AI in Healthcare Systems Using Federated Learning Approaches. *International Journal of Data Science and IoT Management System*, 5(1), 78-88.
- [29]. Kalae, U. K. (2021). Enhancing data analytics and reporting efficiency using Power BI and SQL in cloud computing environments. *Journal of Computational Analysis and Applications*, 29(6), 2021. <https://doi.org/10.48047/jocaaa.2021.29.06>. 48
- [30]. Kalae, U. K. (2025). Optimizing cost-effective cloud data pipeline orchestration across multiple cloud providers. *Journal of Information Systems Engineering and Management*, 10(63s), e726–e741.
- [31]. Saikumar, B. (2023). Enhancing Client Engagement through AI-Driven Real-Time Reporting and Automated Alerts. *International Journal of Enhanced Research in Science, Technology & Engineering*, 12(11), 111–117. <https://doi.org/10.55948/ijerste.2023.1115>
- [32]. Saikumar, B. (2024). Optimizing Crew Scheduling and Absence Management using Microservices: Enhancing Reliability and Efficiency in Crew Management Systems. *International Journal of Enhanced Research in Management & Computer Applications*, 13(11), 50–55. <https://doi.org/10.55948/ijermca.2024.0116>
- [33]. O. Vermesan and P. Friess, *Internet of Things – From Research and Innovation to Market Deployment*. River Publishers, 2014. DOI: <https://doi.org/10.1007/978-3-319-05029-4>
- [34]. S. Sriram and K. Palaniswamy, “Mobile robot assistance for disabled and senior citizens using hand gestures,” *International Journal of Engineering Research*, 2020. DOI: <https://doi.org/10.13140/RG.2.2.30259.3536> 6