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Smart Delivery Robot with obstacle detection + voice commands (IOT)

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ABSTRACT

The rapid advancement of Internet of Things (IoT) and embedded intelligence has enabled the development of autonomous robotic systems for efficient and contactless delivery services. This project presents a Smart Delivery Robot with Obstacle Detection and Voice Commands, designed to operate autonomously in indoor and semi-structured environments. The proposed system integrates IoT connectivity, real-time obstacle detection, and voice-controlled navigation to enhance usability, safety, and operational efficiency.The robot employs ultrasonic and infrared sensors to continuously monitor its surroundings and detect obstacles, enabling dynamic path adjustment and collision avoidance. Voice command functionality is implemented using a speech recognition module or cloud-based voice processing, allowing users to control robot movements and delivery actions through natural language instructions. A microcontroller-based control unit processes sensor data and voice inputs, ensuring accurate decision-making and real-time responsiveness. IoT integration facilitates remote monitoring, command transmission, and status updates via a web or mobile interface.The system aims to reduce human intervention in last-mile delivery tasks, particularly in healthcare facilities, offices, and smart campuses. Experimental evaluation demonstrates reliable obstacle detection, accurate voice recognition, and stable wireless communication. The proposed smart delivery robot offers a cost-effective, scalable, and user-friendly solution for automated delivery applications, contributing to the advancement of intelligent IoT-based robotic systems.

Keywords: Internet of Things (IoT), Smart Delivery Robot, Obstacle Detection, Voice Command Recognition, Autonomous Navigation, Ultrasonic Sensors, Embedded Systems, Wireless Communication, Real-Time Monitoring, Human–Robot Interaction.

I. INTRODUCTION

The growing demand for automation and contactless services has led to significant advancements in smart robotic systems. In recent years, autonomous delivery robots have gained attention in domains such as healthcare, offices, warehouses, educational institutions, and smart cities. These robots aim to reduce human effort, improve operational efficiency, and ensure safe delivery of goods, especially in environments where human intervention may be risky or inefficient.

With the integration of the Internet of Things (IoT), robotic systems can now communicate, share data, and be monitored remotely in real time. IoT-enabled robots offer enhanced flexibility, control, and scalability compared to traditional standalone robots. However, for a delivery robot to function effectively in real-world environments, it must be capable of detecting obstacles, navigating safely, and interacting naturally with users.

This project focuses on the development of a Smart Delivery Robot with Obstacle Detection and Voice Commands, which combines autonomous navigation with intuitive human–robot interaction. The robot uses obstacle detection sensors such as ultrasonic or infrared sensors to identify objects in its path and avoid collisions dynamically. Additionally, voice command functionality allows users to control the robot’s movement and delivery operations using simple spoken instructions, making the system user-friendly and accessible.

The proposed system leverages embedded controllers, wireless communication modules, and IoT platforms to enable real-time monitoring and remote control through a mobile or web interface. By integrating obstacle detection, voice recognition, and IoT connectivity into a

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single platform, the smart delivery robot aims to provide a cost-effective, reliable, and intelligent solution for automated delivery applications. This project demonstrates how emerging technologies can be combined to build practical and scalable robotic systems for modern smart environments.

II. LITERATURE SURVEY

On the Design and Fabrication of a Voice-controlled Mobile Robot

Authors: S. Ahmad et al. (Proc. SciTePress, 2021)

Abstract: This paper presents the design and implementation of a mobile robotic platform that accepts speech commands for motion control. Speech is processed by a voice-recognition module (desktop/cloud or local software) and translated into motion commands transmitted wirelessly to the robot. The study compares different speech-to-text strategies and demonstrates a low-cost architecture combining an Android front end with a microcontroller on the robot. Results highlight tradeoffs between on-device and cloud recognition in latency and robustness, and show that distributed processing (smartphone + microcontroller) achieves practical responsiveness for simple navigation tasks.

An Autonomous Obstacle Avoidance Robot Using Ultrasonic Sensor

Authors: (University / student research paper; ResearchGate, 2020)

Abstract: This development paper describes an autonomous robot that relies on ultrasonic ranging for obstacle detection and avoidance. The ultrasonic sensor provides continuous distance readings; a microcontroller uses these readings to implement a reactive navigation strategy (stop, reverse, steer) when thresholds are crossed. The work evaluates sensor placement, sampling rate, and basic filtering to reduce spurious returns, reporting reliable short-range obstacle detection in indoor environments. The study serves as a practical reference for low-cost, sensor-based collision avoidance in delivery platforms.

IoT Based Smart Delivering Robot for Isolation Ward (Review / System Paper)

Authors: Various (IJISRT, 2020)

Abstract: Motivated by the need for contactless delivery in healthcare (e.g., pandemic isolation wards), this review and system paper surveys architectures for IoT-enabled delivery robots. It covers sensor suites (ultrasonic, IR, bump sensors, cameras), wireless backends (Wi-Fi, MQTT/Blynk), and teleoperation vs. autonomous modes. Several prototype implementations are described that integrate mobile apps for remote monitoring and telemetry. The paper highlights challenges such as navigation in cluttered corridors, reliability of wireless links in hospitals, and sterilization/maintenance considerations for medical use.

Speech Recognition-Based Wireless Control System for Mobile Robotics

Authors: S. Gupta et al. (MDPI, 2025)

Abstract: This recent study proposes a low-latency speech-control architecture that offloads recognition to an Android client while the ESP32 microcontroller handles motor control and wireless communication. By performing speech-to-text on the smartphone and sending compact commands over Bluetooth/Wi-Fi, the system reduces onboard computation and preserves responsiveness. The paper reports experiments showing high command recognition accuracy in quiet and moderately noisy indoor settings, and discusses practical issues like command sets, confirmation feedback, and security of wireless command channels.

IoT-Based Delivery Robot with Theft Detection for Food and Goods Supply

Authors: K. Shankar et al. (E3S Conf., 2025)

Abstract: Addressing last-mile delivery concerns, this paper describes an IoT delivery robot that combines basic obstacle avoidance, GPS/Wi-Fi tracking, and theft-detection features (tamper sensors, remote alerts). The architecture uses an ESP32/Arduino core, camera or weight sensors for package monitoring, and cloud notifications for anomalous events. The authors demonstrate a prototype that can autonomously navigate short indoor/outdoor routes and send real-time telemetry to a web dashboard. The work is useful for designers who must add security and remote monitoring to

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delivery robots.

Voice-Controlled Robotic Systems: Implementation and Case Studies

Authors: assorted conference/journal project papers (various 2019–2025; e.g., IRJET/IRJMETS/IRJET entries)

Abstract: A collection of project-level papers showing practical implementations of voice and Bluetooth control for robotic vehicles. Typical designs use an Android app (Google Speech API) or local keyword spotting combined with Bluetooth/Wi-Fi to send motion commands to an Arduino/ESP32. Most projects pair voice control with ultrasonic sensors for obstacle detection so the robot can either obey voice commands or override them when safety limits are reached. These papers provide many implementation details (wiring, motor drivers, command grammars) helpful for rapid prototyping and classroom projects.

III. EXISTING SYSTEM

In existing delivery robotic systems, automation is often limited to basic functionalities such as remote-controlled movement or simple obstacle avoidance. Many current robots rely on manual control using handheld remotes, Bluetooth-enabled mobile applications, or RF controllers, which require continuous human intervention for navigation and delivery tasks. These systems are effective only in structured and controlled environments, as they lack intelligent decision-making capabilities and cannot adapt autonomously to dynamic surroundings.

Some existing systems incorporate obstacle detection using ultrasonic or infrared sensors to prevent collisions. While these robots can identify obstacles and perform basic avoidance maneuvers such as stopping or changing direction, they typically operate on predefined logic without higher-level navigation or integration with user interaction mechanisms. As a result, their ability to handle complex or unpredictable environments remains limited.

Voice-controlled robotic systems have also been developed, allowing users to issue basic movement commands through speech recognition. However, most of these systems function independently of IoT platforms and rely on short-range communication technologies such as Bluetooth. This restricts their operational range and prevents real-time remote monitoring, data logging, or cloud-based control. Additionally, voice-controlled robots often lack safety mechanisms to override commands during obstacle encounters, leading to potential navigation issues.

Although IoT-enabled devices exist that provide remote monitoring and control via the internet, they are generally not combined with autonomous navigation and voice interaction in a unified system. These solutions primarily focus on connectivity rather than intelligent behavior. Consequently, existing systems fail to deliver a fully autonomous, interactive, and scalable delivery solution. The lack of integration between obstacle detection, voice commands, and IoT connectivity highlights the need for a smarter and more comprehensive delivery robot capable of operating efficiently with minimal human intervention.

IV. PROPOSED SYSTEM

The proposed system presents a Smart Delivery Robot with Obstacle Detection and Voice Commands integrated with IoT, designed to provide autonomous, safe, and user-friendly delivery operations in indoor and semi-structured environments. The system combines embedded intelligence, real-time sensing, and internet connectivity to minimize human intervention while improving operational efficiency. By integrating multiple technologies into a single platform, the proposed solution addresses the limitations of existing delivery robots.

The robot is equipped with obstacle detection sensors such as ultrasonic and infrared sensors that continuously monitor the surrounding environment. Sensor data is processed by a microcontroller to detect obstacles in real time and dynamically adjust the robot’s movement, ensuring collision-free navigation. This allows the robot to operate safely in dynamic environments where obstacles may appear unexpectedly.

Voice command functionality is incorporated to enable natural human–robot interaction. Users can control the robot using simple spoken commands such as movement instructions or delivery-related

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actions. Voice input is processed using a speech recognition module or cloud-based voice processing through a mobile device, and the recognized commands are transmitted wirelessly to the robot for execution. Safety logic ensures that voice commands are overridden when obstacles are detected, prioritizing collision avoidance.

IoT integration enables real-time monitoring, control, and data exchange over the internet. The robot's status, sensor readings, and operational updates are transmitted to a cloud platform, allowing users to monitor deliveries remotely through a web or mobile application. The system also supports remote command transmission, making it suitable for smart campuses, hospitals, offices, and warehouses.

Overall, the proposed system delivers a cost-effective, scalable, and intelligent delivery solution by combining autonomous navigation, voice interaction, and IoT connectivity. The design enhances reliability, safety, and usability, making it a practical implementation of smart robotics in modern automated environments.

V. SYSTEM ARCHITECTURE

The system architecture of the proposed Smart Delivery Robot with Obstacle Detection and Voice Commands using IoT is designed as a modular and layered framework that integrates sensing, control, communication, and user interaction components. At the core of the architecture is a microcontroller unit (such as Arduino or ESP32), which acts as the central processing and decision-making unit. It coordinates sensor inputs, executes control logic, and manages communication between hardware components and the IoT platform.

The sensing layer consists of obstacle detection sensors, primarily ultrasonic and infrared sensors, mounted on the robot to continuously scan the surrounding environment. These sensors provide real-time distance and proximity data to the microcontroller. Based on predefined threshold values, the controller determines whether an obstacle is present and initiates appropriate actions such as stopping, slowing down, or changing direction. This ensures safe and collision-free navigation even in dynamic environments.

The voice command module forms the human–robot interaction layer of the system. Voice inputs are captured through a smartphone application or a dedicated voice recognition module. Speech-to-text processing is performed either locally on the device or via cloud-based services. The recognized commands are transmitted wirelessly to the robot using Bluetooth or Wi-Fi communication. The microcontroller interprets these commands and converts them into motion control signals for the motor driver, allowing intuitive and hands-free operation of the robot.

The actuation layer includes DC motors, motor drivers, and wheel assemblies responsible for the physical movement of the robot. The motor driver receives control signals from the microcontroller and regulates motor speed and direction accordingly. The control logic ensures that obstacle detection has higher priority than voice commands, thereby maintaining safety during operation.

The IoT layer enables real-time connectivity between the robot and remote users. Using a Wi-Fi module, the robot sends operational data such as movement status, obstacle alerts, and delivery progress to a cloud platform. Users can access this information through a web or mobile dashboard and can also issue remote commands if required. This layer enhances scalability, monitoring, and control, making the system suitable for smart environments.

Overall, the system architecture emphasizes modularity, real-time responsiveness, and seamless integration of sensing, control, voice interaction, and IoT connectivity. This layered design allows easy upgrades, future expansion, and reliable performance, making the proposed smart delivery robot a robust solution for automated delivery applications.

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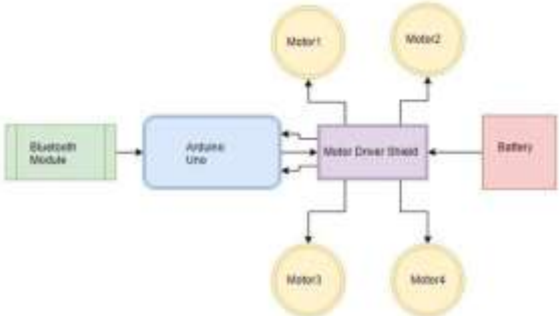

Fig 5.1: Structure of the Proposed System

The given image illustrates the hardware architecture of the smart delivery robot's motion control system. At the center of the system is the Arduino Uno, which acts as the main control unit. The Arduino receives control commands wirelessly from the Bluetooth module, which is typically connected to a smartphone or voice-command application. These commands represent movement instructions such as forward, backward, left, or right. After processing the received commands, the Arduino sends appropriate control signals to the motor driver shield.

The motor driver shield functions as an interface between the low-power control signals of the Arduino and the high-power requirements of the motors. It amplifies the signals and controls the direction and speed of the motors based on the logic received from the Arduino. The system uses four DC motors (Motor1, Motor2, Motor3, and Motor4), indicating a four-wheel drive configuration that provides better stability and maneuverability for the delivery robot. Power for the entire motion system is supplied by the battery, which is directly connected to the motor driver shield to ensure sufficient current for motor operation. Overall, this architecture enables wireless command reception, efficient motor control, and reliable movement of the robot, forming the core mobility subsystem of the smart delivery robot.

VI. IMPLEMENTATION

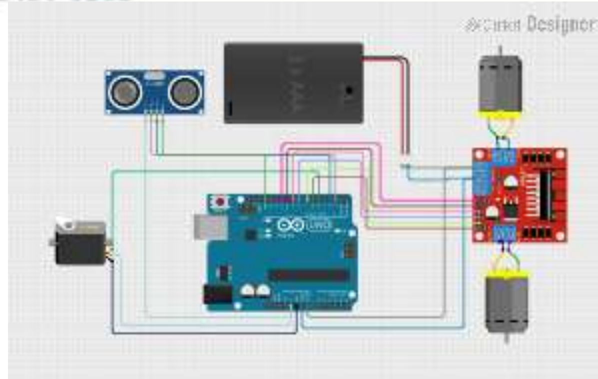

Fig 6.1: Hardware Setup – Smart Delivery Robot

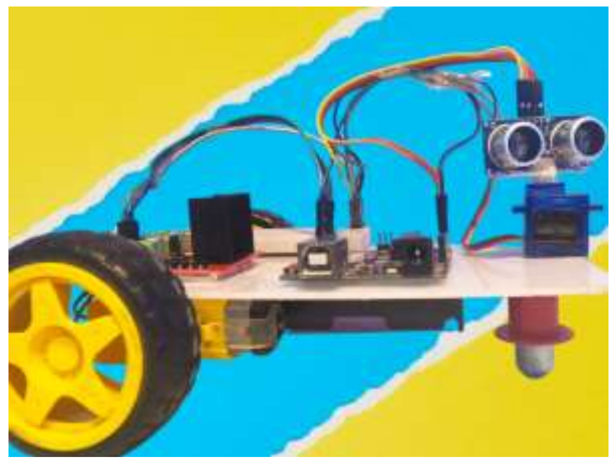

Fig 6.2: Obstacle Detection Using Ultrasonic Sensor

Fig 6.3: Voice Command Interface (Mobile Application)

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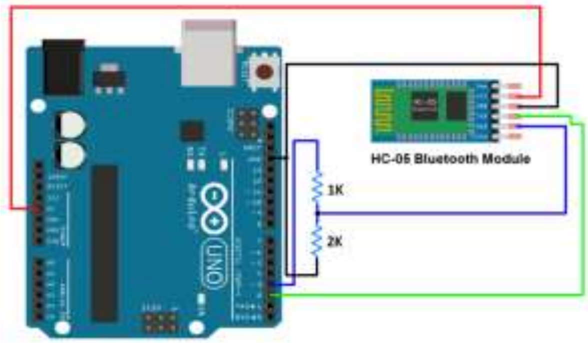

Fig 6.4: Bluetooth / Wireless Communication Status

VII. CONCLUSION

This project successfully demonstrates the design and implementation of a Smart Delivery Robot with Obstacle Detection and Voice Commands using IoT, providing an efficient and user-friendly solution for automated delivery applications. By integrating obstacle detection sensors, voice command functionality, and IoT connectivity, the system enables safe navigation, intuitive human–robot interaction, and real-time monitoring with minimal human intervention.

The use of ultrasonic and infrared sensors ensures reliable obstacle detection and collision avoidance, while voice control enhances accessibility and ease of operation. The microcontroller-based architecture effectively processes sensor data and user commands, coordinating motor control and decision-making in real time. IoT integration further extends the system's capabilities by enabling remote monitoring, status updates, and control through a cloud-based platform.

Overall, the proposed system offers a cost-effective, scalable, and practical approach to autonomous delivery in indoor environments such as hospitals, offices, and educational institutions. The successful implementation highlights the potential of combining embedded systems, IoT, and human–robot interaction technologies to develop intelligent delivery solutions for modern smart environments.

VIII. FUTURE SCOPE

The proposed Smart Delivery Robot can be further enhanced by integrating advanced navigation and intelligence capabilities. Future improvements may include the use of GPS, SLAM (Simultaneous Localization and Mapping), or computer vision techniques to enable accurate path planning and localization in complex and dynamic environments. The incorporation of cameras and deep learning–based object detection models would allow the robot to recognize specific objects, people, and delivery locations, improving autonomy and decision-making.

Voice command functionality can be expanded by integrating large language models and natural language processing techniques to support more complex and conversational interactions. Multilingual voice support and noise-resistant speech recognition can further enhance usability in diverse environments such as hospitals and public spaces. Additionally, gesture recognition and touch-based interfaces can be added to improve human–robot interaction.

From an IoT perspective, future versions of the system can leverage cloud analytics and edge computing for real-time performance optimization and predictive maintenance. Integration with mobile applications, smart building systems, and enterprise management platforms would enable large-scale deployment and fleet management of multiple delivery robots. Security enhancements such as encrypted communication and authentication mechanisms can also be implemented to ensure safe and reliable operation.

Moreover, the robot can be adapted for outdoor and commercial delivery by incorporating higher-capacity batteries, solar charging, and rugged hardware design. Features such as payload monitoring, theft detection, and autonomous docking for charging can significantly extend the system's practicality. These advancements would make the smart delivery robot a robust and intelligent solution for future smart city and industrial automation applications.

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