

AUTONOMOUS PERSON TRACKING ROBOTIC CART

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ABSTRACT

This project focuses on the development of an Autonomous person-tracking robot using embedded electronics and sensor-based navigation. The robot is built around an Arduino Uno microcontroller, which acts as the main controller to process sensor data and control the motors. The system uses an ultrasonic sensor to detect and track a person by maintaining a safe following distance in indoor environments without manual control. IR sensors are mounted on the front and sides of the robot to detect obstacles and prevent collisions, ensuring safe navigation. When an obstacle is detected, the robot either stops or changes its direction accordingly. A 16x2 LCD display is used to show real-time information such as robot movement status and obstacle detection details and tracking updates. The L293D motor driver interfaces the Arduino with DC motors,

enabling forward, backward, and turning motions based on the signals from the Bluetooth module and obstacle sensors. The system is designed to maintain a safe following distance, respond dynamically to changes in the environment, and provide immediate feedback to the user. This low-cost, scalable, and reliable robotic cart has potential applications in smart shopping carts, indoor delivery systems, hospitals for transporting supplies, and personal assistance for the elderly or physically challenged individuals.

KEYWORDS: *Arduino UNO, IR Sensor, Ultrasonic Sensor, 16x2 LCD, L293D Motor Driver*

INTRODUCTION

The rapid advancement of robotics and embedded systems has transformed automation across healthcare, logistics, and

smart environments, leading to the development of autonomous mobile robots. This project focuses on an Autonomous Person Tracking Robotic Cart designed to follow a human and assist in carrying loads, reducing physical effort in daily activities. The system is built using an Arduino Uno microcontroller that processes inputs from sensors and controls the robot's movement. An ultrasonic sensor is used to continuously measure the distance between the robot and the person, ensuring it maintains a safe and constant following range by adjusting its speed and direction. IR sensors provide obstacle detection to prevent collisions and ensure safe operation in indoor environments. DC motors controlled through an L293D motor driver enable precise movement such as forward, backward, and turning actions. A 16×2 LCD display shows real-time system status and distance values.

RELATED WORK

Robotics and embedded systems are widely used in automation, human assistance, and smart mobility solutions. Autonomous systems such as person-tracking robots rely on sensors like ultrasonic and IR modules for distance measurement and obstacle detection. Microcontrollers such as Arduino Uno play a key role in processing sensor data and controlling actuators.

Motor driver circuits enable precise movement of DC motors for navigation. These technologies are applied in healthcare for patient assistance, in warehouses for material handling, and in public spaces for smart transportation. Real-time processing, energy efficiency, and low-cost hardware integration make these systems highly suitable for academic and practical applications.

LITERATURE REVIEW

Recent research in autonomous robotic systems has focused on developing efficient and low-cost solutions for human tracking and navigation. Sensor fusion techniques improve tracking accuracy by combining multiple sensor inputs but increase computational complexity. SLAM-based systems provide autonomous navigation and environment mapping; however, they require high processing power and expensive hardware. GSM-based robotic systems enable remote operation through mobile communication but are affected by network delays and coverage limitations. Joystick-controlled robots offer simple manual operation but lack autonomy, while line-following robots are restricted to predefined paths. These limitations emphasize the need for a cost-effective, real-time autonomous person-tracking

robotic system with improved performance and flexibility.

EXISTING METHOD

The existing system mainly uses manual push-and-pull carts for transporting goods in environments such as hospitals, shopping malls, warehouses, and homes. These carts depend entirely on human effort and require continuous physical involvement for movement and control. They do not contain automation, sensors, or intelligent decision-making capabilities. Manual systems cannot detect obstacles, track users, or maintain a safe following distance, making them less efficient in modern applications. Such systems are unsuitable for elderly and physically challenged individuals and increase human workload. These limitations create the need for an autonomous robotic cart with real-time tracking and movement control capabilities.

PROPOSED METHOD

The proposed system implements an Autonomous Person Tracking Robot using an Arduino Uno microcontroller integrated with ultrasonic sensors, IR sensors, DC motors, an L293D motor driver, and a 16×2 LCD display. The ultrasonic sensor continuously measures the distance between the robot and the target person to maintain a safe following range. IR sensors

are used for obstacle detection and collision avoidance to ensure safe navigation. The Arduino processes sensor inputs and controls motor movement in real time through the motor driver module. The system is designed to be cost-effective, energy-efficient, reliable, and suitable for indoor person-tracking applications.

SYSTEM ARCHITECTURE

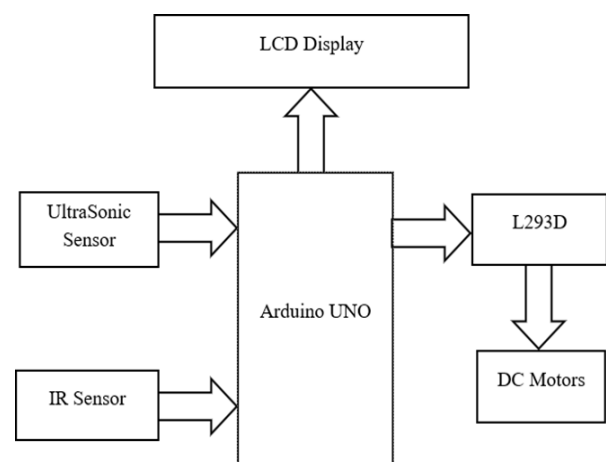


Fig 1: Block Diagram

METHODOLOGY DESCRIPTION

Sensor Input Unit

The ultrasonic sensor and IR sensor are used to continuously monitor the surrounding environment and provide input signals to the Arduino Uno. These sensors detect distance information and obstacles for accurate tracking and safe navigation.

Processing and Control Unit

The Arduino Uno acts as the main controller of the system by receiving sensor

data and processing it in real time. It executes programmed logic and generates control signals based on the received inputs.

Display Unit

A 16×2 LCD display is used to provide real-time information about system operation and sensor readings. It displays parameters such as movement status, distance values, and obstacle alerts.

Motor Driving Unit

The L293D motor driver acts as an interface between the Arduino Uno and the DC motors. It receives control signals from the microcontroller and regulates motor operations efficiently.

Movement and Navigation Unit

DC motors are responsible for the movement of the robotic cart in different directions. The motors perform forward, backward, left, and right movements based on commands generated by the control system.

SOFTWARE AND HARDWARE REQUIREMENTS

Hardware Requirements

Arduino Uno



Fig 2: Arduino Uno

Arduino Uno acts as the central controller of the autonomous person tracking robot and processes all sensor inputs in real time. It executes the programmed logic and sends control signals to the motor driver for movement operations.

Ultrasonic Sensor



Fig 3: Ultrasonic Sensor

The ultrasonic sensor is used to measure the distance between the robotic cart and the target person. It continuously transmits and receives ultrasonic waves to maintain a safe following distance.

IR Sensor



Fig 4: IR Sensor

The IR sensor is used for obstacle detection and collision avoidance during robot

movement. It detects nearby objects and sends signals to the Arduino for immediate action.

L293D Motor Driver



Fig 5: L293D Motor Driver

The L293D motor driver acts as an interface between the Arduino Uno and the DC motors. It controls motor direction and speed based on commands received from the controller.

DC Motors



Fig 6: DC Motors

DC motors provide the required movement for the robotic cart in different directions. They perform forward, backward, left, and right movements according to control signals.

16×2 LCD Display



Fig 7: 16×2 LCD Display

The LCD display is used to show real-time information such as movement status and sensor readings. It helps users monitor system operation and improves interaction with the robot.

Power Supply Unit

The power supply unit provides regulated voltage to all electronic components of the system. It ensures stable operation and protects components from voltage fluctuations.

Connecting Wires and Chassis

Connecting wires establish electrical connections between all hardware components in the circuit. The chassis acts as the mechanical base that supports and holds the robotic components securely.

Software Requirements

Arduino IDE

Arduino IDE is used to write, edit, compile, and upload Embedded C programs into the Arduino Uno board. It provides a simple interface with built-in libraries and

debugging tools for easy development and testing.

Embedded C

Embedded C is used for programming the control logic of the autonomous person tracking robot. The software continuously processes sensor inputs and controls motor operations based on real-time conditions.

Serial Monitor

The Serial Monitor is used to display and monitor data communication between the Arduino board and the computer. It assists in debugging by showing sensor readings and system status during execution.

RESULTS AND DISCUSSION

The experimental evaluation of the Autonomous Person Tracking Robot was conducted in an indoor environment to test its tracking accuracy, obstacle avoidance capability, and real-time responsiveness.



Fig 8: Final Outcome of Autonomous Person Tracking Robot

The autonomous person-tracking robot successfully follows a user while maintaining a safe distance using ultrasonic sensing. It effectively avoids obstacles using IR sensors, ensuring smooth and collision-free navigation. The system provides real-time status updates through the LCD display, improving user interaction and monitoring.

Ultrasonic Sensor – Distance Measurement

The ultrasonic sensor measures the distance between the robot and the object using the time-of-flight principle. The trigger pin sends ultrasonic waves, and the echo pin receives the reflected signal. The time taken for the wave to return is used to calculate the distance. This distance is continuously displayed on the LCD and serial monitor. The system uses this real-time distance data to control robot movement effectively. Accurate distance measurement ensures smooth tracking and safe operation.

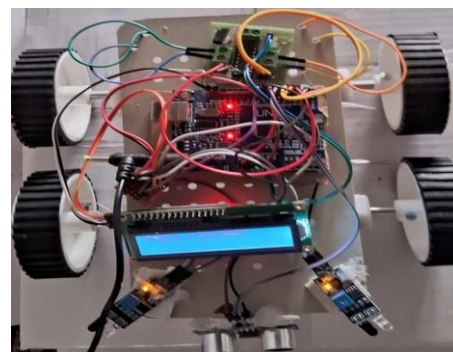


Fig 9: Robot Moving Forward

During testing, the ultrasonic sensor successfully measured the distance between the robot and the target person. The robot was programmed to maintain a predefined safe distance. When the person moved forward, the robot followed smoothly.

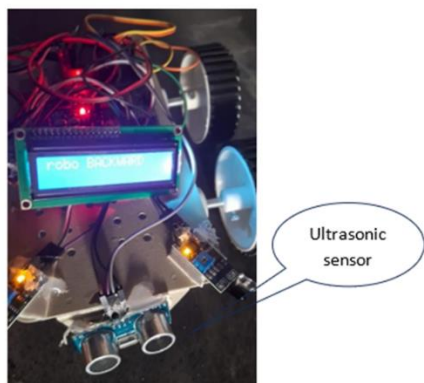


Fig 10: Robot Moving Backward

When the person stopped, the robot also stopped, demonstrating effective distance-based tracking.

Distance-Based Movement Control

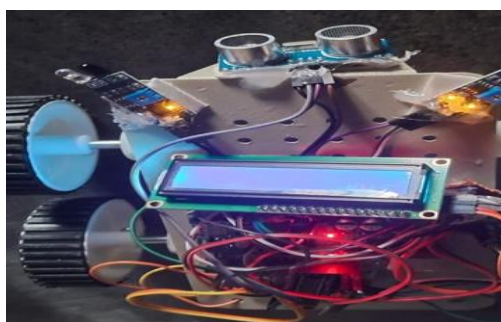


Fig 11: Robot Stops

The robot's movement is controlled using ultrasonic distance measurements. When the distance is greater than 40 cm, the robot moves forward to follow the target. If the distance becomes less than 20 cm, the robot

moves backward to maintain a safe gap and avoid collision. When the distance is between 20 cm and 40 cm, the robot stops, as this range is considered optimal for tracking. The LCD displays the corresponding status such as "FORWARD," "BACKWARD," or "STOP." This logic ensures smooth, safe, and efficient person-following behavior.

IR Sensor – Object Detection and Direction Control

The IR sensors are used to detect obstacles or direction changes. If the left IR sensor detects an object ($IR1 = 0$), the robot turns left by adjusting motor directions. Similarly, if the right IR sensor detects an object ($IR2 = 0$), the robot turns right, avoiding obstacles and correcting the robot's path. The LCD displays "ROBO LEFT" or "ROBO RIGHT" accordingly. This improves navigation and ensures smooth movement in indoor environments.

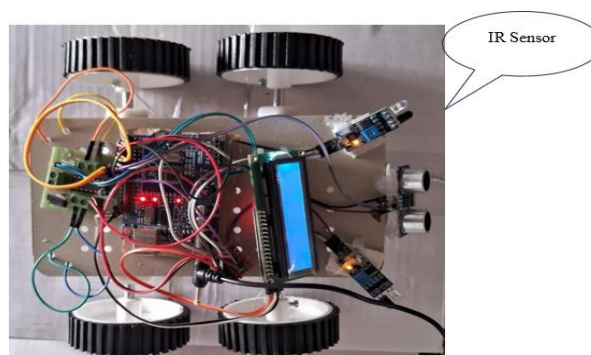


Fig 12: IR Based Operation

The IR sensors are used to detect obstacles or direction changes

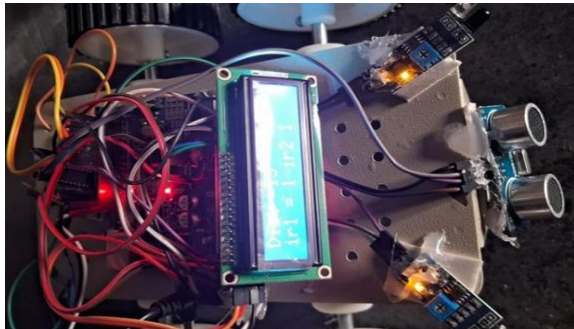


Fig 13: Robot Changing Direction

The autonomous robot was tested successfully and operated according to the programmed logic. It responded properly to real-time sensor inputs and adjusted its movement smoothly. Overall, the final output confirmed that the robot functions reliably as an autonomous tracking system.

CONCLUSION

The project titled “Autonomous Person Tracking Robot” was successfully designed and implemented as a low-cost and efficient robotic assistance system for indoor applications. The system integrates Arduino-based embedded control, sensors, and motor control techniques to automatically track and follow a person while maintaining a safe distance. The developed system reduces human effort and demonstrates the practical application of autonomous robotics with reliable real-time performance.

FUTURE SCOPE

The proposed system can be further enhanced by integrating Artificial Intelligence (AI) and Machine Learning (ML) techniques to improve intelligent decision-making and adaptive tracking behavior. Features such as face recognition and user identification can enable the robot to recognize and follow specific individuals in dynamic environments. Additionally, barcode or QR code scanning technology can be integrated for smart shopping and automated billing applications, increasing usability and functionality.

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