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HUMAN FOLLOWING ROBOT

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Abstract: Path Following Robot is one of the most important aspects of robotics. A Path Following Robot is an autonomous robot which is able to follow a contrasting line that is drawn on the surface. It is designed to move automatically and follow the line. The robot uses arrays of optical sensors to identify the line, thus assisting the robot to stay on the track. The array of four sensor makes its movement precise and flexible. The robot is driven by DC gear motors to control the movement of the wheels. The Arduino interface is used to perform and implement algorithms to control the speed of the motors, steering the robot to travel along the line smoothly. This project aims to implement the algorithm and control the movement of the robot. It can be used in Automated industries as a carrier, small household applications, tour guides in museums and other similar applications.

1. Introduction: Imagine a robot that follows you like a loyal pet. This isn't science fiction; it's a reality with Arduino! Our project focuses on creating a human-following robot that uses sensors to detect your location and motors to navigate its way to you. It's like having a personal assistant on wheels! In this high technology, a robot must be able to detect and follow humans. A robot that can detect and follow human or obstacle within a specific range is called 'Human Following Robot'. Human following robots are currently being used in a number of areas in our world today. As well as being proposed for used in other sectors too. These sector include service areas, household, travel and shopping; Human following robot include detecting the target person, preventing permanent loss of the target person. Determining the distance from detect person and navigating with respect to the target person. The robot should prioritize safety and operate efficiently, maintaining a safe distance from the human and avoiding collisions.

1.1 Objectives: 1. Accurate Path Tracking : The robot should be able to follow a predefined path (such as a line or a marked route) with high precision, minimizing deviation from the set path.
2. Obstacle Avoidance : The robot should detect and avoid obstacles in its path, ensuring uninterrupted navigation along the desired route.
3. Autonomous Navigation : The robot should operate autonomously without manual intervention, utilizing sensors and control algorithms to navigate and adjust its movement.
4. Efficient Control System : Implementing a control system that ensures smooth and efficient movement, adjusting the robot’s speed and direction based on the path and obstacles.
5. Real-time Data Processing : The robot should process data from sensors (like infrared, ultrasonic, or cameras) in real time to adapt quickly to changes in the environment and make immediate adjustments to its path.

2. Literature Review:

TITLE & AUTHOR.	FEATURE	RESULT & OBSERVATION
Title:- Advanced Line Follower Robot[2005] **Author**: Kaja Mohideen, Izham Zainal.	**Power & Energy**:- high capacity batteries for extended Operations.	This study show that supervised learning of power management system for efficient
Title:- Implementation of a line follow robot. **Author**: Mohammad Mehdi	**Build Quality**:- strong build quality with Flexibility Can be used for military purposes, transportation system.	This study show that supervised learning of the Chassis and Body
Title:- LINE FOLLOWING ROBOT **Author**: Sujeet Kumar , Manish Karn.	**Synchronization:-** Multiple vehicles can be synchronized along complex paths using GNSS (Global Navigation Satellite System) time.	This study show that supervised learning of arrangement of sensors
Title:- Design of the Path Following Robot **Author**: Anil kumar.	**Safety and Security**:- it has a camera mounted which records every moment.	The future scope for this research could include adding a GPS module for location based Data.

3. Research Gap: We are adding a feature of safety and security - In which we are going to add emergency stop feature which can stop the Robot Entirely.

1. Increased Efficiency and Accuracy: By following a pre-programmed or sensor-guided path, these robots can transport materials between production stations or buildings with precision. They reduce the chances of human errors such as incorrect deliveries or delays. The robot follows a fixed route efficiently, ensuring timely delivery and supply management.
2. Enhanced Safety: Autonomous robots reduce the risk of accidents and injuries that are often associated with human-operated vehicles. Path-following robots come equipped with obstacle detection sensors to avoid collisions, ensuring a safer working environment.
3. Flexibility in Operations: These robots can be easily reprogrammed to adapt to different paths or modified as per the production requirements, providing greater flexibility compared to traditional methods. The path can be dynamically adjusted based on new production layouts.

4. Problem Statement:

4.1 Problem statement: Line-following robots are designed to follow a predefined path, often marked by a contrasting line on the plane surface and programmed using algorithms. These robots can navigate around complex industrial layouts and transport goods between different parts of a facility or blocks. The key benefit of using a line-following robot in an industry is the automation of material handling and transportation processes, which can drastically reduce the need for human labor, minimize errors, and enhance productivity. Challenges in Traditional Material Handling In traditional industrial setups, goods transporting has been carried out using trucks, crown lifters, and other manually operated vehicles. These methods pose several challenges. High manpower costs: Human drivers are required for transportation between locations, which increases operational expenses. Inefficiency and human error: Human-driven vehicles are prone to errors and inefficiencies, such as delays Role of Path-Following Robots in Automation The use of path-following robots in industrial processes provides several key advantages that address the shortcomings of traditional methods: Reduced Manpower Costs Path-following robots eliminate the need for human drivers, significantly reducing labor costs. The robots can operate autonomously 24/7, without breaks or shifts, leading to continuous production and transportation. Increased Efficiency and Accuracy By following a pre-programmed or sensor-guided path, these robots can transport materials between production stations or buildings with precision. They reduce the chances of human errors such as incorrect deliveries or delays. The robot follows a fixed route efficiently, ensuring timely delivery and supply management.

5. Proposed System:

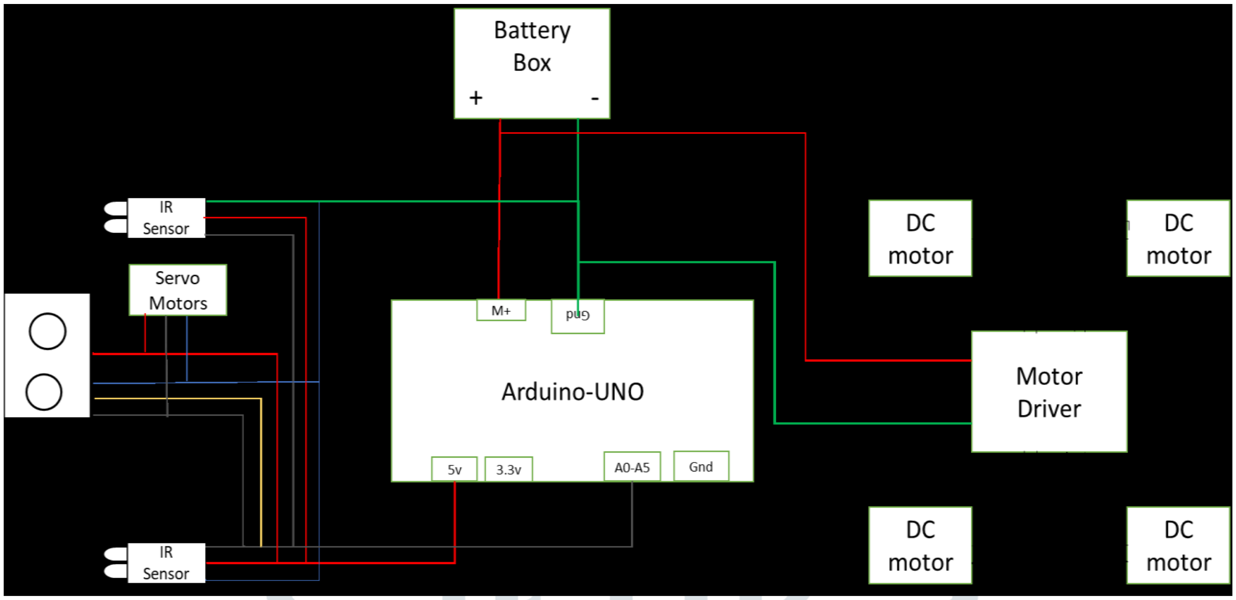
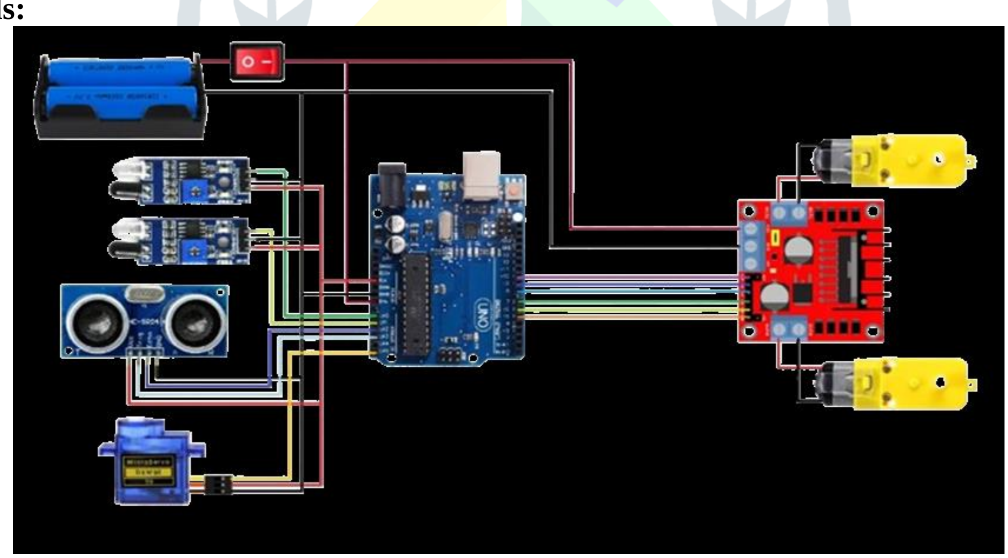


Figure 1: Proposed System

The Internet of Things (IoT) plays a crucial role in enhancing the functionality of pathfollowing robots. By integrating IoT, the robot can communicate with sensors and external devices, enabling real-time data exchange and remote control. This allows for efficient monitoring of the robot's movements, adaptive path adjustments, and seamless integration with smart systems like cloud platforms for data storage and analysis. IoT enables features like remote troubleshooting and updates, making the path-following robot more autonomous and capable of adapting to dynamic environments, ultimately improving its efficiency and usability.

5.1 Design Details:



The design of a path-following robot typically includes a chassis that houses the main components micro-controller Arduino, motors, and battery. It uses DC and servo motors for precise movement, controlled through a motor driver circuit. The robot is equipped with sensors such as (IR), ultrasonic sensors for path detection and obstacle avoidance. The entire system is powered by a rechargeable battery, with careful wiring and circuit design to ensure stable operation and minimal interference.

5.2 Methodology : Sensor Selection Sensors: Choose appropriate sensors (e.g., LIDAR, cameras, ultrasonic) for environment mapping and localization. Sensor Fusion: Implement algorithms to combine data from multiple sensors for improved accuracy.

Path Planning Path Representation: Define the path in a suitable format. Algorithms: Implement algorithm LSRB to navigate obstacles if dynamic path adjustment is needed. Controller Design: Choose a control strategy to maintain the robot on the desired path. Control Strategy Feedback Loop: Implement a feedback loop to continuously adjust the robot's trajectory based on real-time sensor data. Trajectory Generation Trajectory Planning: Generate smooth trajectories that consider speed and acceleration constraints. Motion Profile: Create a motion profile to dictate how the robot accelerates, cruises, and decelerates along the path. Implementation Programming: Use programming languages and platforms suited for robotics (C, C++). Integration: Integrate hardware components motors, controllers and software. Testing and Validation Simulation: Test the robot in simulated environments to evaluate performance. Real-World Testing: Conduct controlled experiments in real-world conditions to fine-tune algorithms. Optimization and Tuning Parameter Adjustment: Tune controller parameters for optimal performance. Deployment Field Trials: Conduct extensive field trials to ensure reliability. Maintenance: Plan for regular updates and maintenance of both hardware and software components. Documentation System Documentation: Maintain clear documentation for system design, algorithms, and operation procedures.

6. Experimental Setup: 6.1 Robot Assembly Assemble of chassis: Attach wheels and motors. Mount the microcontroller securely on the chassis. Connect the motor driver to the microcontroller and the motors. sensor Installation: Position the IR sensors or ultrasonic sensors at the front and/or sides of the robot to detect the path. Wiring: Connect the sensors to the microcontroller. Ensure the power supply is properly connected to the motor driver, motors and microcontroller. Path Creation: Prepare a physical path using tape, paint, or a marked surface for the robot to follow.

Programming: Write a control algorithm that reads sensor data and adjusts the motor speeds accordingly to follow the path. For example: If the left sensor detects the line, turn right. If the right sensor detects the line, turn left. If both sensors are off the line, stop or perform a search pattern.

Testing Environment: Set up a testing area that is clear of obstacles. Ensure good lighting if using vision-based sensors. Experimental Procedure: Calibration: Test individual sensors to ensure they detect the path correctly. Calibrate motor speeds for optimal responsiveness. Initial Trials: Run the robot on the path. Observe its ability to follow the path, making note of any deviations. Data Collection: Record data on the robot's performance, including path-following accuracy and response time. Repeat Testing: Conduct multiple trials to gather consistent data and refine the design. Analysis: Analyze the data to evaluate the robot's performance in terms of accuracy, speed, and efficiency. Make improvements based on performance metrics and re-test.

6.2 Performance Evaluation Parameters When evaluating the performance of an IoT-based Path Following Robot with the specified components, you should consider various technical and operational parameters. These parameters can be categorized into sensor accuracy, system performance, data transmission, and usability. Below are some key evaluation parameters for your report:

1. Sensor Performance

• Accuracy

• Response Time

2. System Integration and Functionality

Arduino Processing Capacity

• Sensor Fusion

3. Power Consumption

4. Latency and Response Time

5. System Scalability

6.3 Software:

1. Arduino IDE: Used for programming micro-controller Arduino, which often serve as the brain of the robot. It allows you to write and upload code for controlling motors, sensors, and other components.

2. MATLAB: Useful for simulating the control algorithms and sensor data processing before implementing them on the actual hardware. also supports direct hardware programming.

3. Proteus: A simulation software used to design and test electronic circuits, helping to simulate the circuit of the path-following robot before building the physical prototype.

7. Result: When you put your hand near to the ultrasonic sensor the robot will start forward. And if you turn your hand to the left side Arduino robot moves one the left side, and if you put your hand in the right The robot will moves in the right direction.

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