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Margdarshak: A Smart Driverless Vehicle Using IR-Based Traffic and Sign Recognition

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Abstract: The rapid advancement of intelligent transportation systems has led to growing interest in autonomous vehicles. This paper presents Margdarshak, a low-cost, sensor-based driverless car prototype designed to recognize and respond to traffic lights, speed limit boards, directional signboards, and obstacles. The system utilizes IR transmitters and a TSOP-based IR receiver to interpret encoded signals from traffic elements. Lane following is achieved using infrared sensors, while ultrasonic sensors enable obstacle detection and avoidance. An ATmega328 microcontroller processes real-time input from sensors and controls the vehicle's motion via a motor driver module. This prototype demonstrates the feasibility of creating a modular, scalable, and autonomous vehicle using simple embedded electronics, making it suitable for academic, smart city, and controlled-environment transport applications.

Unlike traditional autonomous vehicles that rely on image processing and costly AI modules, Margdarshak is built on a simplified IR communication mechanism that simulates traffic scenarios in a structured and repeatable manner. Each traffic signboard is embedded with an IR transmitter that sends a distinct signal pattern representing specific actions like stop, turn, or set speed. These signals are received by the TSOP module, decoded by the microcontroller, and acted upon using motor drivers. By minimizing complexity and cost, this design serves as a learning platform for students and a stepping-stone toward more complex automation. The hardware setup includes IR sensors for line detection, ultrasonic sensors for proximity sensing, and relay modules for directional control. Testing shows accurate responses to red and green light signals, speed adjustments based on IR input, and precise turns at curve indicators. The modular design allows for easy future upgrades such as GPS, voice assistance, or camera-based AI. This paper highlights the effectiveness of combining basic embedded components with logic-based programming to build an efficient, reliable, and replicable driverless car prototype with real-time environmental interaction.

Keywords: IR sensors, TSOP1838, driverless car, embedded systems, autonomous vehicle, ATmega328

I. INTRODUCTION

In recent years, the demand for intelligent transportation systems has grown exponentially due to rising concerns over road safety, traffic congestion, and increasing vehicular accidents. According to the Ministry of Road Transport and Highways (MoRTH), India witnessed over 1.5 lakh road fatalities in 2022, with a significant portion attributed to human errors such as signal violation, speeding, and poor lane discipline. The development of autonomous vehicle technology provides a promising solution to address these challenges by minimizing human intervention and enhancing road safety through sensor-driven automation.

The Margdarshak project introduces a compact, low-cost, and sensor-based prototype of a driverless car aimed at recognizing traffic lights, reading road signboards, and responding to real-time lane and obstacle conditions. Unlike complex AI-driven systems, this prototype uses simple yet effective components like IR transmitters and receivers, ultrasonic sensors, and an ATmega328 microcontroller to demonstrate key functionalities of a smart vehicle in a controlled environment.

Here, are some key aspects of the Margdarshak: A Smart Driverless Vehicle

- 1) **IR-Based Signal Recognition:** Traffic signboards are embedded with IR transmitters that emit encoded signals. These signals are detected by the TSOP1838 IR receiver on the car, which decodes the pattern and enables the vehicle to take appropriate actions like stopping, turning, or adjusting speed.
- 2) **Autonomous Lane Following:** Using downward-facing IR sensors, the car can follow a predefined path (black line) by continuously detecting surface contrast. The microcontroller processes this data to keep the car aligned within the lane using motor adjustments.
- 3) **Obstacle Detection and Collision Avoidance:** An ultrasonic sensor mounted on the front of the vehicle detects any obstruction in its path. If an object is detected within a certain range, the vehicle stops or changes direction to prevent a collision.
- 4) **Real-Time Decision Making and Control:** All sensor inputs are processed by an ATmega328 microcontroller, which executes decision logic and controls motor action through an L298N motor driver. This enables dynamic, real-time control of speed, direction, and stopping, simulating actual traffic responses.

II. LITERATUREREVIEW

A. Sensor-Based Navigation Approaches

Earlier research in autonomous vehicles has focused on image processing, GPS, and AI-based systems. These approaches, while accurate, require high computational power and are expensive to implement, limiting their use in budget-constrained educational prototypes or small-scale environments.

B. Use of Infrared and TSOP Modules

Several low-cost models have utilized IR sensors and TSOP receivers for basic automation like obstacle avoidance and remote control. However, these implementations were limited in scope and did not support comprehensive features such as speed control, traffic signal detection, or lane following.

C. Limitations in Previous Works

Projects based solely on IR or ultrasonic modules often lacked real-time decision-making or integration between different sensors. Many line follower robots, for example, could not interpret road signs or adapt speed based on environmental inputs.

III. PROPOSED METHODOLOGY

A. System Overview

The proposed system simulates a driverless car that navigates by interpreting IR signals, detecting lanes, avoiding obstacles, and adjusting speed based on real-time input. The architecture includes IR transmitters on signboards, TSOP receivers on the car, ultrasonic sensors, IR lane sensors, and a central ATmega328 microcontroller to process all data.

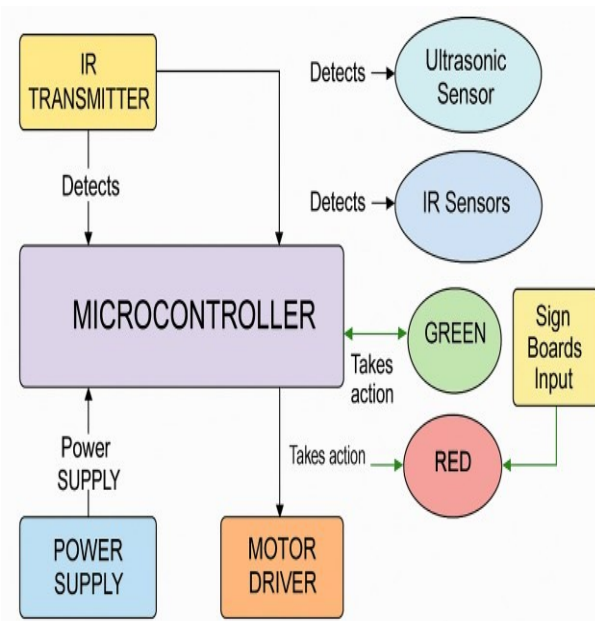


Fig. 1. Block Diagram of the Margdarshak Driverless Car System

B. Traffic Signal and Sign Recognition

Signboards equipped with IR transmitters emit encoded signals representing traffic lights, speed limits, or directional turns. The TSOP1838 IR receiver detects these signals and sends them to the microcontroller. Depending on the decoded signal, the car either stops (red), moves (green), adjusts speed, or turns in a specified direction.

C. Lane Detection and Alignment

Three IR sensors are placed on the underside of the vehicle to follow a black line representing the lane. These sensors detect light and dark contrasts, helping the microcontroller decide if the car should steer left, right, or move forward to stay aligned within the lane.

D. Obstacle Detection and Action

An ultrasonic sensor is mounted on the front to detect any obstacle within a specific range. If an object is detected closer than a set threshold, the microcontroller halts the motor using an relay or adjusts the path, preventing collisions and ensuring safe navigation.

E. Motor and Movement Control

The ATmega328 sends movement commands to an L298N motor driver, which controls the DC gear motors. Based on input from sensors, the microcontroller controls the motors for turning, stopping, or changing speed using PWM signals and directional logic

IV. RESULT

The implementation of the Margdarshak driverless car prototype demonstrated accurate and reliable responses to various simulated traffic conditions. The TSOP1838 IR receiver successfully detected and decoded signals from IR transmitters placed on signboards, allowing the car to stop at red lights, proceed on green, adjust speed based on speed limit instructions, and turn according to directional commands. The IR sensors accurately followed the designated lane by detecting surface contrast, and the ultrasonic sensor effectively halted the car upon obstacle detection. The ATmega328 microcontroller processed sensor data in real-time and executed commands without delay. Overall, the prototype performed smoothly in indoor conditions and proved the feasibility of building a functional, low-cost autonomous vehicle using simple embedded hardware.

V. USECASES

These cases are divided into four categories-

1) Smart Campus Mobility

The prototype can be implemented in university or industrial campuses to automate short-distance transportation. Small autonomous vehicles can follow predefined paths, obey IR-based signboards, and stop at pedestrian crossings, minimizing manual efforts and improving on-campus safety and efficiency.

2) Warehouse and Factory Automation

In warehouses and factories, this system can automate the movement of goods along specific routes. The vehicle can follow floor markings, adjust speed in specific zones, and avoid obstacles using ultrasonic sensors, improving productivity while reducing accidents and labor dependency.

3) Educational and Research Applications

This project serves as an excellent platform for academic learning in robotics, embedded systems, and IoT. It helps students and researchers understand sensor integration, autonomous control, and real-time decision-making, making it ideal for lab experiments and project-based learning environments.

4) Traffic Control Demonstration Models

Urban planners and engineers can use this model to simulate smart traffic systems. By placing IR signals at different intersections and monitoring how the vehicle reacts, traffic flow, signal timing, and accident prevention strategies can be demonstrated in a classroom or exhibition environment.

VI. CONCLUSION

The development and successful implementation of the Margdarshak prototype demonstrates the potential of integrating simple sensor systems with microcontroller-based logic to simulate the core functionalities of an autonomous vehicle. This project was driven by the vision to create a low-cost, scalable, and effective solution for interpreting traffic signals, managing speed, and navigating lanes autonomously. Unlike modern commercial autonomous vehicles that rely heavily on costly GPS modules, camera-based systems, and AI models, Margdarshak relies on cost-effective and widely available components such as IR transmitters, TSOP1838 IR receivers, ultrasonic sensors, and ATmega328 microcontrollers. This makes it not only an affordable solution for developing countries but also a strong academic and educational prototype to teach automation and embedded system concepts.

The system architecture enables the vehicle to take real-time decisions such as stopping at red signals, moving on green, turning as per signboard directions, following lanes using IR sensors, and halting when an obstacle is detected. The successful synchronization of all sensor modules with logical programming validates the efficiency of the overall design.



The performance of the vehicle was tested in various controlled scenarios, and it accurately responded to simulated road conditions. Furthermore, the vehicle's ability to adapt speed based on IR signal input highlights its potential for use in structured and semi-structured environments like university campuses, industries, and automated transport routes. The seamless integration of motor driver modules with relay control and power regulation circuitry further enhances the stability and robustness of the system.

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