IOT BASED SEMI-AUTONOMOUS VEHICLE USING ARDUINO AND NRF

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ABSTRACT

In the modern era of automation and smart technologies, the integration of Internet of Things (IoT) into mechanical devices has revolutionized various industries. The design and implementation of an IoT-based Semi-Autonomous Vehicle using Arduino and NRF capable of transporting payloads weighing up to 10kg. The device is controlled using a joystick interface, facilitating intuitive operation, and communication is facilitated through NRF24L01 modules and Arduino microcontrollers. The proposed system comprises a robust mechanical platform equipped with motors and wheels for mobility. An Arduino microcontroller serves as the central processing unit, coordinating the device's movements and interactions with the user interface. Utilizing the NRF24L01 wireless communication module enables seamless data transmission between the device and the controller, ensuring real-time responsiveness and reliability.

Keywords: Autonomous Vehicle, Wireless Communication, Arduino Uno, NRF24L01

INTRODUCTION

This project combines the versatility of Internet of Things (IoT) technology with the precision of Arduino microcontrollers and the seamless connectivity of NRF modules, all controlled by the intuitive simplicity of a joystick. IoT-based semi-autonomous vehicle revolutionizes the way we interact with and manage heavy loads, whether in industrial settings, logistics operations, or even in our daily lives.With Arduino serving as its brain, our device offers unparalleled reliability and adaptability. The NRF module ensures robust wireless communication, facilitating real-time data transmission and remote control. This allows users to monitor and control the device from a distance, enhancing convenience and efficiency in operation. The joystick serves as the primary input device for controlling the movement and direction of the device. Users can control vehicle movement in four directions by simply manipulating the joystick, allowing for intuitive and effortless navigation. This intuitive control mechanism simplifies operation, making it accessible to users of all skill levels.The vehicle can be operated by moving the joystick, which sends an analog signal to the Arduino Uno. The Arduino Uno processes the analog signal and converts it into a digital signal. The digital signal is then transmitted wirelessly by the nRF24L01 module.

LITERATURESURVEY

[1]A Remote Controlled Mobile Robot based on Wireless Transmission

A construction robot operated remotely via wireless transmission allows tasks to be performed in areas where human presence could be dangerous. Enhancing its capabilities through wireless data transfer expands its potential applications. Developing a reliable, real-time remote control system is crucial for optimizing the robot's efficiency and ensuring its practical utility. The system comprises three main components: a control center, the robot itself, and a display terminal. Through both hardware and software, the robot can mimic the movements of a servo console in real-time. Tests confirm the system's ability to stream live video and accurately control the robot's movements.

[2]A Control of Two Wheels Driven Redundant Mobile Manipulator Using A Monocular Camera System

The demand for robots in various settings, including homes and public places, is on the rise. To enable autonomous operation in dynamic and unfamiliar environments, robots must be able to perceive and understand their surroundings. Additionally, they need to move swiftly and perform tasks with precision. This paper introduces a control system designed for a two-wheeled redundant mobile manipulator equipped with a monocular camera as its visual sensor. The proposed system comprises two control subsystems: task execution control and stabilization control. Task execution control ensures accurate and rapid task completion, while stabilization control maintains the robot's posture. By integrating these two control systems using the null space, the robot can achieve desired motion and stabilization simultaneously. Experimental tests were conducted to validate the effectiveness of the proposed method.

[3]Prototyping a wheeled mobile robot embedding multiple sensors and agent-based control system.
This study presents the design and creation of an autonomous wheeled mobile robot. To achieve autonomy, the robot prototype is equipped with five types of sensors: shaft encoders, ultrasonic transducers, infrared proximity sensors, contact sensors, and monocular vision. These sensors work together to gather accurate information about the robot's surroundings, enabling safe navigation. As part of the ongoing development, an experiment showcasing the robot's capabilities is described, focusing on a behavior called Exploration. This behavior is integrated into the hierarchical control layers of the agent-based control system being developed. With Exploration activated, the robot can navigate autonomously while avoiding obstacles in its path, as demonstrated.

EXISTINGMETHOD

The design of the voice-activated semi-autonomous vehicle was built upon an electric lawnmower platform, specifically a Black & Decker model CM1836. This lawnmower was enhanced by integrating two electric motors, two motor controllers, and a Wi-Fi module to enable communication between an electronic control module and the internet. One of the key enhancements made to the lawnmower platform was the integration of two electric motors and corresponding motor controllers. Commands were transmitted via an internet-enabled speaker, leveraging Amazon Tap with the Alexa operating system to convert voice commands into instructions uploaded to a cloud-based service. The vehicle's controller continuously monitored for new commands from the cloud and executed them accordingly. Control of the vehicle's motion was achieved through the manipulation of relays using a microcontroller (Photon**).** This setup allowed for precise regulation of motor speed and direction, ensuring optimal maneuverability across various operating conditions. Relays were utilized to start and stop the blade motor and the propelling motors, with separate relays for each. The blade motor operated on a simple on-off basis, requiring a single relay, while the propelling motors, responsible for speed and direction, were managed using a DC motor speed controller and a relay array. This setup ensured precise regulation of motor speed and direction, guaranteeing the vehicle's maneuverability and functionality across various operating conditions.

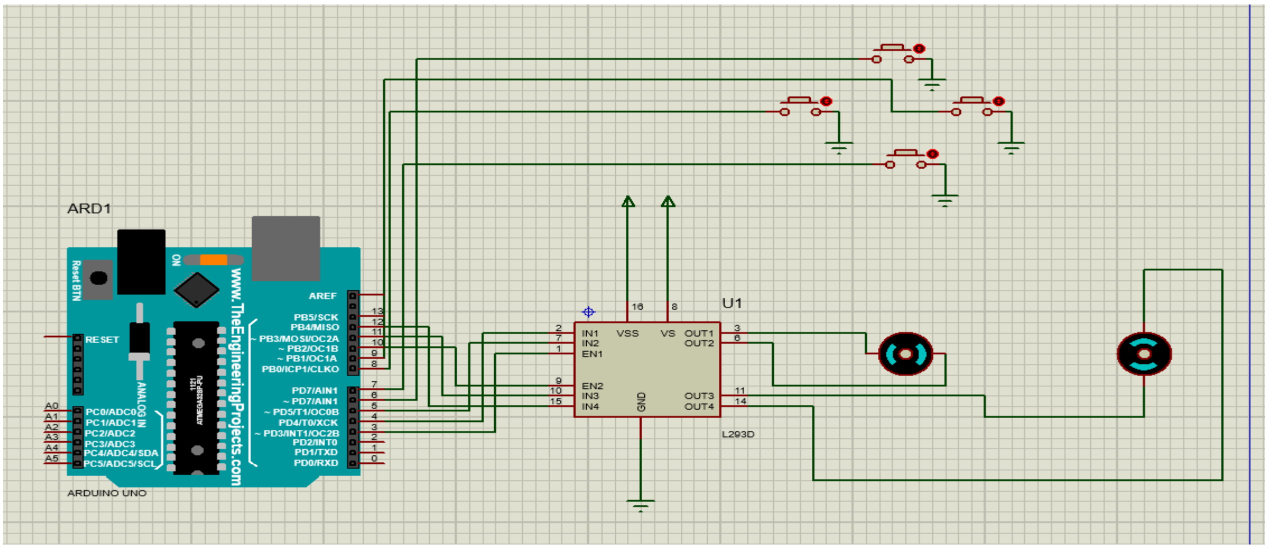


Figure.1. Schematic diagram for Transmitting Section

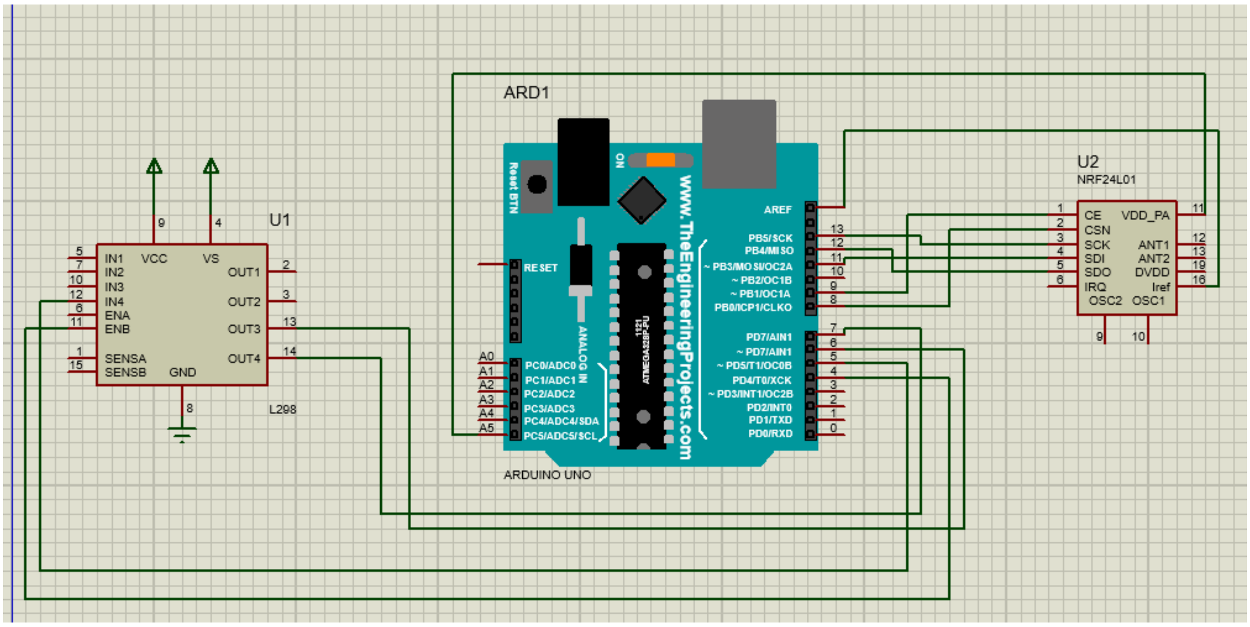
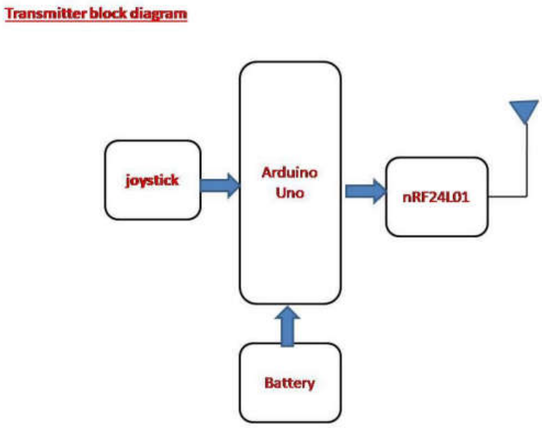


Figure.2. Schematic diagram for Receiving Section

PROPOSEDMETHOD



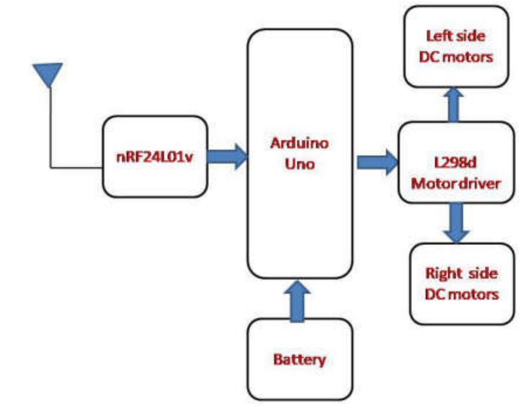


Figure.3. Block diagram for Transmitting Section Figure.4. Block diagram for Receiving Section

Transmitting Section:
Joystick: This is likely used to control the movement of the vehicle in four different directions. The primary purpose of using a joystick is to provide manual control and manipulation of a device or system in multiple directions.
Arduino Uno: This is a microcontroller board that is commonly used in electronics projects. It will likely be used to process the input from the joystick and transmit it to 19 another device. The purpose of using Arduino revolves around its versatility, accessibility, and ease of use in creating a wide range of electronic projects.
NRF24L01: This is a wireless transceiver module that is used to transmit and receive data. It will likely be used to transmit the joystick data to a receiver. The purpose of using the NRF24L01 module is to provide a reliable, low-cost, and energy-efficient solution for wireless communication between devices in a wide range of electronic projects and applications.
Battery: This will provide power to the entire system. The purpose of using a battery in various applications, including robotics, is to provide a portable and reliable source of power.

Receiving Section:
Left and Right DC Motors: These are the motors that drive the wheels of the remote-controlled vehicle. They will spin in opposite directions to turn the vehicle, and in the same direction to move it forward or backward. Motor Driver: This component is responsible for controlling the DC motors based on the signals it receives from the Arduino Uno. It regulates the speed and direction of the motors.
Arduino Uno: This microcontroller board is the brain of the transmitter. It receives input signals from the nRF24L01 module, interprets them, and then sends 22 corresponding instructions to the motor driver to control the DC motors.
NRF24L01: This wireless transceiver module transmits control signals from the Arduino Uno to the receiver (not shown in the diagram) in the remote-controlled vehicle.
Battery: This provides power to the entire transmitter circuit, including the Arduino Uno, motor driver, and nRF24L01 module.

RESULT ANALYSIS

The IoT-based weight-carrying device was assembled using various components, including Arduino Uno microcontroller, NRF24L01 module for wireless communication, joystick module for user input. These components were interconnected as follows: the Arduino Uno was connected to the NRF24L01 module for wireless communication and to the joystick module to receive user input. The analysis of the results for the IoT-based weight carrying device controlled by a joystick using Arduino and NRF reveals several key findings.

Figure.5. Transmitting and Receiving section of a Vehicle

Firstly, the functionality of the device was largely successful, with the joystick controls effectively translating into movement commands for the device and weight measurements obtained reliably. However, there were instances where the wireless communication between the joystick controller and the device using the NRF module experienced occasional signal interference, leading to minor disruptions in control responsiveness. Load capacity testing demonstrated that the device could carry weights within its intended range without malfunctioning or straining its components, aligning with design specifications. Battery life assessments indicated satisfactory operational durations for both the joystick controller and the device on a single charge or set of batteries, ensuring practical usability.

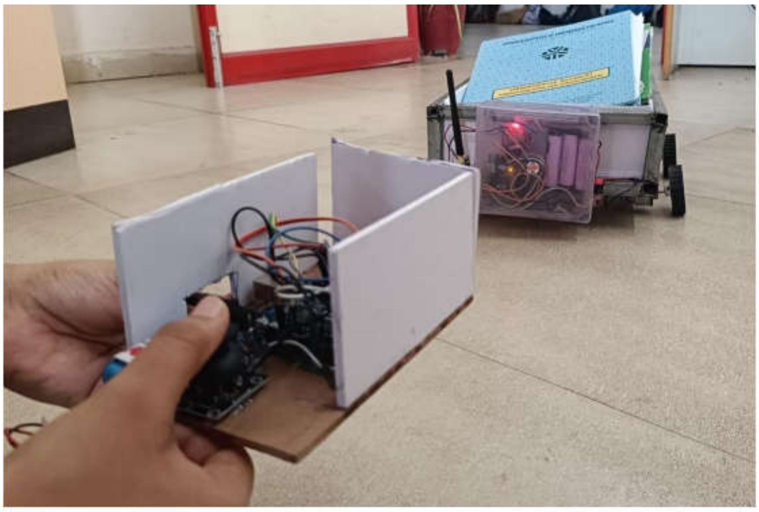


Figure.6. Controlling of vehicle moment by a joystick

Performance metrics, including response time, weight measurement accuracy and power consumption, met predefined benchmarks, with room for optimization in communication reliability. Durability tests revealed the device's resilience to environmental factors and mechanical wear, affirming its long-term reliability. Cost analysis indicated a reasonable investment relative to the benefits and functionality offered by the device, suggesting favorable cost-effectiveness. Overall, the results underscore the success of the IoT-based weight carrying device project, while also identifying areas for refinement and future development to enhance performance and user experience further.
The below table provides the relationship between weight, power consumption and efficiency for the weight carrying Autonomous Vehicle.

Weight(kg)	Power Consumed(Watts)	Efficiency(%)
1	10	90
2	12	85
3	14	80
4	16	75
5	18	70
6	20	65
7	22	60
8	24	55
9	26	50
10	28	45

Figure.7.: Performance Metrics of Weight Carrying Device (up to 10kg)

CONCLUSION

This project successfully demonstrates a IoT-based semi-autonomous vehicle represents a significant advancement in the realm of automated transportation systems. By integrating cutting-edge technologies such as the NRF24L01 wireless modules, Arduino microcontrollers, and intuitive joystick controls, the project has successfully created a versatile platform capable of carrying payloads up to 10kg with precision and efficiency. The seamless wireless communication facilitated by NRF24L01 modules enables real-time control and monitoring, enhancing operational flexibility and responsiveness. This wireless capability enhances operational flexibility, allowing the vehicle to be controlled from a distance and facilitating autonomous operation in dynamic environments. The robust communication protocol provided by NRF24L01 modules ensures reliability and stability, critical for safety and efficiency in transportation applications. The user-friendly joystick interface simplifies operation, allowing users to navigate the device effortlessly. Moreover, the scalability of the Arduino platform offers opportunities for future enhancements and customizations to meet evolving needs and applications.

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