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Arduino controlled electric carrier for automated material movement

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Abstract

The Arduino Controlled Electric Carrier for Automated Material Movement is a smart and efficient material handling system designed to reduce manual labor and improve productivity in industrial and warehouse environments. The system utilizes an Arduino microcontroller to control the movement of an electric carrier through programmed commands and sensor inputs. The carrier is powered by rechargeable batteries and equipped with DC motors for smooth transportation of materials. Obstacle detection sensors are integrated to ensure safe navigation and prevent collisions during operation. The proposed system offers a low-cost, energy-efficient, and user-friendly solution for automated material transportation. By minimizing human intervention, it enhances workplace safety, reduces operational time, and increases overall efficiency. This project demonstrates the application of embedded systems and automation technologies in modern material handling processes, making it suitable for small-scale industries, warehouses, and manufacturing units.

Keywords: Arduino; Automated Material Movement; Electric Carrier; Material Handling System; Industrial Automation; DC Motor Control; Obstacle Detection; Embedded Systems; Smart Transportation; Warehouse Automation

1. Introduction

Material handling plays a vital role in industries, warehouses, and manufacturing units, where the transportation of goods and raw materials is a routine task. Traditional material movement methods often require significant human effort, leading to increased labor costs, reduced efficiency, and potential workplace accidents. With the advancement of automation and embedded systems, automated material handling solutions have become an effective way to improve productivity and safety. The Arduino Controlled Electric Carrier for Automated Material Movement is designed to automate the transportation of materials from one location to another with minimal human intervention. The system uses an Arduino microcontroller as the main control unit, which manages the movement of the carrier through motor drivers and sensors. The electric carrier is powered by a rechargeable battery and equipped with obstacle detection mechanisms to ensure safe and reliable operation. The proposed system offers a cost-effective and energy-efficient alternative to conventional material transportation methods. By integrating automation technology, the carrier can reduce manual workload, increase operational efficiency, and improve safety in industrial environments. This project demonstrates the practical application of microcontrollers, sensors, and motor control systems in developing smart material handling solutions. The Arduino-controlled electric carrier can be widely used in warehouses, production plants, hospitals, and logistics centres where regular transportation of materials is required. Its simplicity, affordability, and adaptability make it a suitable solution for small- and medium-scale industries seeking automation in material handling operations. [1-12]

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2. Methodology

In this paper we are discussing about the circuit of the Arduino-controlled electric carrier consists of an Arduino Uno, motor driver module, DC motors, battery supply, and obstacle detection sensors. The Arduino acts as the central controller, receiving signals from the sensors and sending control commands to the motor driver. The motor driver amplifies these signals to drive the DC motors, enabling forward, reverse, left, and right movement of the carrier. The battery provides the required power to the entire system, ensuring smooth and reliable operation.

- **Arduino Uno Controller** – Central processing unit that controls all project operations.
- **12V Battery Power Supply** – Provides power to the Arduino, motors, and other modules.
- **Bluetooth Remote Control** – Enables wireless control of the carrier's movement.
- **Ultrasonic Sensor** – Detects obstacles and prevents collisions.
- **Load Cell Sensor** – Measures the weight of the material being transported.
- **Motor Driver (L298N)** – Controls the direction and speed of the DC motors.
- **DC Motors** – Drive the carrier in forward, backward, left, and right directions.
- **16×2 LCD Display** – Displays weight, status, and system information.
- **Buzzer Alert System** – Provides warning signals during obstacle detection or overload conditions.
- **Overload Indicator (LED)** – Indicates when the load exceeds the specified limit.
- **Emergency Stop Push Button** – Instantly stops the carrier during emergencies.
- **Charging Port** – Allows convenient recharging of the battery.

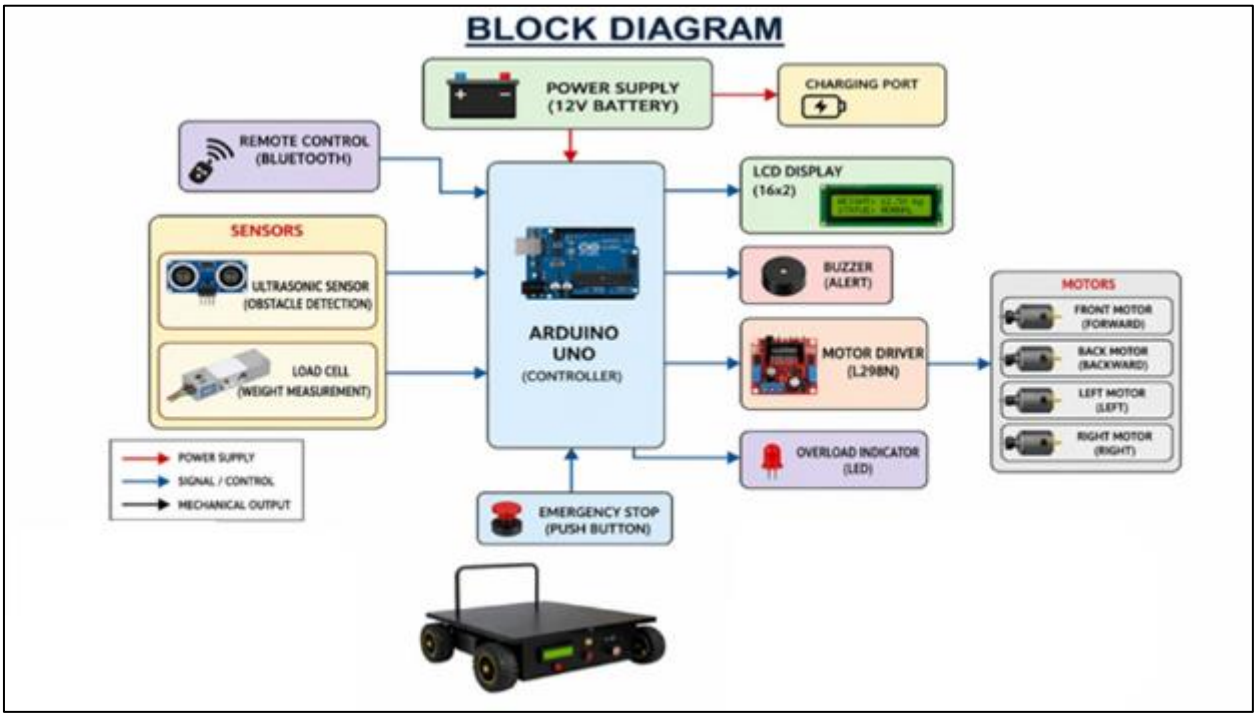

Figure 1 Block Diagram

The Arduino Uno acts as the main controller of the system. A 12V battery powers all components, while Bluetooth remote control sends movement commands to the Arduino. The ultrasonic sensor detects obstacles and the load cell measures the weight of the load. Based on the received data, the Arduino controls the motor driver (L298N), which drives the motors for movement. The LCD displays system status and weight information, while the buzzer, LED indicator, and emergency stop button ensure safe operation.

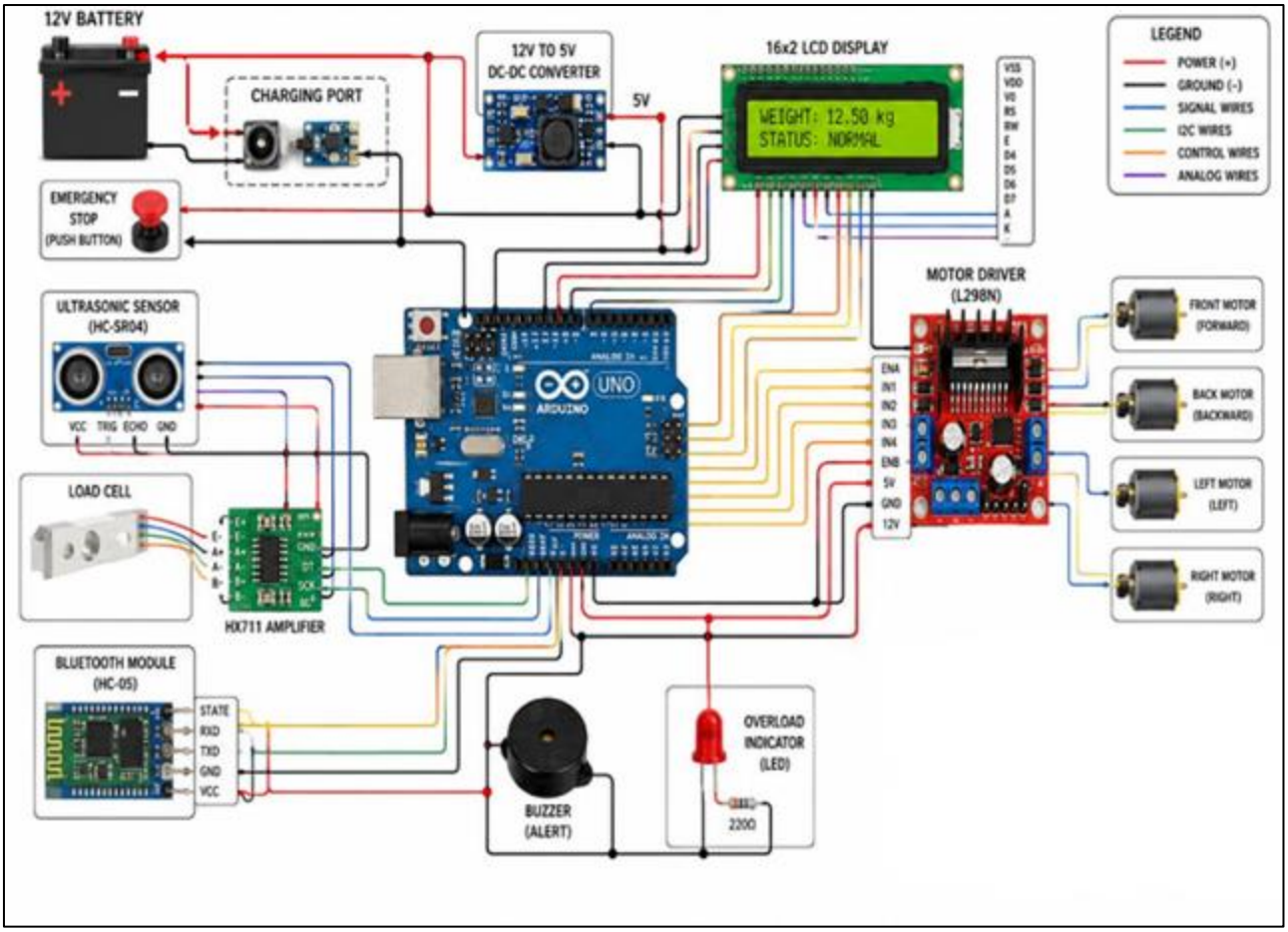

Figure 2 Circuit Diagram

The Smart Material Carrier System is powered by a 12V battery, and a DC-DC converter provides a regulated 5V supply to the Arduino Uno and other modules. The HC-05 Bluetooth module receives wireless commands from a mobile device and sends them to the Arduino. The Arduino acts as the main controller and processes all commands and sensor data. The HC-SR04 ultrasonic sensor continuously detects obstacles in the carrier's path. A load cell with an HX711 module measures the weight of the material being carried. The measured weight and system status are displayed on a 16×2 LCD display.

Based on user commands and sensor inputs, the Arduino controls the DC motors through the L298N motor driver, enabling the carrier to move in the desired direction. If an obstacle or overload is detected, the Arduino stops the carrier and activates the buzzer and LED as warning indicators. An emergency stop switch is also provided to instantly halt the system during emergencies, ensuring safe and reliable operation.

3. Result and discussion

The Smart Material Carrier System is designed to transport materials safely and efficiently using an Arduino Uno-based control system. The entire system is powered by a 12V battery, which provides the required electrical energy to the Arduino Uno, sensors, motor driver, display unit, and other peripheral devices. The Arduino Uno acts as the central processing unit and controls all system operations. The movement of the carrier is controlled wirelessly through a Bluetooth module. The user sends movement commands such as forward, backward, left, right, and stop from a smartphone or any Bluetooth-enabled device. These commands are received by the Bluetooth module and transmitted to the Arduino Uno. After processing the received commands, the Arduino generates appropriate control signals for the motor driver. An L298N motor driver module is used to drive the DC motors of the carrier. Based on the commands received from the Arduino, the motor driver controls the direction and speed of the motors, allowing the carrier to move according to the user's instructions. This enables smooth and flexible operation of the system. To ensure safe navigation, an ultrasonic sensor is mounted on the carrier.

The sensor continuously measures the distance between the carrier and any obstacle present in its path. The distance information is sent to the Arduino for analysis. Whenever an obstacle is detected within a predefined safety range, the Arduino immediately stops the motors to avoid collisions and prevent damage to the carrier or surrounding objects. The system also incorporates a load monitoring mechanism using a load cell and an HX711 amplifier module. The load cell measures the weight of the material placed on the carrier platform. Since the output signal from the load cell is very small, it is amplified and converted into digital data by the HX711 module. This data is then sent to the Arduino for processing. The measured weight is displayed on an LCD display in real time. The LCD also shows system status messages and warning indications, allowing the user to monitor the operating condition of the carrier continuously. This feature improves usability and helps prevent overloading. If the measured load exceeds the predefined maximum limit, the Arduino identifies the overload condition and immediately stops the carrier. Simultaneously, a buzzer and an LED indicator are activated to alert the user. Similarly, when an obstacle is detected, the buzzer and LED provide visual and audible warnings to enhance safety. For emergency situations, an emergency stop push button is provided in the system. When this button is pressed, all motor operations are instantly stopped regardless of the current operating mode. This feature provides an additional layer of safety and allows the user to quickly halt the carrier whenever necessary. Thus, the Smart Material Carrier System combines wireless control, obstacle detection, load monitoring, real-time display, and safety mechanisms to achieve efficient, reliable, and secure material transportation.

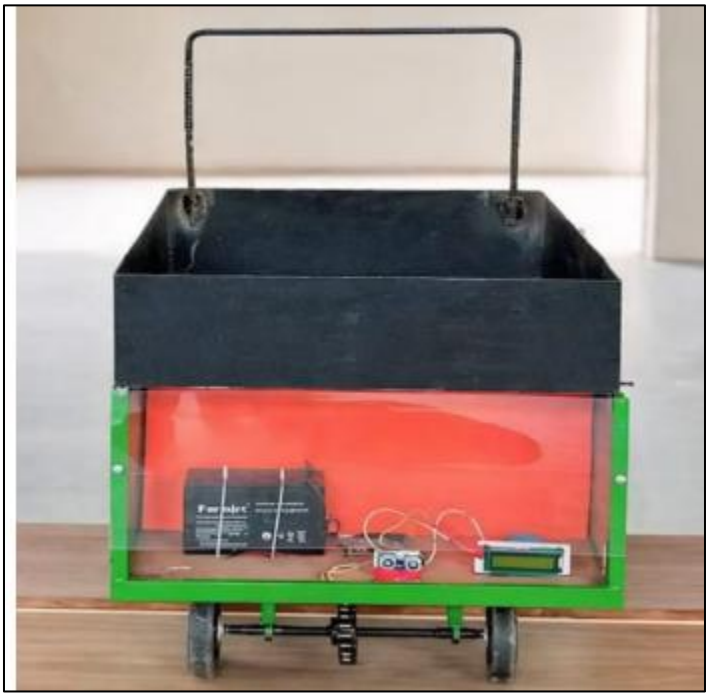

Figure 3 Proposed System

4. Conclusion

The Arduino Controlled Electric Carrier for Automated Material Movement provides an efficient, cost-effective, and reliable solution for material handling. By integrating Arduino, Bluetooth communication, sensors, and motor control, the system reduces manual effort and improves operational efficiency. The inclusion of obstacle detection, load monitoring, and safety features enhances reliability and workplace safety, making the system suitable for industrial and warehouse applications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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