RFID BASED SMART CAR PARKING SYSTEM

MINI PROJECT REPORT

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to

the APJ Abdul Kalam Technological University in partial fulfilment of the requirements for the award of Degree
of
BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

Under the guidance of

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APRIL 2025

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Certificate

This is to certify that the Mini project report entitled **RFID BASED SMART CAR PARKING SYSTEM** is a bonafide work carried out by **Jyothish M S** (KTE22EC041), **Krishna Dinesh** (KTE22EC043), **Neha V M** (KTE22EC048) **, Ria Navas** (KTE22EC052), during 2024-25, in partial fulfilment for the award of the B. Tech degree inElectronics and Communication Engineering of APJ Abdul Kalam Technological University, Rajiv Gandhi Institute of Technology, Kerala.

Project Guide **Co-ordinators**

Head of the Department, ECE

ACKNOWLEDGEMENT

We wish to thank the multitude of people who have helped us to complete this project.

We wish to express our sincere gratitude to our Project Coordinators **Dr. Rezuana Bai J.,** Professor and **Prof. Shinoj K. Sukumaran**, Associate Professor, Department of Electronics and Communication Engineering for inspiring and providing sincere guidance throughout the project.

We would like to express our special thanks of gratitude to our Project Guide, **Prof. Annie George**, Assistant Professor, Department of Electronics and Communication Engineering, who was a continual source of inspiration to us. We are deeply indebted to **Dr. David Solomon George.**, Professor and Head ofthe Department, Electronics and Communication Engineering, for providing permission and availing all the required facilities for undertaking the project in a systematic way. We wish to express oursincere thanks to **Dr. Prince A.**, Principal, for providing us with all the facilities. Further we extend our gratitude to all teaching and non-teaching staff of the Department of Electronics and Communication Engineering, for the cooperation.

Finally, we would like to express thanks to our friends, family and well-wishers who guided, helped and prayed for us to complete the project work on time.

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ABSTRACT

The RFID Based Smart Car Parking System with Weight Sensing Capability is a modern solution designed to optimize parking operations, enhance security and ensure safety. This system combines radio frequency identification technology based payment and weight sensors to automate vehicle entry and exit while preventing overweight vehicles from accessing the parking facility. Upon entering the parking lot, an RFID reader scans the tag and if validated, the barrier gate opens and the parking fee is automatically deducted. If a vehicle exceeds the predetermined weight limit, the system triggers a notification and restricts access. This reduces human intervention, minimizes delays and provides a secure and efficient parking experience.

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INTRODUCTION

Parking management has become a crucial aspect of urban infrastructure, especially with increasing vehicle numbers and limited parking spaces. Traditional parking systems often involve manual ticketing and cash payments, leading to inefficiencies, delays, and inconvenience. To address these challenges, we have introduced RFID-based smart parking systems with weight sensing capabilities, enabling a seamless, automated, and fair parking experience.

This automated parking system reduces human intervention, minimizes delays, and provides a secure and efficient parking experience. It is particularly suitable for commercial and residential parking lots, where efficient space management and user convenience are essential. The project demonstrates a cost-effective and scalable solution for modern parking challenges.

Radio Frequency Identification (RFID) technology enables vehicles to be identified and charged automatically as they enter and exit parking areas. Each vehicle is equipped with an RFID tag linked to a prepaid account, allowing for quick, cashless, and hassle-free transactions.

CHAPTER-2

SYSTEM DESCRIPTION

The RFID-based smart car parking system integrates RFID technology, weight sensors, and an LCD display to automate vehicle entry, exit, and payment while ensuring safety and efficiency. Each vehicle has an RFID tag linked to a prepaid account for seamless, contactless transactions. At the entrance, a weight sensor checks if the vehicle meets the weight limit to prevent heavy vehicles from entering, an RFID reader scans the tag, verifies the balance and deduct the parking fee automatically. Additionally, an LCD display shows real-time parking slot availability, helping drivers find vacant spots easily. This smart system enhances security, reduces congestion, prevents infrastructure damage, and improves parking management for a smooth user experience.

2.1 BLOCK DIAGRAM

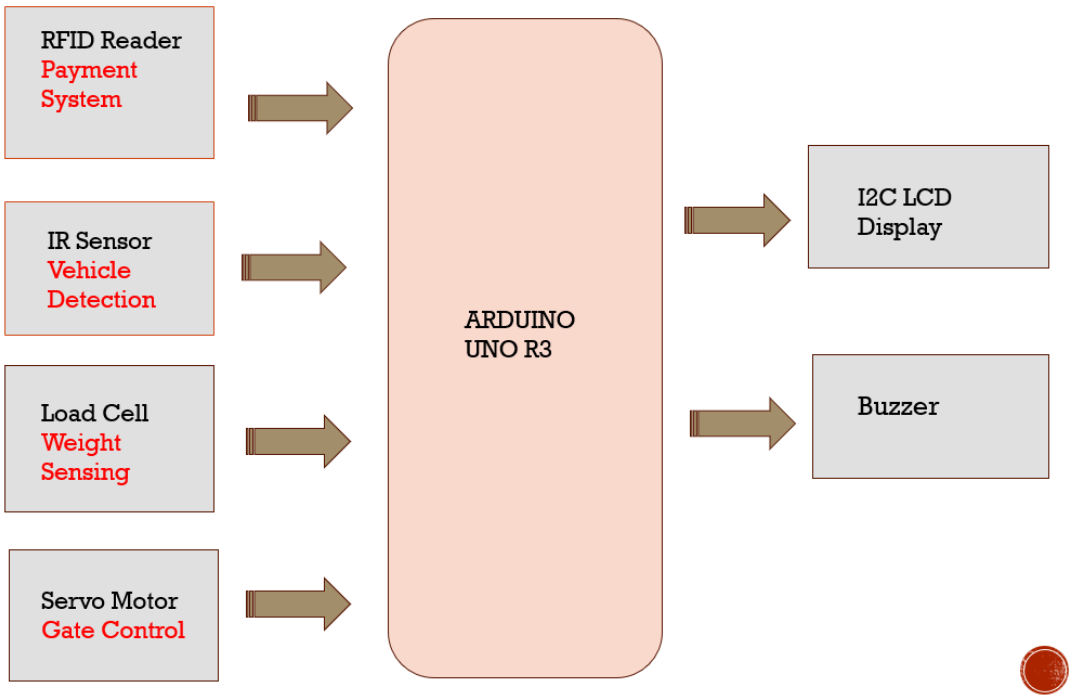

Fig 2.1.1: BLOCK DIAGRAM

2.2 CIRCUIT DIAGRAM

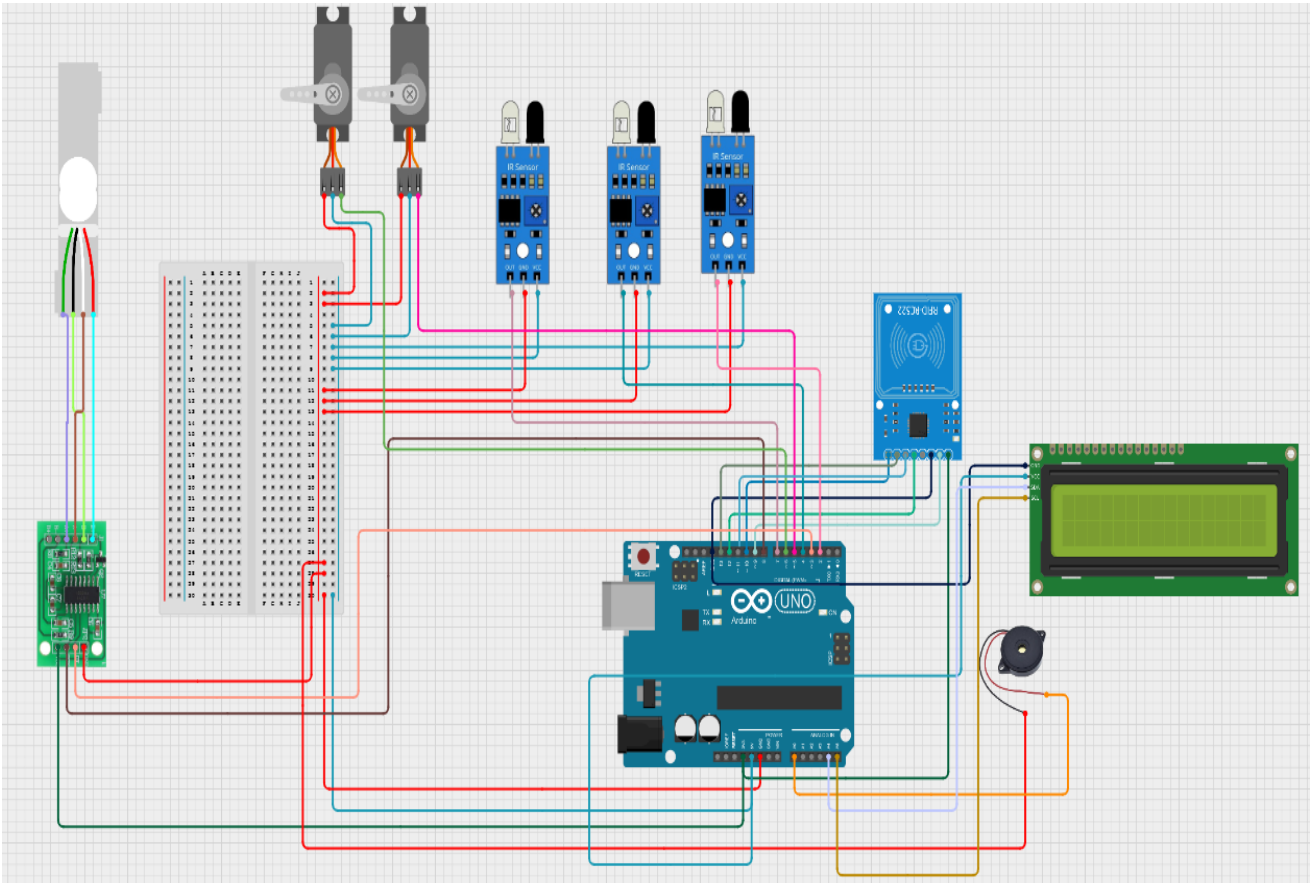

Fig. 2.2.1: CIRCUIT DIAGRAM

2.3 WORKING

The RFID-based smart car parking system is an advanced solution that automates vehicle entry, exit, and payment using RFID technology, a load cell for weight sensing, IR sensors for vehicle detection, an LCD display for slot availability, and a servo motor for gate control. The system ensures a seamless, contactless, and efficient parking experience while maintaining infrastructure safety and optimizing space management.

When a vehicle approaches the parking entrance, an IR sensor detects its presence, triggering the system. The LCD display shows the number of available parking slots. The load cell measures the vehicle's weight to prevent entry of heavy vehicles that could damage the parking structure. If the vehicle meets the weight criteria, the RFID reader scans the RFID tag attached to the vehicle. The system then checks if the tag is valid and whether the linked prepaid account has sufficient balance. If authentication and payment is successful, the servo motor then opens the gate, allowing the vehicle to enter.

The system then updates the database, freeing up the parking slot and updating the availability on the LCD screen. After each vehicle goes through the exit gate controlled by the servo motor, the slots displaying also gets updated.

CHAPTER-3

HARDWARE AND SOFTWARE DESCRIPTION

An RFID-based payment system in a smart car parking system with weight sensing capability using Arduino Uno R3 integrates both hardware and software components for automated vehicle identification, payment, and weight-based parking. The hardware includes an RFID reader (such as the RC522) to scan RFID tags assigned to vehicles, a load cell with an HX711 amplifier to measure the vehicle's weight, an Arduino Uno R3 microcontroller to process data, an LCD display for showing parking details, and a servo or barrier gate for automated access control. The software is developed using the Arduino IDE, where the RFID system authenticates the vehicle, retrieves stored user payment details, and, in combination with the load cell, allows the entry to the parking slots. The program also controls gate operations and communicates data for logging or payment processing, making the system efficient, contactless, and automated for modern smart parking solutions.

3.1 HARDWARE DESCRIPTION

3.1.1 ARDUINO UNO R3

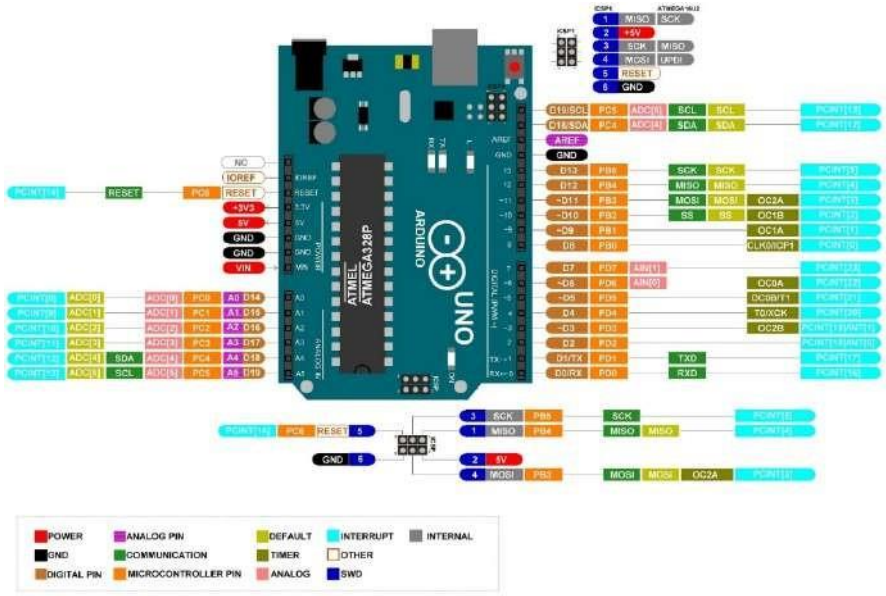

Fig. 3.1.1: ARDUINO UNO

Arduino is an open-source hardware and software platform designed for easy prototyping of electronic projects. At its core lies a microcontroller, typically an Atmel AVR series chip, along with a development environment that simplifies coding and interfacing with external components. With a variety of input/output pins, Arduino boards can interact with sensors, actuators, and other devices, making them suitable for a wide range of applications, from simple LED blinking to complex robotics projects. The platform's affordability, simplicity, and extensive community support have made it a popular choice among hobbyists, educators, and professionals alike for bringing ideas to life in the realm of electronics and programming.

3.1.2 INFRARED OBSTACLE AVOIDANCE SENSOR

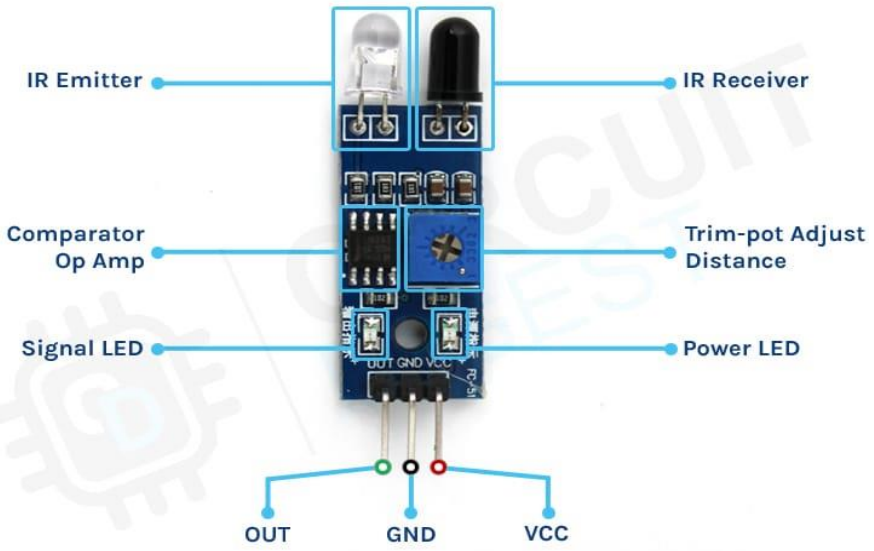

Fig. 3.1.2: IR Sensor Module

An Active Infrared (IR) sensor is a type of IR sensor that consists of both an IR emitter (such as an LED) and an IR receiver (such as a photodiode or phototransistor). The emitter continuously transmits infrared light, which reflects off objects in its path and is detected by the receiver. The intensity of the reflected signal helps determine the presence, distance, or movement of objects. These sensors are commonly used for proximity sensing, obstacle detection, and distance measurement in applications like automatic doors, line-following robots, industrial automation, and parking assist systems. Unlike passive IR sensors, which only detect existing infrared radiation, active IR sensors require an external IR light source, making them more suitable for controlled environments and precise object detection.

3.1.3 16 x 2 I2C LCD DISPLAY

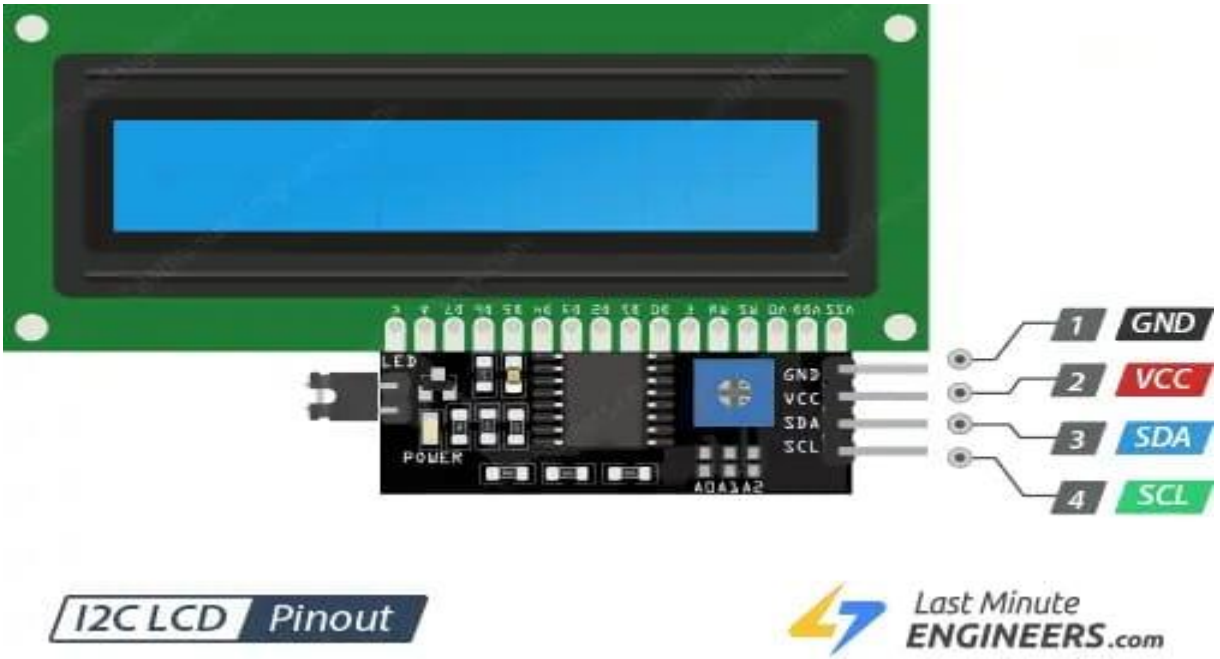

Fig. 3.1.3: I2C LCD DISPLAY

An I2C LCD display is a liquid crystal display module that communicates with a microcontroller using the I2C (Inter-Integrated Circuit) protocol, reducing the number of required connection pins compared to traditional parallel LCDs. It typically features a 16x2 or 20x4 character display, with an integrated I2C adapter (PCF8574 chip) that allows data transmission over just two wires (SDA and SCL), making it ideal for projects with limited GPIO pins. The display is commonly used in Arduino and Raspberry Pi projects for showing text, sensor data, or menu options, and it often includes adjustable backlighting and contrast. Its efficiency, ease of wiring, and simple integration with libraries like LiquidCrystal_I2C make it a popular choice for hobbyists and developers alike.

3.1.4 LOAD CELL AND HX711 AMPLIFIER MODULE

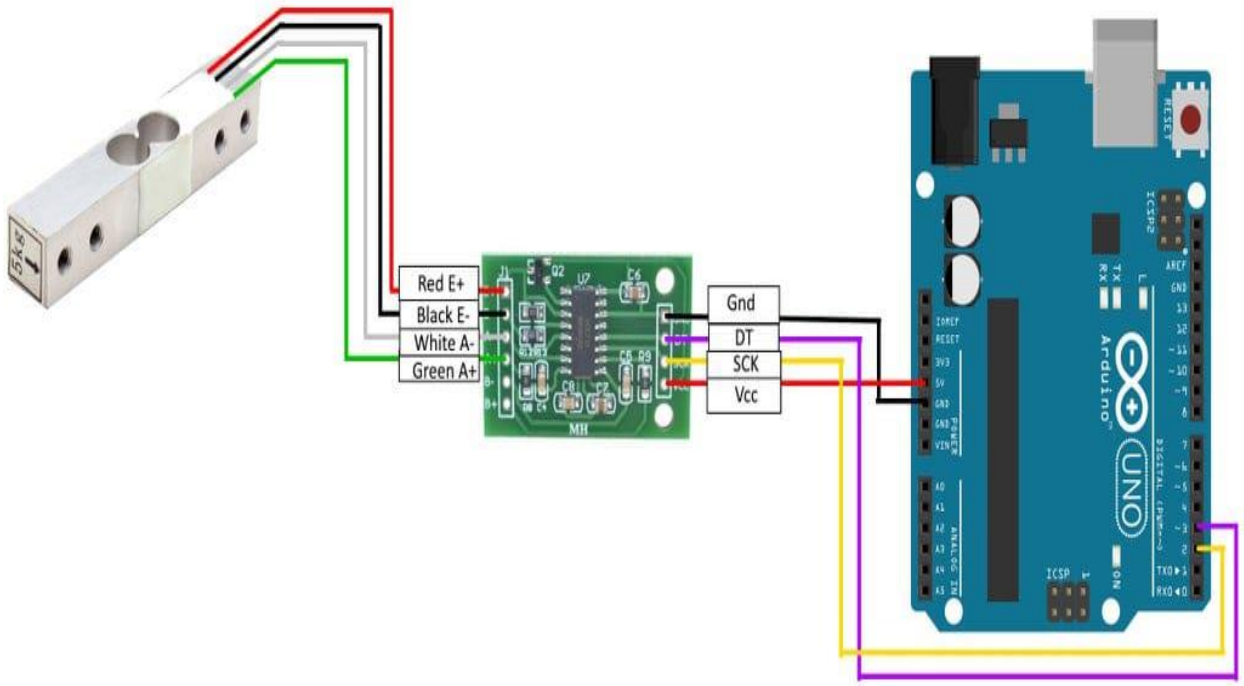

Fig. 3.1.4: 1 Kg LOAD CELL WITH HX711 WEIGHT SENSOR

A Load Cell is a transducer that converts force or weight into an electrical signal. It operates based on the strain gauge principle, where mechanical deformation causes a change in electrical resistance. Load cells come in various types, including strain gauge, hydraulic, and capacitive, with strain gauge-based load cells being the most common. The HX711 is a precision 24-bit analog-to-digital converter (ADC) designed specifically for weight measurement applications using load cells. It amplifies the small electrical signal from the load cell and converts it into a digital signal that microcontrollers, such as Arduino or Raspberry Pi, can process. The HX711 module features dual channels (A and B), a selectable gain (32, 64, or 128), and low noise performance, making it ideal for electronic weighing scales, force measurement systems, and industrial automation.

3.1.5 RC522 RFID READER AND TAG

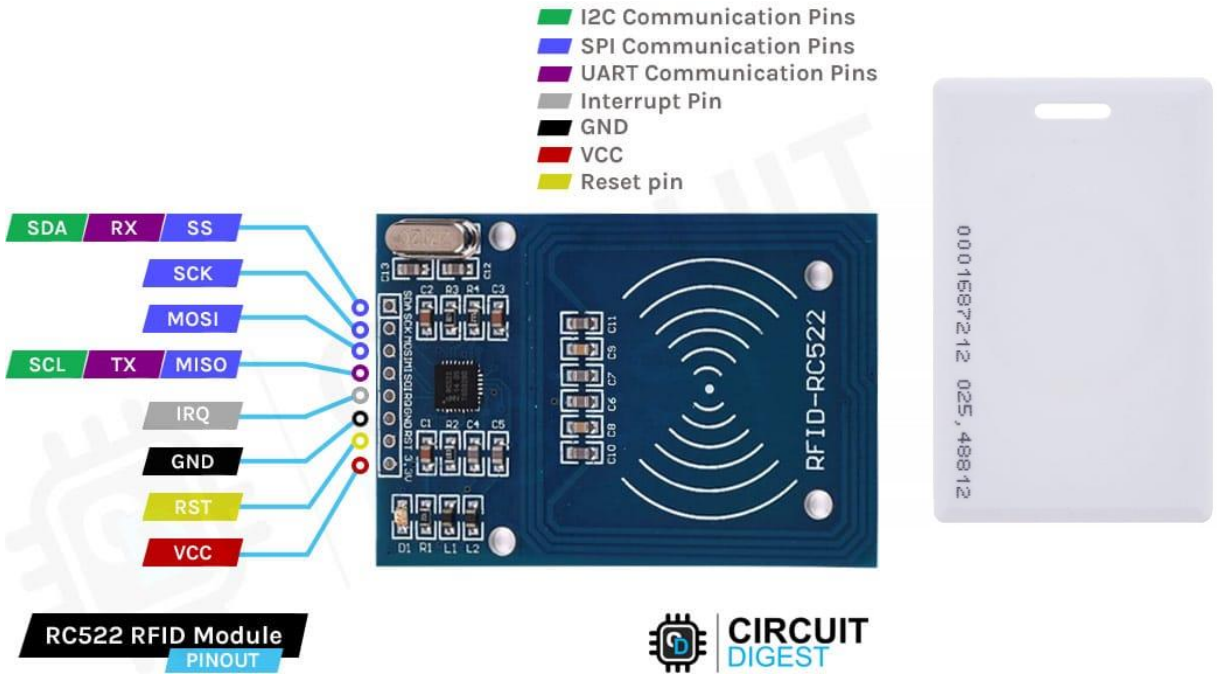

Fig. 3.1.5: RFID READER MODULE AND TAG

An RFID reader and passive tag system enables wireless identification and tracking using radio frequency signals. The RFID reader generates an electromagnetic field that powers the passive RFID tag, which does not have a battery and relies entirely on the reader's signal for energy. The tag contains a microchip that stores a unique identifier (UID) and an antenna that transmits this data back to the reader. Passive RFID tags operate at different frequency ranges, such as Low Frequency (LF), High Frequency (HF), and Ultra High Frequency (UHF), with HF commonly used for access control and contactless payments, while UHF is preferred for inventory management and logistics. Since passive tags are low-cost, lightweight, and durable, they are widely used in applications like retail, asset tracking, transportation, and security systems, providing efficient and automatic identification without requiring a direct line of sight.

3.1 SOFTWARE DESCRIPTION

The RFID based smart car parking system utilizes the Arduino IDE for programming the Arduino Uno microcontroller. Here isthe description of the software components involved.

3.2.1. Arduino IDE

The Arduino IDE (Integrated Development Environment) is a popular open-source software tool used for programming Arduino boards. It provides a user-friendly interface that simplifies the process of writing, compiling, and uploading code onto the Arduino Uno microcontroller. The IDE supports the C++ programming language and offers a comprehensive library of functions and examples.

The software workflow for the RFID based smart car parking system involves the following steps:

1. Code Development: The software code is developed using the Arduino IDE, including defining variables, configuring pin modes, collecting data from the sensor and displaying it on the LCD display.

2. Compilation and Upload: The code is compiled within the Arduino IDE to check for errors and then uploaded to the Arduino Uno board via USB connection, making it ready for execution.

3. Payment using data from user's RFID tag: Data read from the RFID tag of each vehicle owner and parking fee deducted from the account balance.

4.Weight sensing and permitting only the entry of light weight vehicles: The Load cell output also incorporated with the gate opening using the servo motor.

CHAPTER 4

RESULTS AND DISCUSSION

The RFID based smart car parking system achieved its objectives by performing the parking entry and exit of vehicles with accurate payment system and also the weight detection of vehicles entering. It integrated Arduino UNO, Load cell weight sensor, RFID reader and LCD display for weight sensing, parking fee payment and displaying the availability of parking slots.

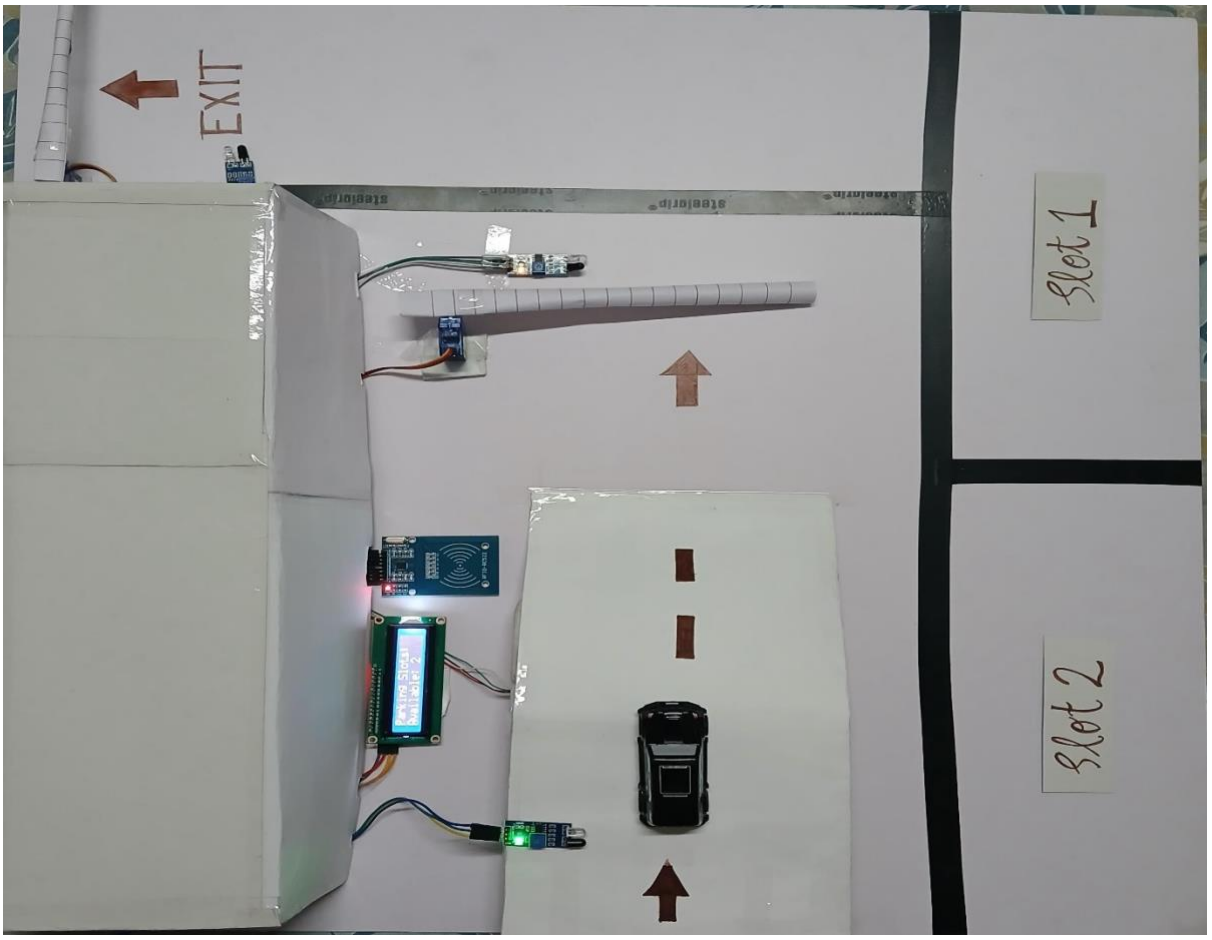

Fig 4.1: RFID based payment in smart car parking system with weight sensing capability

Key Results:

1. Payment system: The RFID module successfully detected and authenticated registered RFID tags and payment transactions were processed.

2. Weight monitoring: The weight sensor, interfaced with Arduino Uno R3, was tested with different demo weights and the system successfully prevented entry for vehicles exceeding the predefined weight threshold while allowing access to lighter vehicles.

3.Parking slots availability: Parking slots were calculated according to the entry and exit of vehicles and also displayed on the LCD screen.

In summary, the RFID-based smart car parking system with weight sensing capability successfully automates vehicle entry and payment processing while preventing heavy vehicles from accessing restricted areas. The system demonstrated efficient RFID authentication (within 2-3 seconds), accurate weight detection with minor variations, and reliable unauthorized entry prevention. Compared to traditional parking systems, it offers faster processing, enhanced security, and greater automation. Overall, the system proves to be an efficient solution for modern urban parking management.

CHAPTER 5

CONCLUSION

The RFID based smart car parking system is a revolutionary step in modern parking management. It enhances efficiency, reduces congestion, ensures fair pricing, and provides a seamless user experience. By using RFID technology, vehicles can be identified seamlessly, allowing cashless and contactless entry and exit. The weight sensor determines the vehicle's weight, which can be used for overload detection. With increasing urbanization, such smart systems are essential for optimizing space usage and improving overall traffic management. As technology continues to evolve, further integration with mobile apps, IoT, and AI can enhance parking automation, making urban mobility smarter and more convenient.

CHAPTER 6

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CHAPTER 7

APPENDIX

ALGORITHM:

Step 1: Initialization

1. **Initialize Components**
    - Attach servos to pins 5 and 6.
    - Set up IR sensors (ir1, ir2, ir3) as inputs.
    - Configure buzzer on pin A0 as output.
    - Set up the LCD display and initialize the RFID module.
    - Start the serial monitor at 9600 baud rate.
    - Initialize the HX711 weight sensor and calibrate it.
    - Display a welcome message on the LCD.
    - Set the initial available parking slots (e = 2).

Step 2: Read Sensor Values

2. **Read IR sensor values**
    - Read values from ir1, ir2, and ir3.
3. **Read weight sensor value**
    - If HX711 is ready, get the weight of the vehicle.
    - If the weight exceeds 150g, trigger the buzzer for a warning.

Step 3: Check for Vehicle Entry

4. **Detect Vehicle Entry Attempt**
    - If ir1 (entry sensor) detects a car and ir2 (middle sensor) is clear and parking slots (e > 0) are available **AND** the weight is less than 300g:
        - Display “Waiting for RFID” on LCD.
        - Wait for a valid RFID card to be scanned.
5. **Read RFID Card**
    - If a new card is detected, read its UID.
    - Convert the UID into a string and check if it matches a registered card.

Step 4: Validate Payment

6. **Check Card Balance**
    - If card UID matches a registered card:
        - Display the available balance on LCD.
        - If the balance is **≥ 35**, deduct 35 units.
        - Open entry gate (motor1.write(0)), allowing the car in.
        - Reduce available parking slots (e = e - 1).
        - Update LCD display.
        - If balance is insufficient, display an error message and trigger buzzer.
7. **Unauthorized Card Handling**
    - If an unregistered card is used:
        - Display "Unauthorized" on LCD.
        - Deny access.

Step 5: Detect Vehicle Exit

8. **Detect Car Movement**
    - If ir2 detects a car and ir1 does not, close the entry gate (motor1.write(90)).

9. **Detect Exit Attempt**
    - If ir3 (exit sensor) detects a car while the other sensors do not, open the exit gate (motor2.write(90)).
    - Wait for 4 seconds, then close the exit gate.
    - Increase available parking slots (e = e + 1).
    - Ensure e never exceeds 2.
    - Update the LCD display.

Step 6: Repeat Loop

10. **Continue Monitoring**

- Repeat all the steps continuously to monitor parking availability, RFID access, and vehicle movement.