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Smart Parking System

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Abstract: ***In many situations, the people owning vehicles should leave their vehicles parked for couple of days to travel by other means of transportation (Flights from International Air ports). Sometimes the vehicles get damaged and they even get stolen. The vehicles needed to be parked in specified area safety. Keeping the above problem in mind, our research work proposes an idea of smart parking system. The user shall be given a slot and an admin card of the parking lot after making the online payments. The user can use the admin card to access the parking lot. The door opens if the admin card is used. The parking lot shall also be equipped with firefighting system, infrared sensors, motion sensor with efficient signaling/feedback system interlinked to Communication devices, so as to detect if incase of fire or someone breaks into the parking lot, intended to steal or make damages to the vehicle. The smart parking system sends alert message with live streaming to the admin/user/customer's Mobile or any Communication devices making him/her aware of the situation and initiate right action to protect the vehicle from further destruction.***

Keywords: Vehicle, Parking, Safety, Detect.

I. INTRODUCTION

The traditional parking system in India, with its reliance on manual attendants, faces numerous challenges in the modern era. As India experiences rapid urbanization, a surge in vehicle ownership, and technological advancements, the traditional parking system must confront a range of obstacles to meet the evolving needs of the population. This essay explores the key challenges encountered by the traditional parking system in India and highlights the importance of adapting to overcome these hurdles. One of the foremost challenges faced by the traditional parking system is the exponential growth in the number of vehicles, which has resulted in overcrowded parking spaces and insufficient infrastructure [1].

Many cities and commercial areas lack adequate parking facilities to accommodate the rising demand, leading to congestion, haphazard parking, and traffic congestion. The lack of planning and infrastructure development poses a significant hurdle in managing parking effectively. The traditional parking system's reliance on manual attendants can contribute to traffic congestion and delays. In bustling commercial areas and busy marketplaces, the process of finding a parking spot, waiting for an attendant to guide the vehicle, and subsequent parking maneuvers can impede the smooth flow of traffic. This issue not only frustrates vehicle owners but also affects the overall efficiency of transportation networks [2].

Another significant challenge in the traditional parking system is the potential for vehicle theft, damage, and unauthorized access. While parking attendants play a vital role in ensuring the security of parked vehicles, instances of theft and unauthorized activities have raised concerns about the reliability of the system. The lack of standardized training, background checks, and monitoring mechanisms for parking attendants contributes to these security challenges. The traditional parking system's resistance to adopting technological advancements hinders its efficiency and effectiveness. With the rise of automated parking systems, mobile applications for parking reservations, and smart parking solutions, the traditional approach risks becoming outdated and inefficient. Embracing technology can streamline the parking process, enhance user experience, and improve overall operational efficiency [13].

However, the lack of awareness, financial constraints, and resistance to change pose hurdles in integrating technology into the traditional system. The traditional parking system also presents social and economic challenges. Many parking attendants come from economically disadvantaged backgrounds and rely on their occupation as their primary source of income. As the parking landscape transforms, traditional parking attendants may face job insecurity and displacement. Ensuring a smooth transition to new parking systems while providing training and alternative employment opportunities becomes crucial to address these challenges. The rapid urbanization and increasing vehicle ownership in India have posed significant challenges to managing parking spaces efficiently. To address these issues, the implementation of a robust Parking Management System (PMS) has become essential [4].

The concept of the Parking Management System in India, its key components, benefits, and the challenges associated with its implementation.

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The PMS begins with the development of well-planned and properly designed parking infrastructure. This includes the construction of multi-level parking facilities, underground parking lots, and dedicated parking spaces in commercial areas, residential complexes, and public spaces. Adequate signage and markings are crucial for guiding drivers to available parking spots. Leveraging technology, smart parking solutions enhance the efficiency and convenience of parking management. These include automated parking guidance systems that use sensors to detect vacant parking spaces, electronic display boards indicating parking availability, and mobile applications that allow users to locate and reserve parking spots in advance [5].

PMS incorporates cashless payment methods to streamline the parking process. Mobile payment apps, RFID (Radio Frequency Identification) tags, and contactless card systems facilitate hassle-free and secure transactions. These systems reduce the dependence on cash, minimize waiting times, and enhance the overall user experience. Efficient traffic flow management is an integral part of the PMS. Implementing traffic signals, lane markings, and one-way systems within parking lots helps minimize congestion and ensures smooth movement of vehicles. Effective traffic management reduces the time spent searching for parking, thereby enhancing the overall efficiency of urban mobility [6].

A well-implemented PMS optimizes the utilization of available parking spaces, reducing the instances of overcrowding and haphazard parking. By efficiently guiding drivers to vacant spots, it minimizes unnecessary traffic congestion and improves the overall flow of vehicles. By reducing the time spent searching for parking spaces, PMS significantly contributes to alleviating traffic congestion and reducing vehicle emissions. The streamlined parking process helps to create a more sustainable and environment-friendly urban environment. The incorporation of smart parking solutions, such as mobile apps and real-time parking information, enhances the overall user experience [7]. Drivers can quickly locate available parking spaces, reserve spots in advance, and make seamless cashless transactions, saving time and reducing frustration. Implementing a well-managed PMS can generate additional revenue streams for the government or parking operators .By implementing paid parking systems, the revenue generated can be utilized for the maintenance and development of parking infrastructure, further improving the parking ecosystem. Implementing an effective Parking Management System in India is not without its challenges. The lack of adequate parking infrastructure in many cities poses a significant challenge. Addressing this issue requires a comprehensive approach, including the construction of new parking facilities, retrofitting existing spaces, and integrating parking solutions into urban planning from the outset [8].

The successful implementation of a PMS relies on the integration of advanced technologies. However, the digital divide, limited access to smartphones, and the need for reliable internet connectivity in certain areas pose challenges to technology adoption. Ensuring equitable access to smart parking solutions is crucial for their effective implementation. Encouraging behavioral change among drivers is essential for the smooth functioning of a PMS. Educating the public about the benefits of the system, promoting compliance with parking regulations, and creating awareness about responsible parking practices are necessary steps to instigate positive changes. The successful implementation of a PMS requires close collaboration among various stakeholders, including government authorities, parking operators, technology providers, and the public. Effective coordination, clear regulations, and shared responsibilities are essential to overcome the challenges and ensure the sustainable management of parking spaces [9].

II. LITERATURE SURVEY

India possesses the world's third-largest road network, and approximately 60% of the population prefers road transport. As of 2015, the country had a total of 210,023,289 registered motor vehicles, with seven states having over 10 million vehicles each. Currently, most parking systems in India are manually operated, lacking technological interventions. Consequently, these systems incur higher costs, suffer from inefficiency, and fail to optimize existing parking spaces. However, the implementation of advanced automated/smart parking management systems can address these issues [10].

In their research, a system capable of detecting vacant parking slots using infrared sensors and displaying the information on an LCD screen was designed and developed. The system aims to alleviate the difficulties faced during peak hours when finding parking spaces becomes challenging. By displaying the availability of parking slots, the system assists drivers in easily parking their vehicles. The research focused on using ultrasonic sensors to detect parking slot vacancies and displaying the information on a screen. Additionally, a web application was developed to allow users to monitor the parking slot status over the internet [11]. Their research involved creating a system that detects and displays parking slot vacancies through a mobile app. Users can log in to the app and reserve slots for their vehicles. The system utilizes Raspberry Pi and ultrasonic sensors for slot detection and generating output. The research presented the development of a system capable of detecting and displaying vacant parking spaces. Users can utilize mobile applications to detect available slots. The research aimed to reduce the overall system cost by utilizing a picture microcontroller [12].

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Smart parking systems leverage the Internet of Things and sensor technology to obtain real-time data on parking availability and traffic conditions. These systems incorporate various devices and processes to detect parking space occupancy. Sensors and cameras record and process data, providing real-time information on traffic occupancy. A smart system connects these devices and centralizes the data, which is then analyzed using big data techniques to determine on-street and off-street parking space availability [13]. Smart parking relies on sensors such as dual-channel loop detectors and ultrasonic vehicle presence sensors to precisely determine the number of vehicles in a parking lot at any given time. These sensors detect parking space occupancy, identify full parking garages, and provide accurate vehicle location information. In closed spaces, sensors are used to detect available parking spaces and provide visual indicators to drivers. LED indicators display red or green lights to indicate occupied or vacant parking spaces, respectively. This facilitates the search for vacant parking spots and improves overall parking efficiency [14].

Airports require efficient parking management due to various parking requirements and high traffic volume. Smart Parking offers tailored solutions for airports, including hardware, machines, and software to manage traffic flow and congestion. By utilizing advanced software platforms, Smart Parking integrates seamlessly with existing site management systems. In comparison to traditional parking lots, smart parking systems require approximately 70% less space to accommodate the same number of cars. This space optimization allows for additional parking spaces, non-parking utilization, or the creation of green spaces. Smart parking systems eliminate the need for driving lanes, ramps, and pedestrian walkways, resulting in a reduction in structure and volume. Prototype systems have been developed, such as the Smart Parking System, to provide safe, secure, and user-friendly vehicle parking management in designated parking lots using a simple digitalized system [15]. Despite the growing popularity of road transport and the significant number of motor vehicles in India, most parking systems in the country continue to rely on manual operations without technological interventions. This traditional approach results in higher costs, inefficiency, and underutilization of existing parking spaces. While some research has been conducted on developing automated/smart parking management systems, there are still research gaps that need to be addressed. Firstly, the existing research primarily focuses on specific aspects of smart parking systems, such as using infrared sensors, ultrasonic sensors, or mobile applications for detecting and displaying parking slot vacancies. However, there is a lack of comprehensive research that examines the integration of multiple technologies and solutions to create a holistic smart parking management system [16].

Secondly, the research conducted so far has mainly been limited to small-scale prototypes or experimental setups. There is a need for more extensive studies that evaluate the feasibility, scalability, and effectiveness of smart parking systems in real-world scenarios, considering the diverse parking needs and infrastructure challenges present in different regions of India. Furthermore, while the benefits of smart parking systems, such as space optimization, improved traffic flow, and enhanced user experience, have been highlighted, there is limited research on the economic viability and cost-effectiveness of implementing such systems on a larger scale. A comprehensive cost-benefit analysis, including the initial investment, maintenance costs, and long-term financial implications, would provide valuable insights for policymakers and stakeholders [16]. Moreover, the research gap extends to the social and behavioral aspects of smart parking systems. It is crucial to understand the attitudes, perceptions, and adoption barriers among the public, parking attendants, and other relevant stakeholders. Exploring the social acceptance, privacy concerns, and behavior change required for successful implementation can guide the development of strategies to ensure widespread acceptance and utilization of smart parking systems [17,18]. Lastly, while the research touched upon the application of smart parking systems in airports, there is a need for more comprehensive studies specifically focused on the unique requirements and challenges faced by airports in managing parking and traffic flow. This includes factors such as safety, efficient utilization of parking spaces, integration with existing airport management systems, and accommodating the varying parking needs of different airport users [19,20]. Addressing these research gaps would contribute to the development of a comprehensive understanding of smart parking systems and pave the way for their effective implementation in India. Such research would provide valuable insights to policymakers, urban planners, and parking management authorities, enabling them to make informed decisions and design sustainable and efficient parking solutions that cater to the evolving needs of the Indian population.

III. PROJECT OBJECTIVES

By introducing the smart parking system, the following objectives are framed.

1) To Provide Optimal Utilization of Space
2) To construct on minimum available space
3) To Lower Construction Cost
4) To provide and ensure Safety of vehicle
5) To provide user friendly system by digitization
6) To Provide Real Information on the vehicle

In various situations, vehicle owners often need to leave their vehicles parked for extended periods, which can pose risks such as damage, theft, and parts theft. The current parking systems in place do not provide a guarantee for the safety of parked vehicles.

IV. PROBLEM FORMULATION

In various situations, vehicle owners often need to leave their vehicles parked for extended periods, which can pose risks such as damage, theft, and parts theft. The current parking systems in place do not provide a guarantee for the safety of parked vehicles. Airports, especially large international ones, face unique challenges in managing parking due to the diverse parking needs, including medium to long-term parking, short stay drop-offs, and pick-ups. Ensuring efficient traffic flow and congestion management in the extensive airport parking areas is crucial. Additionally, with millions of people passing through airports each year, proper management of parking and vehicle access is vital to address safety concerns. Smart Parking has a wealth of experience in assisting airports with site management. They offer a comprehensive range of parking hardware, machines, and software solutions tailored to meet various requirements. Their purpose-built software platform seamlessly integrates with existing site management platforms. By implementing advanced automated/smart parking management systems, these problems can be effectively addressed [21,22].

V. METHODOLOGY

Project methodology plays a crucial role in the success and outcomes of any project. It provides a structured and systematic approach to guide the project from initiation to completion. Project methodology is significant because it provides a structured approach for project execution. It ensures clarity and direction, enabling stakeholders to understand project objectives and deliverables. It facilitates effective project planning and resource management, leading to optimized resource allocation. It helps identify and mitigate risks, improving project outcomes. It promotes communication, collaboration, and quality assurance, ensuring successful project completion.

Following methodology will be followed in our project:

1) Review of literature :
2) Collection of existing data: Relevant reports and publications will be utilized for the purpose.
3) Mapping the information: Information collected from material research centers and industries.
4) Material Procurement: Materials for research work are to be procured from selected agencies ensuring quality.
5) Fabrication Work: By adopting modern techniques and quality electrical & electronic parts the fabrication will be carried out.
6) Testing & Validation Work: Evaluation of smart parking system under various conditions is done under the support of modern testing machines available in research centers and industries ensuring working of the system.

A. Design

Design plays a significant role in various aspects of our lives, ranging from products and services to architecture and user experiences. Here are ten key points highlighting the significance of design:

1) *Functionality:* Design ensures that products, systems, or services fulfill their intended purpose effectively and efficiently.
2) *User Experience:* Good design enhances the user experience, making products or services intuitive, enjoyable, and easy to use.
3) *Aesthetics:* Design considers the visual appeal, aesthetics, and sensory elements, creating a pleasing and engaging experience for users.
4) *Differentiation:* Design allows products and services to stand out from competitors, making them unique and memorable in the market.
5) *Problem Solving:* Design thinking and methodologies provide innovative solutions to complex problems, addressing user needs and improving efficiency.
6) *Communication:* Design effectively communicates information, ideas, and concepts visually, making it easier for users to understand and engage with.
7) *Branding and Identity:* Design plays a crucial role in creating and communicating a brand's visual identity, influencing perceptions and building brand loyalty.
8) *Efficiency and Sustainability:* Design focuses on optimizing resources, reducing waste, and creating sustainable solutions that have minimal environmental impact.
9) *Emotional Connection:* Design evokes emotions and creates a connection with users, fostering positive associations and building long-term relationships.
10) *Economic Impact:* Well-designed products and services can drive economic growth, increasing market demand, and attracting customers.

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Design software provides efficiency and precision, enabling designers to work more effectively. It offers a wide range of creative tools, fostering innovation and experimentation. Collaboration features facilitate seamless teamwork and communication among design teams. Integration with other tools streamlines workflows and enhances productivity. Overall, design software helps produce high-quality designs, saving time and costs. The present design involves the use of modeling software to create SPS of prototype as shown in the figure 1.

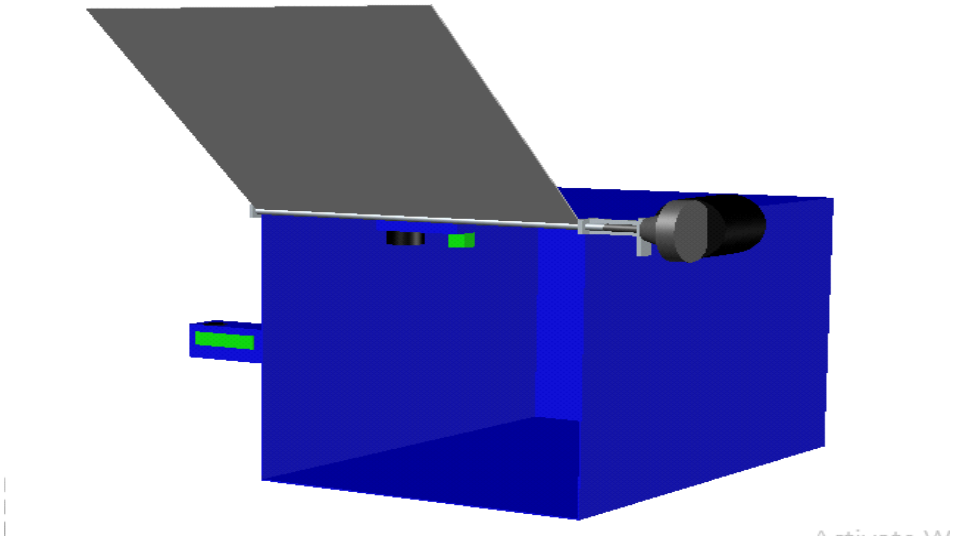


Figure 1. Prototype of Smart Parking System

Figure 2 illustrates the operation of the Smart Parking System (SPS). Initially, a parking structure is constructed, followed by the installation of a motorized door. The system incorporates an RFID scanner to scan the administrator card. It also includes an alert system consisting of passive infrared sensors and a buzzer to detect any unauthorized entry. The project utilizes an Arduino UNO microcontroller. To access the parking structure, the customer must first make the payment and receive an RFID administrator card. Only the administrator card can open the door, while other cards will not grant access. Once the vehicle is parked, the user must close the door. In the event of an attempted break-in, the passive infrared sensor detects the presence of an individual, and the buzzer sounds to alert security personnel.

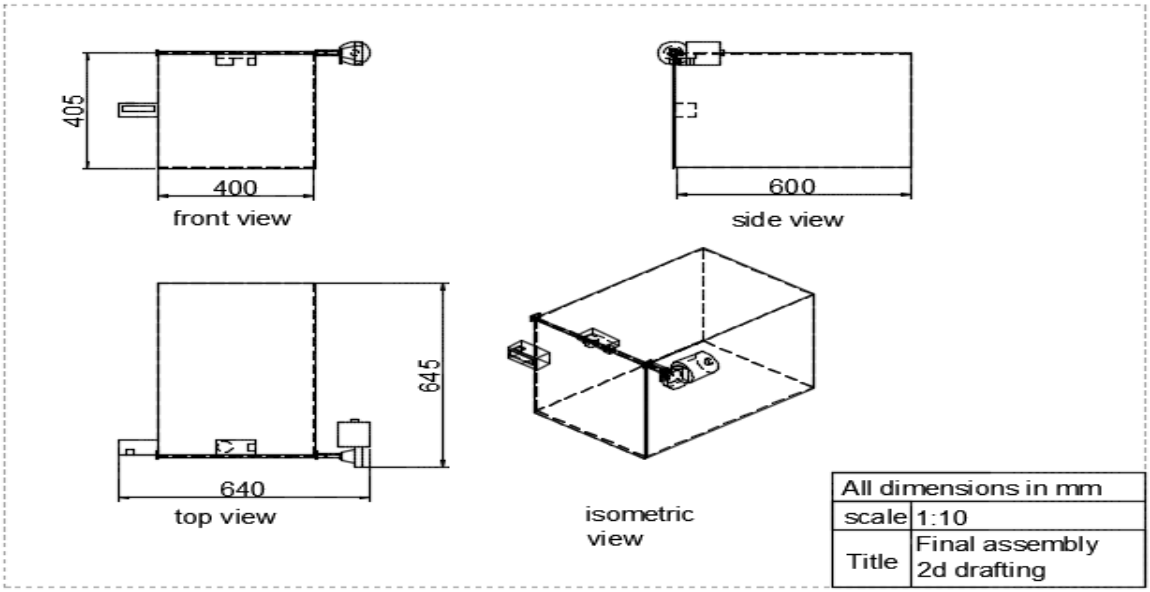


Figure 2. Working of Smart Parking System

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VI. PROGRAMMING

```
#include <ezButton.h>
#include <MFRC522.h>
#include <SPI.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
// Initialize the RFID reader module
#define SS_PIN 10
#define RST_PIN 9
MFRC522 mfrc522(SS_PIN, RST_PIN);
// Define the pins for the relays, limit switches and RFID sensor
#define RELAY1 7
#define RELAY2 8
int buton1 = 5;
int buton2 = 3;
int PIRsensor = 2;
int flame_sensor = 4;
int flame_detected;
int buzzer = A0;
#define SWITCH1 6
#define SWITCH2 0
// Define the authorized RFID tag
struct authorizedTag {
  byte tag[4];
  char name[20];
};
authorizedTag authorizedTags[] = {
  {{0x03, 0x37, 0xBF, 0x02}, "Manu"},
  {{0xAA, 0xA8, 0x52, 0x2F}, "Manuraj"}
};
ezButton limitSwitch1(SWITCH1);
ezButton limitSwitch2(SWITCH2);
int count = 0;
void setup()
{
  // Initialize the relays and limit switches
  pinMode(RELAY1, OUTPUT);
  pinMode(RELAY2, OUTPUT);
  digitalWrite(RELAY1, HIGH);
  digitalWrite(RELAY2, HIGH);
  pinMode(SWITCH1, INPUT_PULLUP);
  pinMode(SWITCH2, INPUT_PULLUP);
  pinMode(PIRsensor, INPUT);
  pinMode(buzzer, OUTPUT);
  pinMode(flame_sensor, INPUT);
  // Initialize the RFID reader
  SPI.begin();
  mfrc522.PCD_Init();
  lcd.init();
  lcd.clear();
```

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```
 lcd.backlight();
 limitSwitch1.setDebounceTime(50);
 limitSwitch2.setDebounceTime(50);
 Serial.begin(9600);
 Serial.println("Motor Direction of Rotation");
 Serial.println("Using 2 Relays and RFID Sensor");
delay(2000);
}
void loop()
{
 int val = digitalRead(PIRsensor);   // read PIR sensor value
 if (val == HIGH)
 {
   Serial.println("Motion Detected");// check if the sensor is HIGH
   digitalWrite(buzzer, HIGH); // turn BUZZER on
   delay(100); // delay 100 milliseconds
   digitalWrite(buzzer, LOW); // turn Buzzer OFF
   delay(200);
 }
 else
 {
    digitalWrite(buzzer, LOW); // turn Buzzer OFF
 }
    flame_detected = digitalRead(flame_sensor);
    if (flame_detected == HIGH)
 {
  digitalWrite(buzzer, HIGH);   // turn BUZZER on
  delay(1000); // delay 100 milliseconds
  digitalWrite(buzzer, LOW); // turn Buzzer OFF
 delay(200);
 }
 else
 {
  digitalWrite(buzzer, LOW);
 }
 lcd.clear();
 start:
 count = 0;
 int forward = 0;
 // Check for an authorized RFID tag
 if (mfrc522.PICC_IsNewCardPresent() && mfrc522.PICC_ReadCardSerial())
 {
  bool authorized = false;
  for (int i = 0; i < sizeof(authorizedTags) / sizeof(authorizedTag); i++)
 {
     if (memcmp(mfrc522.uid.uidByte, authorizedTags[i].tag, sizeof(authorizedTags[i].tag)) == 0)
{
    lcd.setCursor(2, 0);
    lcd.print("WELCOME");
    lcd.setCursor(2, 1);
```

```
    lcd.print(authorizedTags[i].name);
    delay(2000);
    Serial.println("Access granted to " + String(authorizedTags[i].name));
    count = 1;
    // rest of the code
    while (count == 1)
  {
     lcd.clear();
     limitSwitch1.loop();
     limitSwitch2.loop();
     int state1 = limitSwitch1.getState();
     int state2 = limitSwitch2.getState();
      // Set the direction of rotation based on the state of the push buttons
      int U = digitalRead(buton1);
      int H = digitalRead(buton2);
        if (U == HIGH)
      {
         forward = 1;
         digitalWrite(RELAY1, HIGH);  // Read the state of the limit switches
         digitalWrite(RELAY2, LOW);
         Serial.println("Rotating in CW");
         }

   if (H == HIGH)
{
   digitalWrite(RELAY1, LOW);
   digitalWrite(RELAY2, HIGH);
   Serial.println("Rotating in CCW");
}
   // Stop the motor if either of the limit switches is triggered
   if (state1 == LOW || state2 == LOW)
{
   digitalWrite(RELAY1, HIGH);
   digitalWrite(RELAY2, HIGH);
   Serial.println("Stopped");
     if (state2 == LOW && forward == 1)
{
   delay(1000);
   goto start;
          }
        }
      }
     }
       else
  {
     Serial.println("Access denied!");
     count = 0;
  }
       mfrc522.PICC_HaltA();
```

```
    mfrc522.PCD_StopCrypto1();
     }
   }
 }
```

VII. FLOW CHART OF SMART PARKING SYSTEM

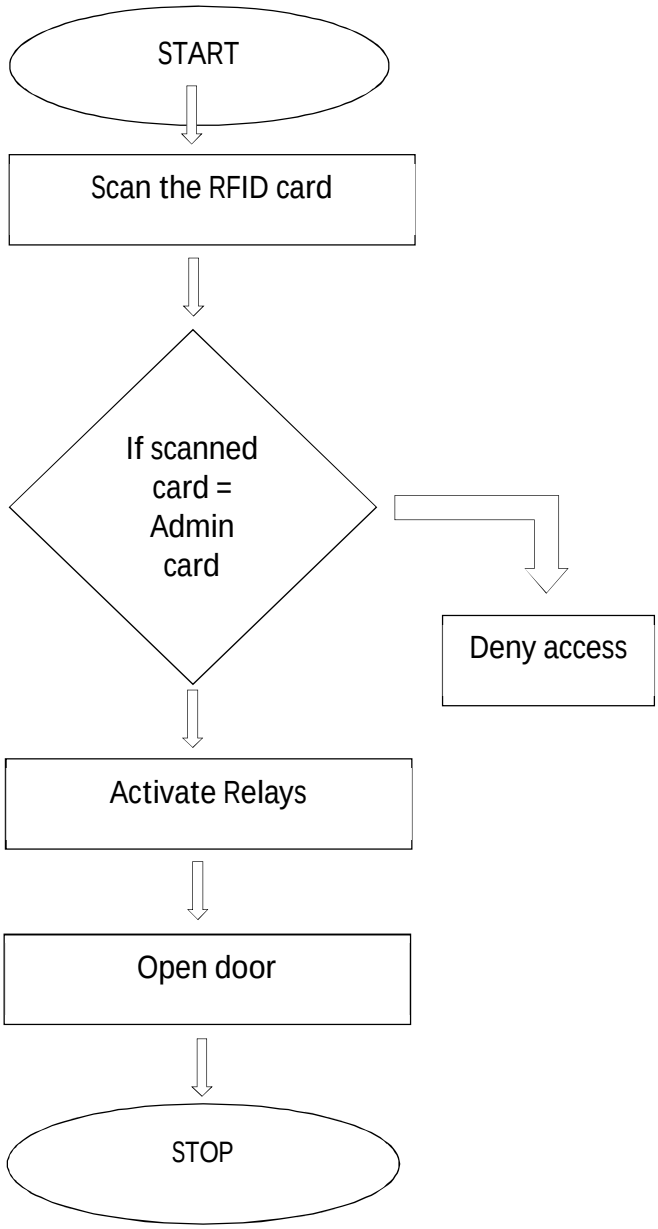


Figure 3. Flow chart for Door open

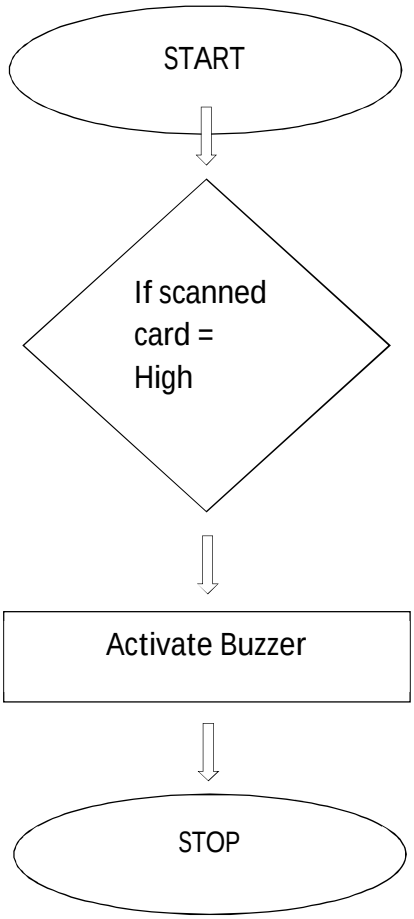


Figure 4 Flow chart for Door close

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VIII. COST ESTIMATION

Project completed is as shown in the figure 5, and its cost estimation is the process of predicting the quantity, cost, and price of the resources required by the scope of a project. Since cost estimation is about the prediction of costs rather than counting the actual cost, a certain degree of uncertainty is involved.

A. Purpose of Cost Estimation

The purpose of cost estimation is to give project stakeholders accurate information concerning the related project costs. It is easier to make lasting decisions if there is information to back them up. Cost estimation also gives clients value-aided options and helps clients minimize expenses.

Table 1 Cost Estimation of Project

SL NO	COMPONENTS	QUANTITY	AMOUNT
1	2 MM SHEET MEATL	10 SQ FT	1800
2	WIPER MOTOR	1	1750
3	12 VOLT LEAD ACID BATTERY	1	1900
4	BUCK CONVERTER	1	170
5	ARDUINO UNO	1	950
6	RFID SCANNER AND TAGS	1	2400
7	LCD WITH I2C	1	2390
8	RELAYS	2	1300
9	PIR SENSOR	1	1285
10	ACTIVE BUZZER	1	1870
11	JUMPER WIRES	50 PC	1830
12	PAINT AND PRIMER	200 ML	1700
TOTAL			**19345**

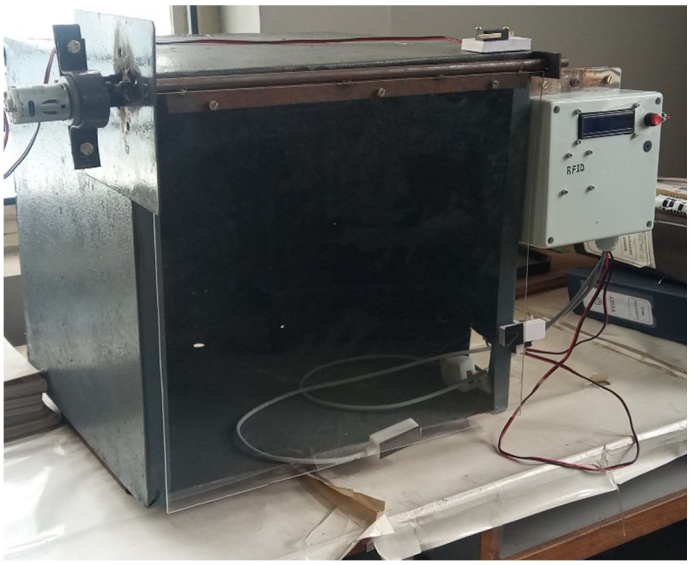


Figure 5. Prototype of Smart Parking System

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IX. CONCLUSION

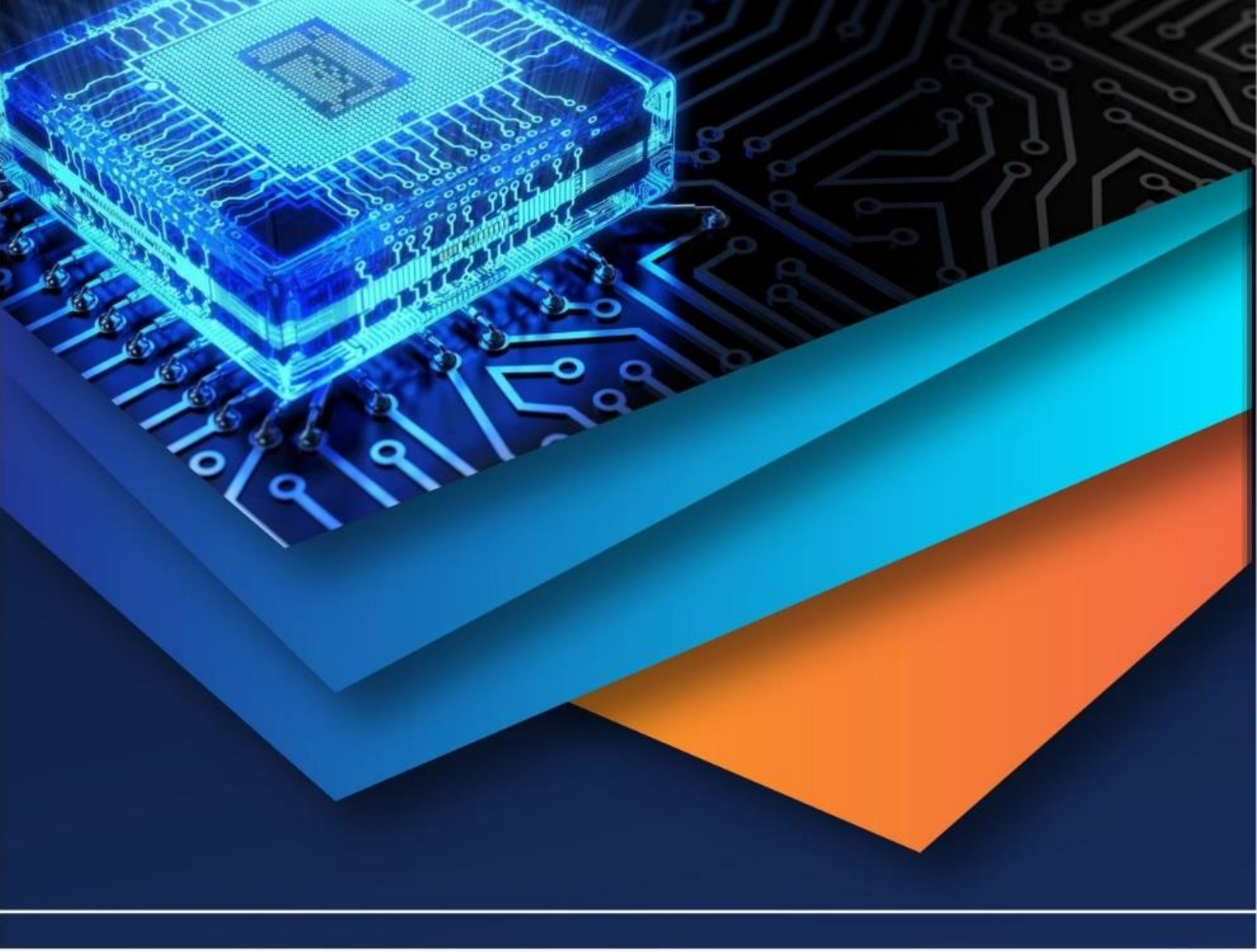
In conclusion, the traditional parking system in India faces several challenges in ensuring the safety and efficiency of parked vehicles, especially in situations where vehicles are left unattended for extended periods. To address these issues, the research proposes the implementation of a smart parking system. This system includes the construction of parking structures, the use of RFID technology for access control, and the integration of alert systems such as infrared sensors and buzzers to detect unauthorized entry. By incorporating advanced technologies, such as the Arduino UNO microcontroller, the system ensures secure and user-friendly parking experiences. The smart parking system also offers real-time monitoring and alerts, enabling prompt action in case of emergencies or security threats. By embracing such a system, the system can enhance the safety and convenience of parking, optimize space utilization, and improve overall traffic management.

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