SMART CAR PARKING SYSTEM USING IoT

A Project Report

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in partial fulfillment of requirements for the award of credits for subjects

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Bachelor of Technology

in

Artificial Intelligence and Data Science

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CERTIFICATE

This is to certify that the report entitled **SMART CAR PARKING SYSTEM USING IoT** submitted by **Kalyani** , **Kavaru Amith** , **Madesh KK** & **Parima** to the School of Artificial Intelligence, Amrita Vishwa Vidyapeetham, Faridabad in partial fulfillment of the B.Tech. degree in Artificial Intelligence and Data Science is a bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

We hereby declare that the project report **SMART CAR PARKING SYSTEM USING IoT**, submitted for partial fulfillment of the requirements for the award of the degree of Bachelor of Technology of the School of AI, Amrita Vishwa Vidyapeetham, Faridabad, India is a bonafide work done by us under supervision of Dr. Abhishek and Dr. Sakshi Ahuja .

This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources.

We also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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Abstract

This project presents a smart car parking system leveraging IoT technology to address parking management challenges in urban areas. The system's primary objective is to automate the process of identifying vacant parking slots and provide real-time availability information to users. Using Arduino as the central controller, the IoT-based system integrates key components: ultrasonic sensors (one for slot, one for the gate), an LCD display for slot availability, LEDs (green for empty slots, red for full slots), a servo motor for gate control, jumper wires for connections, and resistors to protect LEDs.

The system operates on IoT principles: ultrasonic sensors detect the presence of vehicles in parking slots and relay the data to the Arduino, which processes the information to control LEDs and update the LCD. The gate's operation is automated by an ultrasonic sensor and servo motor, ensuring a smooth entry/exit experience.

The estimated cost of this prototype is approximately 1,500–2,000, including the components provided by the institution. The out-of-pocket expense incurred is 568/-, making it a cost-effective IoT-enabled solution for small-scale parking areas. By automating parking management, this system reduces manual effort, minimizes traffic congestion, and saves valuable time. Leveraging IoT technology with minimal resources, this scalable project offers a practical and efficient solution to address modern parking challenges.

Acknowledgement

We would like to express our sincere gratitude to everyone who supported and guided us throughout the completion of this project.

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We also wish to acknowledge the support and motivation provided by our families and friends—Krishna Manohar, Sri Balaji, and Pujya Ganesh—whose assistance in making the circuit and unwavering encouragement gave us the strength to persevere.

Lastly, we are grateful to our institution for providing the resources, facilities, and a conducive environment that enabled us to bring this project to fruition. This experience has been an invaluable learning opportunity, and we look forward to applying the knowledge and skills gained in future endeavors.

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Ω	Resistance
I	Current
V	Voltage
cm	Centimeter
m	meter
$^\circ$	Degrees
mA	Milliampere (Current)

Chapter 1

Introduction

The rapid urbanization and rising number of vehicles in metropolitan areas have made parking a critical challenge.Finding suitable parking spaces has become increasingly complex, resulting in wasted time, excessive fuel consumption, and heightened traffic congestion. Traditional parking systems, relying heavily on manual searching and static arrangements, are proving insufficient to meet the demands of modern urban life. These inefficiencies highlight the urgent need for innovative and efficient solutions.

A Smart Car Parking System (SCPS) addresses these challenges by leveraging cutting-edge technologies such as sensors, IoT (Internet of Things), machine learning, and real-time data processing. SCPS provides real-time information about parking availability, guiding drivers to the nearest vacant spaces. By optimizing parking space usage, the system reduces the time required for searching and minimizes associated fuel consumption, thereby alleviating traffic congestion. In advanced implementations, SCPS can also automate the parking process, offering seamless convenience for users.

This project aims to design and implement an SCPS that tackles the inefficiencies of traditional systems. By integrating real-time monitoring, automated guidance, and enhanced space management, the proposed system not only improves user experience but also contributes to a sustainable and smarter urban environment, addressing both current and future parking challenges effectively.

The introduction of such systems can drastically reduce parking-related issues and contribute to the overall improvement of traffic management and urban infrastructure.

This system also holds the potential for integration with other smart city initiatives, such as traffic flow management and environmental monitoring, making it an essential component in the transition to more sustainable urban living.

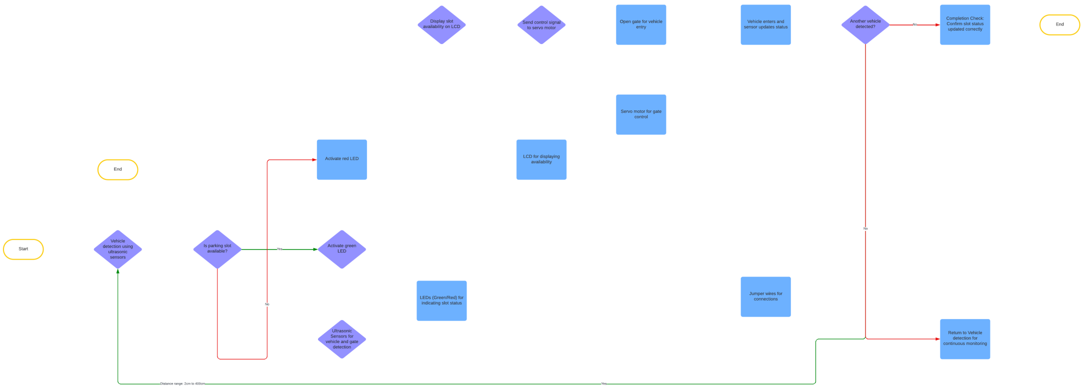

Figure 1.1: Block diagram for SCPS

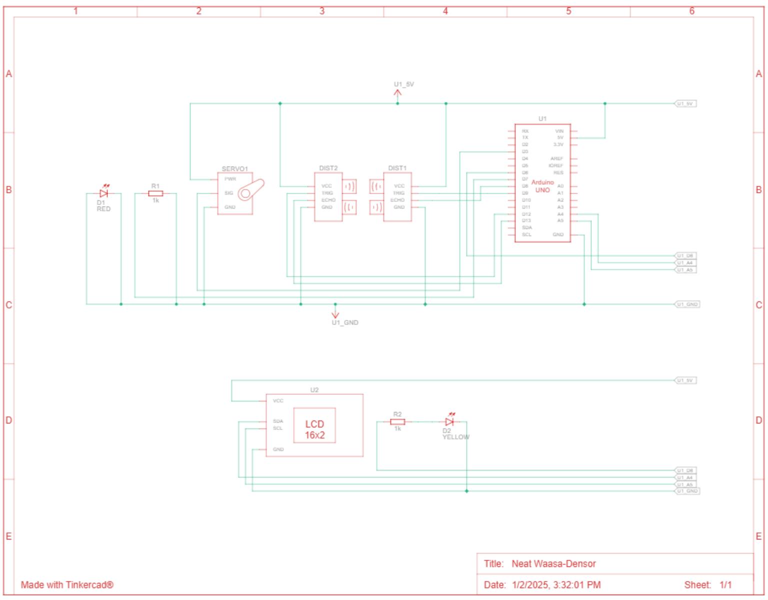

Figure 1.2: Tincercad Schematic View

Chapter 2

Existing Technologies

Introduction

This chapter reviews the existing technologies used in car parking systems, ranging from traditional manual methods to more advanced automated solutions. It covers ticket-based systems, automated parking, sensor-based parking systems, and mobile app-based systems. Despite the benefits of these technologies, they still face limitations such as inefficiency, high costs, and complex implementations. The proposed solution in this report utilizes **red and green LEDs** for availability indication, **LCD screens** at the gate, **servo motors** for automated parking, and **ultrasonic sensors** for **vehicle detection** to provide a more efficient, cost-effective, and user-friendly system.

2.1 Existing Technologies in Smart Car Parking Systems

2.1.1 Mobile Application-Based Parking Systems

Description

Mobile applications allow users to locate available parking spots, reserve spaces, and make payments using their smartphones.

Pros

- Convenient for users to book and pay remotely.
- Reduces time spent searching for parking.

Cons

- Requires constant internet connectivity.
- Limited user adoption due to app-specific dependencies.

Solution in SCPS

Our system integrates **real-time parking space updates** via mobile apps while providing offline navigation for better user experience. By employing **cloud-based data storage**, the system ensures accessibility without dependency on high-speed connectivity.

2.1.2 License Plate Recognition (LPR) Systems

Description

LPR systems use cameras and software to identify vehicle license plates, enabling automated entry, exit, and billing.

Pros

- Enhances security and minimizes fraud.
- Automates payment and vehicle tracking.

Cons

- High setup costs and maintenance requirements.
- Inaccurate detection in poor lighting or adverse weather conditions.

Solution in SCPS

SCPS incorporates **infrared-enabled cameras** for better plate recognition in low-light conditions. Additionally, **edge computing** reduces latency and enhances the accuracy of license plate detection.

2.1.3 Automated Payment Systems

Description

Contactless payment systems using RFID, NFC, or mobile wallets simplify parking fee transactions.

Pros

- Speeds up the payment process.
- Reduces human intervention.

Cons

- Dependence on digital infrastructure.
- Vulnerable to cyber-attacks.

Solution in SCPS

Our system employs **secure payment gateways** with **blockchain technology** to enhance transaction security. A fallback option for cash payments ensures continuity in case of technical issues.

2.1.4 Real-Time Parking Guidance Systems

Description

Real-time guidance systems use LEDs, LCDs, or mobile apps to inform drivers of available parking spots.

Pros

- Reduces search time for parking spaces.
- Enhances user experience by providing clear guidance.

Cons

- High installation and maintenance costs.
- Hardware failures can disrupt the system.

Solution in SCPS

SCPS employs **low-energy LED indicators** combined with **predictive analytics** to anticipate parking demand and optimize space usage, minimizing maintenance costs.

2.1.5 Cloud-Based Parking Management Systems

Description

Centralized parking systems store and process data on the cloud, enabling remote management and scalability.

Pros

- Provides valuable insights into parking trends.
- Scalable for large parking infrastructures.

Cons

- Dependent on reliable internet connectivity.
- Potential data privacy and security risks.

Solution in SCPS

Our SCPS employs **hybrid cloud architecture** for seamless operation during network outages. Data is encrypted to ensure privacy and security while supporting remote monitoring and analytics.

2.2 Conclusion

The integration of these technologies into a Smart Car Parking System (SCPS) resolves the inefficiencies of traditional parking methods. By utilizing real-time monitoring, automated payment solutions, and data-driven insights, SCPS not only enhances user experience but also contributes to the sustainability of urban environments.

Chapter 3

Working Principle

The smart car parking system leverages multiple technologies to automate the parking process, ensuring efficient space utilization and reducing the time spent by drivers searching for available spots. The system employs ultrasonic sensors for vehicle detection and parking spot monitoring, Arduino for data processing and parking allocation, and servo motors for gate control. Real-time information is displayed on an LCD screen, helping drivers locate available spaces. Below is the detailed working of each component:

Main Objectives

1. Vehicle detection using ultrasonic sensors.
2. Automatic gate operation using an SG90 servo motor.
3. Real-time slot display using a 16x2 LCD and green LED for an empty spot and red LED for a full spot.

3.1 Vehicle Detection and Monitoring

Utilize ultrasonic sensors to detect vehicles and continuously monitor parking spaces. These sensors measure proximity to determine parking spot occupancy, ensuring accurate and real-time updates about available and occupied spots.

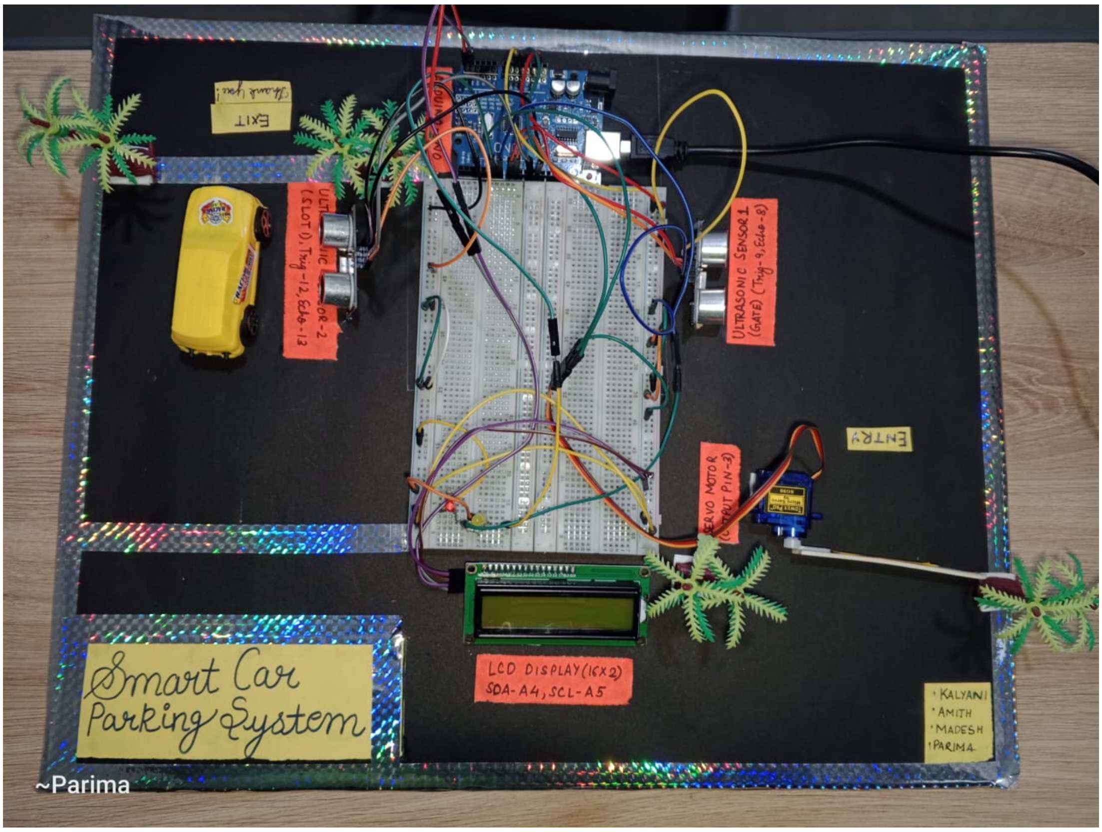

Figure 3.1: Smart car Parking System(SCPS)

3.2 Automated Parking Slot Allocation and Gate Control

Leverage an Arduino system to allocate parking slots efficiently by processing data from ultrasonic sensors.Automate gate operations using ultrasonic sensors and an SG90 servo motor for seamless vehicle entry and exit, enhancing security and reducing delays.

3.3 Real-Time Information Display and Spot Indicators

Implement a 16x2 LCD screen to display real-time parking status, helping drivers quickly locate available spaces. Complement this with LED indicators at each spot to visually signal availability (green for free, red for occupied), reducing search time and improving user experience in large areas like malls,hospitals and parks .

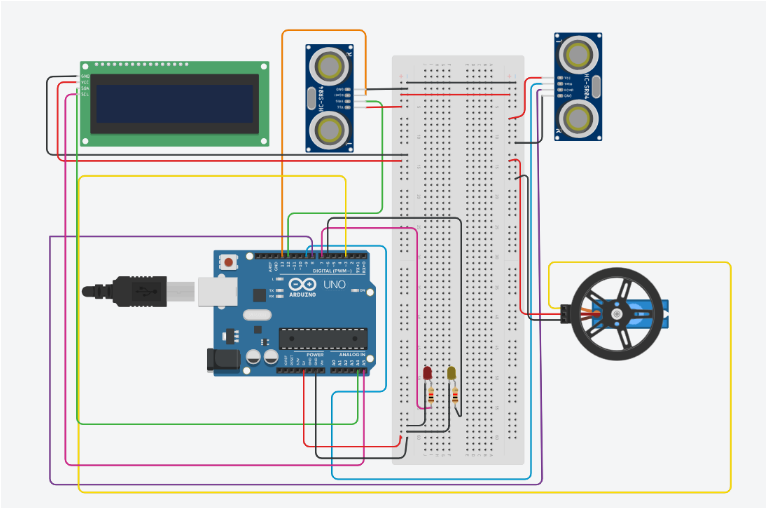

Figure 3.2: Tincercad Circuit

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3.4 Hardware Requirements

Table 3.1: Hardware Requirements for SCPS

S.No	Components	Quantity	Link to Buy	Cost
1	Arduino Uno R3	1	Buy Here	300-400/-
2	Breadboard	2	Buy Here	40-50/-
3	Ultrasonic Sensors (HC-SR04)	2	Buy Here	200-300/-
4	LEDs (Green and Red)	2	Buy Here	1-5/-
5	Resistors	2	Buy Here	1-5/-
6	Servo Motor (SG90)	1	Buy Here	300/-
7	Power Supply	1	Buy Here	399/-
8	Jumper Wires	20+	Buy Here	35-40/- (set of 10)
9	16x2 LCD Display	1	Buy Here	169/-

3.5 Working specification and principle of components used

1. Arduino Uno

Working Principle: The Arduino Uno is the main microcontroller responsible for controlling and managing the entire system. It processes input from sensors and controls the output to actuators like motors and displays.

Specifications:

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Clock Speed: 16 MHz(16 million instructions per second.)
- Input/Output Pins: 14 digital, 6 analog

Role: It reads data from ultrasonic sensors to detect vehicle presence and allocates parking spaces. It also controls the servo motor for gate operation and manages the display of parking status.

2. Breadboard

Working Principle: A breadboard is used for prototyping and testing the circuit before finalizing the connections. It allows for easy insertion of components and wiring without soldering.

Specifications:

- Standard size (ex: 400 points or 830 points)
- Provides power rails for easy connections of power and ground

Role: Provides a temporary platform for assembling and testing all the circuit components.

3. Ultrasonic Sensors(HC-SR04)

Working Principle: Ultrasonic sensors emit high-frequency sound waves and measure the time taken for them to reflect back from nearby objects (ex: vehicles). This helps in calculating the distance to the object.

Specifications:

- Range: 15cm
- Operating Voltage: 5V
- Accuracy: ±1 cm

Role: Used to detect the presence of vehicles in the parking spaces. They continuously monitor the status of parking spots and provide input to the Arduino to determine whether the spot is available or occupied.

4. LEDs (Green and Red)

Working Principle: LEDs are diodes that emit light when current flows through them. They are used as indicators in the parking system.

Specifications:

- Voltage: 5V
- Current: 5-7mA (per LED)

Role: Green LEDs indicate available parking spaces, while red LEDs indicate occupied spaces. They are controlled by the Arduino based on data from the ultrasonic sensors.

5. Resistors

Working Principle: Resistors limit the flow of electrical current in a circuit to prevent damage to sensitive components.

Specifications:

- Value: 330 (Orange, Orange, Brown , gold)

Role: Resistors are used to protect LEDs, and other components from excessive current, ensuring the system operates safely.

6. Servo Motor(SG90)

Working Principle: A servo motor rotates to a specific angle based on the control signal it receives. It is typically used for precise positioning.

Specifications:

- Operating Voltage: 5V
- Torque: 1.5 to 3 kg·cm
- Rotation Angle: 90°
- Weight : approx 9gm

Role: Controls the automatic opening and closing of the parking barrier gate. The servo motor is activated by the Arduino when a vehicle is detected at the entrance.

7. Power Supply

Working Principle: A power supply converts electrical energy from a source (ex: AC mains or a battery) to the necessary voltage levels required for the system components.

Specifications:

- Voltage: 12V DC (for Arduino and sensors)

Role: Provides the required power for the Arduino, ultrasonic sensors, servo motor, LCD display, and LEDs without again connecting to laptops.

8. Jumper Wires

Working Principle: Jumper wires have connectors on both ends (male or female) and are used to make connections between different components on the breadboard or to the Arduino.

Specifications:

- Length: Varies (typically 10-30 cm)
- Type: Male-to-male, male-to-female, or female-to-female

Role: Used to connect components (e.g., sensors, LEDs, motors) to the Arduino and link different parts of the circuit for testing and operation.

9. I2C Module and 16x2 LCD Display

Working Principle: The I2C module enables 2-wire communication (SDA, SCL) between the Arduino and the 16x2 LCD, which displays alphanumeric characters using liquid crystal technology.

Specifications:

- Voltage: 5V
- Communication: I2C protocol (2-wire: SDA, SCL)
- LCD Type: 16 columns x 2 rows

Role: The I2C module reduces wiring, and the LCD displays real-time parking slot availability and status.

Specifications:

- Size: 16 characters x 2 lines
- Operating Voltage: 5V
- Interface: I2C or parallel

Role: Displays real-time parking information such as the number of available parking spots and their locations. This information helps drivers navigate to the nearest available parking space.

3.6 Arduino programming

3.6.1 Introduction

This Arduino code controls a smart car parking system using ultrasonic sensors, a servo motor for gate operation, and an LCD display to show the slot status. The system automates parking management by detecting car presence, controlling the gate, and indicating slot availability.

3.6.2 Libraries Used

- **Servo Library** (`<Servo.h>`): Used to control the servo motor that opens and closes the parking gate.
- **Wire Library** (`<Wire.h>`): Used for I2C communication between the Arduino and the LCD display.
- **LiquidCrystal_I2C Library** (`<LiquidCrystal_I2C.h>`): Provides functions to interface with an LCD display using I2C protocol, which reduces the number of pins required for communication.

3.6.3 Code Explanation

Initialization

- **LCD Setup:** The LCD is initialized with the address `0x27` (common I2C address for 16x2 LCDs). It has 16 columns and 2 rows.
- **Pins Setup:** Ultrasonic sensors, LEDs, and the servo motor are initialized with the corresponding pin numbers.

Sensor and Motor Operations

- **Ultrasonic Sensor 1:** The first ultrasonic sensor is used to check if a car is parked in the first slot. If the distance is less than 15 cm, it indicates a car is present, and the LCD shows `"Slot 1:  Full"`, while the red LED lights up. If no car is detected, the LCD displays `"Slot 1:  Empty"`, and the yellow LED is turned on.
- **Ultrasonic Sensor 3:** The third ultrasonic sensor is used to control the gate. If an object (car) is detected within 15 cm, the gate (servo motor) opens for 2 seconds, allowing the car to pass. If no car is detected, the gate stays closed.

Servo Control

- The servo motor operates based on the reading from ultrasonic sensor 3. If the car is detected (distance ¡ 15 cm), the gate opens for 2 seconds (`servo.write(90)`). After that, the gate closes (`servo.write(0)`).

3.6.4 Key Functions

- `pulseIn()`: Measures the time it takes for the ultrasonic sensor to receive the echo, which is used to calculate the distance of the object.
- `servoMotor.write()`: Sets the servo motor to specific angles. `0` means the gate is closed, and `90` means the gate is open.
- `lcd.print()`: Updates the LCD display to show the parking slot status.

```
#include <Servo.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Initialize the LCD (Address 0x27, 16 columns and 2 rows)
LiquidCrystal_I2C lcd(0x27, 16, 2);

Servo servoMotor;

const int trigPin1 = 12;
const int echoPin1 = 13;
const int trigPin3 = 9;   // New Ultrasonic Sensor 3 (Trigger Pin)
const int echoPin3 = 8;   // New Ultrasonic Sensor 3 (Echo Pin)
const int redLed1 = 7;
const int yellowLed1 = 6;
const int servoPin = 3;

long duration1, distance1;
long duration3, distance3;
```

```
void setup() {
  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);
  pinMode(trigPin3, OUTPUT);  // Pin for Ultrasonic Sensor 3
  pinMode(echoPin3, INPUT);
  pinMode(redLed1, OUTPUT);
  pinMode(yellowLed1, OUTPUT);

  servoMotor.attach(servoPin);
  servoMotor.write(0);  // Initial position of servo

  Serial.begin(9600);

  lcd.init();      // Use begin() instead of init()
  lcd.backlight();       // Turn on the LCD backlight
}
```

```
void loop() {
  // Ultra Sonic Sensor 1
  digitalWrite(trigPin1, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin1, LOW);
  duration1 = pulseIn(echoPin1, HIGH);
  distance1 = duration1 * 0.034 / 2;

  if (distance1 < 15) {
    digitalWrite(redLed1, HIGH);
    digitalWrite(yellowLed1, LOW);
    lcd.setCursor(0, 0);
    lcd.print("Slot 1: Full    ");
  } else {
    digitalWrite(redLed1, LOW);
    digitalWrite(yellowLed1, HIGH);
    lcd.setCursor(0, 0);
    lcd.print("Slot 1: Empty   ");
  }
```

```
  // Ultra Sonic Sensor 3 (Replacing PIR Sensor)
  digitalWrite(trigPin3, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin3, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin3, LOW);
  duration3 = pulseIn(echoPin3, HIGH);
  distance3 = duration3 * 0.034 / 2;

  // Control Servo Motor based on Ultrasonic Sensor 3
  if (distance3 < 15) {  // Object detected within 15cm
    servoMotor.write(90);
    delay(2000);  // Open the gate
  } else {
    servoMotor.write(0);   // Close the gate
  }

  delay(100);  // Small delay to stabilize the loop
}
```

Chapter 4

Results and Discussion

This chapter presents the findings and analysis of the Smart Car Parking System. The results are discussed in terms of the performance of the system's key features, such as vehicle detection, parking slot allocation, gate control, and real-time monitoring. The effectiveness of the system's sensors, controller, motor, and display system are examined. Finally, the limitations of the system are analyzed, and potential improvements are suggested to enhance its efficiency and functionality.

4.1 Vehicle Detection and Monitoring

4.1.1 Description

Ultrasonic sensors detect vehicles by measuring the distance between the sensor and the vehicle, determining whether a parking spot is occupied or available. The system continuously monitors the parking spot status, updating in real time with red (occupied) or green (empty) LEDs.

4.1.2 Results

The vehicle detection system accurately identified vehicles within the expected range, and the monitoring system provided reliable updates on parking spot statuses. Green LEDs indicated empty spots, and red LEDs showed occupied ones.

4.1.3 Discussion

The system performed well, but there were limitations in detecting larger vehicles or vehicles parked at angles. To improve detection accuracy, additional sensor technologies like LiDAR or infrared sensors could be used. Sensor misalignment or obstruction like smog due to weather conditions could affect accuracy, so using multiple sensors per spot or improving alignment would help.

4.2 Automated Parking Slot Allocation and Gate Control

4.2.1 Description

The system processes sensor data to allocate the nearest available parking slot to the vehicle. Gate control is automated, opening and closing based on the vehicle's arrival, detected by a SG90 servo motor.

4.2.2 Results

The parking allocation system efficiently guided drivers to the nearest available spot, reducing parking time. The gate control functioned smoothly, responding promptly to detection signals without delays.

4.2.3 Discussion

The allocation system worked well for general parking scenarios, but future improvements could prioritize spaces closer to entrances or based on vehicle size and type. Delays might occur during peak hours, and upgrading to more robust motors(Brushless DC Motors (BLDC)) or adding a backup system could improve gate reliability.

4.3 Real-Time Information Display and Spot Indicators

4.3.1 Description

A real-time display system uses an LCD display of 16*2 to show the status of parking spots, such as ”Slot 1: Full” or ”Slot 2: Empty.” The information is updated in real time to provide accurate parking availability.

4.3.2 Results

The display system functioned effectively, providing clear guidance for drivers. The LED indicators accurately updated the status of each parking spot on the lcd board at the entrance.

4.3.3 Discussion

For smaller parking lots, the system worked well. However, for larger or multi-level structures, additional display units or a mobile app integration or google map collaboration could be explored. A more sophisticated system could notify drivers when a spot becomes available at ease of their home.

4.4 Conclusions and Future Improvements

4.4.1 Summary

The Smart Car Parking System successfully performed vehicle detection, parking slot allocation, gate control, and real-time status display. The integration of green(empty) and red(occupied) LEDs to indicate available and occupied parking spots proved effective for reducing confusions. The ultrasonic sensors were instrumental in accurately detecting vehicle presence and providing real-time updates using LCD display and automatic gate control to the drivers in large multiplex areas.

4.4.2 Future Enhancements

To improve the parking system, several advanced features can enhance user experience and operational efficiency. Voice Guidance would offer hands-free directions to help drivers find available spaces. Traffic flow sensors could optimize movement by guiding vehicles to less crowded areas, while real-time mobile updates would allow users to check live space availability. Collision prevention systems, using sensors and alarms, would ensure the safety of both vehicles and pedestrians. Additionally, automatic slot assignment would streamline parking by directing cars to vacant spots, and reserving parking in advance via a mobile app guarantees space availability in crowded areas.

For larger or multi-level parking lots, digital display boards at entrances would show available spots per row, making decision-making faster. Google Maps integration could guide drivers directly to their designated parking spots. Moreover, IoT-enabled 2-step stacker systems would allow cars to be parked vertically, maximizing space usage in crowded areas. These innovations together would create a more efficient, safer, and user-friendly parking experience, benefiting both drivers and operators.

4.5 Limitations

1. **Privacy Concerns**: Collecting sensitive data, such as user and vehicle information, could raise privacy issues if not securely managed. Inadequate data protection could lead to unauthorized access or misuse, violating privacy regulations.

2. **Sensor Dependency**: The system relies heavily on sensors for accurate vehicle detection and parking spot allocation. Any malfunction or inaccuracies in sensor data could lead to incorrect parking status updates or misdirection of vehicles, affecting system efficiency.

3. **Coverage in Large Areas**: Large or multi-level parking lots may require additional sensors and infrastructure to ensure full coverage. This could increase the system's complexity, installation time, and operational costs, particularly in expansive or multi-floor facilities.

4. **Initial Setup Cost**: The setup cost, including installation of sensors, infrastructure, and development of the mobile app, could be prohibitively high. This may limit its adoption, especially in smaller parking facilities or locations with budget constraints.

5. **Maintenance**: Ongoing maintenance is required to keep sensors, LEDs, and mobile apps functioning optimally. Regular updates, recalibration of sensors, and system checks could lead to additional operational costs and resource allocation.

6. **Voice Guidance Effectiveness**: Although voice guidance could improve user experience, it may not function well in noisy environments or locations with heavy traffic. Miscommunication or inaudible instructions may hinder its effectiveness.

7. **Real-Time Mobile Updates**: Real-time updates provided via the mobile app could be impacted by poor network connectivity or signal interference, leading to delayed or inaccurate parking availability information, particularly in areas with weak signals.

8. **Complexity in Advanced Features**: Features like collision prevention, automatic slot assignment, mobile reservations, and vertical parking systems may introduce additional complexities. These features require precise sensor calibration, robust algorithms, and efficient management to avoid issues like false alarms, inefficient space usage, and system breakdowns.

4.6 Future scope of the project

A.Parking System Hardware Requirements and Costs

4.6.1 The system includes various components to ensure smooth operation.

Voice Guidance System

The voice guidance system uses directional speakers and a voice processing unit to provide clear instructions. It is equipped with wireless modules for cloud updates. **Estimated cost:** 20,000 - 40,000.

Traffic Management

Traffic Management is handled by sensors (IR, ultrasonic, or cameras) to monitor vehicle flow, smart traffic lights/barriers for routing, and data processing units for optimal routes. Estimated cost: 2,00,000 - 3,00,000.

Real-Time Mobile Updates

For Real-Time Mobile Updates, server-side and cloud infrastructure sync data with the app for live updates, ensuring smooth operation. Estimated cost: 1,50,000 - 3,00,000.

Collision Prevention

Collision Prevention includes ultrasonic/radar sensors at narrow points, alarm systems for alerts, and cameras for real-time monitoring. Estimated cost: 1,50,000 - 2,00,000.

Automatic Slot Assignment

Automatic Slot Assignment uses automated gates, RFID/ANPR systems for vehicle identification, and LED indicators for real-time slot updates. Estimated cost: 3,00,000 - 5,00,000.

Mobile Reservation System

The Mobile Reservation System relies on IoT-based RFID/QR code readers for entry/exit, cloud infrastructure for syncing reservations, and automated payment gateways. Estimated cost: 2,00,000 - 4,00,000.

Display Boards

Display Boards use large LED panels with real-time data updates and processing units for availability per row. Estimated cost: 1,50,000 - 2,00,000.

Google Maps Integration

Google Maps Integration includes GPS modules for accurate parking lot mapping, advanced sensors/cameras for multi-level mapping, and server infrastructure for live updates to Google Maps. Estimated cost: 2,00,000 - 4,00,000.

2-Step Stacker System

The 2-Step Stacker System integrates IoT-enabled stackers for vertical parking, automated motors and sensors for car movement, and control systems for smooth operation. Estimated cost: 5,00,000 - 10,00,000.

B. AI Integration with existing work

Kalyani's Ideas:

- Slot Allocation Based on Car Size: AI allocates parking slots based on car size.
- Dynamic Pricing: Adjusts pricing according to car age and fuel type like Through LPR if car;s age is greater than 15 yrs it will be charged more if its petrol it will be charged more than Diesel cars. Lastly if it's EV car it will be charged even less as it is more sustainable for the environment.
- Availability Predictions & Rush Updates: AI predicts available slots and rush hours.

- Destination-Based Slot Allocation: Allocates parking near the user's destination.
- Weather-Adapted Slot Assignment: AI assigns sheltered spots in bad weather.

Madesh's Ideas:

- Energy Harvesting: Converts kinetic, thermal, or mechanical energy to electricity.
- AI-Driven Parking Lot Climate Control: Regulates temperature and air quality in parking garages.
- Predictive Analytics for Air Quality: Adjusts ventilation based on predicted air quality.
- Energy Efficiency: Optimizes energy use in garages based on occupancy.
- Occupancy-Based Lighting Control: Adjusts lighting according to occupancy.

Amith's Ideas:

- License Plate Recognition (LPR): Uses AI for automated entry/exit and security.
- Energy Management: Optimizes energy use for lighting, ventilation, and EV charging.
- Predictive Maintenance: AI monitors and maintains parking facility equipment.
- Real-Time Slot Allocation: Allocates parking dynamically based on user preferences.
- Automated Billing: Charges users based on time parked using LPR.

Parima's Ideas:

- Number Plate Reading: Automates gate operations and verifies license plates.
- Voice Assistants: Allows users to navigate and book slots via voice.

- Emergency Management: Detects emergencies like fires and alerts users.
- Unauthorized Entry Detection: Monitors and alerts for duplicate or stolen vehicle entries.
- Slot Navigation & Booking: Enables voice-based slot booking and navigation before arrival.

Chapter 5

Conclusion

In conclusion, the Smart Car Parking System offers an efficient and user-friendly solution to address the growing issue of parking space management in urban environments. By leveraging advanced technologies such as ultrasonic sensors, which detect vehicle presence using sound, real-time updates on parking space availability, and automated systems, this system enhances parking space utilization and reduces the time spent searching for a parking spot. Cities like Delhi, Mumbai, Bengaluru, and Chennai can greatly benefit from such technology, alleviating traffic congestion and improving the overall parking experience for drivers. Additionally, it minimizes the environmental impact by reducing fuel consumption and emissions due to unnecessary driving. In the future, the integration of AI could further optimize the system by predicting parking space availability, automating parking assignments, and enhancing overall efficiency, thus creating a better environment for future generations. Future improvements may also involve integrating payment systems, expanding the network of parking spaces, and enhancing the system's scalability to accommodate more users in less time. Overall, the Smart Car Parking System paves the way for smarter, more efficient urban mobility solutions.

Key Points

- **Efficient Parking Management**: Utilizes ultrasonic sensors for real-time vehicle detection and availability updates.

- **Traffic Congestion Alleviation**: Reduces time spent searching for parking, contributing to less traffic.
- **Environmental Benefits**: Minimizes fuel consumption and emissions by avoiding unnecessary driving.
- **AI Integration**: Future AI implementation for parking predictions, automated assignments, and enhanced system efficiency.
- **Scalability and Expansion**: Plans to integrate payment systems, expand the network of parking spaces, and improve system scalability for more users.

Chapter 6

Cost Estimation for (SCPS) at Amrita Hospital, Faridabad

Table 6.1: Estimated Cost Breakdown for Implementation at Amrita Hospital, Faridabad

Category	Description	Cost ()
1. Hardware Costs	Sensors (1000 per sensor, 100 sensors)	1,00,000
	Cameras (5000 per camera, 20 cameras)	1,00,000
	Gate Systems (30,000 per gate, 2 gates)	60,000
	Display Panels (10,000 per panel, 4 panels)	40,000
	Voice Guidance System (Speakers and Microphone)	15,000
	Mobile App Integration	1,00,000
	Traffic Management Sensors (3000 per sensor, 50 sensors)	1,50,000
	Collision Prevention Sensors (5000 per sensor, 20 sensors)	1,00,000
	Parking Slot Indicators (50 per LED, 200 LEDs)	1000
Total Hardware Cost		**6,56,000**
2. Software Development	Parking Management Software Development	15,00,000
	Mobile Application Development	10,00,000
	Google Maps Integration for Navigation	2,00,000
	Automatic Slot Assignment System Development	3,00,000
	Cloud Storage for Real-Time Updates	3,00,000
Total Software Development Cost		**33,00,000**
3. Installation and Infrastructure	Cabling and Networking	3,00,000
	Civil Works (Construction and Slot Marking)	4,00,000
	Server Setup for Data Processing	1,00,000
Total Installation and Infrastructure Cost		**8,00,000**
4. Maintenance and Operations	Annual Maintenance Cost	2,00,000
	Staff Training	1,00,000
	Upgrades and Software Support	1,00,000
Total Maintenance and Operations Cost		**4,00,000**
Grand Total		**51,56,000**

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