VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANA SANGAMA, BELAGAVI – 590 018, KARNATAKA, INDIA

MINI-PROJECT REPORT

on

"Smart Parking"

Submitted in partial fulfillment of the requirements for the completion of

MASTER OF COMPUTER APPLICATIONS

Submitted By

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DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS

VIVEKANANDA COLLEGE OF ENGINEERING & TECHNOLOGY

[A Unit of Vivekananda Vidyavardhaka Sangha, Puttur (R)]

Affiliated to Visvesvaraya Technological University and Approved by AICTE New Delhi & Govt. of Karnataka

Nehru Nagara, Puttur – 574 203, DK, Karnataka, India

2024-25

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DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS

CERTIFICATE

Certified that the project work entitled **Smart Parking,** carried out by **Sanath P V (4VP23MC025)** a bonafide student of **VIVEKANANDA COLLEGE OF ENGINEERING & TECHNOLOGY, PUTTUR**, in partial fulfillment for the award of **MASTER OF COMPUTER APPLICATIONS** under **VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI** during the year 2024 – 25.The project has been approved as it satisfies the academic requirements in respect of Mini-Project work prescribed for 3rd Semester **IoT Lab with Mini-Project (22MCAL37)** in Master of Computer Applications Degree.

Dr. Rajeshwari M **Project Guide**	**Dr. Jothimani K** **Director-MCA**

EXTERNAL EXAMINERS

Name of the Examiners	Signature with date
1…….....	.....
2…….....	.....

DECLARATION

I hereby declare that, the project entitled **"Smart Parking"** is executed only by me, under the guidance of **Dr. Rajeshwari M, Assistant Professor, Department of MCA, Vivekananda College of Engineering and Technology, Puttur**, for the partial fulfillment of the requirements in respect of Mini- Project work prescribed for the 3rd Semester **IoT Lab with Mini-Project (22MCAL37)** for the award of the **Master of Computer Applications** by **Visvesvaraya Technological University, Belagavi.**

4VP23MC025 Sanath P V ……

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Abstract

Efficient parking management is essential for reducing congestion, optimizing space utilization, and improving user convenience. Traditional parking systems rely on manual monitoring, leading to inefficiencies such as incorrect occupancy detection, delays, and unauthorized parking. Additionally, the lack of real-time parking status updates increases frustration for drivers searching for available spaces.

To address these challenges, this project proposes an IoT-enabled smart parking system that enhances accuracy, automation, and real-time monitoring. The system integrates infrared (IR) sensors, an Arduino Uno microcontroller, and an LCD display to detect vehicle presence and update parking availability dynamically. The IR sensors detect incoming and outgoing vehicles, and the Arduino Uno processes the data to determine available parking slots. The updated status is displayed on the LCD screen, allowing drivers to easily locate vacant spaces.

By automating parking management and providing real-time updates, this system improves efficiency, reduces human intervention, and enhances user experience. The proposed solution is cost-effective, scalable, and suitable for commercial parking lots, shopping malls, and smart city applications.

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Chapter 1

Introduction

The Smart Parking System using IoT is an innovative solution designed to optimize vehicle parking management. By utilizing sensors and automation, this system enhances convenience and efficiency in parking areas. When a vehicle approaches the parking entrance, a sensor detects its presence, triggering the gate to open automatically. Simultaneously, the system displays a message on an LCD screen, providing real-time updates to the driver. Similarly, when the vehicle exits, another sensor detects its departure, opening the gate and displaying the appropriate message on the LCD.

This smart parking system is particularly useful in commercial parking lots, residential complexes, and public spaces, where managing vehicle flow is crucial. By integrating IoT technology, the system minimizes human intervention, reduces waiting time, and enhances overall parking efficiency. This project not only improves user experience but also contributes to better traffic management and security within parking facilities.

1.1 Objectives

- **Accurate Slot Detection** The system ensures precise detection of parking slot availability using high-precision sensors, eliminating errors and ensuring reliable parking management.
- **Real-Time Monitoring and Display** The ESP32 processes sensor data and sends it to an Arduino, which updates the LCD display in real-time, showing available slots and notifying users when a vehicle approaches.
- **Automated Gate Control and Efficiency** By integrating IoT with gate mechanisms, the system automatically opens the gate when a slot is available and displays a ”Slots Full” message on the LCD when no slots are free, enhancing transparency and operational efficiency.

Chapter 2

Literature Review

This paper explores how smart parking, enhanced by communication technology and intelligent transportation systems, improves traditional parking by guiding users to available slots, reducing search time. It notes that non-reservation systems often lead to competition for known slots, while reservation-based systems may face slot shortages. We propose CRPark, a hybrid solution using a Gaussian Mixture model and heuristic algorithm to optimize reservation management, minimizing both competition and parking difficulty. The approach also analyzes competition to effectively lower parking costs. Simulations demonstrate that CRPark outperforms other schemes in reducing costs and balancing demand[1].

This paper examines the inevitability of Smart Parking Systems (SPS) amid growing urban populations and the rising preference for private transportation, which increases vehicle numbers and traffic congestion. It highlights how cruising for parking exacerbates chaos, leading to wasted time, fuel, and energy. The study analyzes smart parking solutions through the lens of Internet of Things (IoT) and Machine Learning (ML), two rapidly advancing fields, providing a technical perspective. A detailed survey of state-of-the-art developments in SPS incorporating IoT and ML is included, alongside an exploration of smart parking's role in smart cities and the benefits of adopting Parking 4.0. Additionally, it addresses current challenges in SPS, proposes potential solutions, and outlines future implementation scopes[2].

This paper addresses the growing challenge of parking allocation in modern cities by analyzing various smart parking systems (SPS). It provides a comprehensive study, comparison, and analysis of SPSs based on technology, sensors, networking, user interface, computational methods, and services. Additionally, it bridges research gaps by evaluating SPS suitability in different environments while highlighting their pros and cons. The detailed comparison helps researchers, designers, and policymakers identify the most suitable SPS. This study also offers insights into current trends in smart parking solutions[3].

This paper proposes an IoT-based E-parking system to tackle urban parking challenges. With increasing vehicle numbers and poor parking management, congestion is a major issue. Existing solutions often ignore real-time improper parking detection and automated fee collection. The proposed system integrates a **parking meter** for efficient parking

management[4].

This paper explores how IoT advancements make smart cities more achievable. It proposes an IoT-based, cloud-integrated smart parking system to address parking challenges. The system monitors and signals parking availability using deployed IoT modules. A mobile application enables users to check and book parking slots in real time. The paper also discusses system architecture and validates its functionality through a use case[5].

Chapter 3

Requirement Analysis

3.1 Existing and Proposed System

3.1.1 Existing System

The current parking systems often rely on manual monitoring or basic sensors without real-time feedback, leading to inefficiencies such as difficulty in finding available slots, lack of automation, and poor user experience. Many parking areas lack automated gate control or real-time slot availability displays, causing delays and confusion for drivers. Additionally, the absence of IoT integration limits transparency and scalability, highlighting the need for a more advanced, technology-driven solution to optimize parking management.

3.1.2 Proposed System

The proposed system introduces an IoT-enabled smart parking solution that integrates IR sensors, a servo motor, an Arduino Uno microcontroller, and an LCD display to provide real-time slot monitoring and automated gate control. The IR sensors detect vehicle presence and slot availability, sending data to the Arduino Uno for processing. The processed data triggers the servo motor to open the gate when a slot is available and updates the LCD display with real-time slot status (e.g., ”Slot Available” or ”Slots Full”). This system enhances transparency, reduces manual intervention, and improves parking efficiency by automating gate access and providing instant feedback to users.

3.2 Hardware Requirements

- **IR Sensor**
  An infrared (IR) sensor is used to detect the presence of vehicles and determine parking slot availability in real time. It senses interruptions in the infrared signal to accurately monitor slot status.

- **Servo Motor**
  A servo motor controls the gate mechanism, automatically opening the gate when a

parking slot is available and closing it when slots are full, providing seamless access control.

- **LCD Display**
  An LCD display presents real-time parking slot status to users (e.g., ”Slot Available” or ”Slots Full”). It ensures clear visibility under various lighting conditions and provides instant feedback to drivers.

- **Arduino Uno**
  Arduino Uno serves as the central control unit, interfacing between the IR sensor, servo motor, and LCD display. It processes sensor data, controls the servo motor, and ensures accurate display of slot availability.

3.3 Software Requirements

- **Arduino IDE**
  The Arduino IDE is an open-source software designed by Arduino.cc for writing, compiling, and uploading code to the Arduino Uno. It provides an accessible programming environment for implementing the smart parking logic, suitable for beginners and experts alike.

- **Wire.h**
  This library enables I2C communication between the Arduino Uno and the LCD display, ensuring seamless data transfer for real-time updates.

- **LiquidCrystalI2C.h**
  This library is used to control the I2C-based LCD display (e.g., 16x2) to show real-time parking slot status, such as availability or full capacity.

- **Servo.h** The Servo library is used to control the servo motor, allowing precise gate movement based on slot availability detected by the IR sensor.

- **C++**
  The project utilizes the Arduino IDE for writing and uploading code to the microcontroller. C++ programming is employed to implement logic, process IR sensor data, control the servo motor, and update the LCD output.

Chapter 4

Software Requirement Specification

The Software Requirement Specification (SRS) defines the features and capabilities that the smart parking system should possess to ensure seamless integration, efficient operation, and user satisfaction. This includes functionalities such as vehicle detection using IoT sensors, automatic gate control, parking slot monitoring, and real-time status updates displayed on an LCD screen.

4.1 Functional Requirements

4.1.1 Vehicle Detection and Gate Control

- The system should detect incoming and outgoing vehicles using IoT-enabled sensors.
- The entry gate should open automatically when a vehicle is detected at the entrance, and the exit gate should open when a vehicle leaves.
- An LCD display should provide real-time status updates regarding gate operations and parking availability.

4.1.2 Parking Slot Monitoring

- The system should continuously monitor and update the availability of parking slots.
- The number of available and occupied slots should be displayed on an LCD screen for drivers' reference.

4.2 Non-Functional Requirements

4.2.1 Reliability

- The system should have a high level of reliability and uptime, ensuring minimal failures.
- Implement failover mechanisms to handle sensor malfunctions or network disruptions effectively.

4.2.2 Performance

- Ensure real-time response for vehicle detection, gate control, and LCD updates.
- Minimize power consumption when the system is idle while maintaining efficiency.

4.2.3 Usability

- The system should be user-friendly, with clear visual indicators and an intuitive interface for easy navigation.
- LCD messages should be easy to read and understand for drivers of varying technical backgrounds.

Chapter 5

Analysis and Design

Analysis and design are critical phases in the development of an IoT-enabled Smart Parking System, ensuring accurate slot monitoring, efficient operation, and reliability. The analysis phase involves gathering requirements, understanding parking management needs, and assessing technical feasibility. The design phase focuses on developing a structured and scalable architecture that integrates IR sensors, a servo motor, Arduino Uno, and an LCD display to ensure seamless data processing and real-time parking slot visualization.

5.1 Circuit Design

The circuit design of the proposed smart parking system integrates an Arduino Uno microcontroller, IR sensors, a servo motor, and an LCD display. The IR sensors detect the presence of vehicles at the entrance and exit, generating signals that are processed by the Arduino Uno. The microcontroller then controls the servo motor to open or close the gate and updates the LCD display with real-time parking slot status.

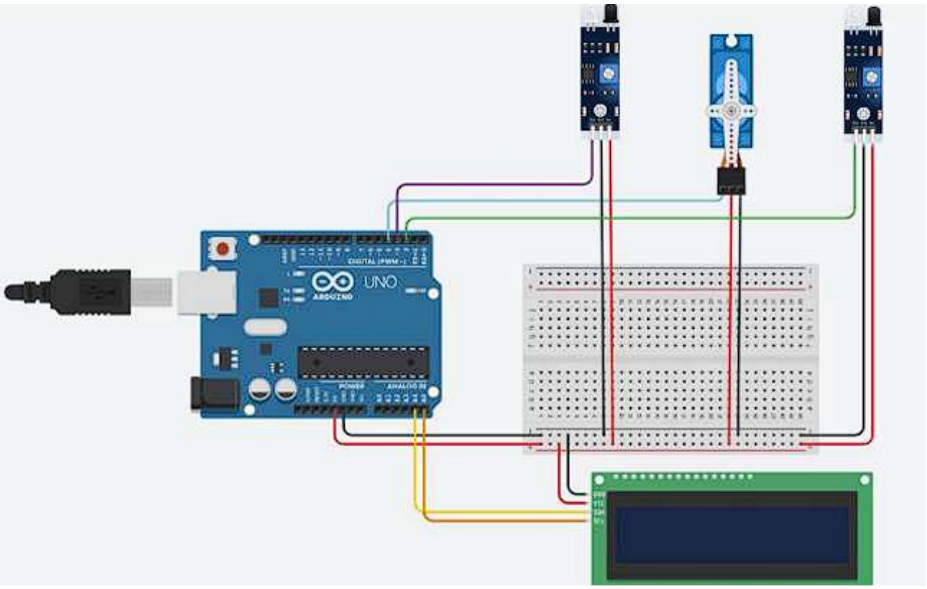

Figure 5.1: Circuit Design

In Figure 5.1 illustrates the connections between components in the system.
The connections include:

- The IR sensors are connected to the Arduino Uno's input pins to detect vehicles entering and exiting the parking area.
- The servo motor is interfaced with the Arduino Uno to control the gate based on slot availability.
- The LCD display is connected to the Arduino Uno to show real-time slot availability and system status.
- Power is supplied to the microcontroller, sensors, servo motor, and display via a regulated power source.

5.2 System Workflow

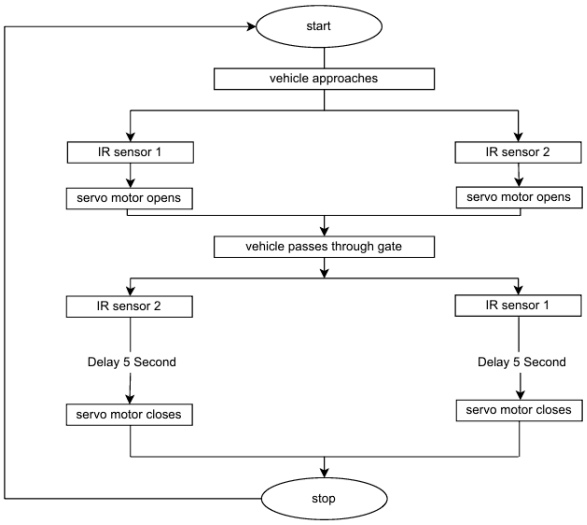

Figure 5.2: Workflow Diagram

In Figure 5.2, the first step in the implementation involved physically preparing the hardware components. This included connecting the positive and negative terminals of the 5V power supply to the positive and negative rails of the breadboard, respectively. Similarly, the positive and negative terminals of both IR sensors were connected to the respective rails of the breadboard. The signal pin of the entrance IR sensor was connected to a digital input pin on the Arduino Uno, while the signal pin of the exit IR sensor was connected to another digital input pin. Additionally, the servo motor was connected to a PWM output pin of the Arduino Uno to control the parking gate. The LCD display was interfaced with the Arduino Uno using appropriate data and control pins to display real-time parking availability.

Chapter 6

Implementation

Implementing a smart parking system involves several steps, including selecting the hardware, setting up the software, connecting to the network, integrating with parking management platforms (if desired), and testing the functionality.

6.1 Circuit Implementation

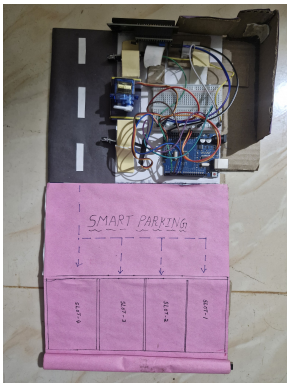

Figure 6.1: Designed Model 1

Figure 6.2: Designed Model 2

Figures 6.1 and 6.2 illustrate the implementation and workflow of our IoT-enabled Smart Parking System, designed to efficiently manage parking spaces and enhance vehicle entry and exit automation. Traditional parking systems often rely on manual monitoring, which can lead to inefficiencies, congestion, and human error. To address these challenges, our system integrates IR sensors, an Arduino Uno microcontroller, a servo motor, and an LCD display to automate parking slot detection and access control.

The IR sensors detect the presence of vehicles at the entrance and exit, triggering the Arduino Uno to process this data and update parking availability in real time. The servo motor operates the parking gate based on vehicle detection, ensuring controlled access. The LCD display provides instant feedback on available parking slots, allowing users to easily find open spaces.

The workflow of the system (Figure 6.2) demonstrates how vehicle detection and parking slot availability are processed and displayed. By automating parking management, the system minimizes human intervention and eliminates manual verification errors. The

Arduino Uno microcontroller ensures seamless data handling, while the LCD provides a user-friendly interface. Furthermore, Figure 6.1 highlights the physical implementation of the Smart Parking System, showcasing its compact and scalable design.

Additionally, this system has the potential for IoT-based remote monitoring, where parking data can be transmitted to a cloud platform for further analysis. This cost-effective and scalable solution is ideal for commercial parking lots, shopping malls, offices, and smart city projects, ultimately improving parking efficiency and reducing traffic congestion.

6.2 Code

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

LiquidCrystal_I2C lcd(0x27, 16, 2);
Servo myservo;

int IR1 = 2;
int IR2 = 3;

int Slot = 4; // Only 4 parking slots available

int flag1 = 0;
int flag2 = 0;

void setup() {
    Serial.begin(9600);
    lcd.init();
    lcd.backlight();

    pinMode(IR1, INPUT);
    pinMode(IR2, INPUT);

    myservo.attach(4);
    myservo.write(100);

    lcd.setCursor(0, 0);
    lcd.print("...ARDUINO␣PARKING...");
    lcd.setCursor(0, 1);
    lcd.print("....SYSTEM....");
```

```
    delay(2000);
    lcd.clear();
}

void loop() {
    if (digitalRead(IR1) == LOW && flag1 == 0) {
        if (Slot > 0) {
            flag1 = 1;
            if (flag2 == 0) {
                myservo.write(0);
                Slot--;
            }
        } else {
            lcd.setCursor(0, 0);
            lcd.print("....SORRY.:(....");
            lcd.setCursor(0, 1);
            lcd.print("..Parking Full..");
            delay(3000);
            lcd.clear();
        }
    }

    if (digitalRead(IR2) == LOW && flag2 == 0) {
        flag2 = 1;
        if (flag1 == 0 && Slot < 4) {
            myservo.write(0);
            Slot++;
        }
    }

    if (flag1 == 1 && flag2 == 1) {
        delay(1000);
        myservo.write(100);
        flag1 = 0;
        flag2 = 0;
    }

    lcd.setCursor(0, 0);
    if (Slot == 4) {
        lcd.print("...SLOT EMPTY!...");
```

```
    } else {
        lcd.print("....WELCOME!....");
        lcd.setCursor(0, 1);
        lcd.print("Slot.Left:..");
        lcd.print(Slot);
        lcd.print(".."); // To clear any leftover characters
    }
}
```

Chapter 7

Testing

The table 7.1 describes smart parking system involves verifying its functionality, reliability, and performance to ensure that it operates as intended and meets user expectations.

Table 7.1: System Testing Results

Sl No	Testing	Results Obtained
1	Functional Testing	Verify basic functions such as detecting vehicles, opening/closing the gate, and updating the parking availability display.
2	Integration Testing	Ensure smooth communication between sensors, the Arduino board, and the LCD display. Verify that the system correctly updates parking status based on sensor inputs.
3	Performance Testing	Assess response times, accuracy of vehicle detection, and overall system performance under different conditions. Test multiple vehicle entries/exits in quick succession.
4	Network Connectivity Testing	If applicable, test the system's connectivity with external modules (such as Wi-Fi or cloud-based storage for data logging).
5	Usability Testing	Ensure that the system provides clear and easy-to-read parking status updates. Test with different users to evaluate user-friendliness.

Chapter 8

Conclusion

In this project, an IoT-enabled smart parking system was developed to address the limitations of conventional parking management methods. Traditional parking systems often suffer from inefficiencies due to manual monitoring, lack of real-time updates, and poor space utilization, leading to delays and frustration for drivers. By integrating high-precision IR sensors with an Arduino Uno microcontroller, a servo motor, and an LCD display, the proposed system ensures real-time monitoring and accurate parking slot management. The system continuously tracks slot availability, controls gate access, and displays parking status, reducing manual intervention and enhancing transparency in parking operations.

The implementation of the Arduino Uno microcontroller enables efficient processing of sensor data, ensuring accurate detection of vehicles with minimal delay. The system's ability to instantly display slot availability on an LCD screen and automate gate control provides drivers with immediate feedback, improving parking efficiency and user experience. Additionally, the smart parking system is designed to be cost-effective and scalable, making it a suitable solution for parking lots, commercial buildings, and urban environments. The system's performance was evaluated through various testing methods, confirming its reliability and efficiency under different operating conditions.

Overall, the IoT-enabled smart parking system represents a significant advancement in parking management technology. It enhances space utilization, reduces delays, and improves the overall efficiency of parking operations. With further enhancements, such as mobile app integration, cloud-based monitoring, and predictive analytics, this system has the potential to revolutionize urban parking by providing an intelligent and automated approach to parking management.

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