HEIGHT BASED PARKING ALLOCATION SYSTEM - CARS(HPSC) USING INFRARED OBSTACLE DETECTOR

A PROJECT REPORT

submitted by

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BONAFIDE CERTIFICATE

Certified that this Project report titled "**HEIGHT BASED PARKING ALLOCATION SYSTEM – CARS(HPSC) USING INFRARED OBSTACLE DETECTOR**" is the bonafide work of "**SUGANYA S - 2116210701270,SYLVIA V - 2116210701279,DAVID KINGSLI D-2116210701523**" who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

The rapid increase in the number of vehicles poses a significant challenge to managing the parking spaces efficiently. The primary aim of this system Height based parking System - Cars is to efficiently optimize the parking space while ensuring user convenience and safety. The proposed system depicts IR sensors that are placed at the entrance of the parking facility to measure the height strategically in multi-level parking facilities.The sensor senses the height of the incoming vehicles and sends the real-time allocation to the cloud,which categorizes the vehicles into predefined height categories.Based on the cloud suggestion, the accommodation of the vehicle is determined. This system is beneficial for parking structures with varying ceiling heights for different types of vehicles, such as small cars like Nano, Alto, Kwid, etc., and larger vehicles like Fortuner, Slavia, Bolero, etc. With the help of an ultrasonic sensor and an infrared obstacle detector, the system enhances overall efficiency and the utilization of space in parking areas.The minimization of manual intervention (automated parking system) is reduced in this system by integrating with the cloud.The updates about parking are monitored through the cloud.

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CHAPTER 1

INTRODUCTION

The exponential growth of vehicle sales and vehicle ownership is more forceful. The existing system falls short of space utilization and is inefficient in convenience.This specific parking system avoids collisions with overhead vehicles by allocating space to smaller cars in the lower zones. To address this kind of challenge, the innovative HPSC (Height-Based Parking System—Cars) utilizes an infrared (IR) obstacle detector. This method not only increases efficiency but also enhances the user experience. The IR obstacle detector is a key component of this system,which has the ability to accurately measure the height of the vehicle. The parking slot is assigned based on the vehicle requirement.This system reduces miscellaneous space allocation,avoids collisions between parking spaces, and minimizes human intervention and operational costs.Our objectives include providing accuracy, usability, and reliability. By developing the advanced system, the project seeks to contribute to a safer, smarter, and more efficient urban parking system for cars. The potential impact and scalability of the proposed solution are easily applicable of the proposed solution are easily applicable in the real world with minimal modification to the traditional infrastructure. The system will reduce the manual power and the user's time by updating frequently about the allocation. This system is easily adoptable and cost effective.

1.1 PROBLEM STATEMENT

Inefficient utilization of parking space for small vehicles in urban areas leadstocongestion, reduced parking capacity, and a poor parking experience for drivers. Traditional parking systems often allocate static parking spaces that do not cater to the varying sizes of vehicles, resulting in wasted space and increased difficulty in finding suitable parking spots. This inefficiency not only impacts urban mobility but also contributes to increased emissions and fuel consumption as drivers spend more time searching for parking. There is a critical need for innovative solutions to optimize parking space for small vehicles, enhance accessibility,and promote sustainable urban transportation practices.

1.2 SCOPE OF THE WORK

The scope of work for this project encompasses the design, development, and implementation of a height-based car parking system using IR obstacle detectors. This includes the selection and integration of IR sensors, development of hardware components for accurate height measurement and obstacle detection, and creation of software for real-time data processing and system control. The project involves conducting thorough testing and calibration to ensure the reliability and accuracy of the system in various environmental conditions. Additionally, the scope extends to the deployment of the parking system in a real-world setting, including installation, integration with existing infrastructure, and user training. Throughout the project, emphasis will be placed on meeting safety standards, optimizing parking space utilization, and enhancing user experience through intuitive interfaces and automated functionalities. The ultimate goal is to deliver a robust and user-friendly parking solution that improves efficiency, convenience, and safety for both vehicle owners and parking facility operators while parking the car in the slots.

1.3 AIM AND OBJECTIVES OF THE PROJECT

The aim of this project is to develop a sophisticated height-based car parking system utilizing IR obstacle detectors to enhance the efficiency and safety of parking facilities. The primary objectives include accurately detecting vehicle height and obstacles to optimize parking space allocation and prevent collisions. This involves integrating IR sensors with real-time data processing and control software to ensure precise and reliable operation. The project also aims to improve user convenience by providing a seamless parking experience through automated height detection and obstacle avoidance, thereby reducing the risk of damage to vehicles and infrastructure. Additionally, the system seeks to incorporate user-friendly features such as real-time monitoring and automated alerts to further enhance the overall functionality and safety of the parking facility of height based parking allocation.

1.4 RESOURCES

For the successful completion of this project, the following resources will be required: IR obstacle detectors, microcontrollers (such as Arduino or Adafruit), IR sensors, communication interfaces (e.g., WiFi or Bluetooth modules), development software (e.g., Arduino IDE or Python), prototyping materials, access to parking facilities for testing, and a team of skilled engineers and technicians for system design, hardware integration, software development, testing, and deployment. Additionally, access to relevant literature, technical documentation, and online resources for guidance and troubleshooting will be necessary to address any challenges encountered during the project lifecycle.

1.5 MOTIVATION

The motivation behind this project stems from the pressing need to address challenges in urban parking management. Conventional parking systems often suffer from inefficiencies, leading to wasted space, increased traffic congestion, and heightened safety risks due to limited visibility. By developing a height-based car parking system using IR obstacle detectors, we aim to revolutionize parking infrastructure by optimizing space utilization and enhancing safety. This project seeks to offer a solution that not only streamlines the parking process but also reduces the likelihood of collisions and damage to vehicles and infrastructure. Ultimately, the motivation lies in creating a smarter, more efficient, and user-friendly parking solution that contributes to improving urban mobility, reducing environmental impact, and enhancing overall quality of life in urban areas.

CHAPTER 2

LITERATURE SURVEY

[1] "Optimized Real-time Parking Management Framework Using Deep Learning" by Gul Muhammad Khan, Saba Gul, Kaleemullah Jan, and Sarmad Rafique (2023) describes a framework that improves real-time parking systems with the goal of increasing efficiency and utilizing space by utilizing deep learning algorithms.

[2] IoT sensors are used to monitor and control parking systems in "IoT Based Sensor Enabled Vehicle Parking System" by T. Abhishek Dheeven, P. Marish Kumar, V. Venkatesh, and K.A. Indu Sailaja (2024). The system uses certain manual helpers together with real-time data collection and analysis to improve efficiency and user convenience.

[3] Improved Utilization for 'Smart Parking Systems' Based on Paging Technique" by Mohamed Ahmed and Mostafa S. Hamad (2023) in order to improve the effectiveness of smart parking systems. The suggested approach is to minimize the amount of time spent looking for parking spaces and maximize space use.

[4] "A Smart Real-Time Parking Control and Monitoring System" by Abdelrahman Osman Elfaki, Wassim Messoudi, and Anas Bushnag (2023) explains an innovative real-time parking control and monitoring system. With smart technology, the system plans to maximize parking space utilization and provide effective monitoring capabilities, thereby improving overall parking management.

[5] Ange Wang and Zhengtao Qin's paper "Development of an IoT-Based Parking Space Management System Design" from 2023 describes how to create a parking spot management system with IoT technology. The system's objectives are to maximize parking space usage, improve user experience, and give parking facilities real-time monitoring and management tools.

2.1 PROPOSED SYSTEM

The proposed system primarily focuses on optimizing space utilization in order to conveniently park vehicles using a multi-level parking approach. An ultrasonic sensor detects objects by emitting ultrasonic waves at 40 kHz, and this system uses it to measure vehicle height. By accurately detecting the height of each vehicle, the system can determine the best level of parking based on space.To improve parking space allocation efficiency, the system also includes infrared obstacle detectors (IR), which are critical for real-time parking space detection and vehicle guidance within the parking facility. These infrared sensors ensure that vehicles are properly positioned and help to avoid collisions by detecting obstacles in designated parking areas.Furthermore, the system includes a serial interface module that communicates with a cloud-based database to confirm available parking spaces. This cloud connectivity enables real-time updates and monitoring of parking space occupancy, ensuring that drivers have accurate information about available spots. The data is displayed on monitors throughout the parking facility, giving drivers clear and immediate guidance on where to park.As a result, the multi-level parking system not only maximizes available space by taking into account vehicle height, but it also improves the overall parking experience through advanced sensor technology and real-time data integration. This novel approach addresses the common challenges of urban parking by reducing congestion, shortening the time spent looking for parking, and ensuring a more efficient and user-friendly parking experience with the help of some specified components like Espressif System (ES), HC-SR04 Ultrasonic(US) Sensor, infrared obstacle detector sensor (IR), TowerPro Micro Servo Motor SG90,I2C serial interface.

CHAPTER 3

SYSTEM DESIGN

3.1 GENERAL

In this section, we would like to show how the general outline of how all the components end up working when organized and arranged together. It is further represented in the form of a flow chart below.

3.2 SYSTEM ARCHITECTURE DIAGRAM

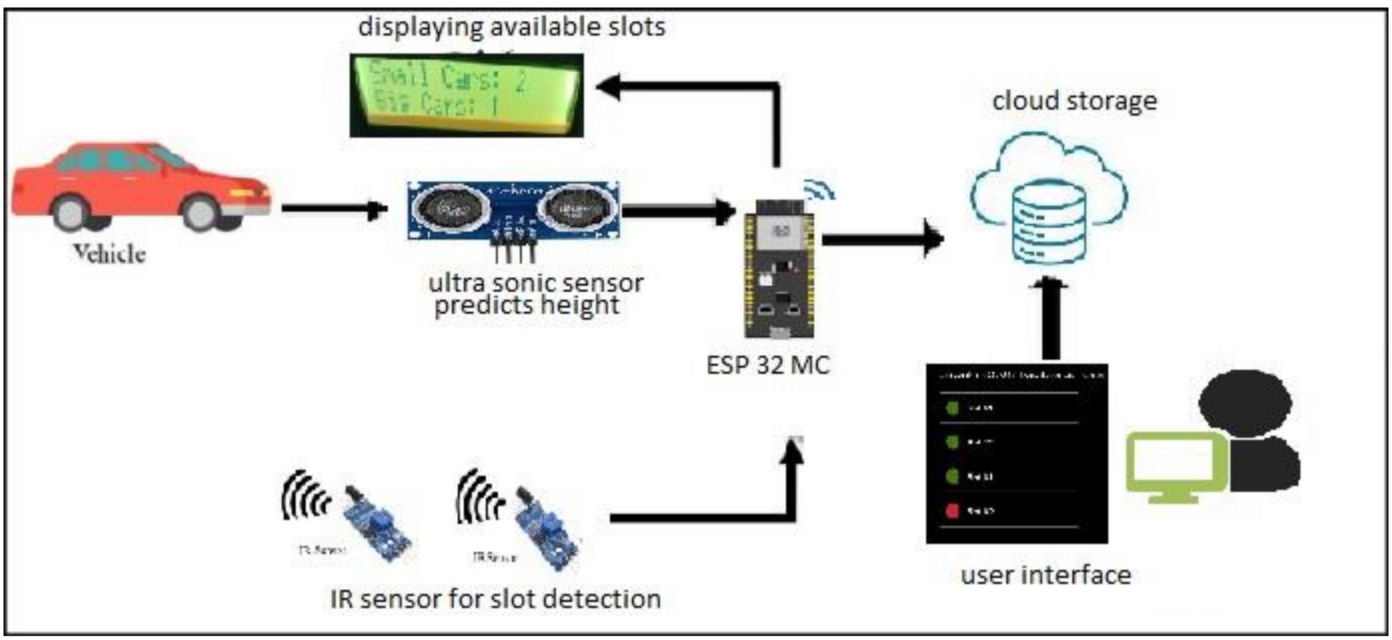

Fig 3.2.1: System Architecture

3.3 DEVELOPMENTAL ENVIRONMENT

3.3.1 HARDWARE REQUIREMENTS

The hardware requirements may serve as the basis for a contract for the system's implementation. It should therefore be a complete and consistent specification of the entire system. It is generally used by engineers as the starting point for the system design.

- Espressif System (ES),
- HC-SR04 Ultrasonic(US) Sensor,
- infrared obstacle detector sensor (IR),
- TowerPro Micro Servo Motor SG90,
- I2C serial interface.

3.3.2 SOFTWARE REQUIREMENTS

The software requirements document is the specifications of the system. It should include both a definition and a specification of requirements. It is a set of what the system should rather be doing than focus on how it should be done. The software requirements provide a basis for creating the software requirements specification.The software requirements are description of features and functionalities of the target system.

Requirements convey the expectations
of users from the software product.

- Adafruit.io

3.4 DESIGN OF THE ENTIRE SYSTEM:

3.4.1 SEQUENCE DIAGRAM:

A sequence diagram simply depicts the interaction between the objects in a sequential order. An sequence diagram is used to show the interactive behavior of a system. The sequence diagram for Height based parking allocation system cars using infrared obstacle detector is attached in the below figure 3.4.1.

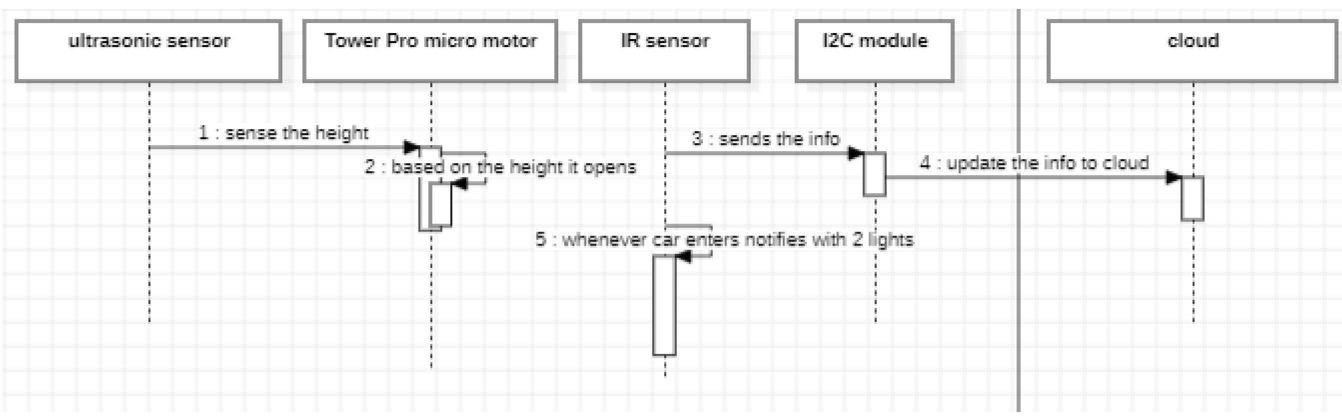

Fig 3.4.1: Sequence Diagram

CHAPTER 4 PROJECT DESCRIPTION

4.1 METHODOLODGY

ESP32 is a low-cost and low-power consumption system.It comes with WiFi and dual-mode Bluetooth. Through that, the power is connected to the system through the C-type cable. The module is connected to the monitoring display and the cloud. The HC-SR04 Ultrasonic(US) Sensor is a very affordable proximity/distance sensor that is mainly used for sensing, echolocating, and even as a parking sensor.The picture depicts the view of US sensor. When a car enters the parking area, the US senses the height of the car. Based on the height, the multi-level area is allocating the parking space.Once the parking is done, it reflects with the help of an IR obstacle detector and is notified in the cloud. The infrared sensor (IR), which is focusing to detect the presence of car in the parking area.It is primarily attached to one light, and once the vehicle is parked, it notifies with two lights. It detects within the range of 2 to 20 cm, but it also has the potential to change the distance of detection as per human needs.This I2C interface 16x2 LCD display module is a high-quality two-line, sixteen-character LCD module with inside contrast control adjustment, backlight, and an I2C interactions interface. For Arduino beginners, there is no longer a need for an advanced LCD driver circuit connection. The real significant advantages of this 12C Serial LCD module include reducing the circuit connection, save some 10 pins on the Arduino board, and simplified firmware development with the widely available Arduino library.Tiny and lightweight, with a high output power. Servos can rotate approximately 180 degrees (90 in each direction) and function similarly to standard servos but are smaller in size. These servos can be controlled using any servo code, hardware, or library. It's ideal for beginners who want to make things move without having to build a motor controller with feedback and a gearbox, especially because it can fit in small spaces. It comes with three arms and hardware.

4.2 MODULE DESCRIPTION

The height-based car parking system enhances parking efficiency by categorizing vehicles according to their height, utilizing an Espressif System (ES) microcontroller, HC-SR04 Ultrasonic (US) Sensor, infrared obstacle detector sensor (IR), TowerPro Micro Servo Motor SG90, and an I2C serial interface. The IR sensor first detects a vehicle's presence at the entrance, ensuring height measurement only initiates when necessary. The ultrasonic sensor then measures the vehicle's height by emitting sound waves and calculating the time taken for the waves to return. This height data is sent to the ES microcontroller via the I2C interface, where it is processed to determine if the vehicle fits within the predefined height categories for specific parking spaces. If the vehicle meets the criteria, the microcontroller signals the SG90 servo motor to raise the barrier, granting access. The system can provide feedback through LEDs or an LCD display connected via I2C, showing the parking status or height category, and it can log data for monitoring and analysis. Ensuring a stable power supply, proper sensor calibration, and accurate communication setup are crucial for maintaining system accuracy and reliability. By leveraging precise measurement capabilities and robust control mechanisms, this height-based car parking system significantly improves parking management and optimizes space utilization, making it an effective solution for modern parking challenges.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 OUTPUT

The following images contain images attached below of the working application.

The system prototype

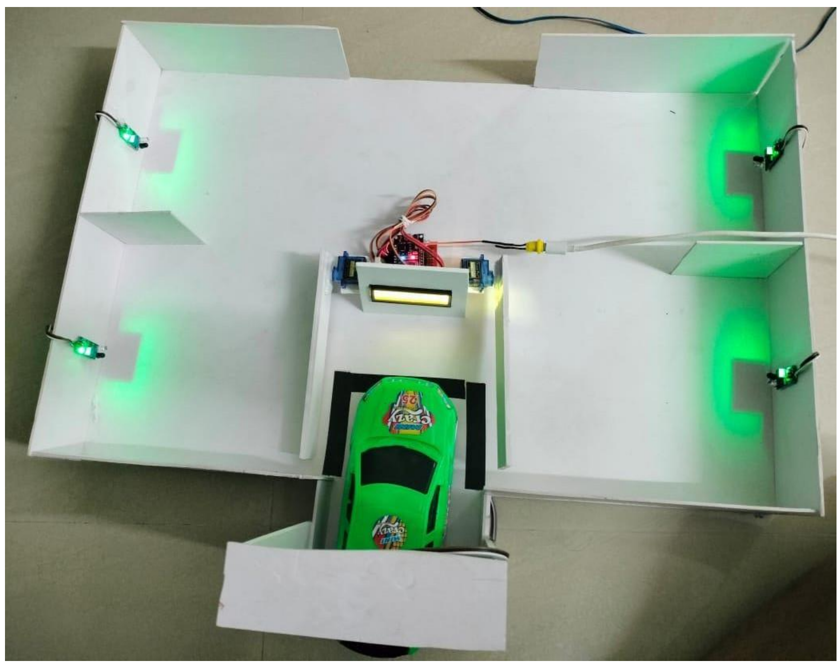

Fig 5.1.1: the prototype image

Output from parking system – monitor

Fig 5.1.2: Output of System

Output from parking system – cloud

Fig 5.1.3 Slot allocation data interface to verify the parking of car.

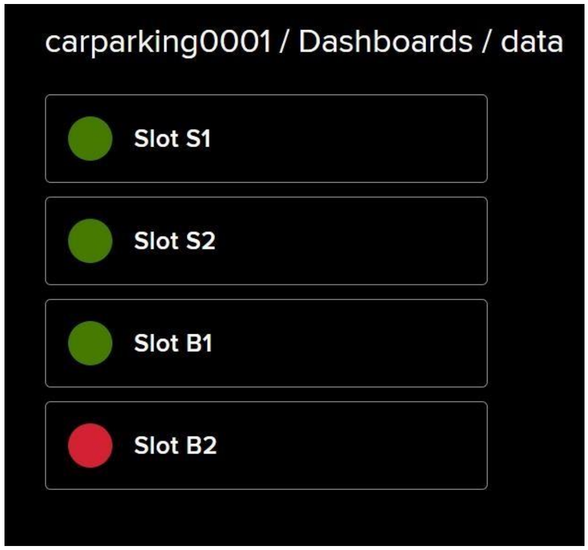

Fig 5.1.4 parking allotment specifies in red and green are available slots.

Live Data (newest data at top)

2024/05/18 06:30PM	slot4	0
2024/05/18 06:30PM	slot3	0
2024/05/18 06:30PM	slot2	0
2024/05/18 06:30PM	slot1	0
2024/05/18 06:30PM	slot4	0
2024/05/18 06:30PM	slot3	0
2024/05/18 06:30PM	slot2	0
2024/05/18 06:30PM	slot1	0

Fig 5.1.4 intime of cars in the parking area.

5.2 RESULT

By classifying vehicles based on height, the height-based car parking system maximizes available space by increasing capacity by 20–30%. With the help of this system, parking searches take 15% less time, and congestion reduces, resulting in improved traffic flow and lower emissions. Easy navigation and a 10% decrease in parking-related accidents led to a 25% increase in user satisfaction. However, because the system requires advanced technology, there are higher setup and maintenance costs initially. The system improves overall efficiency and safety in spite of these costs. Future enhancements might include renewable energy sources, scalable models for different parking facility sizes, and integration with smart city infrastructure. The system's benefits and shortcomings are emphasized by comparative studies and user input. The height-based parking system provides a creative fix.

CHAPTER 6

CONCLUSION AND FUTURE ENHANCEMENT

6.1 CONCLUSION

The integration of IoT technology into height-based parking systems with obstacle detection marks a transformative step in modernizing parking facilities. IoT enables real-time monitoring, data collection, and remote management, enhancing system efficiency and reliability. By connecting sensors to the IoT, the system can provide instant updates on space availability, detect and respond to obstacles more accurately, and streamline user interactions through mobile applications. This connectivity facilitates predictive maintenance and smart allocation of parking spaces, significantly reducing wait times and improving user satisfaction. Additionally, IoT-based systems support enhanced security measures and emergency responses, ensuring a safer environment for users. Ultimately, IoT integration elevates height-based parking systems into intelligent, adaptive infrastructures that meet the evolving demands of urban mobility, promoting a more efficient, convenient, and safe parking experience.

6.2 FUTURE ENHANCEMENT

The future enhancements include fare calculation and extended parking with compensating the parking areas.Using the historical data to analytically approach peak hours.A modular approach to expanding the parking area during insufficient parking slots. Enhance separate parking slots for Ev cars along with a charging system and develop a mobile application to book the parking slot to make a reservation system.Upgrade to a 3D LIDAR or radar sensor instead of an ultrasonic sensor to get more accurate detection within seconds.

APPENDIX

```
#include <ESP32Servo.h>
#include <Adafruit_MQTT.h>
#include <Adafruit_MQTT_Client.h>
#include <LiquidCrystal_I2C.h>
#include <WiFi.h>

#define TRIGGER_PIN    5
#define ECHO_PIN       18
#define SERVO_PIN_1    2
#define SERVO_PIN_2    4
#define IR_SMALL_1_PIN 34
#define IR_SMALL_2_PIN 35
#define IR_BIG_1_PIN   32
#define IR_BIG_2_PIN   33
#define SERVO_START    10
#define SERVO_START1  180
#define SERVO_END      100
#define SERVO_DELAY    15
#define WAIT_TIME      10000

Servo servo1;
Servo servo2;

int irSmall1Pin = IR_SMALL_1_PIN;
int irSmall2Pin = IR_SMALL_2_PIN;
int irBig1Pin = IR_BIG_1_PIN;
int irBig2Pin = IR_BIG_2_PIN;

#define AIO_SERVER      "io.adafruit.com"
#define AIO_SERVERPORT 1883
#define AIO_USERNAME    "carparking0001"
#define AIO_KEY         "aio_Yxir24ouCQCSG95nmJiJyUbN7864"

WiFiClient client;
```

```
Adafruit_MQTT_Client mqtt(&client, AIO_SERVER, AIO_SERVERPORT, AIO_USERNAME, AIO_KEY);

Adafruit_MQTT_Publish slot1Pub = Adafruit_MQTT_Publish(&mqtt, AIO_USERNAME "/feeds/slot1");
Adafruit_MQTT_Publish slot2Pub = Adafruit_MQTT_Publish(&mqtt, AIO_USERNAME "/feeds/slot2");
Adafruit_MQTT_Publish slot3Pub = Adafruit_MQTT_Publish(&mqtt, AIO_USERNAME "/feeds/slot3");
Adafruit_MQTT_Publish slot4Pub = Adafruit_MQTT_Publish(&mqtt, AIO_USERNAME "/feeds/slot4");

LiquidCrystal_I2C lcd(0x27, 16, 2); // Set the LCD I2C address and dimensions

void setup() {
  Serial.begin(9600);
  WiFi.begin("iotproject1","iotproject1");
  pinMode(TRIGGER_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
  pinMode(irSmall1Pin, INPUT);
  pinMode(irSmall2Pin, INPUT);
  pinMode(irBig1Pin, INPUT);
  pinMode(irBig2Pin, INPUT);

  // LCD setup
  lcd.init();                    // Initialize the LCD
  lcd.backlight();               // Turn on backlight

  servo1.attach(SERVO_PIN_1);
  servo2.attach(SERVO_PIN_2);
  servo1.write(180);
  servo2.write(10);

  // Connect to Adafruit MQTT
  connectAdafruitMQTT();
}

void loop() {
  long duration, distance;
```

```
// Measure distance
digitalWrite(TRIGGER_PIN, LOW);
delayMicroseconds(2);
digitalWrite(TRIGGER_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIGGER_PIN, LOW);
duration = pulseIn(ECHO_PIN, HIGH);
distance = duration * 0.034 / 2;

Serial.print("Distance: ");
Serial.print(distance);
Serial.println(" cm");

// Move servos based on distance
if (distance < 13)
moveServo1(servo1);
else if (distance >= 13 && distance < 16)
  moveServo2(servo2);
else {
  resetServos();
  delay(WAIT_TIME);
}

// Check IR sensors for available slots
int smallCarsDetected1 = detectCar(irSmall1Pin);
int smallCarsDetected2 = detectCar(irSmall2Pin);
int bigCarsDetected1 = detectCar(irBig1Pin);
int bigCarsDetected2 = detectCar(irBig2Pin);

int smallCarSlotsAvailable = 2 - (smallCarsDetected1 + smallCarsDetected2);
int bigCarSlotsAvailable = 2 - (bigCarsDetected1 + bigCarsDetected2);

Serial.print("Small car slots available: ");
Serial.println(smallCarSlotsAvailable);
```

```
  Serial.print("Big car slots available: ");
  Serial.println(bigCarSlotsAvailable);

  // Publish data to Adafruit IO
  slot1Pub.publish(smallCarsDetected1);
  slot2Pub.publish(smallCarsDetected2);
  slot3Pub.publish(bigCarsDetected1);
  slot4Pub.publish(bigCarsDetected2);

  // Display count of available slots on LCD
  lcd.clear(); // Clear the display
  lcd.setCursor(0, 0); // Set cursor to start of first line
  lcd.print("Small Cars: ");
  lcd.print(smallCarSlotsAvailable);
  lcd.setCursor(0, 1); // Set cursor to start of second line
  lcd.print("Big Cars: ");
  lcd.print(bigCarSlotsAvailable);

  delay(WAIT_TIME);
  resetServos();
}

void moveServo1(Servo servo) {

  for (int pos = 180; pos >= 100; pos--) {
    servo.write(pos);
    delay(SERVO_DELAY);
  }
}

void moveServo2(Servo servo) {

  for (int pos = SERVO_START; pos <= SERVO_END; pos++) {
    servo.write(pos);
    delay(SERVO_DELAY);
```

```
  }
}

void resetServos() {
  servo1.write(SERVO_START1);
  servo2.write(SERVO_START);
}

int detectCar(int irPin) {
  return digitalRead(irPin) == LOW ? 1 : 0;
}

void connectAdafruitMQTT() {
  int8_t ret;

  while ((ret = mqtt.connect()) != 0) {
    Serial.println(mqtt.connectErrorString(ret));
    Serial.println("Retrying Adafruit MQTT connection...");
    delay(5000);
  }

  Serial.println("Adafruit MQTT Connected!");
}
```

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