Chapter 1

INTRODUCTION

The Smart Parking System is developed to address the challenges of parking management caused by the increasing number of vehicles in urban areas. Traditional parking methods are inefficient, time-consuming, and often lead to traffic congestion and fuel wastage. This project uses modern technologies such as sensors, microcontrollers, and IoT to monitor parking slot availability in real time. The system provides accurate information to users through a digital interface, helping them quickly locate vacant parking spaces. By automating parking management and reducing human intervention, the Smart Parking System improves space utilization, enhances user convenience, and supports efficient urban infrastructure development.

1.1 Brief history of parking system

In the early days, parking systems were completely manual, where vehicles were parked in open areas or designated spaces under human supervision. Parking attendants were responsible for guiding vehicles, issuing paper tokens, and collecting parking fees. As the number of vehicles increased, basic mechanical systems such as entry barriers and printed tickets were introduced to control vehicle entry and exit. However, these traditional systems were time-consuming, prone to errors, required high manpower, and lacked proper monitoring, leading to inefficient space utilization and traffic congestion.

1.2 Modern Parking system

Modern parking systems use advanced technologies to overcome the limitations of traditional parking methods. These systems integrate sensors, microcontrollers, cameras, and Internet of Things (IoT) technology to detect vehicle presence and monitor parking slot availability in real time. Information about vacant and occupied spaces is displayed through digital boards, mobile applications, or web platforms. Automated payment systems and centralized monitoring further improve efficiency, reduce human intervention, and enhance user convenience. Modern parking systems play a crucial role in smart city development by reducing congestion, saving time, and optimizing parking resource management.

Chapter 2

Problem Statement

2.1 Description

Rapid urbanization and the increasing number of vehicles have made parking management a serious challenge in cities and public places such as malls, offices, hospitals, and educational institutions. Traditional parking systems rely on manual monitoring and static parking indicators, which do not provide real-time information about parking space availability. As a result, drivers spend a significant amount of time searching for vacant parking slots, leading to traffic congestion, fuel wastage, increased pollution, and user frustration.

Additionally, conventional parking systems lack proper space utilization, security, and accurate record keeping. The absence of automation and centralized monitoring makes it difficult for authorities to manage parking efficiently and respond to demand variations. These limitations highlight the need for an intelligent and automated parking solution that can monitor parking slots in real time, reduce human intervention, and improve overall parking efficiency.

2.2 Challenge Statement

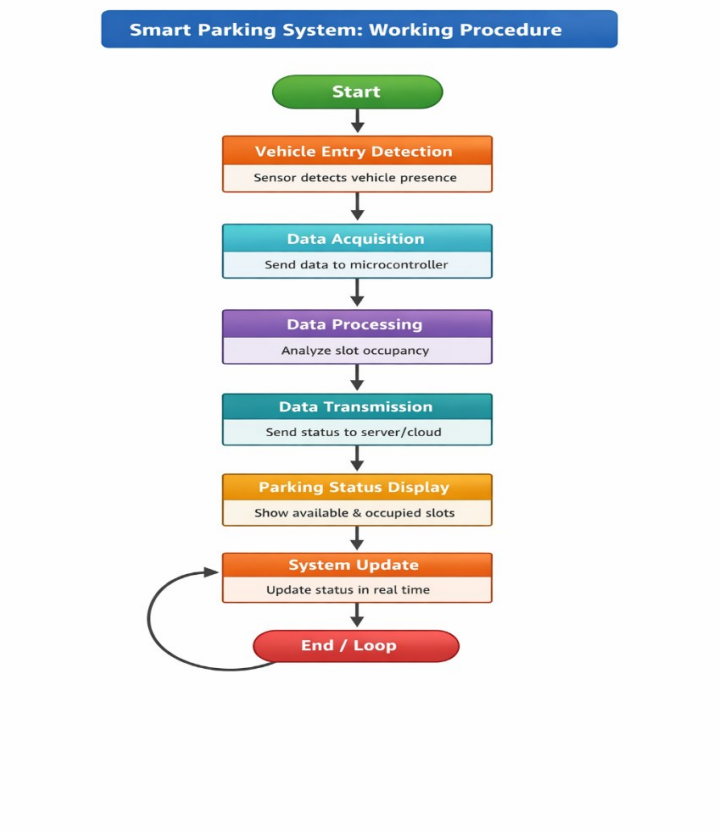
The primary challenge is to design and implement a reliable, cost-effective, and scalable smart parking system that can accurately detect parking slot availability in real time. The system must minimize human intervention, reduce parking search time, and efficiently manage parking spaces under varying traffic conditions. Additional challenges include ensuring sensor accuracy, real-time data transmission, user-friendly access to parking information, and seamless system performance in both small-scale and large-scale parking environments.

Chapter 3

3.1 Design Thinking Process

- **Empathize:** Parking users and attendants were observed to understand common issues such as difficulty in finding empty slots, traffic congestion, and time wastage due to lack of parking information.
- **Define:** The core problem identified was the absence of a real-time system to monitor and display available parking spaces efficiently.
- **Ideate:** Various solutions such as manual monitoring, camera-based systems, and sensor-based automation were considered. A sensor-based smart parking system was chosen for its accuracy and low cost.
- **Prototype:** A basic prototype was developed using sensors and a microcontroller to detect vehicle presence and update parking availability in real time.
- **Test:** The system was tested in a sample parking area and successfully detected occupied and vacant slots with minimal delay, improving parking efficiency.

3.2 Methodology



Start The system is powered ON and all components are initialized.

Vehicle Entry Detection Sensors installed in each parking slot detect the presence or absence of a vehicle.

Data Acquisition Sensor data is continuously sent to the microcontroller for processing.

Data Processing The microcontroller determines whether a parking slot is occupied or vacant based on sensor input.

Data Transmission The processed parking status is transmitted to the central server or cloud using IoT communication.

Parking Status Display Available and occupied parking slots are updated and displayed on a digital interface such as an LCD screen, mobile app, or web dashboard.

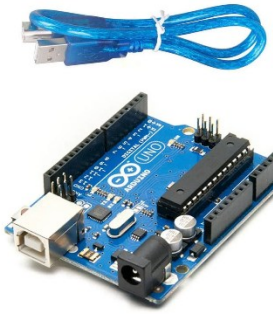
System Update The system updates automatically whenever a vehicle enters or leaves a parking slot.

End / Continuous Loop The process repeats continuously to provide real-time parking information.

3.3 Prototype Description

3.3.1 Materials Used

a) Aurdino uno

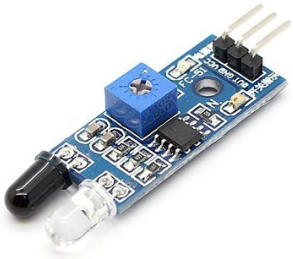


Arduino Uno is an open-source microcontroller board based on the ATmega328P used for controlling electronic components.
It processes input from sensors and executes programmed instructions to control system operations.
In the Smart Parking System, it manages parking slot detection and updates parking status in real time.

b) Servo motor

A servo motor is a rotary actuator used for precise control of angular position.
It operates based on control signals from the microcontroller to rotate to a specific angle.
In the Smart Parking System, the servo motor is used to control the opening and closing of the parking gate.

c) IR Sensor

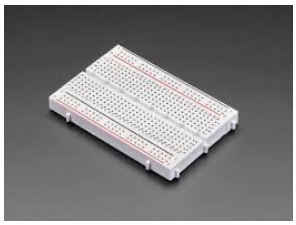


An IR sensor is an electronic device used to detect the presence of objects using infrared radiation.
It works by transmitting and receiving IR signals to identify obstacles or motion.
In the Smart Parking System, the IR sensor is used to detect vehicle entry and occupancy of parking slots.

d) LCD Display with I2C Interface

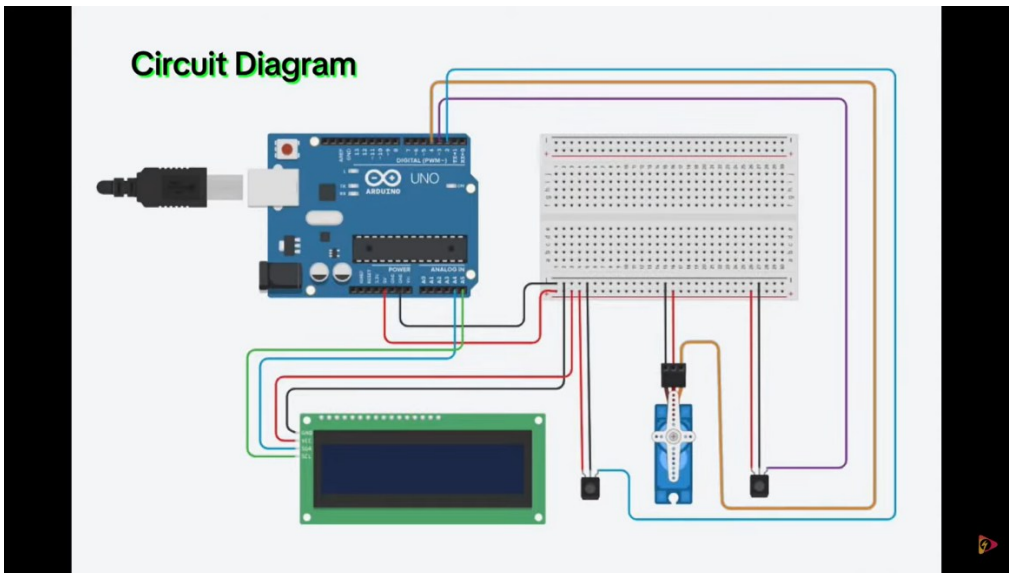
An LCD display with I2C interface is used to display information in a clear and compact form. The I2C module reduces the number of connecting wires by using only two communication lines. In the Smart Parking System, it displays parking slot availability and system status in real time.

e) Breadboard



- A breadboard is a reusable platform used for prototyping electronic circuits without soldering.
- It allows easy connection of components using jumper wires for testing and modification. In the Smart Parking System, the breadboard is used to assemble and test circuit connections during development.

3.3.2 System Diagram (Circuit connection diagram)



The circuit diagram illustrates the hardware connection of the Smart Parking System using an Arduino Uno as the main controller. IR sensors are connected to the Arduino to detect vehicle entry and exit, while a servo motor is interfaced to control the automatic opening and closing of the parking gate. An I2C-based LCD display is connected to show real-time parking status and slot availability. All components are powered through the Arduino and interconnected using a breadboard and jumper wires, enabling proper signal flow and system operation.

Chapter 4

Implementation

- The code used in Arduino Ide is given below
- This code helps to work system by passing signal to Arduino

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

#include <Servo.h>

LiquidCrystal_I2C lcd(0x27, 16, 2);

Servo gateServo;

int irSensor = 2;

int servoPin = 9;

int totalSlots = 5;

int availableSlots = 5;

void setup() {

  pinMode(irSensor, INPUT);

 gateServo.attach(servoPin);

  gateServo.write(0);   // Gate closed

  lcd.init();

  lcd.backlight();

  lcd.setCursor(0, 0);

  lcd.print("Smart Parking");

  lcd.setCursor(0, 1);

  lcd.print("Slots: ");

  lcd.print(availableSlots);

  delay(2000);

  lcd.clear();
```

```
}
void loop() {
  int irValue = digitalRead(irSensor);
  if (irValue == LOW && availableSlots > 0) {
        availableSlots--;
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Car Entered");
    lcd.setCursor(0, 1);
    lcd.print("Slots: ");
    lcd.print(availableSlots);
    gateServo.write(90);   // Open gate
    delay(3000);
    gateServo.write(0);    // Close gate
delay(2000); // Prevent double count
  }
  if (availableSlots == 0) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Parking Full");
    lcd.setCursor(0, 1);
    lcd.print("No Space");
  }
}
```

Chapter 5

Results and Analysis

User Testing & Feedback

Sample:

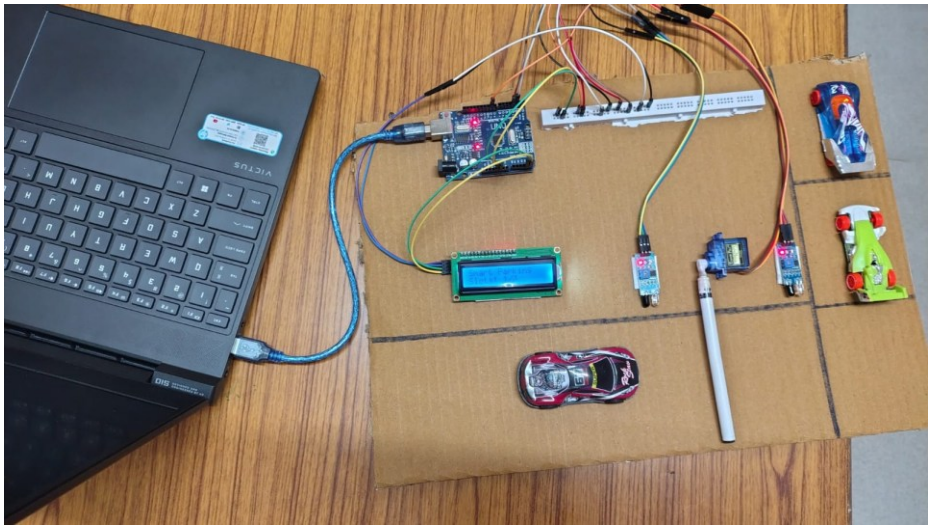
Participants: 6 students and 1 faculty members.

Quantitative Results:

- **Vehicle detection response time: ~1–2 seconds.**
- **Parking search time reduced significantly compared to manual parking.**
- **Slot detection accuracy: 100% during testing.**

Qualitative Feedback:

- **Students: “Finding an empty parking slot became much easier and faster.”**
- **Faculty: “The system clearly displays parking availability in real time.”**
- **Admin: “System operation is smooth with no incorrect slot detection.”**



The image shows the working hardware model of the Smart Parking System. It consists of an Arduino Uno connected to IR sensors for vehicle detection, a servo motor used as an automatic parking gate, and an I2C LCD display that shows parking status and available slots. The parking slots are represented using model cars to demonstrate occupied and vacant spaces. The setup clearly illustrates real-time slot detection, gate control, and display updates, validating the practical implementation of the system.

Chapter 6

Conclusion & Future Work

The Smart Parking System effectively addresses the limitations of traditional parking management methods. It reduces the time spent searching for parking spaces, minimizes traffic congestion, and improves overall parking efficiency through automation. The system provides accurate, real-time information on parking slot availability and reduces the need for manual monitoring. The successful implementation and testing of the prototype demonstrate that the project objectives have been achieved.

Future Work:

- **Integration of a mobile application for real-time parking guidance and reservations.**
- **Implementation of automatic payment and billing systems.**
- **Use of camera-based or AI-powered vehicle detection for enhanced accuracy.**
- **Deployment of the system on a larger scale with cloud-based data management.**

References

Research Papers

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•https://en.wikipedia.org/wiki/Smart_parking

•https://www.arduino.cc/en/Guide/Introduction

• https://iotdesignpro.com/projects/iot-based-smart-parking-system

Annexures

Annexure A – User Feedback Forms

Annexure B – Iteration Notes

Annexure C – Team Roles