SMART CAR PARKING SYSTEM USING INTERNET OF THINGS (IoT)

A Project report submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINNERING

Submitted by

REYANSH	-	2105565
NUPUR KUMARI	-	22057088
MUKESH KUMAR	-	22057043
KAUSHIK DAS	-	22057037
SWAYOM SHREE SHIVANEE BEHERA	-	22057075

Under the guidance of

DR. SUCHISMITA ROUT
Associate Professor

SCHOOL OF COMPUTER SCIENCE ENGINEERING
KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY
BHUBANESWAR, ODISHA - 751024

May 2024

KIIT Deemed to be University

School of Computer Engineering
Bhubaneswar, ODISHA 751024

CERTIFICATE

This is certify that the project entitled

"CAR PARKING SYSTEM USING INTERNET OF THINGS (IoT)"

submitted by

REYANSH	-	2105565
NUPUR KUMARI	-	22057088
MUKESH KUMAR	-	22057043
KAUSHIK DAS	-	22057037
SWAYOM SHREE SHIVANEE BEHERA	-	22057075

is a record of bonafide work carried out by them, in the partial fulfillment of the requirement for the award of Degree of Bachelor of Engineering (Computer Science & Engineering OR Information Technology) at KIIT Deemed to be university, Bhubaneswar. This work is done during year 2023-2024, under our guidance.

Date :10/04/2024

DR. SUCHISMITA ROUT

Project Guide

ACKNOWLEDGEMENT

We would like to express our deep gratitude to our project guide DR. SUCHISMITA ROUT, Associate Professor, Department of Computer Science and Engineering, K I I T , for his guidance with unsurpassed knowledge and immense encouragement. We would like to thank our parents, friends, and classmates for their encouragement throughout our project period. At last but not the least, we thank everyone for supporting us directly or indirectly in completing this project successfully.

ABSTRACT

Introducing our visionary endeavor: the "Smart Parking System Using IoT." Our mission? Granting car owners seamless access to vacant parking spaces while curbing the chaos of urban traffic. Amidst the throes of rapid urbanization plaguing modern cities, our innovative solution stands tall. Harnessing the power of RFID technology, coupled with an ingenious early slot booking feature and an intuitive smart parking website, we aim to revolutionize the parking landscape. At the heart of this technological marvel lies the ARDUINO UNO micro-controller, orchestrating every facet of the system's functionality with unparalleled precision. Infused with infra-red sensors, our system possesses the uncanny ability to discern the presence or absence of vehicles within designated slots. This not only streamlines parking processes but also enhances overall efficiency.

Moreover, by strategically implementing our smart parking infrastructure in key urban hubs, we not only alleviate congestion but also unlock untapped revenue streams for partnering organizations. For end-users, navigating the labyrinth of parking activity is a breeze. With our user-friendly interface, individuals can effortlessly monitor and manage their parking endeavors, ensuring a seamless experience from start to finish.
In essence, our "Smart Parking System Using IoT" isn't just a solution; it's a testament to innovation, efficiency, and progress. Join us as we redefine the future of urban mobility, one parking space at a time.

Keywords: Arduino UNO, RFID, Infra-red Sensors, Driver code.

CONTENTS

Chapter - 1
Introduction

In burgeoning nations like India, China, and Russia, the exponential surge in vehicular volume is causing a cascade of challenges, particularly in urban areas. As the automotive market balloons, so does the conundrum of parking inadequacy, precipitating severe traffic congestion in major cities. This quandary is further exacerbated by the profligate consumption of fuel, predominantly petrol and diesel. Mindful of these pressing issues, the proposition of instituting a smart parking system leveraging IoT technology emerges as a promising solution.

In light of these challenges, the concept of implementing a smart parking system leveraging IoT technology emerges as a prudent solution. By facilitating early parking slot reservations, this innovative approach promises to streamline the parking process, thereby conserving time, finances, and fuel for vehicle owners. The essence of smart parking revolves around the integration of low-cost sensors, real-time data, and user-friendly applications that enable seamless monitoring of parking space availability.

Envisioned applications of IoT technology extend far beyond smart parking systems, permeating various domains such as healthcare, technology, agriculture, and urban infrastructure. Web development, constituting the creation of online platforms, assumes paramount significance in this digital landscape. From rudimentary text pages to sophisticated e-commerce platforms and social networking services, web development encompasses an array of tasks encompassing web engineering, design, content creation, and security provisioning.

The primary objective of smart parking systems transcends mere convenience; it strives to mitigate the time and vexation associated with parking woes. Moreover, by facilitating precise parking guidance, these systems contribute tangibly to environmental conservation efforts, curtailing CO2 emissions, noise pollution, and other deleterious pollutants. Recognizing the pivotal role of parking regulations in urban governance, cities allocate substantial resources to manage parking infrastructures, catering to the needs of motorists while ensuring the orderly flow of traffic.

In this milieu, the advent of web-based platforms and applications emerges as a boon for both motorists and municipal authorities alike. These digital tools expedite parking search processes, furnish pertinent information to parking enforcement personnel, and incentive the adoption of alternative transportation modalities in instances of parking scarcity. In essence, the integration of IoT technology and web development heralds a trans-formative era in urban mobility, where efficiency, sustainability, and convenience converge to redefine the urban landscape.

1.1 Internet of things

The concept of connected device was first introduced since the 1972 but the actual term Internet of things was established by Ashton. It may be depicted as a group of interconnected computing devices consisting of mechanical and digital devices, any items or any living beings. It indicates the capacity to move information over a network without necessity of any human to human or human to computer cooperation. The Internet of things objects consist of sensors, software's, network connections and necessary electronics and it empowers them to gather and exchange data and make them responsive.

Chapter - 2
Objectives

- ✓ Implementing a Smart Parking System with state-of-the-art technology to offer a secure and efficient parking solution to vehicle owners, ensuring peace of mind and convenience.
- ✓ To establish a robust platform for secure parking facilities in metropolitan areas, enhancing safety and accessibility for users.
- ✓ To streamline the parking process, minimizing the time spent by vehicle owners in searching for available slots, thus maximizing efficiency.
- ✓ To mitigate environmental impact by reducing fuel consumption associated with prolonged searches for parking, consequently contributing to alleviating traffic congestion.
- ✓ To design and implement a Smart Parking system leveraging IoT technology with the aim of optimizing parking space utilization, reducing traffic congestion, enhancing user experience, and promoting sustainable urban mobility.
- ✓ Our system aims to optimize parking by monitoring the availability of parking spaces in real-time and providing valuable information to drivers. The system consists of sensors installed in each parking slot, which detect the presence of vehicles.
- ✓ Thanks to the evolution of Internet of things the idea of smart city now seems to be achievable. Consistent efforts are being made in the field of IoT in order to maximize the productivity and reliability of urban infrastructure. Problems such as, traffic congestion, limited car parking facilities and road safety are being addressed by IoT. In this paper, we present an IoT based cloud integrated smart parking system.
- ✓ IoT sensors are deployed in parking spots to detect occupancy status in real-time. These sensors transmit data to a central server, which processes information and relays it to users through mobile apps or digital displays, helping them locate available parking spots.
- ✓ Smart parking systems that utilize IoT (Internet of Things) technology can significantly improve parking management and alleviate common challenges associated with finding parking spaces.
- ✓ For example, a driver can view available parking slots directly from their smartphone with such a solution. Companies, in turn, can supervise their parking spaces more efficiently. And most importantly, they can do it remotely.
- ✓ The car parking system using IoT takes a user authorization mechanism through a mobile app or license plate scanning. At the same time, the controller on the barrier or gate may allow or refuse drivers to park their cars according to the set parameters.
- ✓ Parking administrators can use an IoT-based parking system to supervise all processes at the facility. In particular, this solution monitors parking space availability and facilitates the billing process.
- ✓ A parking system also requires protocols to ensure IoT devices' and sensors' connectivity in the parking lot. These can be MQTT, LoRaWAN, Zigbee protocol for wireless IoT networks, or else.

Chapter - 3
Methodology

3.1 Existing System

A smart parking system employs a multifaceted approach to revolutionize traditional parking management methodologies. At its core, the system relies on a network of sensors strategically placed within parking facilities to monitor the occupancy status of individual spaces. These sensors utilize various technologies such as ultrasonic, infrared, or magnetic sensors to detect the presence of vehicles. The real-time data collected by these sensors is then transmitted to a central control system, where it undergoes sophisticated analysis and processing.

In addition to sensor data, smart parking systems often integrate other technologies such as cameras and license plate recognition systems to enhance accuracy and provide additional insights. These cameras can capture images of parking spaces, allowing for visual confirmation of occupancy and assisting in enforcement activities. License plate recognition technology enables automated entry and exit procedures, as well as the identification of unauthorized vehicles.
Once the data is collected and processed, advanced algorithms and machine learning techniques come into play to optimize parking management strategies. These algorithms consider factors such as historical usage patterns, time of day, and demand forecasts to dynamically adjust parking pricing, allocation, and routing. By leveraging predictive analytics, the system can anticipate peak demand periods and proactively adjust operations to minimize congestion and maximize revenue.

Furthermore, smart parking systems often include user-facing applications or signage that provide real-time information to drivers. These applications display the availability of parking spaces in nearby facilities, guiding drivers to the nearest vacant spot and reducing the time spent searching for parking. Some systems even offer reservation capabilities, allowing users to secure parking spaces in advance and streamline their parking experience.

Overall, the methodology of a smart parking system is rooted in the seamless integration of various technologies, data analysis techniques, and user interfaces to optimize parking resource utilization, improve traffic flow, and enhance the overall parking experience for both drivers and operators.

The existing parking system, often characterized by manual management and outdated infrastructure, faces numerous challenges such as inefficiency, congestion, and lack of real-time information for drivers. Typically, parking facilities rely on static signage or attendants to guide vehicles to available spaces, leading to time-consuming searches and frustration for drivers. Moreover, manual enforcement of parking regulations is prone to errors and inefficiencies, resulting in revenue losses for operators and inconvenience for users.

Without the integration of advanced technologies, existing parking systems struggle to adapt to changing demand patterns and optimize resource allocation. The lack of data-driven insights hinders decision-making processes and limits the ability to implement dynamic pricing strategies or proactive management techniques. Overall, the existing parking system is characterized by its reliance on outdated methods and its inability to meet the evolving needs of urban mobility.

In contrast, a smart parking system represents a significant advancement over the existing model by leveraging sensors, cameras, and data analytics to provide real-time information, optimize operations, and enhance user experience. By transitioning from a manual to an automated approach, smart parking systems offer the potential to alleviate congestion, improve efficiency, and increase revenue generation for parking operators.

3.2 Proposed System

The proposed smart parking system represents a cutting-edge solution meticulously designed to address the challenges faced in traditional parking management. By harnessing a sophisticated combination of state-of-the-art technologies, including advanced sensors, precision servo motors, and an intuitive LCD display interface, this system offers a comprehensive approach to optimizing parking lot operations and enhancing user convenience.

At its core, the system boasts strategically positioned sensors meticulously placed at entry and exit points, as well as individual parking spots throughout the facility. These sensors enable precise detection of vehicle movements, facilitating real-time monitoring of parking spot availability with unrivaled accuracy. Upon vehicle detection, the system seamlessly activates servo motors, precisely controlling entry and exit barriers to ensure smooth access for incoming and outgoing vehicles while upholding stringent security measures.

Furthermore, the system's intuitive LCD display interface serves as a beacon of convenience for users, providing instant updates on parking spot availability, current occupancy status, and pertinent system notifications. This empowers users to make informed decisions and navigate the parking lot with unparalleled efficiency and ease, significantly reducing the time spent searching for an available spot.

Beyond its fundamental functionalities, the proposed system incorporates advanced intelligent algorithms that dynamically optimize parking spot allocation based on real-time demand patterns. Through continuous analysis and adaptation, the system intelligently adjusts spot availability, ensuring maximum utilization of parking resources and minimizing instances of congestion and inefficiency.

With its robust infrastructure and unwavering commitment to user-eccentric design, the proposed smart parking system aspires to revolutionize the parking experience, offering a seamless and hassle-free solution for both operators and users alike. By seamlessly integrating cutting-edge technologies and meticulous attention to detail, this system sets a new standard for efficiency, convenience, and innovation in parking management.

Chapter - 4
Design and development

4.1 Working principle

Optimizing Parking Efficiency : The Role of Arduino Operating Code in Smart Parking Systems.

In a smart parking system using Arduino, the operating code orchestrates the noise of sensors, actuators, and logic to control the parking system. The basis of the policy is to instantly collect information from ultrasonic or infrared sensors to detect the presence of vehicles in each parking lot. By processing this information through precise algorithms, it determines the parking location, updates the central display or sends the information to the mobile application for easy users. Additionally, the right to control servo motors or barriers to control access to the car park makes it impossible for authorized vehicles to enter or exit. Arduino code with integration such as charging and management to optimize parking usage, improve user experience and contribute to the advancement of the smart city.

4.2 Operating code :

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

const int lcd_I2C_address = 0x27;
LiquidCrystal_I2C lcd(lcd_I2C_address, 16, 2);

const int entrySensorPin = 2;
const int exitSensorPin = 12;

const int entryMotorPin = 3;
Servo entryServo;

const int exitMotorPin = 13;
Servo exitServo;

const int parkingSensorPins[8] = {4, 5, 6, 7, 8, 9, 10, 11};
int occupiedSpots = 0;
int availableSpots = 8;

unsigned long entryTime = 0;
unsigned long carLeftTime = 0;
unsigned long fullMessageStartTime = 0;

bool carDetectedEntry = false;
bool carDetectedExit = false;
bool parkingLotFull = false;
bool carLeaving = false;

const int fullMessageDuration = 3000;

const int backlightPin = 10;
int backlightBrightness = 255;
```

```
void setup()
{
  Serial.begin(9600);
  Wire.begin();
  lcd.begin();
  lcd.backlight();
  analogWrite(backlightPin, backlightBrightness);

  entryServo.attach(entryMotorPin);
  exitServo.attach(exitMotorPin);

  entryServo.write(0);
  exitServo.write(90);

  pinMode(entrySensorPin, INPUT);
  pinMode(exitSensorPin, INPUT);
  for (int i = 0; i < 8; i++)
  {
    pinMode(parkingSensorPins[i], INPUT);
  }

  lcd.setCursor(0, 0);
  lcd.print("Welcome to Parking!");
  Serial.println("Setup complete. Ready for operation.");
}

void loop()
{
  carDetectedEntry = digitalRead(entrySensorPin) == LOW;
  carDetectedExit = digitalRead(exitSensorPin) == LOW;

  // Update occupied and available spots count
  occupiedSpots = 0;
  for (int i = 0; i < 8; i++)
  {
    if (digitalRead(parkingSensorPins[i]) == LOW)
    {
```

```
    occupiedSpots++;
  }
 }
 availableSpots = 8 - occupiedSpots;

 if (occupiedSpots == 8)
 {
  if (!parkingLotFull)
  {
    fullMessageStartTime = millis();
    parkingLotFull = true;
    updateDisplay("Parking Lot Full!", "", "");
  }
  else if (millis() - fullMessageStartTime >= fullMessageDuration)
  {
    parkingLotFull = false;
    updateDisplay("Occupied: 8", "Available: 0", "");
  }
 }
 else
 {
  if (carDetectedEntry && availableSpots > 0 && entryTime == 0)
  {
    entryServo.write(90);
    entryTime = millis();
    updateDisplay("Car Entering!", "", "");
    Serial.println("Car entered parking lot.");
  }

  if (millis() - entryTime >= 3000 && entryTime != 0 && !carDetectedEntry)
  {
    entryServo.write(0);
    entryTime = 0;
  }

  if (carDetectedExit)
  {
```

```
      exitServo.write(0);
      carLeftTime = millis();
      carLeaving = true;
      updateDisplay("Car Leaving!", "", "");
    }
    else if (carLeaving && millis() - carLeftTime >= 3000)
    {
      carLeaving = false;
      exitServo.write(90);
      updateDisplay("Occupied: " + String(occupiedSpots), "Available: " + String(availableSpots), "");
    }
    else
    {
      exitServo.write(90);
      updateDisplay("Occupied: " + String(occupiedSpots), "Available: " + String(availableSpots), "");
    }
  }
}

void updateDisplay(String line1, String line2, String line3)
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(line1);
  if (line2 != "")
  {
    lcd.setCursor(0, 1);
    lcd.print(line2);
  }
  if (line3 != "")
  {
    lcd.setCursor(0, 2);
    lcd.print(line3);
  }
}
```

4.3 Arduino parking management system : Code analysis and explanation.

Libraries Used :

- ✓ **Wire.h**: This library enables communication with I2C (Inter-Integrated Circuit) devices, often used for communication between microcontrollers and peripheral ICs.
- ✓ **Liquid Crystal I2C.h**: This library simplifies interfacing with LCDs using I2C communication, reducing the number of required pins and simplifying wiring.
- ✓ **Servo.h**: This library provides functions to control servo motors accurately, allowing precise control of their position.

Global Variables :

- ✓ **lcd_I2C_address :** Holds the I2C address of the LCD module.
- ✓ **lcd:** An instance of the LiquidCrystal_I2C class, facilitating control over the LCD display.
- ✓ **Entry Sensor Pin :** Represents the pin connected to the entry sensor, detecting vehicles entering the parking lot.
- ✓ **Exit Sensor Pin :** Denotes the pin connected to the exit sensor, detecting vehicles exiting the parking lot.
- ✓ **Entry Motor Pin:** Corresponds to the pin connected to the servo motor controlling the entry barrier.
- ✓ **Exit Motor Pin:** Refers to the pin connected to the servo motor controlling the exit barrier.
- ✓ **Parking Sensor Pins:** An array containing the pins connected to parking spot sensors, allowing monitoring of individual parking spots.
- ✓ **Occupied Spots:** Tracks the current number of occupied parking spots.
- ✓ **Available Spots:** Keeps count of the available (vacant) parking spots.
- ✓ **Entry Time:** Records the timestamp when a vehicle enters the parking lot, used for implementing a 5-second delay before closing the entry barrier.
- ✓ **Exit Time:** Stores the timestamp when a vehicle exits the parking lot, used for implementing a 5-second delay before closing the exit barrier.

Functions :

1. setup() :

- ✓ **Purpose:** This function is called once when the Arduino board starts up. It initializes various components and sets up the initial state of the system.

- ✓ **Initialization:**
- **Serial Communication:** Begins serial communication with a baud rate of 9600, which can be useful for debugging.
- **LCD Initialization:** Initializes communication with the LCD using the I2C protocol and sets up the display with a size of 16x2 characters.
- **Servo Motor Attachment:** Attaches the servo motors for the entry and exit barriers to their respective pins.
- **Pin Modes:** Sets the pin modes for entry and exit sensors as well as parking spot sensors.
- **LCD Display:** Clears the LCD display and prints a welcome message indicating that the setup is complete.

- ✓ **Execution:** This function executes only once at the beginning of the program to ensure that all components are properly initialized before the main loop starts.

2. loop() :

- ✓ **Purpose:** The main execution loop of the program, responsible for continuously monitoring sensors, updating the display, and controlling the entry/exit process.
- ✓ **Entry/Exit Detection:**
- It constantly monitors the entry and exit sensors to detect vehicles entering or leaving the parking lot.
- Upon detection of a vehicle entering or exiting, it triggers the corresponding actions such as opening or closing the entry/exit barrier.
- ✓ **Barrier Control:**
- It controls the servo motors to open or close the entry and exit barriers, ensuring smooth entry and exit of vehicles.
- Implements a 5-second delay before closing the barrier to allow vehicles to pass through.
- ✓ **Parking Spot Monitoring:**
- Checks the status of each parking spot sensor to determine occupancy.
- Updates the occupied and available parking spots count accordingly.

- ✓ **Display Update:**
- Updates the LCD display to reflect the current occupancy status and any detected events such as vehicle entry or exit.

- ✓ **Delay:**
- Introduces a small delay at the end of each iteration to prevent rapid execution and allow other tasks to run smoothly.

3. Update Display (String line1, String line2, String line3) :

✓ **Purpose:** A utility function to update the content displayed on the LCD.

✓ **Input Parameters:**

- line1, line2, and line3 are strings representing the content to be displayed on lines 1, 2, and 3 of the LCD respectively.

✓ **Functionality:**

- Clears the LCD display.
- Prints the provided strings on the specified lines of the LCD.

✓ **Usage:**

- Called throughout the code to update the display with relevant information such as occupancy status and event messages.

4.4 Code Flow :

1. **Initialization (setup) :**
    - Serial communication is initialized at a baud rate of 9600.
    - The Wire library is started to enable I2C communication.
    - The Liquid Crystal_I2C library is initialized to control the LCD display with the specified I2C address.
    - Servo motors for entry and exit barriers are attached to their respective pins.
    - Pin modes for entry and exit sensors, as well as parking spot sensors, are set to INPUT.
    - The LCD display is cleared, and a welcome message is printed.
    - Serial communication prints a message indicating that the setup is complete.

2. **Main Loop (loop) :**
    - Continuously monitors the sensors and updates the display based on detected events.
    - Reads the state of entry and exit sensors to detect vehicles entering or leaving the parking lot.
    - **If a vehicle is detected entering or exiting:**
        - Opens the corresponding barrier by rotating the respective servo motor to 90 degrees.
        - Updates the occupancy status and displays it on the LCD.
        - Logs the event via Serial communication.
    - **If a vehicle has been detected entering or leaving for 5 seconds:**
        - Closes the entry or exit barrier by rotating the respective servo motor to 0 degrees.
        - Updates the occupancy status and display.
    - Checks the state of parking sensors to detect if a parking spot is occupied or vacant and updates the occupancy status accordingly.

3. **Update Display Function:**

This function is responsible for updating the content displayed on the LCD. It takes three strings as arguments, representing the content to be displayed on the three lines of the LCD.

I. **Clearing the Display:**
    a. The function begins by clearing the LCD display, ensuring that any previous content is removed before updating.

II. **Printing Content:**
    a. It then prints the provided strings on the LCD, starting from line 1.
    b. If the provided strings for line 2 or line 3 are not empty, the function moves the cursor to the respective line and prints the content.
    c. This ensures that the content provided for each line is displayed clearly on the LCD.

III. Handling Empty Lines:

a. If any of the provided strings are empty, indicating no content for that line, the function skips printing for that line.
b. This prevents unnecessary blank lines from appearing on the LCD and optimizes space usage for displaying relevant information.

Arduino Parking Management System Overview :

The provided Arduino code implements a parking management system designed to monitor and manage a parking lot's occupancy. It utilizes various sensors and servo motors to control entry and exit barriers, along with an LCD display to provide real-time information on parking spot availability. The code initializes necessary components during setup, including serial communication, sensor pins, servo motors, and the LCD display. In the main loop, it continuously checks sensor inputs to detect vehicle entry, exit, and parking spot occupancy changes. Upon detecting events, such as vehicle entry or exit, it opens or closes the corresponding barrier using servo motors and updates the LCD display to reflect changes in parking spot occupancy. The update Display function ensures that the LCD display is refreshed with up-to-date information. Overall, the code efficiently manages the parking lot's operation, enhancing user experience by providing clear visibility into parking spot availability and system status.

Chapter - 5
Module

5.1 Architecture and functional block diagram

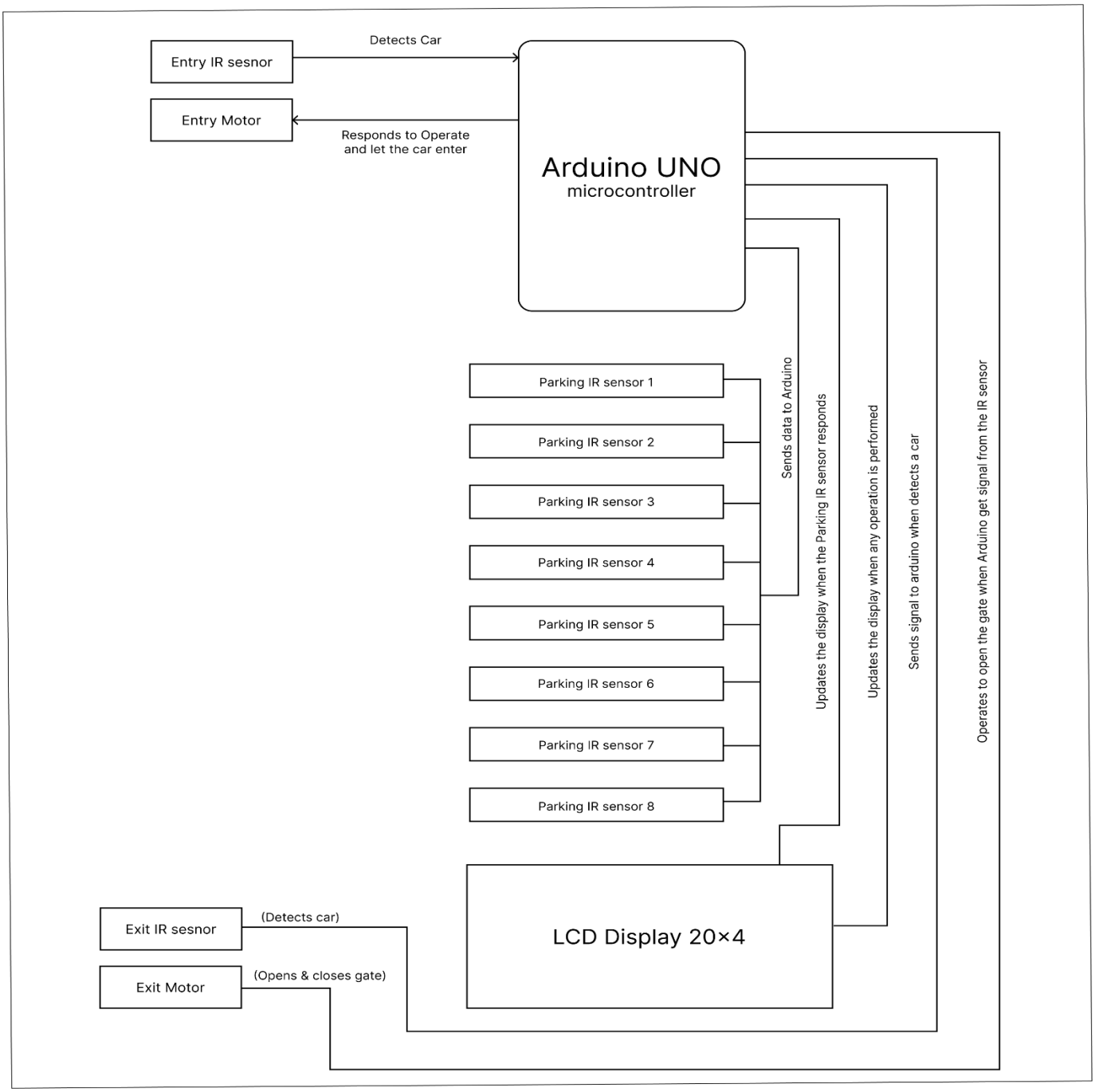


Fig : Architecture and functional block diagram

5.2 Circuit diagram

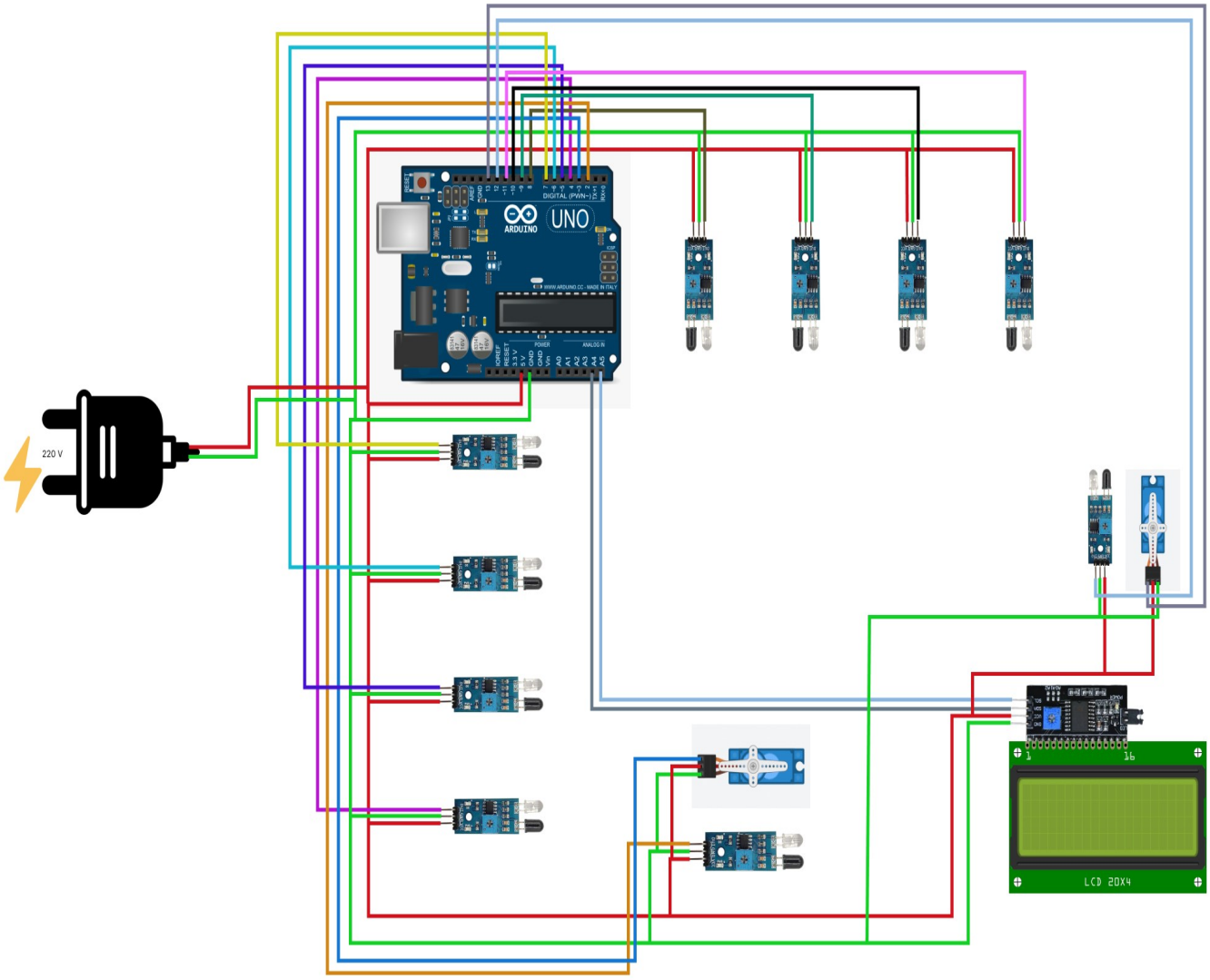


Fig : Circuit diagram

5.3 Module design

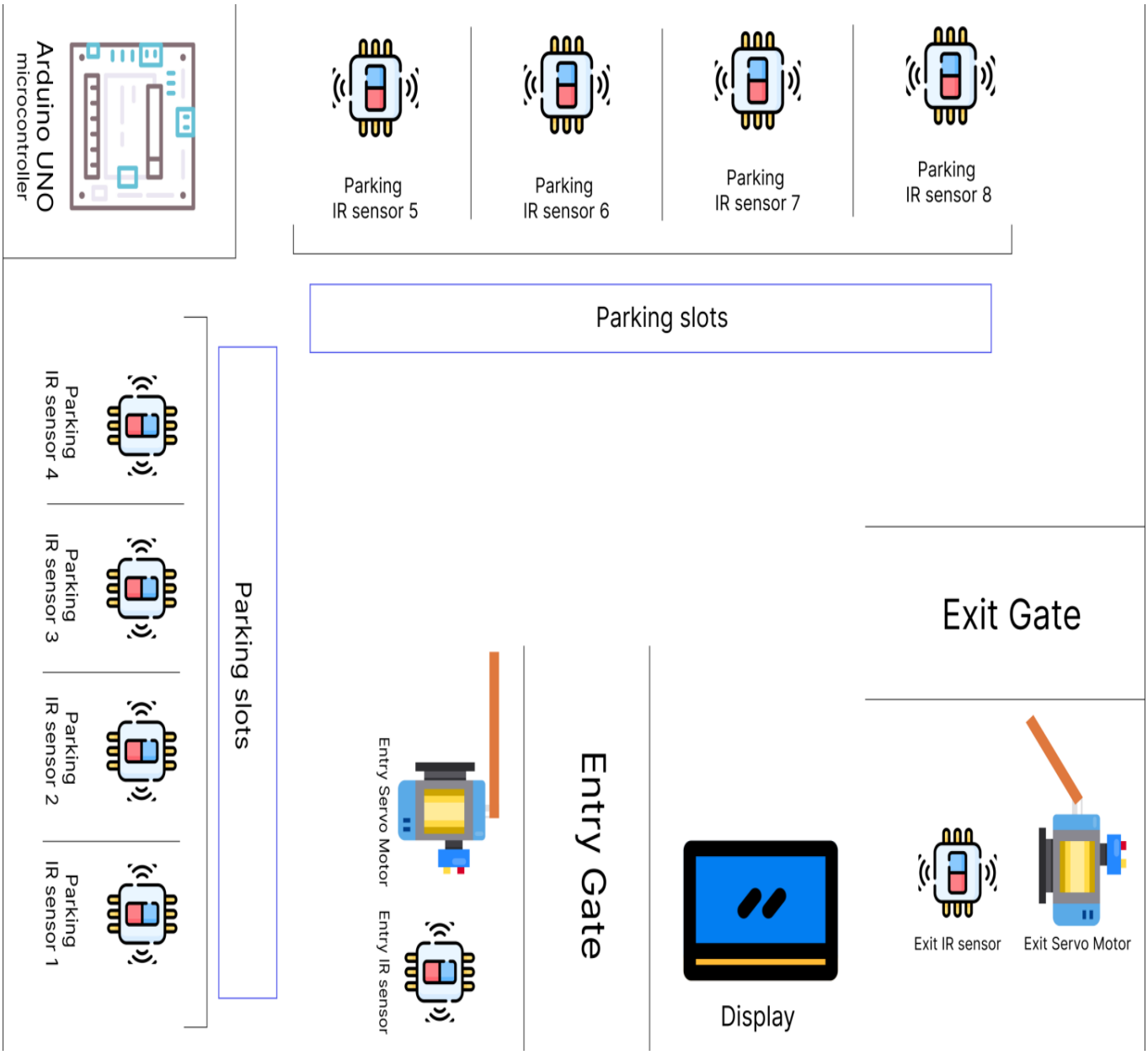
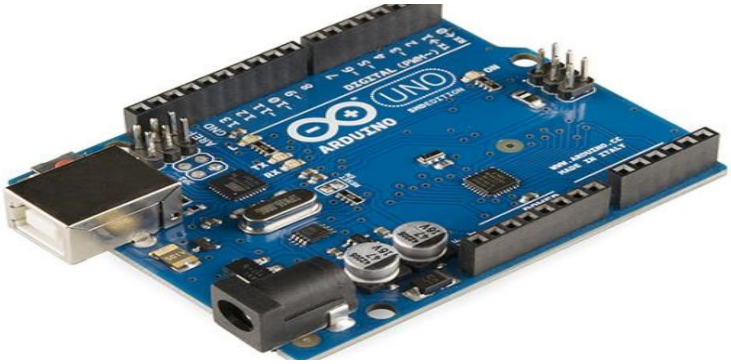


Fig : Module design of the smart parking system

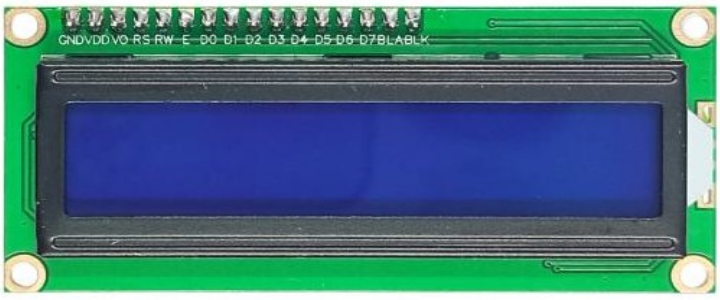
Chapter - 6
Components

1.Arduino Uno :



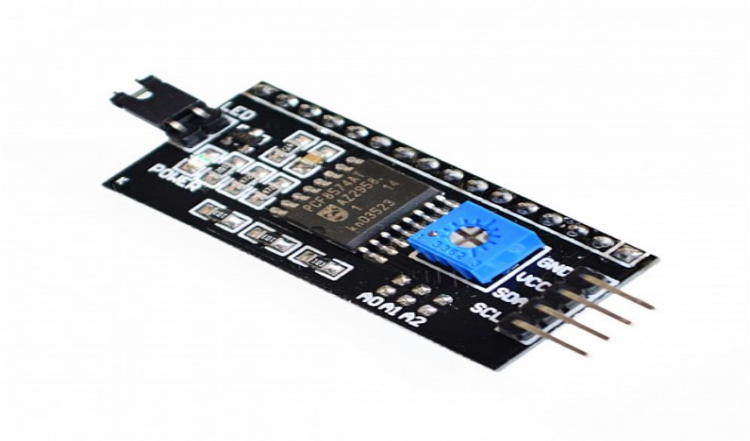
The Arduino UNO is a versatile microcontroller board renowned for its ease of use and broad application in electronics prototyping and DIY projects. Featuring an Atmega328P microcontroller at its core, the UNO offers 14 digital input/output pins, 6 analog inputs, and a range of connectivity options including USB and ICSP headers. Its compact form factor and straightforward programming environment make it accessible to beginners while providing ample flexibility for advanced users. Whether used for robotics, sensor interfacing, or creative electronic art, the Arduino UNO serves as a gateway for innovators to bring their ideas to life through the world of embedded systems.

2.Liquid Crystal Display:



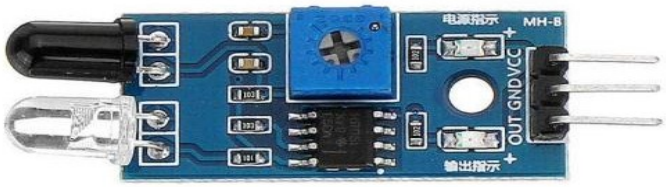
A liquid crystal display (LCD) serves as a vital output component, providing real-time information to users. Displaying details such as available parking slots, occupancy status, and directional guidance, the LCD enhances user experience by offering clear and concise visual feedback. With Arduino integration, the LCD facilitates seamless communication between the parking system's sensors and the user interface, ensuring efficient and user-friendly operation.

3.I2C LCD MODULE :



The I2C LCD module is a crucial component in an Arduino-based parking system, providing clear visual feedback to users. Utilizing the I2C communication protocol, it seamlessly integrates with the Arduino board, conserving valuable digital pins. With its compact size and simplified wiring, the module offers convenience in setup and operation. Displaying real-time information such as parking availability or guidance prompts, it enhances user experience and facilitates efficient management of parking spaces. Its compatibility with Arduino makes it an ideal choice for projects requiring precise and intuitive display capabilities.

4.IR sensor :



The IR sensor plays a pivotal role in an Arduino parking system by detecting the presence or absence of vehicles within designated parking spaces. Emitting infrared light and analyzing the reflected signals, the sensor accurately identifies the occupancy status of each spot. Integrated seamlessly with the Arduino board, it provides real-time data for monitoring parking availability. With its rapid response time and reliable detection capabilities, the IR sensor enables efficient management of parking facilities, optimizing utilization and enhancing overall user convenience.

5.Servo motor :

In the Arduino parking system, the servo motor plays a pivotal role in controlling the movement of barriers or gates. Connected to the Arduino board, it receives signals to rotate within a specified range, allowing for precise positioning of the barrier mechanism. With its compact size and high torque output, the servo motor ensures reliable operation, effectively managing access to parking spaces. Integrated seamlessly into the Arduino environment, it enables automated control of barriers based on input from sensors or user commands, enhancing the efficiency and convenience of the parking system.

6.Jumper wires :

jumper wires serve as essential connectors, facilitating the seamless integration of various components. These wires, typically made of flexible and insulated material, enable the establishment of electrical connections between sensors, actuators, and the Arduino board. With their male and female connectors, jumper wires offer versatility in configuring circuits while maintaining reliability. Their simple plug-and-play nature simplifies the assembly process, allowing for quick prototyping and troubleshooting. By providing a reliable means of interconnection, jumper wires streamline the development and operation of the Arduino parking syste

Chapter - 7
Advantages

- ✓ **Optimized Parking Space Utilization:** Smart parking systems efficiently utilize available parking space, reducing congestion and maximizing capacity.
- ✓ **Real-Time Parking Availability:** Users can access real-time information about available parking spots, saving time and reducing frustration.
- ✓ **Convenience:** With features like mobile apps, users can easily find, reserve, and pay for parking spaces without hassle, enhancing convenience.
- ✓ **Reduced Traffic Congestion:** By guiding drivers directly to available parking spots, smart parking systems help reduce unnecessary circling and congestion on the roads.
- ✓ **Environmental Benefits:** Less time spent searching for parking means reduced fuel consumption and emissions, contributing to environmental sustainability.
- ✓ **Improved Safety:** Reduced traffic congestion and better-organized parking areas contribute to a safer environment for both pedestrians and drivers.
- ✓ **Revenue Generation:** Smart parking systems can generate additional revenue through features like premium parking, advertising, or partnerships with local businesses.
- ✓ **Data Insights:** The system collects data on parking patterns, helping municipalities and businesses make informed decisions about infrastructure planning and resource allocation.

Chapter - 8
Disadvantages

- ✓ **Initial Cost:** Implementing IoT-based smart parking infrastructure involves significant upfront costs for purchasing and installing sensors, connectivity devices, and backend systems. This can be a barrier to adoption, especially for smaller municipalities or parking operators with limited budgets.

- ✓ **Reliability:** IoT systems rely on technology to accurately detect and report parking availability. System failures, sensor malfunctions, or connectivity issues can lead to inaccurate or unreliable parking information, frustrating drivers and undermining trust in the system.

- ✓ **Privacy Concerns:** Collecting data from IoT sensors, such as license plate numbers or location information, raises privacy concerns. Without proper safeguards and data protection measures in place, there is a risk of unauthorized access or misuse of sensitive information, leading to privacy breaches.

- ✓ **Cybersecurity Risks:** IoT devices are vulnerable to cyber attacks and hacking attempts. A compromised smart parking system could result in unauthorized access to data, manipulation of parking availability information, or even control over physical infrastructure, posing security risks to both users and the public.

- ✓ **Digital Divide:** Not all drivers may have access to or be comfortable using IoT-enabled devices, such as smartphones or navigation systems. This could create disparities in access to parking information, with certain demographic groups or individuals being disadvantaged by their inability to utilize the technology effectively. Addressing this digital divide is essential to ensure equitable access to smart parking solutions.

Chapter - 9
Conclusion

The conclusion of an IoT based smart parking system would likely highlight its effectiveness in reducing traffic congestion, improving parking management, and enhancing the overall convenience for drivers. Additionally, it would emphasize the potential for scalability and integration with other smart city initiatives to create more efficient urban environments. Overall, IoT based smart parking systems have the potential to revolutionize urban mobility and enhance the quality of life for city dwellers. Traffic Reduction: By providing real-time information about available parking spaces, IoT-based smart parking systems help drivers locate parking spots more efficiently, reducing the time spent circling around in search of parking. This, in turn, decreases traffic congestion and emissions, contributing to a more sustainable urban environment.

Improved Parking Management: With sensors installed in parking spaces, authorities can monitor parking occupancy and usage patterns more effectively. This data can be used to optimize parking policies, pricing strategies, and infrastructure planning to better meet the needs of the community. Enhanced User Experience: Drivers benefit from the convenience of finding parking quickly and easily using mobile apps or digital signage that display real-time availability. This improves their overall experience and satisfaction with the urban environment. Scalability and Integration: IoT-based smart parking systems are highly scalable and can be easily expanded to cover larger areas or integrated with other smart city initiatives such as traffic management, public transportation, and environmental monitoring. This interconnected approach maximizes the efficiency and effectiveness of urban infrastructure.

Data-driven Insights: The wealth of data generated by IoT sensors can provide valuable insights into parking trends, usage patterns, and peak demand periods. This information can be used to make informed decisions about future infrastructure investments and urban planning initiatives. Cost Savings: By reducing the time spent searching for parking and optimizing parking utilization, IoT-based smart parking systems can lead to cost savings for both drivers and parking operators. This can result in increased revenue for municipalities and businesses while reducing the overall economic burden associated with urban parking.

In conclusion, IoT-based smart parking systems offer a comprehensive solution to the challenges of urban parking management, providing benefits such as reduced traffic congestion, improved user experience, and data-driven insights for better decision-making. As cities continue to grow and evolve, embracing smart technologies like IoT will be crucial in creating more efficient, sustainable, and livable urban environments.

Chapter - 10
Future scope

Smart parking systems utilizing Internet of Things (IoT) technology represent a significant advancement in how parking spaces are managed in urban environments. Traditional parking management often relies on manual methods, which can be inefficient and lead to frustration among drivers searching for parking spots. With the proliferation of IoT devices and connectivity, smart parking solutions offer a more dynamic and data-driven approach to address these challenges.

At the core of smart parking systems are sensors embedded in parking spaces or infrastructure. These sensors can detect the presence or absence of vehicles in real time, sending this information to a centralized platform via the internet. This data is then processed and analyzed using advanced algorithms, including predictive analytics and machine learning. One of the key benefits of IoT-enabled smart parking is improved accessibility and convenience for drivers. By accessing mobile applications or other digital platforms, drivers can easily locate available parking spaces nearby. Some systems even allow users to reserve parking spots in advance, reducing the stress and uncertainty associated with finding parking in busy areas.

Moreover, smart parking systems contribute to more efficient use of parking spaces. By analyzing historical data and current trends, these systems can optimize parking allocation, ensuring that spaces are utilized effectively. This optimization not only benefits drivers by increasing the likelihood of finding parking but also helps alleviate traffic congestion and reduce emissions associated with circling for parking.

Looking ahead, the future of smart parking holds immense potential. As IoT technology continues to evolve, we can expect further advancements such as increased accuracy of sensor data, scalability to accommodate larger urban areas, and integration with other smart city initiatives such as traffic management and public transportation systems. Ultimately, smart parking represents a crucial component of creating more sustainable and livable urban environments.

Chapter - 11
References

- Hassoune, W. Dachry, F. Moutaouakkil and H. Medromi, "Smart parking systems: A survey," 2016 11th International Conference on Intelligent Systems: Theories and Applications (SITA), Mohammedia, Morocco, 2016, pp. 1-6, doi: 10.1109/SITA.2016.7772297. keywords: {Intelligent sensors;Automobiles;Monitoring;Magnetic sensors;Urban areas;Smart parking Systems;sensors;Smart parking Technologies;Smart parking services;Internet of things (IOT);Multi-agent systems;Expert systems},

- Nene, S., Mundle, S., Mahajan, S., Yeginwar, S., Panchal, L.
  A study of vehicular parking systems
  (2020) ICICCT 2019 – System Reliability, Quality Control, Safety, Maintenance and Management, pp. 207-215. Cited 8 times.
  Springer Singapore

- Paidi, V., Fleyeh, H., Håkansson, J., Nyberg, R.G.
  Smart parking sensors, technologies and applications for open parking lots: A review
  (2018) IET Intelligent Transport Systems, 12 (8), pp. 735-741. Cited 109 times.
  www.ietdl.org/IET-ITS
  doi: 10.1049/iet-its.2017.0406

- Kumar Gandhi, B.M., Kameswara Rao, M.
  A prototype for IoT based car parking management system for smart cities
  (2016) Indian Journal of Science and Technology, 9 (17), art. no. 92973. Cited 57 times.
  http://www.indjst.org/index.php/indjst/article/view/92973/69540
  doi: 10.17485/ijst/2016/v9i17/92973

- Cynthia, J., Bharathi Priya, C., Gopinath, P.A.
  IoT based smart parking management system
  (2019) International Journal of Recent Technology and Engineering, 7 (4), pp. 374-379. Cited 18 times.
  www.ijrte.org