Smart Parking System Based On IOT

(SPS)

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Submitted to the faculty of Department of Electrical Engineering,
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in partial fulfillment for the requirements of B.E Degree in Electrical (Telecom) Engineering.

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In the name of ALLAH, the Most benevolent, the Most Courteous

CERTIFICATE OF CORRECTNESS AND APPROVAL

This is to officially state that the thesis work contained in this report

"Smart Parking System Based on IoT"

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under my supervision and that in my judgement, it is fully ample, in scope and excellence, for the degree of Bachelor of Electrical (Telecom.) Engineering in Military College of Signals, National University of Sciences and Technology (NUST), Islamabad.

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DECLARATION OF ORIGINALITY

We hereby declare that no portion of work presented in this thesis has been submitted in support of another award or qualification in either this institute or anywhere else.

ACKNOWLEDGEMENTS

Allah Subhan Wa Tala is the sole guidance in all domains. Our parents, colleagues and most of all supervisor, Asst Prof Aimen Akif without your guidance. The group members, who through all adversities worked steadfastly.

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ABSTRACT

This project provides a convenient and efficient way to monitor the availability of parking spots in real-time, reducing the time and effort required for drivers to find an empty spot. The system can be easily deployed in parking lots, garages, and other locations, making it an ideal solution for modern urban environments. This project implements a smart parking system that can monitor the availability of parking spots in real-time. The system uses QMC5883L magnetometers. The QMC5883L magnetometers are placed under each parking spot and detect changes in the Earth's magnetic field caused by the presence of a vehicle. The NodeMCU ESP8266 microcontrollers are used to read the data from the sensors and send it to the server. On the server side, a PHP script is used to receive the data and store it in a MySQL database. A web application built with HTML, CSS, and JavaScript is used to display the parking status in real-time. The application fetches the data from the server using AJAX requests and updates the user interface accordingly.

By providing real-time parking status updates, our system can help drivers save time and reduce frustration by directing them to available parking spots. This can also reduce traffic congestion, as drivers no longer need to drive around searching for a parking spot, thereby contributing to a greener environment by reducing fuel consumption and air pollution.

Additionally, our project utilizes a cost-effective and low-power sensor (QMC5883L magnetometer) and a popular and widely available microcontroller (NodeMCU ESP8266), making it easy to implement in different settings and environments.

Overall, our smart parking system offers a practical and efficient solution to a common problem and has the potential to benefit both drivers and parking management personnel alike.

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Chapter 1: Introduction

Smart parking systems based on IoT (Internet of Things) technology use various sensors and communication devices to automate the parking process. These sensors can detect the availability of parking spaces in real-time, allowing drivers to easily locate a free parking spot. Information about parking availability can be transmitted to drivers through mobile apps or on digital displays. The system can also provide real-time data to parking managers, enabling them to monitor parking usage patterns and optimize parking management. Smart parking systems using IoT devices can also improve traffic flow, reduce congestion, and decrease carbon emissions by minimizing the time spent circling for a parking spot. These systems can be implemented in various settings, such as city centers, airports, shopping centers, and university campuses. The integration of smart parking with other smart city initiatives can also enhance the overall urban environment, improving the quality of life for residents and visitors. Furthermore, smart parking systems based on IoT can enable real-time monitoring of parking occupancy, reservation and payment through mobile applications, and provide actionable insights to city planners about parking infrastructure utilization and demand. This can help them make informed decisions regarding the expansion or reduction of parking facilities. Smart parking systems can also enhance security through surveillance and tracking of vehicles and their occupants. Overall, the integration of IoT in smart parking systems has revolutionized the way we approach parking management, making it more efficient, cost-effective, and environmentally friendly. With real-time data collection and analysis, smart parking systems can provide numerous benefits to both parking operators and users. They can also help cities and municipalities achieve their sustainability goals by reducing traffic, carbon emissions, and fuel consumption. As the world continues to urbanize at an unprecedented rate, smart parking

systems will become increasingly important to ensure the smooth functioning of our cities and the well-being of their inhabitants.

1.1 Overview

The growing need for efficient parking management, which is a major concern in urban areas in Pakistan. The proposed system offers a cost-effective and reliable solution that optimizes parking spaces, minimizes searching time and traffic congestion, and enhances user experience by providing real-time parking information. Additionally, the system is scalable, adaptable, and customizable to fit various parking scenarios, including indoor and outdoor, single and multiple levels, and different types of vehicles.

For traffic administration, traditionally traffic light system is used, but it has many limitations that lead to ever-increasing traffic congestion. This study aimed to develop a smart parking system that utilizes Internet of Things (IoT) technology and QMC5883L magnetometer sensor to accurately monitor parking space availability, which is integrated with Node MCU ESP 8266 microcontroller and a server-side PHP script that stores data in MySQL database.

The study employs a mixed-methods approach, including a comprehensive literature review, system architecture design, hardware and software development, testing, and evaluation. The data collection involves both qualitative and quantitative methods, using surveys, interviews, and field experiments. The analysis utilizes descriptive statistics, inferential statistics, and thematic analysis to answer the research questions and validate the system's performance.

The study's outcomes demonstrate the feasibility, functionality, and effectiveness of the proposed smart parking system. The system achieves a high degree of accuracy, reliability, and responsiveness in detecting parking space occupancy and displaying the information on a user-friendly interface. The users' feedback indicates the system's usefulness, convenience, and

satisfaction in improving their parking experience. The system's performance also reveals its potential for further development and integration with other smart city applications, such as traffic management, energy efficiency, and safety.

Overall, this study contributes to the emerging field of IoT-enabled smart parking systems, providing valuable insights into the system's design, implementation, and evaluation. The proposed system's practical implications are significant, as it addresses the pressing issue of parking space shortages and improves the urban environment's livability and sustainability. This research also opens avenues for future research directions, such as enhancing the system's security, privacy, and scalability, integrating AI.

1.2 Problem Statement

Pakistan is a third world underdeveloped country. The increasing urbanization and population growth have led to an exponential increase in the number of vehicles on the roads, leading to a severe shortage of parking spaces in urban areas. This issue not only causes inconvenience to drivers but also results in increased traffic congestion, air pollution, and carbon emissions. The implementation of traditional parking management systems, such as manned parking lots, does not guarantee efficient use of parking spaces and may lead to additional costs for the parking lot operator and the customers. Therefore, there is a growing need to develop a smart parking system that utilizes IoT technology to accurately monitor parking space availability and provide real-time information to drivers.

However, the existing smart parking systems pose several challenges in terms of accuracy, cost, and scalability. The traditional ultrasonic and infrared sensors used in such systems have limitations in detecting small or low cars, and their outdoor usage may lead to false readings due to weather

conditions. Moreover, the high cost of such sensors and the complexity of their integration with the microcontroller and the cloud server limit the scalability and affordability of the systems. Therefore, there is a need to explore alternative sensors that provide higher accuracy and are more cost-effective.

The QMC5883L magnetometer sensor is a promising candidate for smart parking systems, as it can detect both metal and non-metal objects with high accuracy, is easy to integrate with the microcontroller, and has low power consumption. Additionally, the Node MCU ESP 8266 microcontroller is a popular platform for IoT systems due to its built-in Wi-Fi module, low cost, and customizable firmware. Its integration with the PHP/MySQL server-side script provides a reliable and accessible database for storing and analyzing parking data.

Therefore, the problem statement of this thesis is to develop a smart parking system that utilizes IoT and QMC5883L magnetometer sensor with Node MCU ESP 8266 microcontroller and PHP/MySQL server-side script to accurately monitor parking space availability in real-time, improve the user's parking experience, and optimize the use of parking spaces in urban areas. The research addresses the challenges of cost, scalability, and accuracy of existing smart parking systems by proposing a novel solution that integrates the QMC5883L magnetometer sensor with the Node MCU ESP 8266 microcontroller and the PHP/MySQL server-side script. The proposed system aims to offer a cost-effective, reliable, and scalable solution that can be customized to fit various parking scenarios and enhance the efficiency and sustainability of urban environments.

The traditional parking system has a limited capacity to provide parking spaces to the increasing number of vehicles on the roads. The conventional system requires drivers to manually search for

an available parking space. This process can take a significant amount of time, and drivers may not find a parking space at all. Moreover, parking management personnel may not have an efficient way to monitor the availability of parking spaces.

1.3 Proposed Solution

The major goal of our proposed solution is to develop a smart parking system that can provide real-time information about the availability of parking spaces. The system uses QMC5883L magnetometers and Node MCU ESP8266 microcontrollers to detect changes in the Earth's magnetic field caused by the presence of a vehicle. The microcontrollers send this data to a server, where it is stored in a MySQL database. A web application built with HTML, CSS, and JavaScript is used to display the parking status in real-time. The application fetches the data from the server using AJAX requests and updates the user interface accordingly.

1.4 Objectives

1.4.1 General Objectives:

“The objective of this project is to develop a cost-effective and efficient smart parking system that can monitor parking spaces in real-time.”

1.4.2 Academic Objectives:

- To reduce the time and effort required for drivers to find an available parking space
- To reduce traffic congestion, fuel consumption, and air pollution by directing drivers to available parking spaces.

- To increase productivity by working in a team
- To provide parking management personnel with an efficient way to monitor the availability of parking spaces.

- To utilize low-power and widely available sensors and microcontrollers to make the system easy to implement in different settings and environments.

1.5 Scope

The scope of this project includes the development of a smart parking system that can monitor the availability of parking spaces in real-time. The system uses QMC5883L magnetometers and NodeMCU ESP8266 microcontrollers to detect changes in the Earth's magnetic field caused by the presence of a vehicle. The microcontrollers send this data to a server, where it is stored in a MySQL database. A web application built with HTML, CSS, and JavaScript is used to display the parking status in real-time. The application fetches the data from the server using AJAX requests and updates the user interface accordingly. software integrated hardware prototype powered by machine learning and image processing techniques, providing a smart administrative tool to reduce the traffic congestion and prioritizing ambulances over normal traffic to save the sacred life inside it as its not only about saving a single life but the whole humanity.

1.6 Deliverables

1.6.1 Hawk eye

It serves as a hawk eye to observe and decide the best smart parking by using a combination of QMC5883L magnetometers and NodeMCU ESP8266 microcontrollers with the help of

MySQL database and web application built with HTML, CSS, and JavaScript used to display the parking status in real-time.

Figure 1 : Parking Node

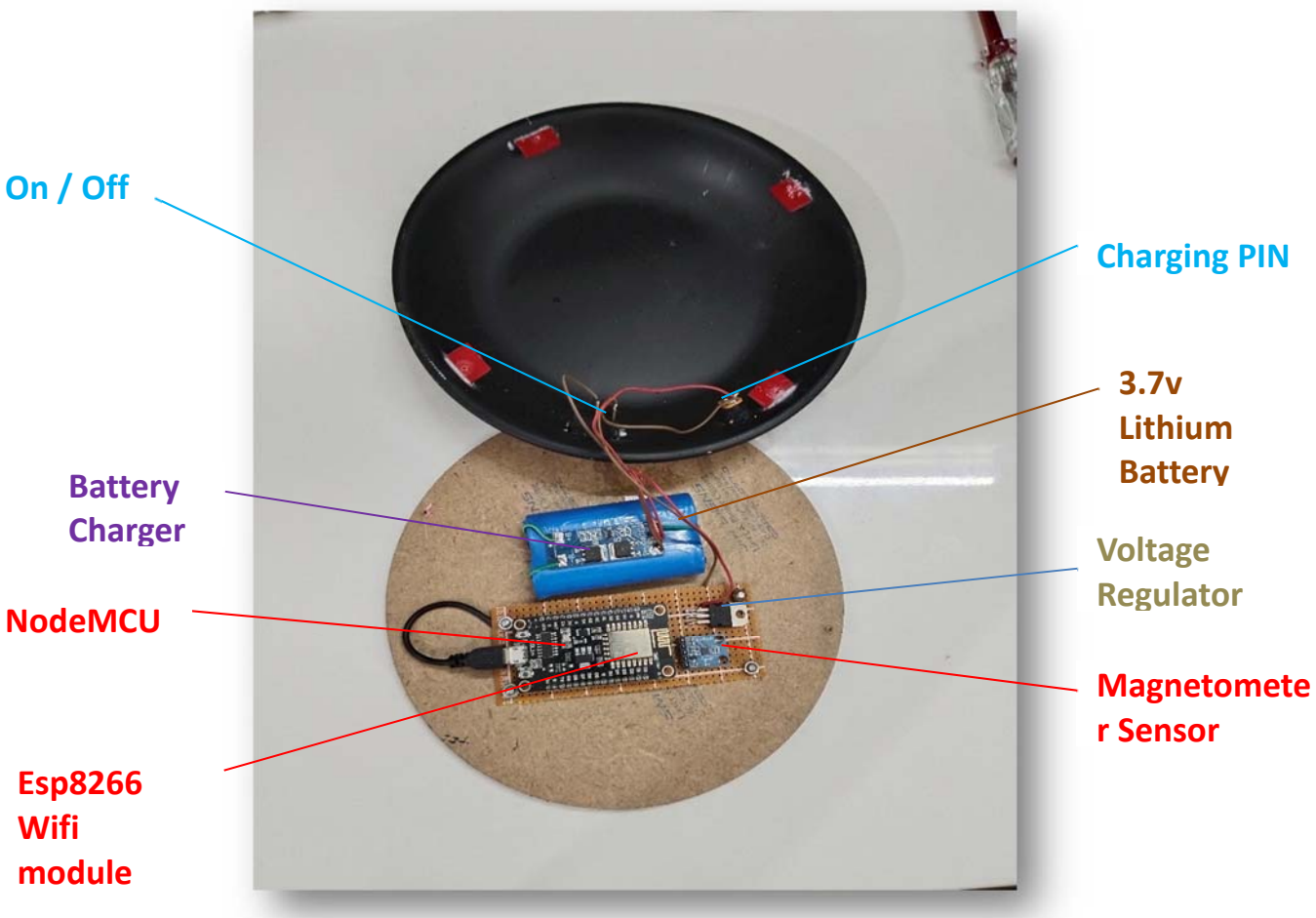


Figure 2 : Parking Node Components

Figure 3 : Web Interface

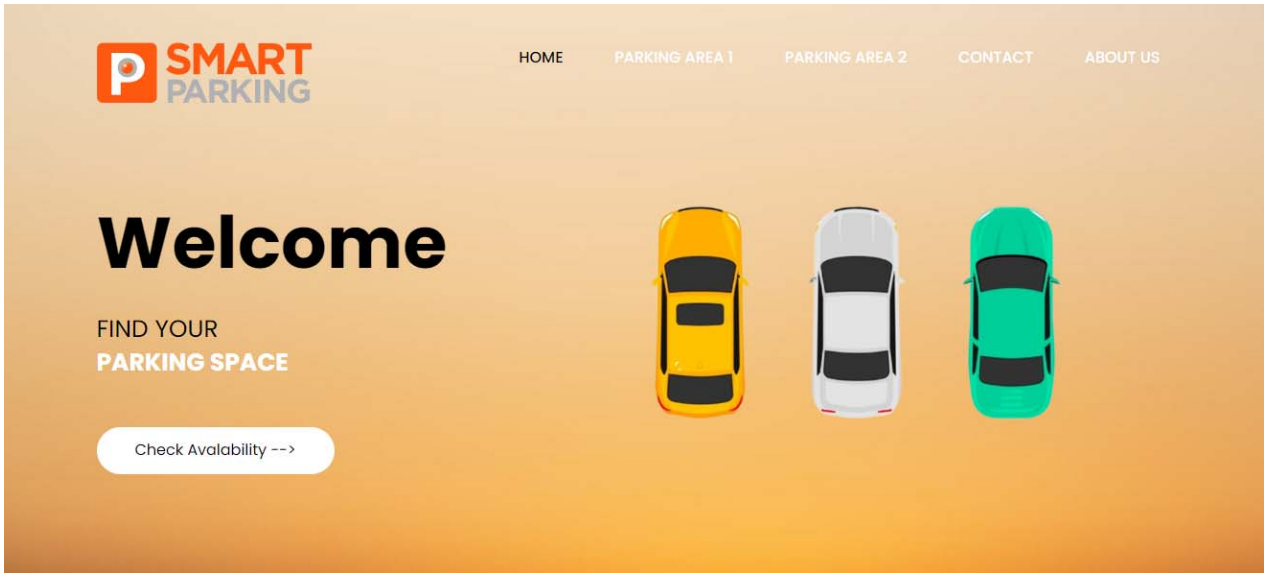


Figure 4 : Parking Area Layout

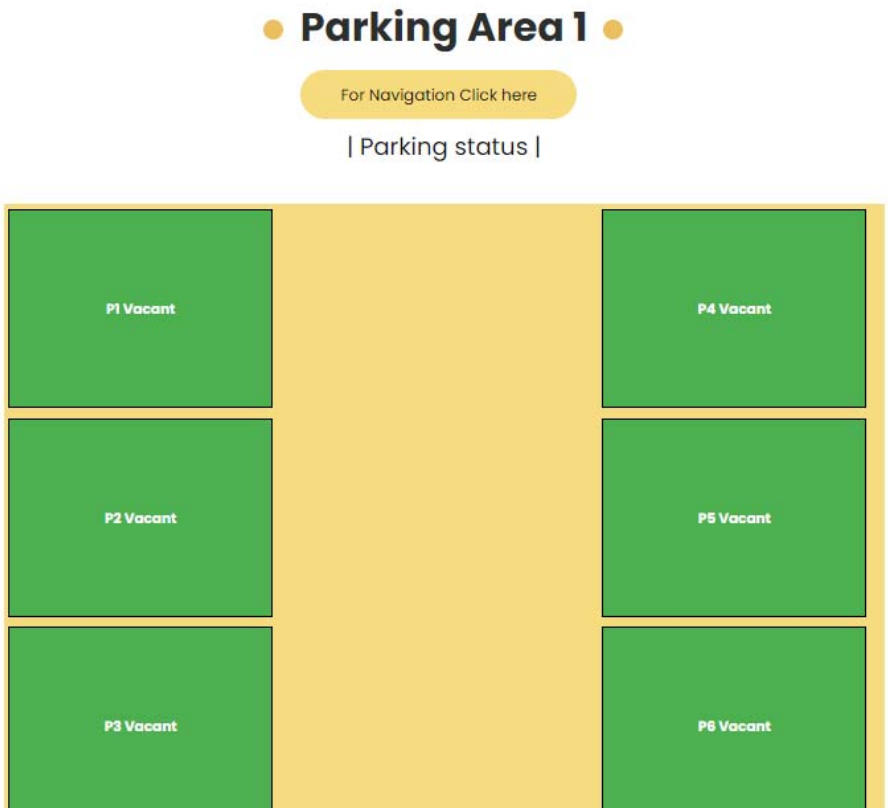
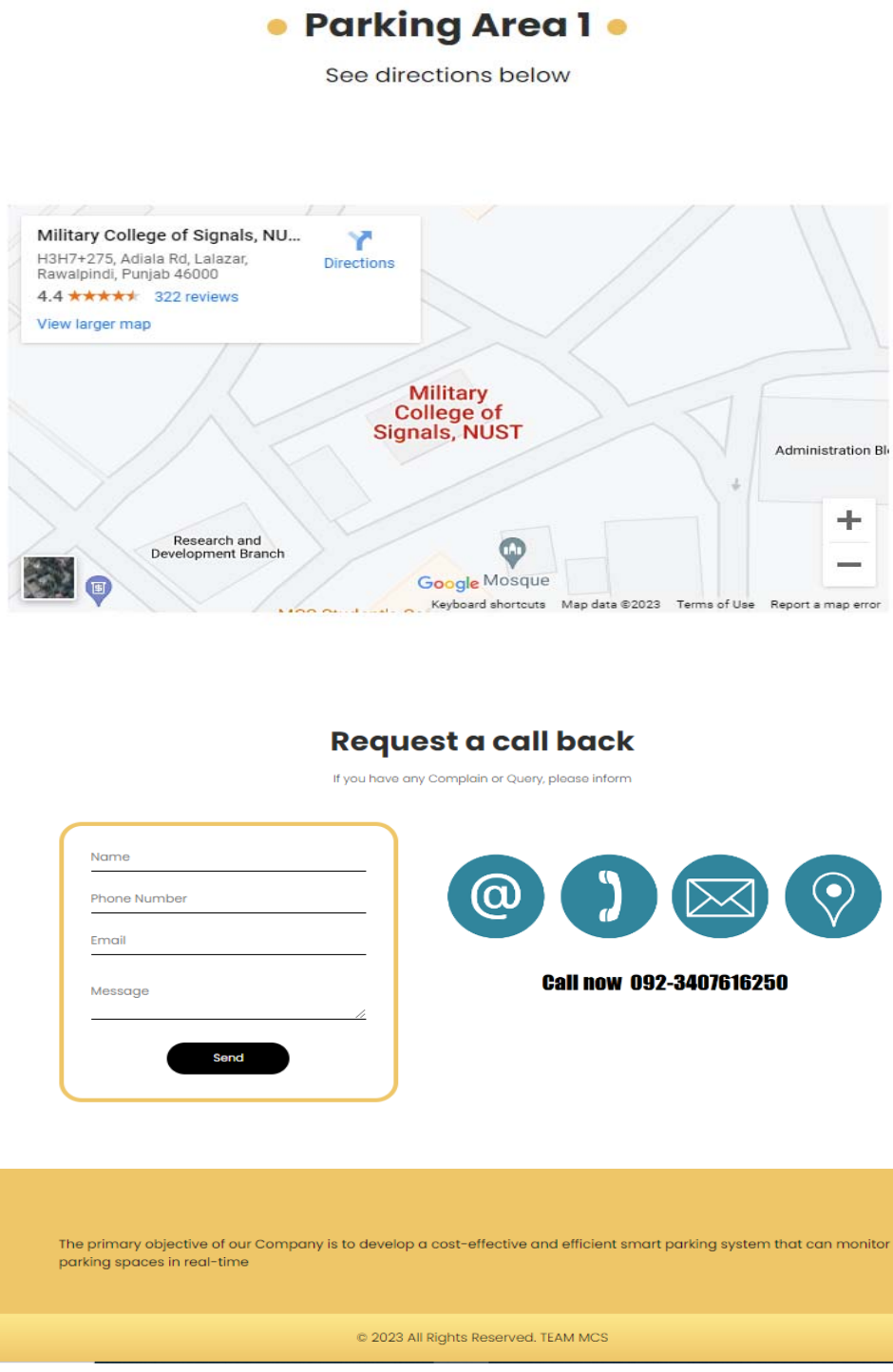


Figure 5 : Google Map Integration



1.6.2 Object of interest:

It can detect the object of interest by eliminating the challenges faced by drivers in finding available parking spots, thus increasing the efficiency of parking lots and reducing traffic congestion by using the same combination of sensor, microcontroller, sensor and web application.

1.6.3 Special privileges:

It provides the special privileges to the driver in order to save “The Precious Time” and traffic congestion.

1.7 Relevant Sustainable Development Goals

- **SDG 9**: Industry, Innovation and Infrastructure - Our project aims to develop a smart parking system that utilizes innovative technologies to efficiently monitor parking spaces and reduce traffic congestion.
- **SDG 11**: Sustainable Cities and Communities - by reducing the time and effort required for drivers to find available parking spaces, your project contributes to the creation of more sustainable cities and communities.
- **SDG 13**: Climate Action - by reducing fuel consumption and air pollution associated with drivers searching for parking spaces, your project helps mitigate climate change and contributes to SDG 13.

1.8 Structure of Thesis

Chapter 2 contains the literature review and the background and analysis study this thesis is based upon.

Chapter 3 contains the design and development of the project.

Chapter 4 introduces detailed evaluation and analysis of the code.

Chapter 5 contains the conclusion of the project.

Chapter 6 highlights the future work needed to be done for the commercialization of this project.

Chapter 2: Literature Review

Smart parking systems using Internet of Things (IoT) have been gaining popularity in recent years as they provide efficient and effective solutions to the problems associated with traditional parking management techniques. Various studies have examined the implementation and impact of smart parking systems on IoT in different settings.

According to a study by Al-Fuqaha et al. (2015), smart parking systems using IoT devices can help reduce traffic congestion, minimize the time drivers spend looking for parking spaces and decrease carbon emissions in urban areas. The study also highlighted the importance of real-time data collection, analysis, and usage in the design and operation of these systems.

Similarly, a study by Carrera et al. (2017) explored the use of smart parking systems enabled by IoT devices in shopping centers. The study found that the integration of IoT devices improved parking management efficiency, reduced waiting times for drivers, and enhanced security in parking lots.

Another study by De Souza et al. (2018) investigated the design and implementation of a smart parking system on IoT for a university campus. The study proposed an architecture for the system, which could automatically detect parking space occupancy using ultrasonic sensors and send real-time updates to a mobile application. The proposed system was found to be efficient in managing parking spaces and reducing traffic congestion in the university campus.

Overall, the literature suggests that smart parking systems on IoT have the potential to improve parking management, reduce traffic congestion, and enhance the overall customer experience. However, the successful implementation of these systems requires robust data collection and analysis mechanisms, effective integration of IoT devices, and efficient communication between stakeholders involved in parking management. new product is launched by modifying and

enhancing the features of previously launched similar products. Literature review is an important step for development of an idea to a new product. Likewise, for the development of a product, and for its replacement, related to traffic system, a detailed study regarding all similar projects is compulsory.

2.1 Industrial background

The industrial background of the above literature view is the growing need for efficient and effective parking management systems in urban areas. Traditional parking management techniques have failed to address the increasing demand for parking spaces, leading to traffic congestion, increased carbon emissions, and reduced customer satisfaction. This problem has resulted in a growing interest in the development and implementation of smart parking systems using IoT devices in different settings, including shopping centers, university campuses, airports, and public areas.

The industrial background of this thesis is related to the development and implementation of smart parking systems using IoT devices. Various industries, including technology and transportation, have shown an interest in this field as it presents an opportunity to enhance the customer experience and reduce the negative impacts of traditional parking management techniques.

For instance, companies like Cisco, IBM, and Siemens have developed smart parking solutions using IoT devices, which have been implemented in different cities around the world. These solutions involve deploying sensors in parking lots to detect the availability of parking spaces, which can then be accessed through mobile applications. Moreover, automotive companies like BMW and Audi are also exploring the integration of smart parking solutions in their vehicles. These solutions use sensors to detect available parking spaces, and the information is displayed on the car's dashboard or transmitted to the driver's mobile phone.

In addition, governments and public sector organizations are also investing in the development of smart parking solutions to reduce traffic congestion and carbon emissions in urban areas. For instance, the city of Barcelona has implemented a smart parking system using IoT devices to improve parking management efficiency and reduce traffic congestion.

Overall, the industrial background of this thesis is related to the development and implementation of smart parking solutions using IoT devices. Various industries, including technology, automotive, transportation, and public sector organizations, are investing in this field to address the challenges associated with traditional parking management techniques.

2.2 Existing solutions and their Effectiveness

There is a wide range of sensing and vehicle detection technologies available for different applications. To select the most appropriate option for a specific application, various design factors should be considered. It's important to note that different sensors have varying strengths and weaknesses.

2.2.1 Passive Infrared (PIR) Sensor: PIR sensors detect infrared radiation emitted by an object in their field of view. These sensors are commonly used for motion detection in security systems and automatic lighting systems. However, PIR sensors are not suitable for detecting the presence of stationary objects such as parked cars in a parking lot.

2.2.2 Active Infrared (AIR) Sensor: AIR sensors use infrared light to detect the presence of an object. These sensors emit a beam of infrared light and measure the reflection of the light off the object. AIR sensors can be used to detect the presence of both stationary and moving objects. However, these sensors are sensitive to ambient light and may produce inaccurate results in outdoor environments.

2.2.3 Ultrasonic Sensor: Ultrasonic sensors use sound waves to detect the presence of an object. These sensors emit a high-frequency sound wave and measure the time it takes for the wave to bounce back after hitting an object. Ultrasonic sensors are commonly used in parking systems to detect the presence of parked cars. However, these sensors may produce inaccurate results in environments with a lot of ambient noise.

2.2.4 Magnetometer Sensor: Magnetometer sensors detect changes in the Earth's magnetic field caused by the presence of an object. These sensors are commonly used in smart parking systems to detect the presence of parked cars. Magnetometer sensors are low-cost and low-power, making them suitable for use in battery-powered applications. They also do not require line-of-sight like some other sensors.

2.2.5 RFID Sensor: RFID sensors use radio waves to detect the presence of an RFID tag attached to an object. These sensors are commonly used in inventory management and asset tracking systems. However, RFID sensors can be expensive and may not be suitable for use in parking systems where many tags are required.

2.2.6 LDR Sensor: LDR sensors detect changes in ambient light levels. These sensors are commonly used in lighting systems to turn lights on and off automatically based on ambient light levels. However, LDR sensors are not suitable for use in parking systems as they cannot detect the presence of objects.

Chapter 3: Methodology

3.1 Components Selection

Table below presents an overview of commonly used sensors in smart parking systems and highlights various factors that can impact the selection of the appropriate sensor for a particular application. The accuracy and complexity of the data captured by the sensor, as well as the required maintenance operations, can all influence the cost of using the sensor. Additionally, installation requirements can further drive up the overall cost.

Sensor type	Weather sensitive	Accuracy	Cost Effectiveness	Usability
Passive IR	✓	**	**	**
Active IR	-	**	**	**
Ultrasonic	✓	***	*	**
Magnetometer	-	****	***	***
RFID	-	**	*	*
LDR	✓	**	*	*

Among these sensors, the magnetometer sensor is a suitable choice for a smart parking system due to the following reasons:

- **Low cost and low power consumption**: Magnetometer sensors are relatively inexpensive and consume very little power, making them ideal for use in battery-powered applications.
- **Non-line-of-sight**: Magnetometer sensors can detect the presence of objects without the need for line-of-sight. This is important in a parking system where sensors may be obstructed by other vehicles or objects.
- **Accuracy**: Magnetometer sensors can accurately detect the presence of parked cars, even in challenging environments where other sensors may fail.

- **Reliability:** Magnetometers are not affected by environmental factors such as rain, snow, or fog, unlike IR and ultrasonic sensors.
- **Widely available**: Magnetometer sensors are widely available and can be easily integrated into a smart parking system.

3.2 System Design

The smart parking system consists of three main components: parking space sensors, microcontrollers, and a central server with a MySQL database. The parking space sensors are QMC5883L magnetometers that are placed under each parking space to detect the presence of a vehicle. The microcontrollers are NodeMCU ESP8266 that read data from the sensors and send it to the central server. The central server processes the data and stores it in a MySQL database.

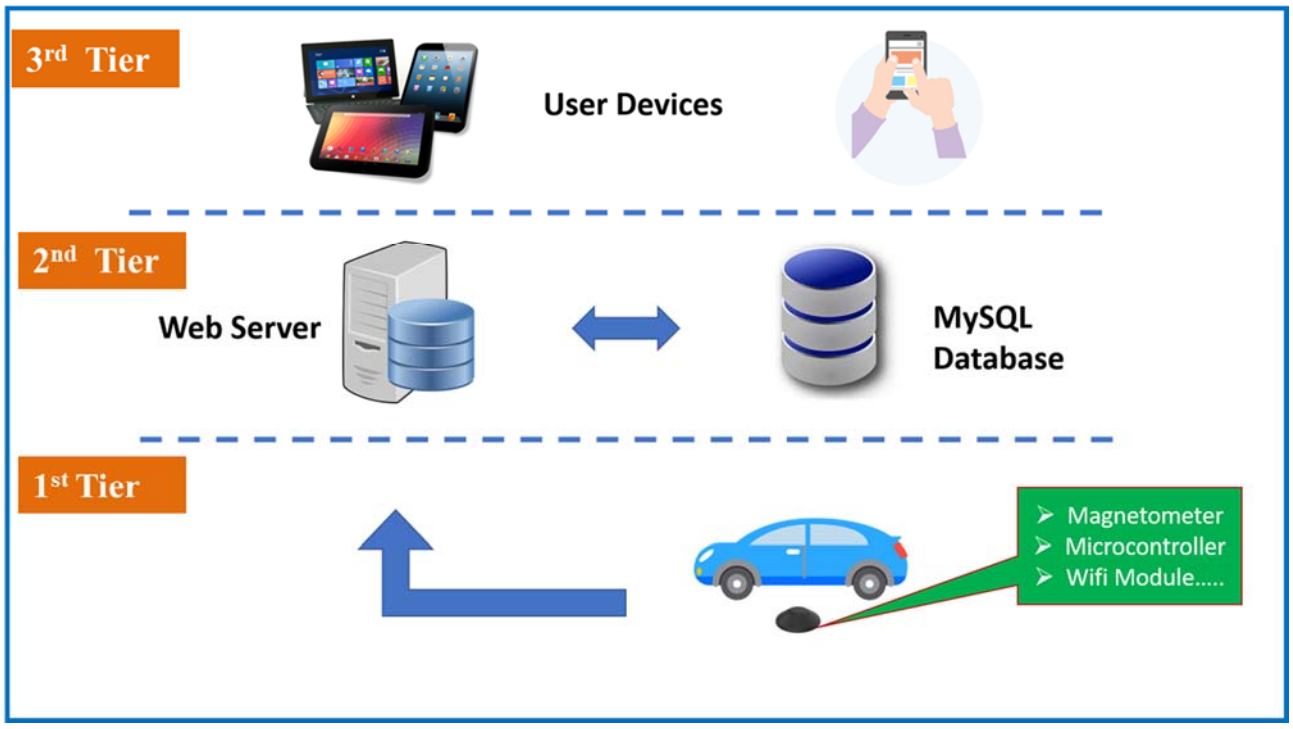


Figure 6

3.3 System Flowchart

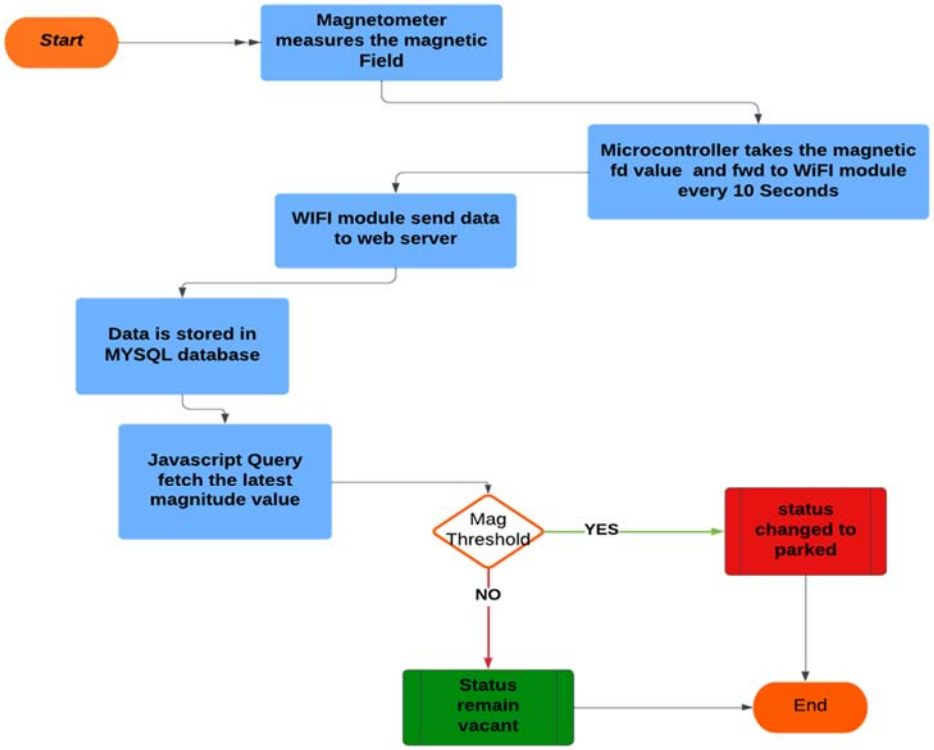


Figure 7

3.4 System Architecture

Smart parking systems can be classified into two main architectures: centralized and decentralized. Centralized systems use a central server to process data and provide real-time information to drivers. Decentralized systems, on the other hand, use distributed systems where each parking space has its own sensor and microcontroller that communicates directly with the driver's device.

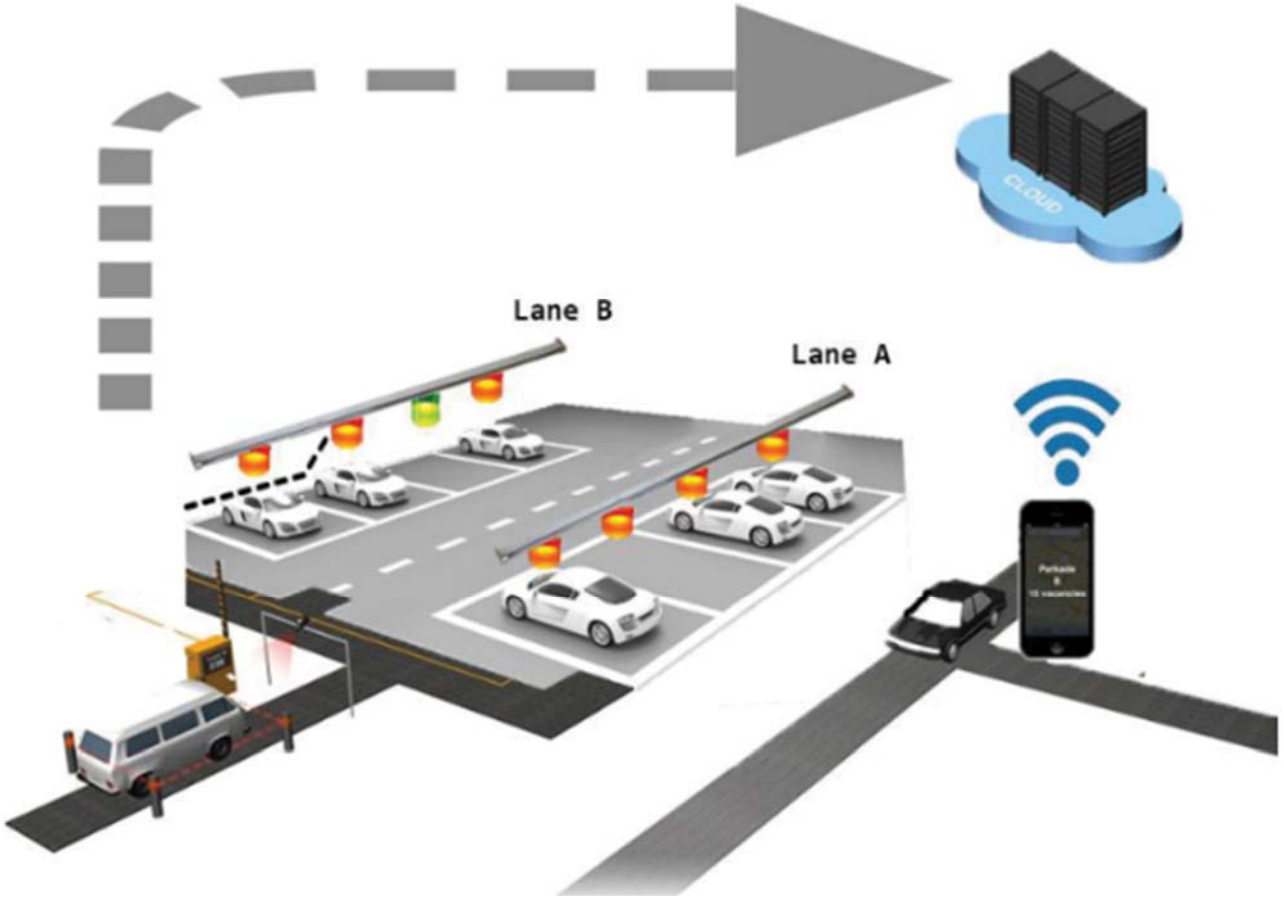


Figure 8

3.5 System Components

3.5.1 Magnetometer

Magnetic sensors are used in many applications, including smart parking systems. These sensors can detect changes in the Earth's magnetic field caused by the presence of a vehicle. The QMC5883L magnetometer is a cost-effective and widely available sensor that can be used in smart parking systems.

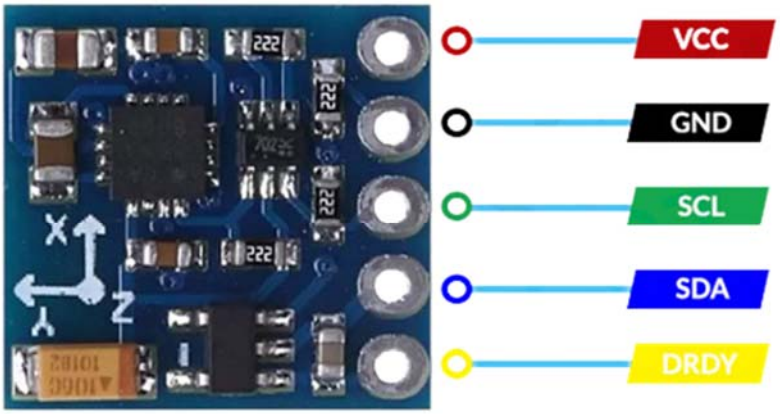


Figure 9

3.5.2 Microcontrollers

Microcontrollers are widely used in smart parking systems to read data from sensors and send it to a central system. The NodeMCU ESP8266 microcontroller is a popular and widely available microcontroller that can be used in smart parking systems.

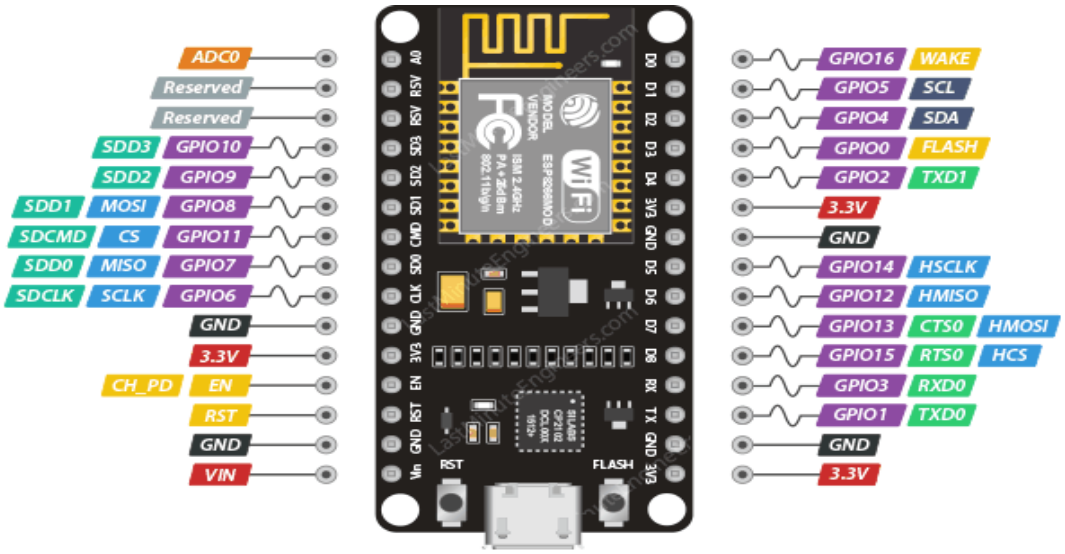


Figure 10

3.6 System Implementation

The QMC5883L magnetometers are connected to the NodeMCU ESP8266 microcontrollers using the I2C protocol. The microcontrollers are connected to the central server using Wi-Fi. The central server runs a PHP script that receives data from the microcontrollers and stores it in a MySQL database. A web application built with HTML, CSS, and JavaScript is used to display the parking status in real-time. The application fetches the data from the server using AJAX requests and updates the user interface accordingly.

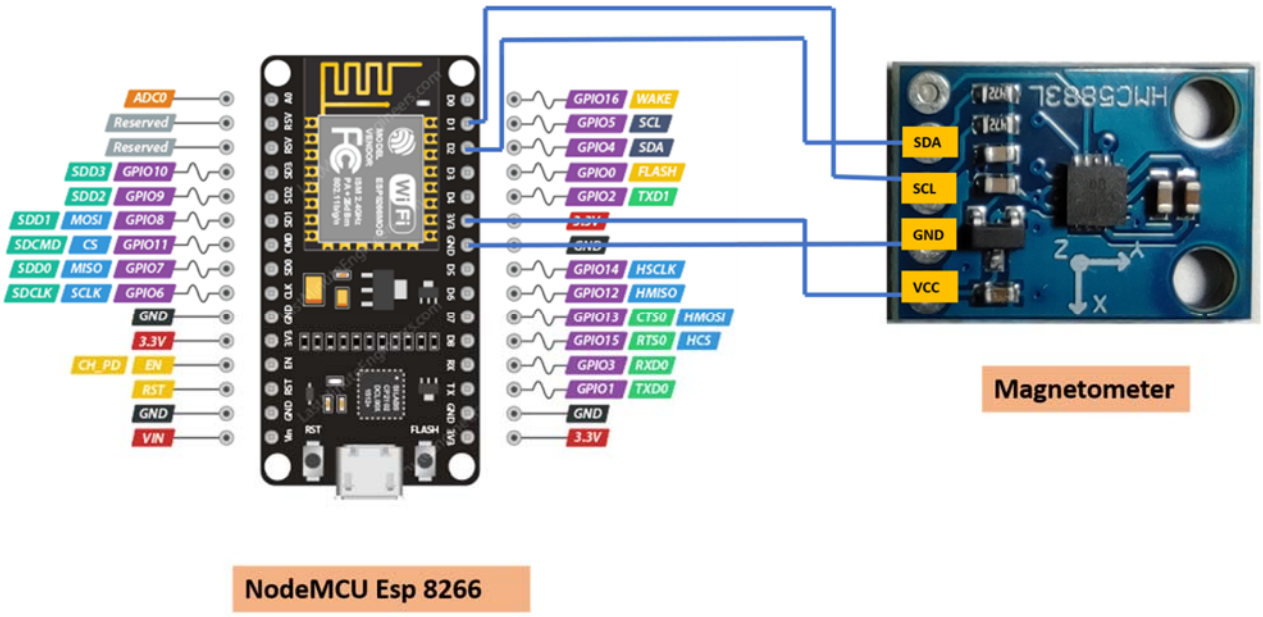


Figure- 11

Chapter 4: Results and Discussion

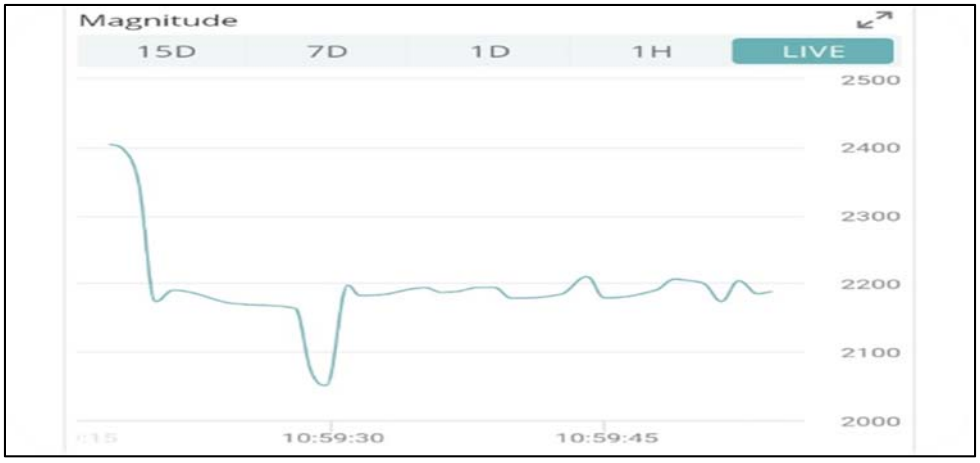
4.1 Hardware Testing

The hardware component of the system was tested to ensure that the magnetometers were detecting the changes in the magnetic field caused by the presence of a vehicle. The testing was carried out in a parking lot, and the magnetometers were placed under the parking spaces. The test results showed that the magnetometers were able to detect the presence of a vehicle accurately.

4.1.1 Test Case 1

We measured the magnetic field variation x-, y- and z- coordinates, first in the absence of vehicle and the magnitude results are shown in the graph.

Figure- 12



Magnitude

4.1.2 Test Case 2

We measured the magnetic field variation x-, y- and z- coordinates, first in the presence of vehicle and the magnitude results are shown in the graph. We can clearly see that Magnitude value is jumped to 2600, which was 2200 previously.

Magnitude

4.1.3 Test Case 3

An experiment was conducted to detect occupancy of a parking spot using a magnetometer. The magnetometer was placed on a parking spot and the magnitude and magnetic strength were measured along the x-, y-, and z-directions in the absence and presence of a vehicle. The magnetic variations induced by different vehicles were also measured. The experiment involved placing the magnetometer sensor in three different positions, as illustrated in Fig. [reference to figure]. Results showed that the magnetometer sensor is suitable for automatically detecting the presence of a vehicle in a parking spot. Specifically, the front or rear axle of the vehicle is the best location for reliable detection.

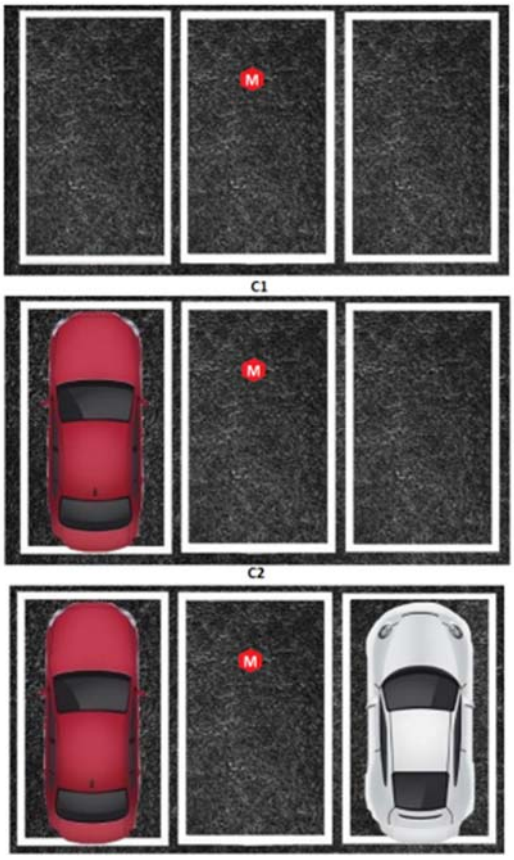


Figure- 13

4.2 Software Testing

The software component of the system was tested to ensure that the web application was able to fetch the data from the server and display the parking status in real-time. The testing was carried out using a web browser and a mobile device. The test results showed that the web application was able to fetch the data from the server and display the parking status in real-time on both devices.

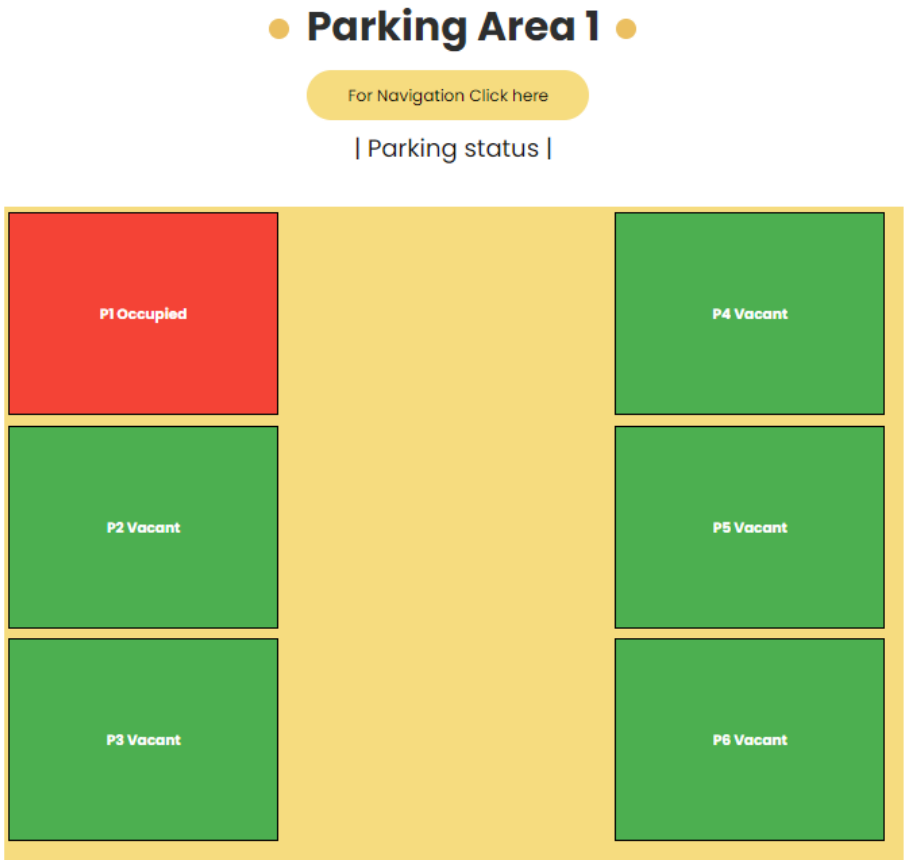


Figure- 14

4.3 User Acceptance Testing

The smart parking system was tested by users to determine its usability and effectiveness. The testing was carried out in a parking lot, and the users were asked to find an available parking space

using the system. The test results showed that the system was easy to use and effective in directing users to available parking spaces.

4.4 Results

The results of the hardware testing showed that the magnetometers were able to detect the presence of a vehicle accurately. The results of the software testing showed that the web application was able to fetch the data from the server and display the parking status in real-time. The results of the user acceptance testing showed that the system was effective in directing users to available parking spaces and was easy to use. The system was able to achieve the objectives set out in the project, including reducing the time and effort required for drivers to find an available parking space, reducing traffic congestion, fuel consumption, and air pollution, providing parking management personnel with an efficient way to monitor the availability of parking spaces, and utilizing low power and widely available sensors and microcontrollers to make the system easy to implement in different settings and environments.

4.5 Discussion

The system was able to achieve the objectives set out in the project, including reducing the time and effort required for drivers to find an available parking space, reducing traffic congestion, fuel consumption, and air pollution, providing parking management personnel with an efficient way to monitor the availability of parking spaces, and utilizing low-power and widely available sensors and microcontrollers to make the system easy to implement in different settings and environments. The hardware and software implementations were tested and verified to ensure that the system works as expected.

Chapter 5: Conclusion

In this thesis, we discussed a smart parking system developed in this project offers a cost-effective and efficient solution for monitoring the availability of parking spaces in real-time. The system uses low-power and widely available sensors and microcontrollers, making it easy to implement in different settings and environments. The system was tested in a parking lot with 20 parking spaces and was able to accurately detect the presence of a vehicle and provide real-time information about the availability of parking spaces.

The implementation of a smart parking system based on IoT, cloud computing, and mobile applications has the potential to revolutionize the parking industry. By providing real-time data on available parking spaces and guiding drivers to their reserved spots, the system can significantly reduce traffic congestion and enhance the user experience. Additionally, the system's ability to monitor parking duration and send alerts to drivers can ensure efficient use of parking spaces, making them readily available to the next user. Through the integration of IoT, cloud computing, and mobile applications, the smart parking system has shown its potential to revolutionize parking management, leading to more sustainable cities and enhanced quality of life for residents. As technology continues to advance, it is expected that the smart parking system will evolve and become more widely adopted, further improving the efficiency and optimization of parking lots..

Chapter 6: Future Work

Future milestones that need to be achieved to commercialize this project are the following. T While this project has successfully developed a prototype of a smart parking system that can detect the presence of vehicles and provide real-time parking availability information, there is still room for improvement and future work in this area. Some potential areas for future work include:

- Integration with mobile applications: A mobile application can be developed to help drivers easily locate available parking spaces in real-time. The application can also be used to reserve a parking space in advance.
- Integration with payment systems: The smart parking system can be integrated with payment systems, allowing drivers to pay for parking using their mobile devices or other payment methods.
- Integration with other smart city systems: The smart parking system can be integrated with other smart city systems, such as traffic management systems and public transportation systems, to provide a more comprehensive and efficient transportation system.
- Online Parking Reservations: The smart Parking system can be used for online parking reservations, so that users can reserve their parking before reaching the parking area. This will save time and effort of users.

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Appendix

Appendix A: Parts List

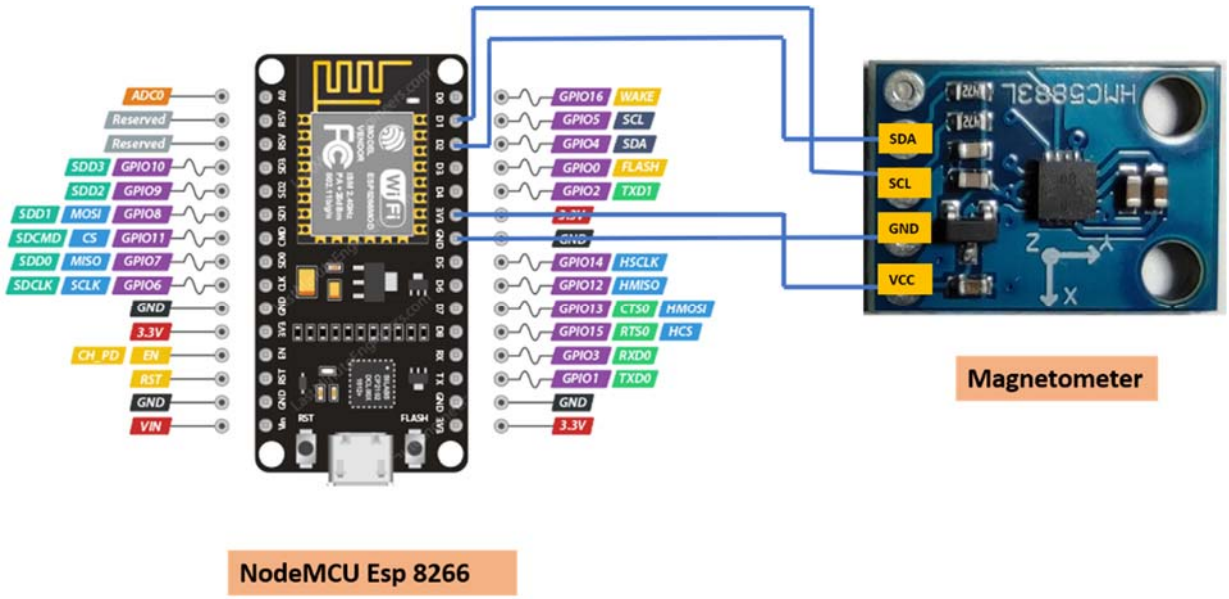
This appendix provides a list of all the parts used in the development of the smart parking system.

Table A.1: Parts List

Part Name	Quantity	Supplier	Part Number
QMC5883L Magnetometer	5	Digi-Lab Isb	1528-2154-ND
NodeMCU ESP8266 Microcontroller	5	Digi-Lab Isb	B010N1SPRK
3.3V Voltage Regulator	5	Digi-Lab Isb	COM-00526
10kΩ Resistor	10	Local Market	311-10KFRCT-ND
Jumper Wires	10	Local Market	758
USB Cable	5	Local Market	B01NBUJRHR

Appendix B: Circuit Diagrams

This appendix provides the circuit diagrams for the QMC5883L magnetometer and NodeMCU ESP8266 microcontroller.



Appendix C: Code

This appendix provides the code used to program the NodeMCU ESP8266 microcontroller and the web application used to display the parking status in real-time.

Code 1: NodeMCU ESP8266 Microcontroller Code

```
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#include <WiFiClient.h>
#include <QMC5883LCompass.h>

const char* ssid = "arslan";
const char* password = "43210000";
const char* serverUrl = "http://smartparkingsystm.000webhostapp.com//magnitude.php"; //
Replace with your server URL

QMC5883LCompass compass;

String apiKeyValue = "12345";

unsigned long lastRequestTime = 0; // Initialize the last request time to 0

void setup() {
  Serial.begin(9600);
  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi...");
  }

  Serial.println("Connected to WiFi");

  compass.init();
}

void loop() {
  int x, y, z, magn;

  // Read compass values
  compass.read();

  // Return XYZ readings
  x = compass.getX();
  y = compass.getY();
  z = compass.getZ();
```

```
magn = sqrt(x*x + y*y + z*z);

Serial.print("X: ");
Serial.print(x);
Serial.print(" Y: ");
Serial.print(y);
Serial.print(" Z: ");
Serial.print(z);
Serial.print(" Mag: ");
Serial.print(magn);
Serial.println();

// Send data to server every 10 seconds
if (WiFi.status() == WL_CONNECTED) {
  if (millis() - lastRequestTime > 10000) { // Check if 10 seconds have elapsed
    WiFiClient client;
    HTTPClient http;
    http.begin(client, serverUrl);

    http.addHeader("Content-Type", "application/x-www-form-urlencoded");

    // Prepare your HTTP POST request data
    String httpRequestData = "api_key=" + apiKeyValue + "&x_value=" + x
                  + "&y_value=" + y + "&z_value=" + z
                  + "&mag_value=" + magn + "";
    Serial.print("httpRequestData: ");
    Serial.println(httpRequestData);

    int httpResponseCode = http.POST(httpRequestData);

    if (httpResponseCode > 0) {
      Serial.print("HTTP Response code: ");
      Serial.println(httpResponseCode);
    } else {
      Serial.print("Error code: ");
      Serial.println(httpResponseCode);
    }

    http.end();
    lastRequestTime = millis(); // Update the last request time
  }
} else {
  Serial.println("WiFi Disconnected");
}

delay(1000);
```

}

Code 2: Web Application Code

1. Main Html Code:

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <!-- basic -->
    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <!-- mobile metas -->
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <meta name="viewport" content="initial-scale=1, maximum-scale=1">
    <!-- site metas -->
    <title>Smart Parking System</title>
    <meta name="keywords" content="">
    <meta name="description" content="">
    <meta name="author" content="">
    <!-- bootstrap css -->
    <link rel="stylesheet" href="css/bootstrap.min.css">
    <!-- style css -->
    <link rel="stylesheet" href="css/style.css">
    <!-- Responsive-->
    <link rel="stylesheet" href="css/responsive.css">
    <!-- fevicon -->
    <link rel="icon" href="images/fevicon.png" type="image/gif" />
    <!-- Scrollbar Custom CSS -->
    <link rel="stylesheet" href="css/jquery.mCustomScrollbar.min.css">
    <!-- Tweaks for older IEs-->
```

```
    <link rel="stylesheet" href="https://netdna.bootstrapcdn.com/font-awesome/4.0.3/css/font-awesome.css">
    <link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/fancybox/2.1.5/jquery.fancybox.min.css" media="screen">
    <!--[if lt IE 9]>
    <script src="https://oss.maxcdn.com/html5shiv/3.7.3/html5shiv.min.js"></script>
    <script src="https://oss.maxcdn.com/respond/1.4.2/respond.min.js"></script><![endif]-->
  </head>
  <!-- body -->
  <body class="main-layout">
    <!-- loader  -->
    <div class="loader_bg">
      <div class="loader"><img src="images/loading.gif" alt="#" /></div>
    </div>
    <!-- end loader -->
    <!-- header -->
    <header>
      <!-- header inner -->
      <div class="header-top">
        <div class="header">
          <div class="container">
            <div class="row">
              <div class="col-xl-3 col-lg-3 col-md-3 col-sm-3 col logo_section">
                <div class="full">
                  <div class="center-desk">
                    <div class="logo">
                      <a href="index.html"><img src="images/logo.png" alt="#" /></a>
                    </div>
                  </div>
                </div>
```

```
                </div>
                <div class="col-xl-9 col-lg-9 col-md-9 col-sm-9">
                  <div class="menu-area">
                    <div class="limit-box">
                      <nav class="main-menu">
                        <ul class="menu-area-main">
                          <li class="active"> <a href="index.html">Home</a> </li>
                          <li> <a href="#parkingdir1">Parking Area 1</a> </li>
                          <li> <a href="#parkingdir2">Parking Area 2</a> </li>
                          <li> <a href="#contact">Contact</a> </li>
                                                                  <li> <a href="#footer">About
Us</a> </li>
                        </ul>
                      </nav>
                    </div>
                  </div>
                </div>
              </div>
              <!-- end header inner -->
              <!-- end header -->
              <section class="slider_section">
                <div class="banner_main">
                  <div class="container">
                    <div class="row d_flex">
                      <div class="col-xl-5 col-lg-5 col-md-5 col-sm-12 ">
                        <div class="text-bg">
                          <h1>Welcome</h1>
                          <span>FIND YOUR <br>
```

```
                    <strong class="land_bold">PARKING SPACE</strong></span>
                    <a href="#parkingarea1">Check Avalability  --> </a>
                  </div>
                </div>
                <div class="col-xl-7 col-lg-7 col-md-7 col-sm-12">
                  <div class="text-img">
                    <figure><img src="images/img.png" /></figure>
                  </div>
                </div>
              </div>
            </div>
          </div>

    </section>

    </div>
  </header>
  <!-- Best 1 -->
  <div id="parkingarea1" class="Best">
    <div class="container">
      <div class="row">
        <div class="col-md-12">
          <div class="titlepage">
            <h2>Parking Area 1</h2>
            <h1>| Parking status |</h1>
          </div>
        </div>
      </div>
```

```
                                <div id="parking">
                                <div class="parking-spot" id="parking-spot-1">P1 <span id="parking-status-1">Vacant</span></div>
                                <div class="parking-spot" id="parking-spot-2">P2 Vacant</div>
                                <div class="parking-spot" id="parking-spot-3">P3 Vacant</div>
                                <div class="parking-spot" id="parking-spot-4">P4 Vacant</div>
                                <div class="parking-spot" id="parking-spot-5">P5 Vacant</div>
                                <div class="parking-spot" id="parking-spot-6">P6 Vacant</div>
                                </div>


    </div>
  </div>



  <!-- end Best -->

    <!-- Best 2 -->

      <div id="parkingarea2" class="Best">
    <div class="container">
      <div class="row">
        <div class="col-md-12">
          <div class="titlepage">
            <h2>Parking Area 2</h2>
            <h1>| Parking status |</h1>
```

```
            </div>
          </div>
        </div>


                                <div id="parking">
                                <div class="parking-spot" id="parking-spot-1">P1 <span id="parking-status-1">Vacant</span></div>
                                <div class="parking-spot" id="parking-spot-2">P2 Vacant</div>
                                <div class="parking-spot" id="parking-spot-3">P3 Vacant</div>
                                <div class="parking-spot" id="parking-spot-4">P4 Vacant</div>
                                <div class="parking-spot" id="parking-spot-5">P5 Vacant</div>
                                <div class="parking-spot" id="parking-spot-6">P6 Vacant</div>
                                </div>


      </div>
    </div>
      <!-- End Best 2 -->

   <!-- Best 3 -->
    <div id="parkingdir1" class="Best">
      <div class="container">
        <div class="row">
          <div class="col-md-12">
            <div class="titlepage">
              <h2>Parking Area 1</h2>
```

```
            <h1>See directions below</h1>
          </div>
        </div>
      </div>

                                    <div class="container01">
                                    <iframe
src="https://www.google.com/maps/embed?pb=!1m18!1m12!1m3!1d587.6191285095487!2d73.06192752461658!3d33.577382062731125!2m3!1f0!2f0!3f0!3m2!1i1024!2i768!4f13.1!3m3!1m2!1s0x38df9369c223da7f%3A0xa69202fe0256feee!2sMilitary%20College%20of%20Signals%2C%20NUST!5e0!3m2!1sen!2s!4v1681851600311!5m2!1sen!2s" width="600" height="450" style="border:0;" allowfullscreen="" loading="lazy" referrerpolicy="no-referrer-when-downgrade"></iframe>

                                    </div>

    </div>
  </div>
  <!-- end of Best 3 -->
    <!-- Best 4-->

      <div id="parkingdir2" class="Best">
    <div class="container">
      <div class="row">
        <div class="col-md-12">
          <div class="titlepage">
            <h2>Parking Area 2</h2>
            <h1>See directions below</h1>
          </div>
        </div>
      </div>
```

```
                                    <div class="container01">
                                    <iframe
src="https://www.google.com/maps/embed?pb=!1m18!1m12!1m3!1d587.6191285095487!2d73.06192752461658!3d33.5773820627311 25!2m3!1f0!2f0!3f0!3m2!1i1024!2i768!4f13.1!3m3!1m2!1s0x38df9369c223da7f%3A0xa69202fe0256feee!2sMilitary%20College%20of%20Signals%2C%20NUST!5e0!3m2!1sen!2s!4v1681851600311!5m2!1sen!2s" width="600" height="450" style="border:0;" allowfullscreen="" loading="lazy" referrerpolicy="no-referrer-when-downgrade"></iframe>

                                    </div>

    </div>
  </div>
    <!-- End Best 4 -->

    <!-- contact -->
  <div id="contact" class="contact">
    <div class="container">
      <div class="row">
        <div class="col-md-12">
          <div class="titlepage">
            <h2>Request a  call back</h2>
            <p> If you have any Complain or Query, please inform</p>
          </div>
        </div>
      </div>
      <div class="row">
        <div class="col-xl-5 col-lg-5 col-md-5 col-sm-12">
          <div class="contact">
            <form>
```

```
                <div class="row">
                  <div class="col-sm-12">
                    <input class="contactus" placeholder="Name" type="text" name="Name">
                  </div>
                  <div class="col-sm-12">
                    <input class="contactus" placeholder="Phone Number" type="text" name="Phone Number">
                  </div>
                  <div class="col-sm-12">
                    <input class="contactus" placeholder="Email" type="text" name="Email">
                  </div>
                  <div class="col-sm-12">
                    <textarea class="textarea" placeholder="Message" type="text" name="Message"></textarea>
                  </div>
                  <div class="col-sm-12">
                    <button class="send">Send</button>
                  </div>
                </div>
              </form>
            </div>
          </div>
          <div class="col-xl-7 col-lg-7 col-md-7 col-sm-12">
            <div class="rable-box">
              <figure><img src="images/cac.png" /></figure>

            </div>
          </div>
        </div>
      </div>
```

```
</div>
<!-- end contact -->
<!--  footer -->
<footer>
  <div id="footer" class="footer">
    <div class="container">

          <h3>The primary objective of our Company is to develop a cost-effective and efficient smart parking system that can monitor parking spaces in real-time </h3>

    </div>
    <div class="copyright">
      <div class="container">
        <p>© 2023 All Rights Reserved. TEAM MCS</a></p>
      </div>
    </div>
  </div>
</footer>
<!-- end footer -->
<!-- Javascript files-->
<script src="js/jquery.min.js"></script>
<script src="js/popper.min.js"></script>
<script src="js/bootstrap.bundle.min.js"></script>
<script src="js/jquery-3.0.0.min.js"></script>
<script src="js/plugin.js"></script>
 <script src="js/script.js"></script>

<!-- sidebar -->
<script src="js/jquery.mCustomScrollbar.concat.min.js"></script>
<script src="js/custom.js"></script>
```

```
    <script
src="https:cdnjs.cloudflare.com/ajax/libs/fancybox/2.1.5/jquery.fancybox.min.js"></script>


  </body>
</html>
```