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Revolutionize Urban Mobility with a Smart and Efficient Parking System Seamlessly Integrated with IoT Technology

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Abstract: The rapid growth of urbanization and vehicle ownership has intensified the demand for intelligent, automated, and efficient parking management systems capable of reducing congestion, search time, and operational inefficiencies. The proposed solution presents an innovative Smart parking system driven by the Internet of Things (IoT) technology, incorporating an LCD screen, an Infrared sensor, an Arduino Board, and a Node MCU microcontroller. Upon a vehicle's arrival, the IR sensor swiftly determines space availability, promptly updating the LCD to reflect open parking spots. Leveraging IoT technology, the system is designed to be both cost-effective and highly efficient. It meticulously records parking activities in a centralized data base for administrative purposes, streamlining the process for drivers to locate vacant spots and minimizing search time. Through a prototype, the system successfully showcased its capability to reserve parking slots, while user acceptance tests yielded positive feedback, underscoring its potential to enhance the driving experience and inspire future advancements in parking solutions.

Keywords: Automobile Parking Management Solution, Infrared Sensor, Liquid Crystal Display (LCD) Panel, Node MCU Microcontroller, Internet of Things (IoT), Arduino Board.

1 Introduction

In today's rapidly evolving urban landscapes, the challenge of parking congestion has become increasingly prevalent. The traditional approach to managing parking spaces often leads to inefficiencies, frustration, and wasted time for drivers and administrators.

However, amidst these challenges, the emergence of IoT technology presents a groundbreaking opportunity to revolutionize urban mobility. By seamlessly integrating IoT technology into parking systems, cities can unlock a new era of smart and efficient parking solutions [1]. This innovative approach contributes directly to Sustainable Development Goal 11 (Sustainable Cities and Communities) by promoting smarter mobility, reduced congestion, and enhanced urban livability."

Navigating the urban landscape has become increasingly challenging for drivers, especially in densely populated cities where the proliferation of automobiles exacerbates the scarcity of parking spaces, leading to numerous practical difficulties asserting that parking issues have become pervasive and are rapidly escalating across all urban centers. Recognizing the pressing need for improved parking management, researchers worldwide have endeavored to develop more efficient systems [2].

Among the proposed solutions, leveraging Internet of Things (IoT) technology has emerged as a promising avenue. In this setup, the infrared sensor will identify the object as depicted in [Figure 1].

Fig. 1: IR Sensor in car parking

The Internet of Things serves as the crucial bridge connecting the physical realm to the digital domain, facilitating remote access to offline resources and transforming conventional objects into interconnected entities. Essentially, IoT entails the connectivity of smart devices to a global network via modern wireless communication systems. Moreover, the concept of IoT embodies the paradigm of ubiquitous connectivity, enabling seamless interaction with any object, from any location, at any time. Across various domains, IoT has been harnessed to create an array of innovative parking systems, exemplified by the utilization of Wireless Sensor Networks (WSNs) [3].

Research Gap and Main Contributions- Existing parking management systems relay on camera-based image processing, RFID (Radio Frequency Identification) or

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WSN (Wireless Sensor Networks). These solutions suffer some limitations, mainly: (a) complexity, (b) installation and maintenance cost, and (c) energy consumption. Additionally, some works proposed a conceptual framework without deployment feasibility. This situation led to research investigating low-cost, real-time, light-weight, easy-deployed systems.

The main contributions of this paper is four-fold: (a) Design of low-cost IoT-based solution for parking management, (b) real-time data synchronization with central database, (c) prototype implementation and experimental validation, and (d) user acceptance evaluation.

2 IoT Integration in Parking System

IoT indicates the network of physical objects or "things" embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet. These objects can range from simple household items like refrigerators and thermostats to complex industrial machinery and vehicles. The concept behind IoT is to enable these objects to collect and exchange resources autonomously, leading in increased efficiency, improved decision-making, and even new services and business models. IoT has applications across various industries, including healthcare, transportation, agriculture, manufacturing, and more in [Fig.1].

In the smart and efficient car parking system, the Internet of Things (IoT) has a vital role in optimizing management and operation of parking facilities. Here's how IoT can be utilized in such a system.

2.1 Sensor Integration

IoT-enabled sensors can be deployed in parking spaces to detect the presence or absence. These sensors are either integrated into the ground or affixed to parking barriers, providing continuous real-time monitoring of each spot's occupancy status.

Fig. 1: IoT in various industries

2.2 Data Collection and Processing

The data collected by these sensors is transmitted wirelessly to a centralized system using IoT communication protocols such as Wireless Fidelity, Bluetooth, or cellular connectivity. This data includes information about available parking spots, occupancy duration, and patterns of usage.

2.3 Smart Parking Management System

A central management system processes the data received from sensors to provide real-time information to drivers searching for parking spaces. This system can analyze historical data to predict parking demand and optimize parking allocation.

2.4 Data Analytics and Optimization

By collecting and analyzing data from IoT sensors, parking operators can gain insights into parking usage patterns, peak hours, and customer preferences. This data can be used to optimize parking facility layouts, pricing strategies, and operational workflows to maximize revenue and customer satisfaction.

Overall, IoT technology enables the creation of a smart and efficient car parking system by providing real-time visibility, automation, and optimization of parking operations, ultimately improving the parking experience for both drivers and parking facility operators.

3 Literature Review

This section provides a summary of several relevant studies focusing on the utilization of infrared sensor technologies by researchers across various systems and methodologies.

3.1 Maximizing the Potential of IR Sensor Technology to Revolutionize Both Smart Security Systems and Smart Home Automation

A consortium of scholars proposed the development and deployment of an avant-garde smart home infrastructure harnessing cutting-edge infrared sensor technology to meticulously monitor human movements and seamlessly illuminate designated spaces upon entry. Within this sophisticated framework, the IR sensor meticulously gathers data regarding object presence or absence, transmitting this crucial information to the central controller. Seamlessly integrated into the network, the IR sensor and relay collaborate harmoniously. Upon receiving the transmitted data, the controller orchestrates precise signals to designated relays, thereby dictating the operational state of connected appliances. This meticulously crafted system employs four infrared sensors intricately linked to a central microcontroller [4].

Similarly, another iteration of a smart home setup employs an infrared sensor to detect human motion within confined areas. This system features dual infrared sensors to discern entry or exit from a room, complemented by an LED indicator signaling detection of human movement [5]. The resulting multidisciplinary insights demonstrate how solar-powered metro rail systems can enhance urban sustainability by lowering dependence on fossil fuels, reducing carbon footprints, and improving transport resilience. These findings highlight the importance of integrating renewable energy systems into urban infrastructure planning to develop sustainable and livable cities for present and future generations.[26]

An IR sensor-based smart home security system. The infrared sensor was strategically placed at the entrance of a home to detect human movement. Both the sensors and the camera module were linked to the Arduino Uno board. The Node MCU board was then connected to the Arduino Uno board. Upon finding any movement, the camera module activated, capturing an image of the person in front of the house's entry [6]. The recorded photograph will then be sent to the user's email and saved in the folder on the homeowner's computer. The outcomes are also viewable on a smartphone.

3.2 utilizing Infrared Sensors in Traffic Control

An infrared sensor in the creation of a traffic control system to detect obstructions as vehicles pass by. The IR sensor is designed to pick up signals in situations where there is a lengthy obstacle or a high density of cars on the road, contributing to effective traffic control. More traffic means that it will take longer for a route to go past the traffic signal, whilst less traffic means it will take less time [7]. To ensure proper coordination with the traffic signal, these infrared sensors are deployed to detect approaching vehicles. Harnessing the wealth of data harvested by these sensors, the Raspberry Pi controller assumes a pivotal role, acting as the central nexus orchestrating decisions regarding the activation or deactivation of signal lights on the corresponding sides of the thoroughfare. Exploiting nuanced insights into traffic density, the Raspberry Pi governs the intricacies of the traffic control system, determining the display of requisite signals contingent upon the prevailing conditions.

In term, the author suggested and created an IR sensor-based traffic management system. The system's goal is to detect traffic jams by carefully counting the direction in which the car is traveling. Every important route has a display panel that alerts drivers to traffic congestion.

The system will deploy a pair of infrared sensors along every signal and main road, strategically positioned for optimal detection. Upon detection of a vehicle by the initial sensor, the counter increments by 8 units, signifying its passage. Subsequently, as the second sensor identifies the vehicle's presence, the count is updated to reflect the accurate "vehicle count," while decrementing the prior counter. A congestion event is inferred if the first sensor registers vehicle activity but the second sensor remains inactive for a predefined duration. The microprocessor of the 8051 family was linked to the infrared sensor.

3.3 Garbage Monitor Using an Infrared Sensor

This researcher proposed a waste management solution leveraging IR sensor technology to avert overflowing garbage bins.The system architecture consists of various components, including an Arduino Uno, Liquid Crystal Display, light source(LED), chime(buzzer), Infrared sensors, energy provision, and Wireless Fidelity module. AnIR sensor is responsible for detecting the trash level once garbage is deposited into the can, providing an efficient method for garbage monitoring [9].

The amount of waste in the trash can be indicated by the panel, illuminated at varying intensities. The refuse can's capacity when it is full of rubbish will be shown on the LCD. The buzzer will begin to sound when the garbage can is 80 percent loaded. The Wi-Fi module incorporated into the Node MCU will send a message to the appropriate device indicating that the garbage bin is almost full.

A comparable system is centered on the waste monitoring system. Similar to the prior technique, the goal of this one is to determine the garbage's level. Four infrared sensors are employed in this system to display the different levels of waste that have accumulated in the bucket. The author proposed a system where the output from the garbage monitoring system, likely obtained through IR sensors, is sent to a microcontroller [10]. This microcontroller then relays the information to the control room using a GSM module. This approach ensures that the garbage levels are efficiently communicated to the central monitoring system for timely and effective management.

Table 1 illustrates a comparison between the related work and the work proposed in our paper.

Table 1: Comparison of parking management systems in the literature

System Type	*Detection Technology*	*Infrastructure Cos*	*Computational Complexity*	*Installation Complexity*
RFID-based	RFID tags and readers	High (requires RFID tags per vehicle and multiple readers)	Low–Moderate	Moderate
Camera-based	Image processing / Computer Vision	High (cameras + processing units)	High (requires image processing algorithms)	High
WSN-based	Wireless sensor nodes (magnetic, ultrasonic, etc.)	Moderate–High	Moderate	Moderate
IT-based (our proposal)	Infrared proximity sensors	Low	Low	Low

4 Existing system

The author proposed the conventional method of finding a parking space involves aimlessly driving around until a vacant spot is located, often resulting in wasted time and fuel due to the uncertainty of the destination. Alternatively, employing However, this system may pose challenges in multi-storeyed parking structures, resembling the aimless driving scenario. Furthermore, while modern puzzle parking management systems offer an advanced alternative, they come with drawbacks. Installation and maintenance costs can be prohibitive for small businesses or individuals. Moreover, these systems have limited capacity, potentially causing inconvenience when exceeding their capabilities. A destination-specific approach within the parking structure can streamline the process[11]. A smart car parking system offers a more efficient solution by providing visual cues indicating available spaces in [Illustration 1]. Drivers can simply glance at rows of LED lights, with red indicating occupied spaces and yellow denoting availability.

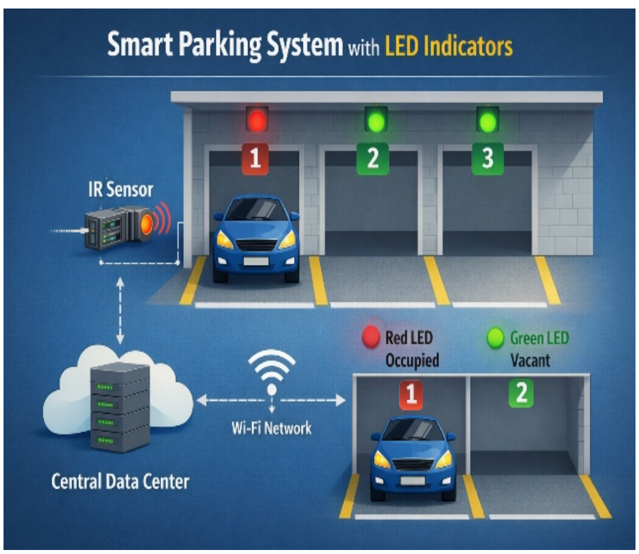


Illustration 1: Smart parking system using LED

5 Proposed System

This section describes the methods used to construct the suggested Internet of Things automobile parking system.

5.1 Harnessing the Prowess of Infrared Sensors to Architect a Cutting-Edge IoT-Driven Car Parking Management System

[Illustration 2] showcases the intricate system architecture implemented in the smart and efficient parking system seamlessly integrated with IoT technology, seamlessly integrating state-of-the-art IR sensor technology. The system encompasses a myriad of components, including the IR sensor, Node MCU microcontroller, Display panel, and a specialized HTTP server entrusted with data repository.

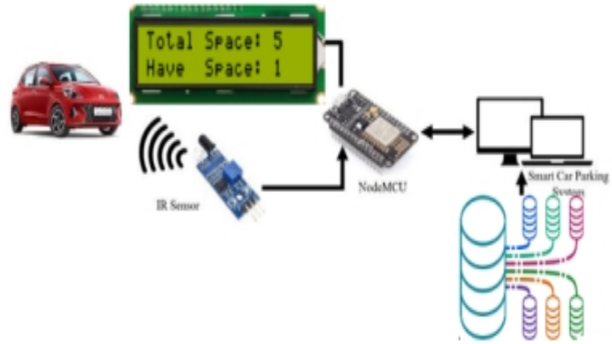


Illustration 2: Exploring the Intricacies of IoT-Enabled Car Parking Management System Architecture

The incorporation of Internet of Things (IoT) technology into the proposed parking system revolutionizes the user experience as they navigate parking facilities. Upon arrival, the user's vehicle is swiftly identified by the IR sensor, a pivotal component of the IoT infrastructure. This data is seamlessly transmitted to the Node MCU microcontroller, which orchestrates the system's operations in tandem with the IR sensor and LCD display. The LCD panel dynamically showcases available parking spots, offering real-time insights to incoming drivers. Notably, the precision of the system allows users to pinpoint their designated parking space with ease, enhancing convenience and efficiency. Furthermore, the captured data regarding parking space availability is securely stored in the database, ensuring seamless access via the vehicle parking management system's intuitive interface. The integration of an access point facilitates robust connectivity, enabling timely communication between the microcontroller and the database. This connectivity is vital for relaying crucial information, including vehicle ingress and egress events, and updating the status of parking spaces in real-time. Ultimately, the meticulous orchestration of IoT components optimizes the parking experience, empowering both users and administrators with actionable insights and seamless connectivity throughout the parking facility.

5.2 IR Sensor-Based Internet of Things-Based Vehicle Parking Management System Implementation

This subtopic covers the setup procedures for the necessary hardware and software needed to construct the suggested infrared sensor car parking system. The suggested system was developed using a variety of gear, including an LCD display, an IR sensor, a Node MCU, jumper wire cables, a breadboard, and microUSB. Additionally, the Arduino IDE, Notepad++, and SERVER are the three types of software that are employed in this suggested system. The Node MCU microcontroller can be programmed or communicated with via the LCD display and IR sensor using the Arduino IDE software. In the meantime, the database and user interface of the suggested vehicle parking management system are being developed using Notepad++ and SERVER software.

The primary goal is to create and build an automated parking system that uses infrared sensor technology to identify vehicles. The procedure included creating an infrared sensor-based vehicle parking system. This infrared sensor is used to identify a car when it pulls into an empty parking spot. Additionally, the LCD display panel in this suggested system was utilized to show the availability of a parking space. The vehicle parking management system's interface provides users with comprehensive access to the wealth of data collected and stored in the database. This interface serves as a gateway for users to interact with and leverage the information gathered by the system. The paramount goal of the proposed parking system is to guarantee the flawless operation and efficacy of the sophisticated information framework it provides.

To validate the effectiveness and usability of the system, a practical approach was taken, involving the creation and integration of a small-scale prototype of the automobile parking system. This exemplary prototype, illustrated in [Illustration 2], integrates the fundamental elements of the car parking management system, featuring cutting-edge infrared sensor technology at its core. By deploying this prototype, real-world testing can be conducted to assess the system's performance and user experience in practical scenarios.

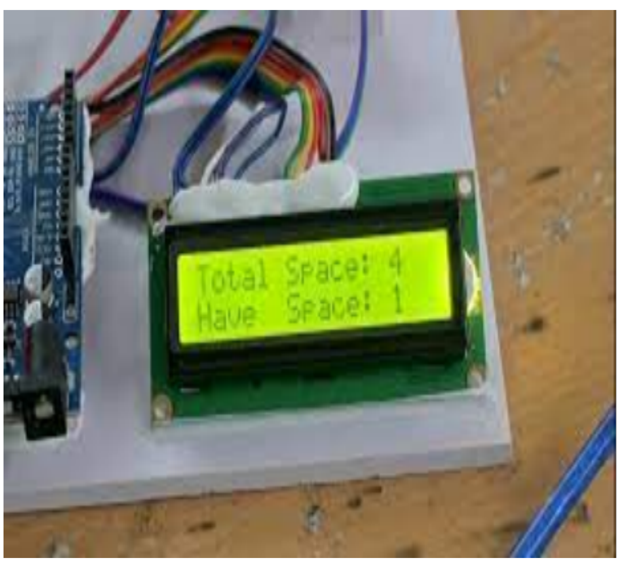
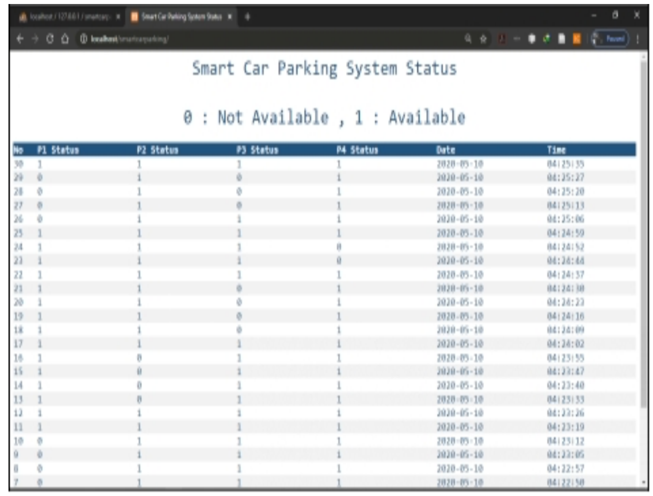


Illustration 3: Delving into the Prototype of an IoT-Infused Car Parking Management System Harnessing Advanced IR Sensor Technology

PHP was harnessed for crafting the interface of the car park management system working in tandem. Meanwhile, the microcontroller adeptly captured data from the IR sensor and seamlessly integrated it into the database. [Illustration 4] vividly portrays the system's visualization of parking slot availability, offering an exhaustive portrayal of the current status of parking spaces in real time.



Smart Car Parking System Status

0 : Not Available , 1 : Available

No	P1 Status	P2 Status	P3 Status	P4 Status	Date	Time
30	1	1	1	1	2020-05-10	04:25:35
29	0	1	0	1	2020-05-10	04:25:27
28	0	1	0	1	2020-05-10	04:25:20
27	0	1	0	1	2020-05-10	04:25:13
26	0	1	1	1	2020-05-10	04:25:06
25	1	1	1	1	2020-05-10	04:24:59
24	1	1	1	0	2020-05-10	04:24:52
23	1	1	1	0	2020-05-10	04:24:44
22	1	1	1	1	2020-05-10	04:24:37
21	1	1	0	1	2020-05-10	04:24:30
20	1	1	0	1	2020-05-10	04:24:23
19	1	1	0	1	2020-05-10	04:24:16
18	1	1	0	1	2020-05-10	04:24:09
17	1	1	1	1	2020-05-10	04:24:02
16	1	0	1	1	2020-05-10	04:23:55
15	1	0	1	1	2020-05-10	04:23:47
14	1	0	1	1	2020-05-10	04:23:40
13	1	0	1	1	2020-05-10	04:23:33
12	1	1	1	1	2020-05-10	04:23:26
11	1	1	1	1	2020-05-10	04:23:19
10	0	1	1	1	2020-05-10	04:23:12
9	0	1	1	1	2020-05-10	04:23:05
8	0	1	1	1	2020-05-10	04:22:57
7	0	1	1	1	2020-05-10	04:22:50

Illustration 4: Refined Interface Design for Car Parking Management System

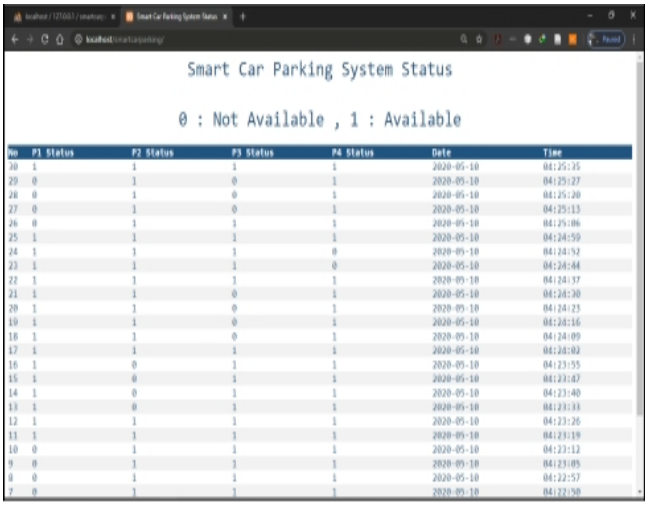
5.3 Specifies the Experiment and Simulation

According to the prototype blueprint of the envisioned parking system, as illustrated in [Illustration 2], four infrared sensors are strategically deployed in front of each parking slot to intricately discern the presence or absence of vehicles. Moreover, an LCD display board positioned at the entrance dynamically presents accurate information regarding the availability of vacant parking spaces whenever a vehicle occupies a slot.

Within each parking bay, an infrared sensor is intricately installed to discern the presence or absence of an automobile. These sensors are seamlessly integrated with the Node MCU microcontroller. Subsequently, the microcontroller diligently updates the server database with sensor data, transmitting pertinent information every time a vehicle enters or exits a parking space. Operating as input devices within this proposed parking infrastructure, the sensors facilitate real-time data acquisition, while the LCD screen, functioning as an output interface, serves as a visual indicator of parking slot availability. The display seamlessly updates, representing vacant parking slots with the symbol '//', and occupied slots with 'XX'. This instantaneous status depiction on the LCD screen offers users a quick and intuitive means to ascertain parking space availability within the facility.

Illustration 5: LCD Screen Status

Upon vehicle detection, the IR sensors seamlessly initiate communication with the database through a WiFi connection, swiftly transmitting pertinent data. [Illustration 5] vividly portrays the dynamic parking status within the vehicle parking management system. Constantly refreshed on this interface is the real-time value of the IR sensor, accurately depicting parking space availability. A value of 0 denotes unavailability, while 1 signifies an available parking spot. Moreover, the database meticulously logs the timestamp of each car's entry and exit from the parking space, ensuring comprehensive record-keeping.



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27	0	1	0	1	2020-05-10	04:25:13
26	0	1	1	1	2020-05-10	04:25:06
25	1	1	1	1	2020-05-10	04:24:59
24	1	1	1	0	2020-05-10	04:24:52
23	1	1	1	0	2020-05-10	04:24:44
22	1	1	1	1	2020-05-10	04:24:37
21	1	1	0	1	2020-05-10	04:24:30
20	1	1	0	1	2020-05-10	04:24:23
19	1	1	0	1	2020-05-10	04:24:16
18	1	1	0	1	2020-05-10	04:24:09
17	1	1	1	1	2020-05-10	04:24:02
16	1	0	1	1	2020-05-10	04:23:55
15	1	0	1	1	2020-05-10	04:23:47
14	1	0	1	1	2020-05-10	04:23:40
13	1	0	1	1	2020-05-10	04:23:33
12	1	1	1	1	2020-05-10	04:23:26
11	1	1	1	1	2020-05-10	04:23:19
10	0	1	1	1	2020-05-10	04:23:12
9	0	1	1	1	2020-05-10	04:23:05
8	0	1	1	1	2020-05-10	04:22:57
7	0	1	1	1	2020-05-10	04:22:50

Illustration 6: Monitoring Parking Availability Status in the Car Parking Management System with Exquisite Precision

To verify the reliability of the proposed parking system prototype, rigorous testing of its functionality was conducted. This comprehensive assessment aimed to ensure the system's resilience against potential hardware configuration failures, logical inconsistencies, and linguistic errors. To execute the prototype test effectively, various scenarios were meticulously considered and deliberated upon.

Case 1: The LCD panel status precisely communicates the availability of car parking spaces by displaying the '//' symbol whenever a slot is vacant. As illustrated in [Illustration 7], the screen indicates that four parking spaces are currently available for vehicle parking.

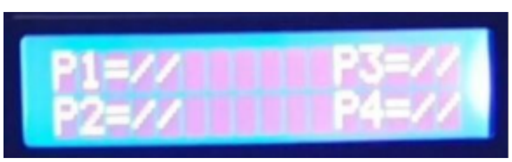

Illustration 7: Status of LCD screen (four spaces are available)

Case 2: The LCD panel swiftly updates the status of parking space P1, transitioning to display the 'XX' symbol, signifying its occupation, as depicted in [Illustration 8], when the initial car occupies parking slot 1 (P1). Subsequent vehicles can then gauge the availability of parking in spaces P2, P3, or P4. This dynamic display system fosters efficient and real-time monitoring of parking space occupancy, ensuring optimal utilization of available parking spots.

Illustration 8: The current status of the LCD screen indicates that the P1 slot is unavailable at this time

Case 3: Upon the departure of the initial vehicle from parking space number one (P1), the LCD panel promptly updates the space's availability for parking, displaying the "\\" symbol to indicate its availability, as depicted in [Illustration 8]. This swift update ensures that subsequent vehicles can readily identify and utilize the now vacant parking space, facilitating seamless parking management.

Illustration 9: Status of LCD (screen Revised Accessibility Status for Parking Bay P1)

Case 4: As the second vehicle gracefully glides into slot 2 (P2) and a third vehicle elegantly occupies slot 3 (P3), the LCD panel promptly synchronizes, dynamically reflecting the real-time availability status of the parking slots. Displaying the 'XX' symbol, it indicates that these parking spaces are now occupied, as depicted in [Illustration 10]. Until all parking spaces are filled by vehicles, any subsequent vehicle will be directed to park in either P1 or P4 slot, ensuring optimal utilization of the available parking space.

Illustration 10: The current status of the LCD screen indicates that the P2 and P3 slots are inaccessible

The developed prototype was evaluated through a series of operational scenarios (Case 1–Case 4). The testing confirmed the following functional outcomes:

- The IR sensor accurately detected vehicle presence and absence in each parking slot.
- The NodeMCU microcontroller successfully processed sensor signals and updated slot status.
- The LCD panel dynamically reflected real-time availability using predefined symbols:

  ‘//’ for vacant slots

  ‘XX’ for occupied slots
- The central database correctly logged vehicle entry and exit timestamps.

Across all tested scenarios, the system maintained consistent behavior without logical failure or communication breakdown. The transition of parking slot status (vacant → occupied → vacant) was successfully demonstrated under sequential vehicle movements. These results validate the correct integration between the system layers: sensing layer, processing layer, and display layer within the IoT-based architecture.

5.4 Test of User Acceptance

The performance of the suggested prototype was assessed to make sure all requirements were met. A series of questionnaires were distributed to each responder in order to conduct the User Acceptance Test (UAT). This testing was done to verify sure the system meets user acceptance requirements and that it can perform the needed task in accordance with specifications. The respondents were chosen at random from among drivers with prior parking system experience. Data were gathered utilizing a quantitative research strategy by analyzing survey questionnaires that respondents completed using the arithmetic mean technique.

The study encompassed a cohort of thirty participants to meticulously evaluate the reception of the envisaged vehicle parking system. Preliminary exhibitions elucidating the system's operational intricacies preceded the participants' engagement in an exhaustive questionnaire, encompassing twelve intricately crafted items stratified into Perceived Ease of Use (PEU), Perceived Usefulness (PU), ATTitude (ATT), and intention to use (BI). Respondents meticulously gauged their responses on a spectrum from "strongly disagree" to "highly agree," delineating a nuanced score range from 1 to 5. Subsequently, an arithmetic mean technique was applied to analyze the data, and the total mean was computed using the scale provided in Table 1, which ranges from zero to five. This total mean was then categorized into negative, neutral, and positive classifications, enabling an assessment of the user acceptability of the proposed parking solution.

The depicted outcomes in [Illustration 11] elucidate an exceedingly positive response from participants regarding the functionalities and attributes of the vehicle parking system. Remarkably, the Perceived Usefulness (PU) and Perceived Ease of Use (PEU) scores, registering at 4.30 and 4.40, respectively, underscored participants' profound satisfaction with the system's usability and practicality. Furthermore, the overarching mean outcomes for Attitude (ATT) and Intention to Use (BI), both soaring to 4.40, signify a robust inclination towards embracing the proposed car parking system. This preference is largely attributed to the system's efficiency in saving drivers' time by promptly indicating the availability of vacant parking spaces. The favorable feedback received during the User Acceptance Test (UAT), with an overall total mean of 4.34, further validates the positive reception and potential success of the proposed parking solution.

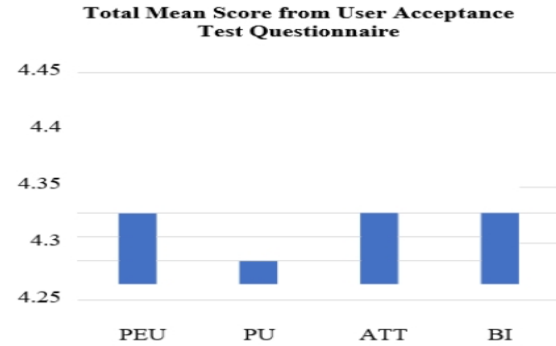

Illustration 11: Aggregate Mean Rating for Every Component during User Acceptance Testing (UAT)

6 Result and Discourse

Utilizing an advanced IR sensor, the Internet of Things-based automobile parking management system seamlessly executes its tasks, encompassing precise detection of car presence or absence, real-time display of parking space availability, and systematic storage of sensor data in a comprehensive database. Furthermore, the benefit of the suggested parking system is that it may provide the user with a precise parking space location. Building upon the definitive findings, it was unequivocally established that the envisioned IR sensor-based car parking system not only emerged as an exceptionally auspicious concept but also showcased remarkable potential for further refinement and advancement. Furthermore, the overwhelmingly positive response from respondents underscored their enthusiastic acceptance of the suggested parking system, particularly in its ability to mitigate the pervasive issue of vehicle parking, thereby minimizing the wastage of time associated with searching for available parking spaces.

7 Summary and Future Prospects

The proposed parking system, employing an infrared sensor, was developed with the Internet of Things (IoT) as its central idea. This study offers an effective method for locating a parking spot. A prototype of an Internet of Things (IoT)-based car parking management system with an infrared sensor was developed to aid drivers in locating open parking spaces. This suggested parking system used an infrared sensor to determine whether a car was there and how available a parking space was. There are always parking spaces available.

Monitored, and the LCD screen's data is updated regularly. The precise position and availability status of a parking space are shown on the LCD panel. In the meantime, the database also contains the IR sensor's data. The prototype of the proposed parking system was created for an individual parking spot; however, it is possible to expand this model to accommodate several storage spaces. Additionally, an interface for the automobile parking management system was made available so that the administrative management could track the condition of a parking space as well as the precise moment a car arrives or quits. The suggested parking system's output is beneficial to apply in any parking area to facilitate drivers in quickly locating available space.

In addition, the proposed parking system was evaluated using a user acceptance test to gauge the level of acceptance among the general public. Most of the participants it was a fantastic idea to create a parking solution designed to assist vehicles discover an available parking spot rapidly and positively welcomed the suggested parking system employing an IR sensor. Due to its capacity to economize consumers' time, energy, and fuel consumption, it presents a remarkable convenience to them. By developing a sophisticated smartphone application facilitating users in navigating, locating, and pre-booking parking spaces online, this endeavor can be significantly amplified.

Future enhancements of the proposed system may focus on expanding the prototype to support multi-slot and multi-level parking environments. Integration with a dedicated mobile application would enable real-time navigation, online reservation, and digital payment functionalities. All

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