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IOT-ENABLED SMART PARKING SYSTEM FOR URBAN DEVELOPMENT

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ABSTRACT

The IoT-based Smart Parking System is a revolutionary solution designed to address the challenges of urban parking management. This innovative system integrates advanced sensor technology, IoT connectivity, and real-time data analysis to optimize parking space utilization. With the ability to monitor parking space occupancy, provide real-time information to drivers, and enhance parking management, the IoT-based Smart Parking System promises to reduce traffic congestion, save time and fuel for motorists, and improve urban mobility. Parking allocation has become a major problem in modern cities for which numerous smart parking systems (SPS) have been developed. This paper aims to provide comprehensive study, comparison and extensive analysis of SPSs in terms of technological approach, sensors utilized, networking technologies, user interface, computational approaches, and service provided. Moreover, the paper fills up the research gap by providing a clear insight into the suitability of SPSs in various environmental conditions and highlights their advantages/disadvantages. The extensive comparison among multiple aspects of SPSs would enable researchers, designers, and policymakers to identify the best suited SPS and understand the current trends in this sector.

Keywords: IR Sensors, Arduino UNO, LCD, Buzzer, IoT module.

1. INTRODUCTION

As urban populations continue to grow, the demand for efficient parking solutions becomes increasingly critical. Urban centers face the challenges of traffic congestion, air pollution, and the frustration of drivers searching for parking spaces. The traditional approach to parking management, reliant on manual monitoring and inadequate information dissemination, no longer meets the needs of modern cities. The emergence of the Internet of Things (IoT) and sensor technology has opened new possibilities for addressing these challenges. The IoT-based Smart Parking System harnesses these technologies to create a smarter, more efficient parking environment. This system revolutionizes the way parking spaces are monitored, communicated, and managed. In the following sections, we will explore the limitations of the existing parking systems and the innovative features and benefits of the proposed IoT-based Smart Parking System. The evolution from the conventional parking management approach to a smarter and more effective system marks a significant leap in urban mobility and convenience.

The quantity of automobiles on the road is growing daily at an exponential rate. Utilising the available space as well as possible is necessary to provide parking for every car. Parking problems are a result of a rise in the number of cars on the road as well as improper use of the existing space. Developing a smart parking system that aids in locating the closest accessible parking spot is crucial. This saves the user a great deal of time, lowers the car's fuel use, and ultimately lowers emissions. A survey claims that it takes users 15 minutes or more to find a parking spot that works for their car, which increases

fuel consumption, pollution, traffic jams, and user wait times. The relevant problem can be solved with a smart parking system, which largely automates the process of finding available parking spaces with little to no help from humans. This comprises an IOT module's hardware that is installed on-site and utilised for a variety of functions, such as determining if parking spots are available, integrating safety and security alarm systems for things like gas leaks and fires, automating gate opening and shutting mechanisms, and gathering data in real-time for the cloud. As part of this Smart Parking System, a mobile application has been developed that offers comprehensive details on parking space availability, allows users to reserve a time slot in advance, guides users from their location to the parking lot, and generates a charge after a space is used. This Smart Parking System makes advantage of the Internet of Things (IoT) concept, allowing for remote hardware kit control and monitoring with only an internet connection. The networking of physical components, such as different sensors and devices with the capacity to communicate with other physical devices and exchange data in real time over the internet, can be used to represent the Internet of Things.

The problem of a rising number of cars every year but not an equal number of parking spaces was addressed by the "Smart Car Parking Management System". In comparison to systems that are sold commercially, they were able to create "The Smart Parking System" at the lowest possible cost. They save the details of a certain parking space at a specific local host inside an area. They also employed cloud storage to store data on several parking lots in one location, and they eventually used it for remote sensing. They also improved the image processing method for identifying the car's licence plate in the database where they save data.

One of the main uses of Bluetooth technology, home automation, is used to illustrate the applications of Internet of Things (IOT) in this article, "Internet of Things (IOT): An overview and its applications". The home automation interface with IOT offers several diagnostic services to help identify and track down system issues. The work's programme chart explains how to switch the LAMP on and off as well as how to quit the programme.

2. LITERATURE SURVEY

As per [1], smart parking systems often gather data on parking spots that are accessible within a specific area and utilise real-time processing to assign cars to available spots. It entails the use of inexpensive sensors, real-time data gathering, and automated payment systems compatible with mobile phones to enable users to book parking in advance or very precisely anticipate where a spot will likely be. When smart parking is implemented as a system, fewer individuals are needlessly circling city blocks in search of space, which lowers automobile emissions in metropolitan areas. It also enables towns to precisely control the amount of parking available. One of the main issues with driving in cities is locating vacant parking places and stopping unlawful parking. Smart parking helps with these issues. This suggests that M2M systems prioritise convenience over accuracy and safety. Three elements make up the parking assistance system: a showing unit, a control module, and monitoring modules. In addition to the aforementioned three components, it will also have an SMS gateway and a centralised supervisory system to keep track of parking spaces. The monitoring module has ambient light and ultrasonic sensors that detect open parking spots and send the information to the control unit via ZigBee. In addition to identifying the vehicle, the sensor offers other details including how long the vehicle has been parked and its current condition. After processing the data, the control units forward it to the central supervisory system. The drivers are not informed in advance about the available slots. We are aware that parking systems are frequently affected by IoT algorithms, which represent a new paradigm that improves device connectivity [2]. It is increasingly turning into a crucial component that ties large systems

together. Customers would have a more sophisticated perspective of the malls thanks to improvised automobile parking arrangements, which would benefit their companies. The number of vehicles on the road has led to a massive development in the parking business. Therefore, in this case, parking space transparency is crucial. Numerous kinds of detectors have been created using cameras, GPS, and other technologies; nevertheless, they are not very precise, cost a lot of money, and demand a lot of processing power. The paper proposes an IoT-powered Smart Outdoor Parking System to address the increasing reliance on parking cars in metropolitan areas. It reviews existing parking technology and systems, highlighting their shortcomings. The proposed system is more energy-efficient and uses Wi-Fi and ARM processors for communication. Future improvements include a companion application for checking parking space availability and reserving places, a load sensor, LED indicators, and a parking management database [3]. The document discusses the development of a smart parking system using IoT and GPS to minimize searching time, fuel consumption, and pollution. It aims to find, allocate, and reserve parking for authenticated users, providing navigation instructions to reach the parking area easily. The system utilizes sensors such as IR Sensor, RFID, GSM, and ANPR System, along with hardware components like Arduino Mega, LCD 16*2, Servo motor, and more. The solution involves a flow chart for booking slots, navigation, payment, and security verification, with access granted through RFID card/token and QR code confirmation.

3. EXISTING SYSTEM

The current parking management systems in urban areas rely on traditional, manual, and inefficient methods. These systems suffer from various limitations, including limited visibility into parking space availability, resulting in drivers' difficulty in quickly finding open spots. Inefficient resource allocation involves manual counting of available spaces by parking attendants, leading to inaccuracies. Drivers often lack real-time information on parking space availability, causing increased traffic congestion and unnecessary fuel consumption. Inefficient parking management contributes to congested parking areas, where drivers spend excessive time searching for available spots. Moreover, these systems do not provide comprehensive data for analyzing parking patterns, adjusting rates, or enhancing security. As a result, the existing systems offer a frustrating and inadequate parking experience for drivers, necessitating the adoption of a smarter solution.

4. PROPOSED SYSTEM

4.1 OVERVIEW

The proposed IoT-based parking system is equipped with a range of essential components to facilitate efficient and smart parking management.

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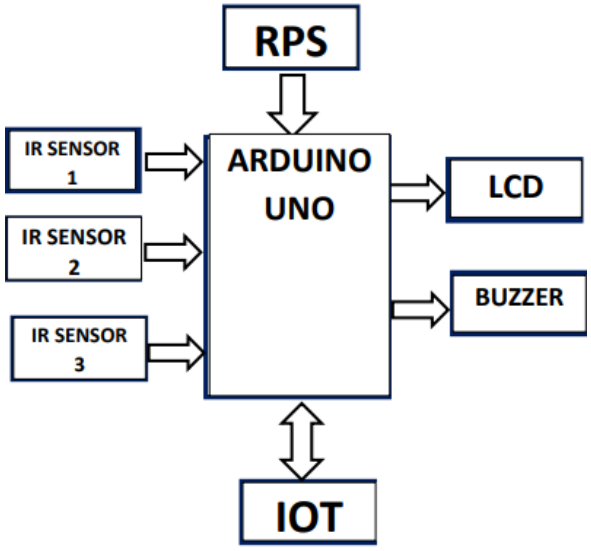

Fig. 1: Block diagram of proposed system.

The key components of the system include:

- Three IR (Infrared) Sensors: These sensors are strategically placed in parking spaces to detect the presence or absence of vehicles. They provide real-time information about parking space occupancy.
- LCD Display: An LCD screen is incorporated at a prominent location, such as the entrance or within the parking area. It displays essential information, including the number of available parking spaces and other instructions.
- Buzzer: A buzzer is used to provide audible alerts and notifications. It can be triggered in response to various events, such as vehicle entry or exit, or when the parking area is full.
- IoT Device: An Internet of Things (IoT) device is the central element of the system. It collects data from the IR sensors, processes the information, and facilitates data transmission to a centralized server or cloud platform. The IoT device enables remote monitoring and control of the parking area.
- Parking Space Occupancy Monitoring: The three IR sensors are strategically positioned within the parking area to monitor the occupancy of individual parking spaces. They continuously detect the presence of vehicles. When a vehicle enters or exits a parking space, the respective IR sensor registers the change in occupancy status. This real-time data is transmitted to the IoT device.
- LCD Display and Real-Time Information: The LCD display, installed at a visible location, presents real-time information to drivers and parking attendants. It indicates the number of available parking spaces within the parking area, helping drivers quickly identify open spots. The display can also provide instructions and directions for efficient parking.
- Audible Alerts and Notifications: The buzzer is integrated into the system to provide audible alerts and notifications. It can be programmed to sound when specific conditions are met, such as when the parking area is full, and no more vehicles can be accommodated.

— IoT Connectivity and Data Transmission: The IoT device serves as the communication hub of the system. It collects data from the IR sensors and transmits it to a centralized server or cloud platform. This IoT connectivity enables remote access to real-time parking data.
— Remote Monitoring and Control: Users, including parking attendants and management, can remotely access the parking system's data through a web-based dashboard or a dedicated mobile application. This dashboard offers a user-friendly interface for visualizing real-time parking occupancy and status.
— Parking Management and Efficiency: The proposed IoT-based parking system optimizes parking management by providing up-to-the-minute data on parking space availability. This leads to efficient space utilization and improved traffic flow within the parking area. Moreover, the system enhances the overall parking experience for drivers by reducing the time spent searching for available spaces.
— Alerts and Notifications: The system can issue alerts and notifications through various channels, such as email, SMS, or mobile applications. These alerts can inform parking attendants and management about critical events, such as a full parking area or unauthorized entries.

The IoT-based parking system, featuring three IR sensors, an LCD display, a buzzer, and an IoT device, offers a smart and efficient solution for parking management. It enhances parking space utilization, reduces congestion, and provides real-time data for improved decision-making. This system benefits both drivers and parking facility operators by streamlining the parking process and improving the overall parking experience.

4.2 WORKING

A smart parking system uses IoT devices and sensors to collect real-time data on parking lot occupancy and transmits this information to the cloud or local network. It also involves building IoT apps for end-users, like parking administrators and drivers. They can adopt this mobile or web application and access the necessary data on available parking spaces, pricing, etc.

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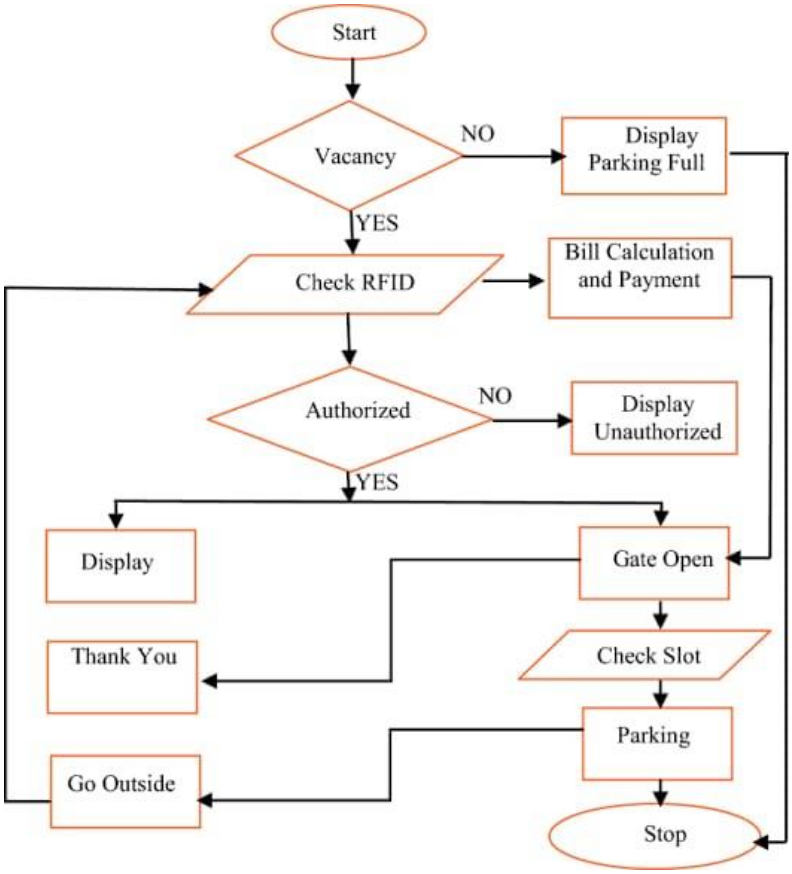

Fig. 2: Flow diagram of proposed system.

Logic Explanation

- Library and Pin Declarations: The code includes the Liquid Crystal Display and Software Serial libraries and declares pins for various components, including IR sensors (irL and irR), an ultrasonic sensor (Trig Pin and Echo Pin), and a buzzer.
- beep() Function: This function is responsible for making the buzzer beep briefly by setting it to LOW and then HIGH after a delay.
- ultra_obj() Function: This function uses an ultrasonic sensor to detect an object in front of it. It sends a trigger signal, measures the time it takes for the echo to return. The calculated data is stored in the obj1 variable and returned.
- Setup Function: In the setup() function, various pins are configured as input or output. The IoT module is initialized using the IoTinit() function, and the LCD displays a startup message.
- Loop Function: The loop() function continuously performs the following tasks:
  - Detects the object using the ultrasonic sensor and displays it on the LCD.
  - If it stops the train, beeps the buzzer, and sends an obstacle detection message via IoT Module.
  - Checks the state of two IR sensors (irL and irR) and displays “Crack” on the LCD if a crack is detected. It stops the model, beeps the buzzer, and sends a message via IoT Module in this case.
- IoTinit() Function: This function initializes the IOT module by sending a series of AT commands. It sets up the module for sending SMS messages

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— converts() and convert() Functions: These functions convert unsigned integers into characters and display them on either the serial monitor or the LCD

5. HARDWARE IMPLEMENTATION

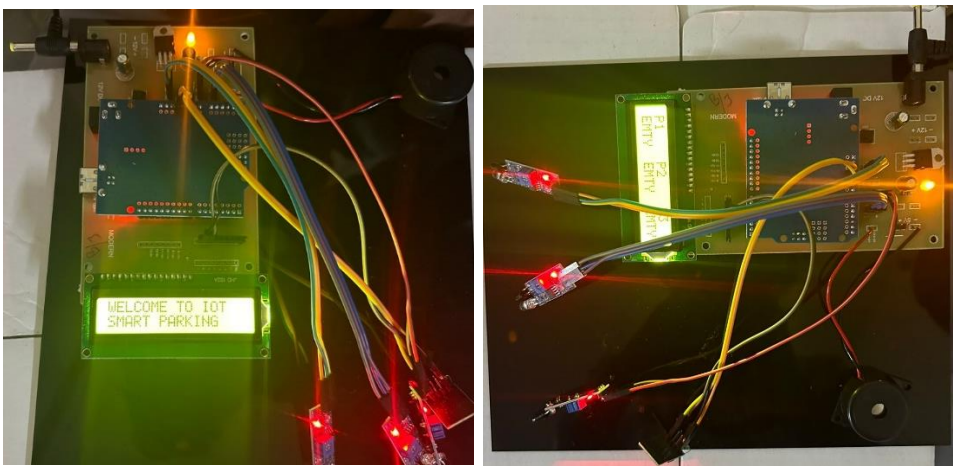

Fig. 23: Overall hardware circuit of smart parking.

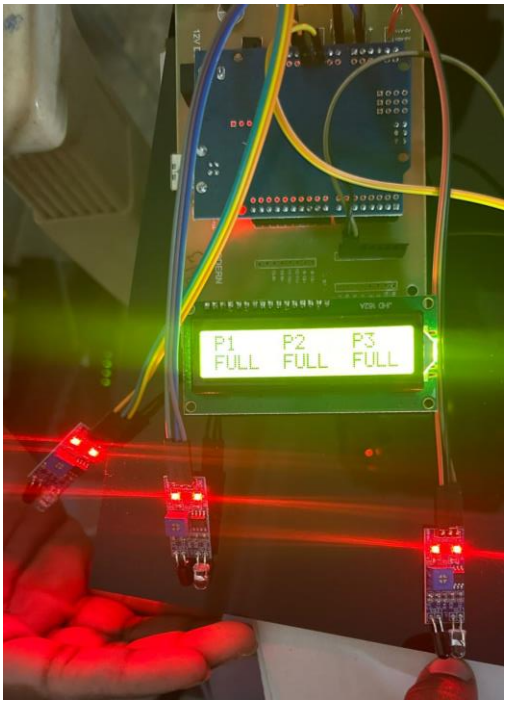

Fig. 4: Detecting parking spaces.

6. CONCLUSION

To conclude, we spoke about the Smart Parking System as a potential answer to the parking problem. By saving a great deal of time, smart parking systems benefit users and the environment by reducing human-generated traffic, which lowers pollution and benefits the community by making better use of all available parking spots. Additional improvements to the Smart Parking System include integrating machine learning and artificial intelligence with the current system to make vehicle identification easier. Additionally, by implementing multi-layered security standards in Al, parking lots can be made secure,

thwarting fraudster attacks. Additionally, the collected data in the cloud may be used to identify user parking habits and provide push notifications to users with suggestions for open parking spaces.

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