

## IoT Framework for Realtime Smart Parking Prediction and Control

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**Abstract** - This high growth in the number of vehicles has greatly exacerbated the problem of vehicle parking, especially at the commercial places and the huge shopping malls. Drivers tend to waste a lot of time in finding vacant slots and this increases fuel use, traffic jams and frustration to users. Parking systems that are conventional are usually not efficient because they use manual monitoring systems as well as paper ticketing. In this paper, plan to present a smart parking system using the Internet of Things (IoT) to monitor and manage the availability of parking. This will be a sensor-equipped system with an ESP32 microcontroller that will be utilized in the determination of the have the slots, and send them to a web-based application where an individual can view the real-time parking location. The proposed system will allegedly optimize the traffic flow, reduce the search time and make the search possible usage of the available space more convenient in general, which will result in the need to consume less fuel.

**Keywords:** internet of things (IoT), Smart Parking, ESP32, Slot Detection, Real-Time Monitoring, Traffic Management.

### 1. INTRODUCTION

With the high pace of urbanization, it has been difficult to control on parking space in high density places. Nowadays, places like malls, multiplexes, and commercial complexes see a huge number of vehicles every day, that makes the necessity of a well-organized and proper parking system. Nevertheless, drivers tend to spend much time in search of a parking spot, particularly during the busiest times, weekends, or holidays. This does not only cause overcrowding in the parking spaces but also causes long queues at entry points and exit points, resulting in frustration among users. The other prevalent issue is the unequal utilization of parking space whereby certain parts receive excessive congestion as compared to others be vacant, primarily due to lack of real-time information. The majority of conventional parking systems continue to use manual management and paper tickets. This complicates the whole process and makes it slow, less efficient and susceptible to human mistakes. Moreover, depending on parking attendants will add to the operation costs and may also make the process even more time-consuming. Inefficient parking management also has an impact on traffic and the environment. Cars that are traveling in search of parking wastes consume fuel and pollute the air. Sometimes the congestion around the parking lots is even extended to the adjoining routes and thus the entire traffic flow is influence, inflicting inconvenience upon people.

In order to overcome these issues, the Internet of Things (IoT) technology is a modern and effective solution. The suggested smart parking makes use of the sensors to record the presence of vehicles in the parking slots, and the ESP32 microcontroller to send the occupancy information to a cloud-based system. It is displayed on a local display unit and web-based application where the users can keep track of the parking availability in real time. Also, RFID technology is integrated in giving safe access

and identification to vehicles and the system is energy efficient and eco-friendly by the use of a solar panel.

The proposed system advances the management of parking, helps to improve the levels of congestion, decrease fuel consumption, and increase the overall convenience of users because the given solution allows utilizing space efficiently, improving the level of security, and shortening the time of search.

### 2. BODY OF PAPER

#### 2.1 Literature Review / Related Work

In [1], the authors developed an intelligent parking system, centered on the optimal energy management, based on the smart grid technology. The model involves an artificial neural network that forecasts the parking demand and the traffic. It also has smart charging and discharging of electric vehicles as a means of enhancing efficiency. It is a system that is developed through optimization with the aim of maximizing profit and energy consumption. The findings demonstrate better performance and economic gains in smart parking spaces.

The authors suggested Fed Park, a smart parking solution in [2] which operates based on the concept of crowdsensing that uses smartphone sensors to detect on-street parking space. The system uses Federated Learning to create an international model without compromising the privacy of people by not sharing raw information. It minimizes the communication overhead as it only sends the model updates rather than sensitive information. The method is tested in different conditions of the city and has high accuracy and reliability. These outcomes show that the system is efficient to deliver real-time information on parking and at the same time maintain data security and privacy.

The authors suggested the use of IoT-based smart parking system in [3] to solve the problem of growing cars and scarce parking slots in cities. The system works on sensors, which track the availability of parking slots and incorporates cloud-based resources to manage it effectively. It creates a mobile application that enables individuals to reserve and check parking space on real-time basis. Also, the system will facilitate automated gate control and calculation of parking fees depending on the duration. The solution suggested will enhance the efficiency of the parking and give an easy and user experience.

In [4], the authors introduced an IoT-based smart parking system to solve the problem of increasing demand of parking space in cities. The parking slot system is based on the sensors and wireless communication technologies that track the availability of parking slots and send information to a cloud server. It is a mobile application that offers real-time information about free parking space and location details to users. IoT and cloud technology can be combined to share data efficiently through data analysis. The proposed system will increase the parking efficiency, decrease the search time, and make the ease of use of the user more convenient.

In [5], the authors came up with a smart parking system (IoT-based) to address the problem of traffic jam and poor parking management in the traditional parking systems. The system has sensors to check slots availability and constant updates in real time as obtained via a mobile application. The technology of NFC is also used to distinguish registered and unregistered vehicles, enhancing the level of access control and security. The proposed system can be especially useful in the settings such as colleges where the levels of parking congestion are extensive. The solution increases the level of parking organization, lessens congestion and makes it more convenient to the users.

**2.2 Problem Statement**

The rate of car additions to the urban areas is so high that it has made the car parking problem a challenging factor. Drivers spend much time in searching for free parking slots, specially in areas like malls and colleges. Traditional parking systems includes human intervention and does not provide any real-time information.

To overcome these challenges, a Smart IoT-based Parking System is proposed. In this system sensors along with an ESP32 microcontroller are used to monitor the occupancy status of parking slots in real time. The availability of parking spaces is displayed on an LCD at the parking area and also on a web application, allowing users to check and book slots remotely. Additionally, RFID technology enhances security by managing user access and identifying vehicles. The system also guides users to available parking spaces, helping reduce search time, traffic congestion, and fuel consumption, while making the overall parking process more efficient.

**2.3 Objectives**

The following are the objectives of the proposed system:

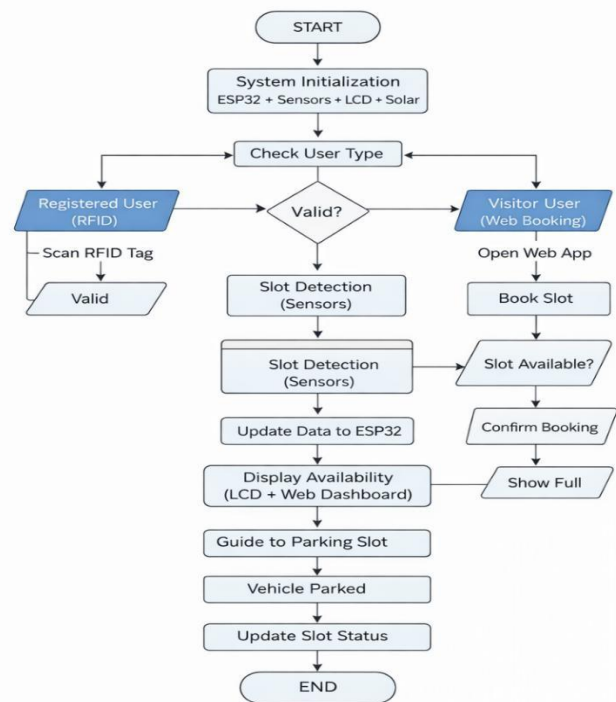
- To design an IoT-based smart parking system to monitor the availability of parking slots in real-time.
- To show the real time data of parking space using an LCD and Web-based app.
- In order to guide the drivers to the empty parking lots and save time in search.
- To minimize the level of traffic, fuel consumption, and waiting time through better parking management.
- To make more of the parking space and the overall ease of the system and its users.

**2.4 Methodology**

The Smart IoT-based Parking System proposed is developed as an efficient parking management system with a clear methodology. The program starts with the initialization phase during which all the hardware components such as the ESP32 (ESP12E) microcontroller, sensors, LCD display, RFID module, and solar power system are started. This system will subsequently verify the type of user, whether the user is a registered or a visitor.

RFID is applied in authentication in case of registered users. A user scans the RFID tag and on successful identification of the credentials, entry to the parking area is allowed. On the web-based application, which serves visitors, they can see the available parking slots and reserve one before hand. A reservation will be taken in case of free spots or the system will be notified that the parking lot is used. Once the access has been

granted, a sensor on each parking spot will check whether there are cars or not. ESP32 microcontroller interprets this information and sends it to a cloud-computer. The real-time parking is indicated on an LCD which shows the parking place and the web dashboard position. This system will then guide the user to the free parking area that will save time and congestion in the parking area. The slot is then given an updated status on the car once it is parked in the slot. The system is made in a manner that it is eco-friendly and efficient in the consumption of energy using a solar panel. Overall, the methodology allows one to control everything in real-time, offer greater security, and guarantee the efficiency of space utilization, and be convenient to the user.



**Description:** The flowchart shows the functioning of the proposed Smart IoT-based Parking System. The key components like ESP32 microcontroller, sensors, RFID module and display unit are setup to start the system. Users can access the parking system through RFID authentication if they are registered, or by making a reservation through web application if they are visitors. Sensors will continuously monitor the parking slots to detect whether it is occupied or available. The information is then updated in real time and displayed on both the LCD screen and the web dashboard. System helps users to find the available parking slots and automatically updates the status of each slot once it is occupied by vehicle.

**2.5 Implementation**

The suggested Smart IoT-based Parking System is a combination of a number of hardware components collaborating to provide an efficient parking management system.

1. The ESP12E Wi-Fi module is the brain of our system. It collects information from sensors. Sends parking data to our web application in real time using Wi-Fi.
2. We use an IR sensor to figure out if a parking spot is taken or not. It helps us determine if a car is in a parking space.

3. The ultrasonic sensor measures the distance between itself and a vehicle. This is really good at figuring out if a parking spot is being used.
4. We use RFID tags and a reader for security. To make sure only authorized people can park. Each registered user gets an RFID tag that they swipe to get into the parking area.
5. The servo motor. Closes the parking gate automatically. It does this based on who's trying to get in and if there are any empty parking spots.
6. The LCD display shows us what parking spots are available and which ones are taken. This information is always up to date.
7. We also have a panel that powers our system. This makes it energy efficient and good, for the environment because it uses power.

### 2.6 Results and Discussion

The offered smart parking system was tested to investigate its functionality and usefulness. It perfectly announced the presence of vehicles and real-time slot availability with the help of the web application. The outcomes revealed that there was a minimum of parking search time, enhanced traffic flow, and enhanced space utilization that proved that the system was effective in improving parking management.

#### 1. System



Fig -1 vision

#### 2. PCB designing

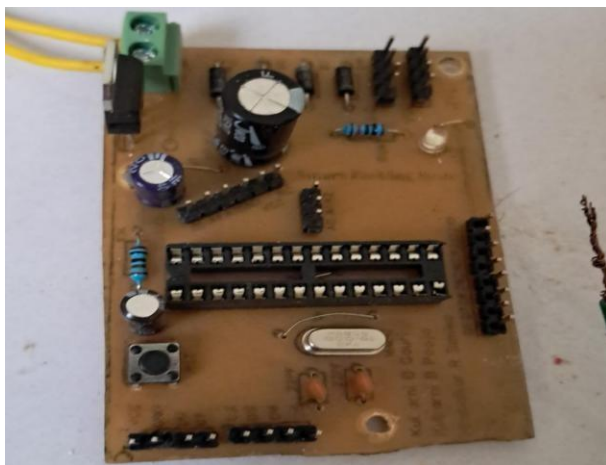


Fig -2: PCB

The proposed smart parking system circuit involves a PCB circuit as the above figure displays. The PCB assembles the highly necessary components, including resistors, capacitors,

voltage regulation and IC sockets, needed to make the system work. It is the main hardware component that links and manages different modules such as RFID reader, sensors, servo motor and LCD display. The circuit is made to take the right signal processing and constant power supply to all parts. This installation reflects the actual implementation of the hardware of the system.

#### 3. Hardware implementation:

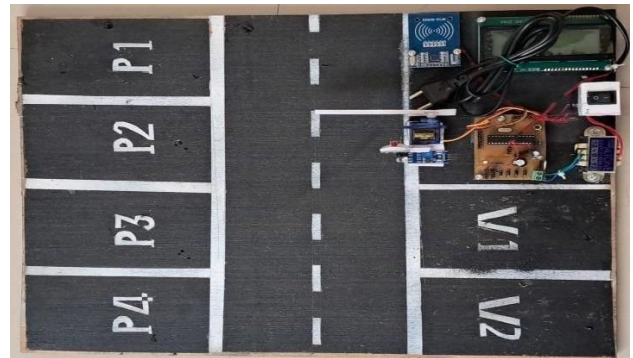


Fig -3. Hardware

The prototype of the proposed smart IoT based parking system is illustrated in the above figure. The model will include several parking spaces (P1-P4) to host registered users, and V1-V2 to accept visitors, as well as a control center. As part of the system, it combines, the RFID module, which is used to authenticate the user, a servo motor that automatically controls the gate and an LCD display to indicate the availability of a parking space. The PCB circuit is the central control unit that processes information that is sent by other modules. The prototype is an example of practical application of real-time parking monitoring and automated access control.

#### 3. Software Implementation:

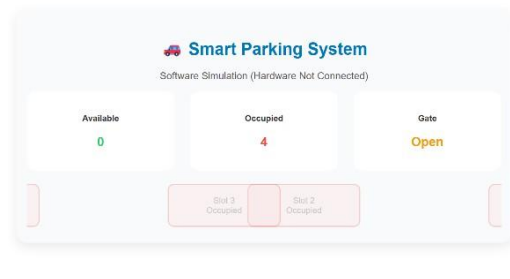


Fig -4: Website

The figure above demonstrates the dashboard created online to examine the smart parking system. The dashboard shows real-time information like available and occupied parking slots as well as the state of the gates. It offers an easy to use interface that lets a user check the availability of parking easily offsite. Depending on the input of the hardware components, the system dynamically updates the data. This shows how IoT technology can be integrated into a web application in order to manage and park efficiently and conveniently.

## 2.8 Limitations

The smart parking system has some limitations. The prototype model is built at a small scale and might need to be changed to fit into a large-scale real world. Vehicle detection accuracy is determined by the performance of the sensor that can be influenced by the environment. The system is currently dependent on stable internet connectivity on real-time update of data on the web dashboard. Also, the prototype has a low hardware implementation and some of its features like solar power and advanced sensing are not completely implemented in the proposed design but in the prototype. Such restrictions can be tackled during any subsequent system improvements.

## 2.9 Future Scope

Future Scope of the Smart Parking System

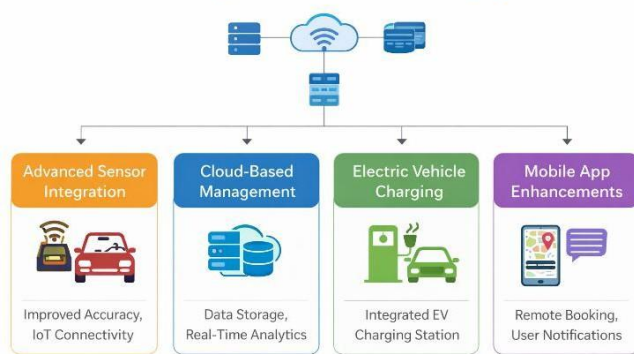


Fig -5: Future scope

The smart parking system that is being proposed can be extended to include the following improvement:

- Advanced sensors to enhance accuracy and reliability in detecting parking slots.
- Adoption of cloud-based operation to make real time data storage and monitoring and analytics.
- Closure of the system to charge electric vehicle (EV) stations.
- Creation of a mobile application which will offer such features as remote booking and user notifications.
- We can utilize this project for real-time usage on crowded places like supermalls, airports, markets.
- Addition of battery storage and solar power to enhance energy efficiency and operation even during power outages.

## 3. CONCLUSIONS

The suggested smart parking system based on the IoT is an effective and safe method to overcome the problems that are connected with the traditional parking management systems. In the context of the use of sensors and ESP32 microcontroller, the system will enable the real-time detection of the availability of parking slots and constant monitoring of the availability of parking slots. The creation of the web-based application will allow users to access the real-time parking data to save time on the search of vacant spaces.

In addition to this, the system enhances utilization of parking space, lessens traffic jam, and it also minimizes fuel consumption that is brought about by the unnecessary movement of vehicles. The security of the system and automation is enhanced by the features of RFID-based access control and automated functioning of the gates. Generally, the

proposed system is an affordable, scalable, and easy to use system that would be suitable to deploy smart parking, which would be befitting in the modern city environment.

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