International journal of imaging science and engineering

ISSN: 1934--9955 www.ijise.net
Vol-20 Issue-01 April 2025

IOT-POWERED SMART PARKING SYSTEM WITH DYNAMIC SLOT ALLOCATION

Battu Sahaja[1], Chittala Ramani [2], Pittla Keshava [3], Mrs.Ch. Mamatha [4]
[1,2,3] UG Scholar, Department of ECE, St. Martin's Engineering College, Secunderabad, Telangana, India, 500100
[4]Assistant Professor, Department of ECE, St. Martin's Engineering College, Secunderabad, Telangana, India, 500100
battusahaja@gmail.com

Abstract:

The rapid urbanization and increasing number of vehicles have led to severe parking congestion in cities, necessitating the development of smarter and more efficient parking solutions. This paper presents an IoT-based Smart Parking System that optimizes parking space utilization and enhances user convenience through real-time monitoring and automated slot allocation. The system is designed using ESP32 microcontrollers and IR sensors, which work in conjunction to detect parking slot occupancy. The collected data is wirelessly transmitted to a centralized cloud server, ensuring seamless real-time updates on parking availability. Users can access this information through a mobile application or web interface, which displays the nearest available slot, thereby reducing search time and minimizing traffic congestion around parking facilities.

By dynamically allocating parking slots based on availability, the system maximizes space usage and ensures smooth vehicle movement. This automated approach significantly reduces fuel consumption and lowers carbon emissions, contributing to a more sustainable urban environment. Additionally, the cloud-based infrastructure enhances scalability, allowing the system to be implemented across different parking facilities, from small lots to large commercial parking structures. The project highlights the potential of IoT-driven smart city solutions, demonstrating how real-time data processing and automation can enhance urban infrastructure, improve user experience, and promote environmental sustainability. This smart parking system not only alleviates common parking challenges but also sets a foundation for the integration of IoT in future intelligent transportation systems.

Keywords: RFID Tag, IR sensor, IoT (Internet of things), ADC (Analog to Digital converter), GPIO Pins (General purpose input output), ESP-32 micro controller.

1. INTRODUCTION

Car parking is a major issues in modern congested cities of today. There simply are too many vehicles on the road and not enough parking space. This has led to the need for efficient parking management systems. Thus we demonstrate the use of IOT based parking management system that allows for efficient parking space utilization using IOT technology. To demonstrate the concept we use IR sensors for sensing parking slot occupancy along with a dc motors to simulate as gate opener motors. We now use a wifi modem for internet connectivity and an AVR microcontroller for operating the system. We use IOTGecko for online connectivity and IOT management GUI design. The system detects if parking slots are occupied using IR sensors. Also, it uses IR technology to sense if avehicle has arrived on gate for automated gate opening.

The system reads the number of parking slots available and updates data with the cloud server to allow for checking parking slot availability online. This allows users to check for available parking spaces online from anywhere and avail hassle free parking. Thus the system solves the parking issue for cities and get users an efficient IOT based parking management system. In recent times the concept of smart cities have gained grate popularity. Thanks to the evolution of Internet of things the idea of smart city now seems to be achievable. Consistent efforts are being made in the field of IoT in order to maximize the productivity and reliability of urban infrastructure. Problems such as, traffic congestion, limited car parking facilities and road safety are being addressed by IoT. In this paper, we present an IoT based cloud integrated smart parking system. The proposed Smart Parking system consists of an on-site deployment of an IoT module that is used to monitor and signalize the state of availability of each single parking space. A mobile application is also provided that allows an end user to check the availability of parking space and book a parking slot accordingly. The paper also describes a high-level view of the system architecture. Towards the end, the paper discusses the working of the system in form of a use case that proves the correctness of the proposed model. The concept of Internet of Things (IoT) started with things with identity communication devices. The devices could be tracked, controlled or monitored using remote computers connected through Internet. IoT extends the use of Internet providing the communication, and thus inter-network of the devices and physical objects, or 'Things'.

The two prominent words in IoT are "internet" and "things". Internet means a vast global network of connected servers, computers, tablets and mobiles using the internationally used protocols and connecting systems. Internet enables sending, receiving,or communicating of

International journal of imaging science and engineering

ISSN: 1934--9955 www.ijise.net

Vol-20 Issue-01 April 2025

information. Thing in English has number of uses and meanings. Dictionary meaning of 'Thing' is a term used to reference to a physical object, an action or idea, situation or activity, in case when we do not wish to be precise. IoT, in general consists of inter-network of the devices and physical objects, number of objects can gather the data at remote locations and communicate to units managing, acquiring, organizing and analyzing the data in the processes and services. It provides a vision where things (wearable, watch, alarm clock, home devices, surrounding objects with) become smart and behave alive through sensing, computing and communicating by embedded small devices which interact with remote objects or persons through connectivity. The scalable and robust nature of Cloud computing is allowing developers to create

and host their applications on it. Cloud acts as a perfect partner for IoT as it acts as a platform where all the sensor data can be stored and accessed from remote locations.

2. LITERATURE SURVEY

Abhirup Khanna, [1]

"IoT based smart parking system". The sensors used in IoT based smart parking system stores and accesses data from remote locations with the help of the cloud these factors give raise to cloud of things (COT). The nodes could be monitored and controlled from any location the system that we propose provides information regarding the availability of the parking slots with the help of the mobile application the users from the remote location can book the parking slots.

Deng, D, [2]

"Cloud-based smart parking system". An algorithm is used to increase efficiency of cloud-based parking system and network architecture technology is used. This algorithm is used to find the lowest cost parking space. Considering the number of parking space available and also considering the distance of the parking space from the user. The user can directly access the cloud-based server and find the information on the parking space. The user can also install an application in their mobile phones to access this information. With the help of this algorithm, waiting time of the user to find a parking space can be minimised. Security aspects are not included in this paper.

O. Orrie B.S., [3]

" A Wireless smart parking system" A wireless sensor node along with smart phone application is being used to find the parking space. Since, wireless technology is used here the system has high accuracy and efficiency. In this system, onboard units are used to communicate with other vehicles. The user parks his vehicle in any one of the several bays available a mechanical lift lifts the vehicle out. A ticket key and id are given to the user and it is only known to the user which is used to retrieve the vehicle. The user need not carry any paper ticket since an RFID card is given to the user. The technology used here is economical. Security features must be improved to protect the user's privacy.

Khaoula Hassoune, [4]

"Smart Parking Systems: A survey" The author of smart parking system the survey has divided detector system and vehicle sensors into two math categories as intrusive sensors and non - intrusive sensors. Intrusive sensors are installed in holes on the road surface by tunnelling under the road. Non-intrusive sensors do not affect the surface of the road and it can be easily installed and maintained. Smart parking system helps us to resolve the grounding problems of the traffic congestion and it also reduces the emission from a car.

Wael Alsafery, [5]

"Smart Car Parking System solution for the IoT in smart cities". A paper proposes efficient way to unfold the issue of parking availability in the real time scenario and to reduce the time consumption. In this, the data is sent locally with devices which filters the data. This signal is transmitted over the cloud for the process as well as for evaluation which uses machine learning algorithms. This paper uses mobile phone application that connects the user with the real time traffic status via Google API. Thus ,avoiding traffic congestion. This paper does not provide the reservation facility for the car parking.

Rachapul Lookmuang, [6]

"Smart Parking Using IoT Technology" Smart parking using IoT technology helps to designs and develops a real smart parking system which provides information for vacant spaces and also helps the user to locate the nearest availability. This paper uses a computer vision to detect vehicle number plate in order to enhance the security. The user can pay for the parking space prior to the entry of the car through mobile payment. Thus, insuring the reservation of the parking. The user is notified about the parking location, number of slots available and all other relevant information. The paper uses efficient algorithms and techniques for extracting license plate text. An algorithm operates on the ultrasonic sensor detection of the vehicle entering into the parking slot and calculates the minimum cost for theuser.

Mohit Patil, [7]

"Smart Parking System based on reservation" Smart parking system based on reservation allows the reservation of a vacant space which involves smart parking system based on reservation (SPSR).This consists of host parking database management which collects and stores data about the driver's identity and parking location. When the parking reservation time is about to expire a notification will be sent to the user through the web service that has been provided to the user by the admin. The main drawback is that some other user can occupy a reserved parking space to avoid this QR scanners are used to identify the user.

Vishwanath, [8]

"Survey Paper on Smart Paring System Based on IoT" It helps us topropose a way in which the user can reserve his parking space by mentioning the destination and the vehicle type with the help ofmobile applications. The booking details will be stored in the cloudwhich finds the shortest path from the user to the parking space , thelocation of the user is updated regularly in the cloud with the help ofGPS . When the user reaches the car parking the RFID is scanned andthe user is allowed into the parking space. The billing is done by thecloud server. The main disadvantage is that the car parking spacemust be registered in the smart parking system for the user to use it. **Dr, V, Kepuska, [9]**

"Smart Car Parking System". This paper describes the implementation of wireless sensor networks (WSN) used in a car parking system with

International journal of imaging science and engineering
ISSN: 1934--9955 www.ijise.net
Vol-20 Issue-01 April 2025

the help of a server which is using xbeezigbee. The car parking system can detect the car which is parked in the parking slot. The aim of this project is to make it cost effective and user friendly. Car parking system helps the user to sustain the data with 90% of accuracy.

J. Cynthia. (10)

"IoT based Smart Parking management system". Smart car parking system provides a comprehensive parking solution for the user as well as admin of the parking area. It provides the feature for a reserved parking slot and identify reserved user. In this, user can navigate to the nearest parking area depending upon the size of the vehicle. The user can reserve parking slot based on hourly, daily, weekly or monthly basis. An algorithm is designed to identify the nearest parking according to the size. The mobile application provided to the user is used to reserve and pay-as-you go service.

3. PROPOSED METHODOLOGY

The proposed system is designed to revolutionize urban parking management by providing real-time updates on parking slot availability and enabling users to reserve slots in advance through an IoT-based mobile application. The growing number of vehicles in cities has led to severe parking congestion, causing unnecessary delays, increased fuel consumption, and environmental pollution. This system aims to address these challenges by integrating ESP32 microcontrollers, IR sensors, RFID authentication, and IoT connectivity to create an automated, efficient, and user-friendly smart parking solution.The system relies on infrared (IR) sensors, which are deployed at each parking slot to detect the presence of a vehicle. These sensors capture real-time occupancy data and transmit it to the ESP32 microcontroller for processing. The ESP32, with its built-in Wi-Fi module, facilitates wireless communication between sensors, cloud servers, and the user interface. The collected data is sent to an IoT server, where it is stored and processed to provide up-to-date parking slot availability.

Users can access this information through a mobile application or web interface, allowing them to locate and reserve parking spaces in advance, thereby reducing the time spent searching for an available spot.

3.1 Block Diagram:

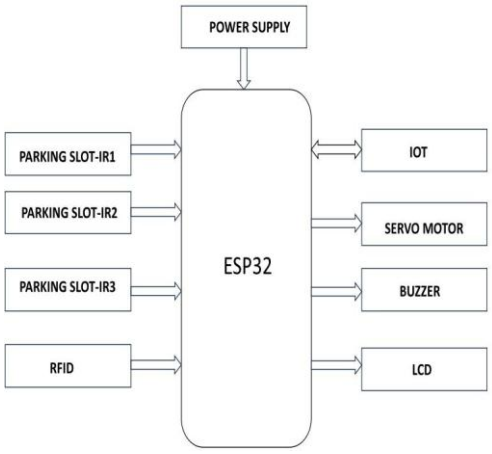


Fig – 3.1 Block Diagram of Circuit

the system is highly scalable, making it suitable for various parking infrastructures, including shopping malls, corporate offices, airports, public parking areas, and residential complexes. The cloud-based infrastructure ensures that the system can be expanded to accommodate additional parking slots without requiring significant hardware modifications.

The IoT-based Smart Parking System using ESP32 represents a major advancement in urban parking management by integrating real-time monitoring, automated slot allocation, and IoT-based notifications. By eliminating manual intervention and leveraging advanced technologies, this system reduces congestion, enhances security, optimizes space utilization, and improves user convenience. The integration of RFID authentication, IR sensors, and real-time cloud- based monitoring ensures that the system remains highly efficient, scalable, and cost-effective.

As urban areas continue to expand and vehicle numbers increase, adopting smart parking solutions will be essential for sustainable city development. This automated, data-driven approach provides a foundation for future smart transportation systems, making cities more connected, efficient, and environmentally friendly.

3.2 Project Working:

This project consist of following modules, RFID reader, ESP32 Micro controller, RPS, IR sensors, LCD display and Servo motor. When a vehicle need parking place them search for parking place. So by checking in online for the availability of parking slots then we prefer parking place. To park a vehicle at first we need to have RFID tag, so RFID reader scans the valid card and it shows the amount deducted from the card. Then the servo motor which acts as gates will be opened and the vehicle will be parked in the slot. The LCD display shows the availability of slots in the parking area,the amount deducted and valid or invalid card.In this way the project works in the cities for vehicle safe parking.

International journal of imaging science and engineering

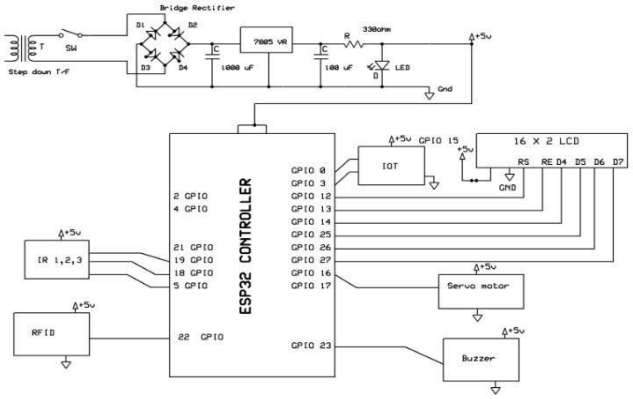
ISSN: 1934--9955 www.ijise.net
Vol-20 Issue-01 April 2025

3.3 SCHEMATIC DIAGRAM

Fig-3.3 Schematic Diagram of ESP32 Controller

This is the pin diagram where all the hardware components are connected. The ESP32 microcontroller has multiple GPIO pins. The step-down transformer, bridge rectifier, capacitors, resistors, and LED are connected in the regulated power supply, which provides 5V to the ESP32 and all input/output modules. Connections can be seen in the above fig-4.3.

- The 16*2 LCD Monitor relates to the digital pins 12, 13, 14,25, 26, 27.
- This is the pin diagram where all the hardware components



are been connected to ESP32 microcontroller. In which 14 GPIO pins as digital pins and 6 GPIO pins. 16MHz crystal oscillator connected internally. The step down transformer ,Bridge rectifier capacitor with 1000f Resisters and led are connected in Regulated power supply which provide the 5v to th e Arduino and all input/output modules.

- Schematic
- 16*2 LCD Monitor has connected with the Digital pins 12, 13, 14, 25, 26, 27.
- WIFI has connected to Digital Pins 0, 3 internalTransmitter and receiver pins.
- 3IR sensors connected to 18, 19, 21 pins.
- RFID connected to digital pin 22.
- Servo motor connected to digital pin 16.
- Buzzer alarm connected to digital pin 23.

International journal of imaging science and engineering

ISSN: 1934--9955 www.ijise.net
Vol-20 Issue-01 April 2025

4. EXPERIMENTAL ANALYSIS

Start:

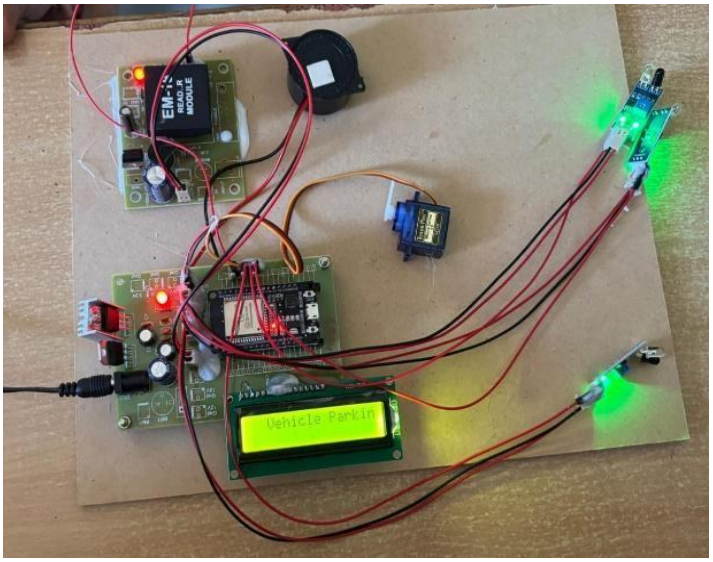


Fig- 4.1 Turning on the Circuit

The above figure shows overall architecture of the smart parking system which includes LCD Display, ESP32 micro controller, Regulated power supply, RFID Reader(Radio Frequency Identification), Servo motor, Buzzer, InfraRed Sensors. When the system is supplied with the power the regulated power supply will convert the AC power to DC power with 5v. Connect the kit with the wi-fi then we can find the title in the LCD display.

Getting Slot availability:

Fig- 4.2 Slot availability

The above figure 4.2 shows that parking slots are full. The vehicle cannot occupy the slots by using the RFID tags. If the parking slots are empty then we can find the empty slots.

ISSN: 1934--9955 www.ijise.net
Vol-20 Issue-01 April 2025

Fig –4.3 Swiping RFID Card

When the RFID tag is valid then is shows the RFID card number and the amount will be deducted from the card. If the card is invalid the it shows the card is invalid.

4.4 Web Server:

S.No	Slot1	Slot2	Slot3	Card	Debited	Balance	Date
1	Full	Empty	Empty	1	10	990	2025-02-21 12:27:50
2	Empty	Empty	Empty	1	10	970	2025-01-23 13:07:32
3	Empty	Empty	Empty	1	10	980	2025-01-23 13:07:06
4	Full	Empty	Full	2	10	990	2025-01-23 13:06:43
5	Empty	Empty	Empty	1	10	990	2025-01-23 13:06:30
6	Empty	Empty	Empty	2	10	990	2025-01-23 12:53:58
7	Empty	Empty	Empty	1	10	980	2025-01-23 12:53:42
8	Empty	Empty	Empty	1	10	990	2025-01-23 12:52:58
9	Empty	Full	Empty	2	10	990	2025-01-22 18:55:16
10	Empty	Empty	Empty	1	10	990	2025-01-22 18:54:25
11	Empty	Empty	Empty	2	10	990	2025-01-22 18:51:10
12	Empty	Empty	Empty	1	10	990	2025-01-22 18:50:14

Fig – 4.4 Web Server

The web Server data shows the parking slot availability. The data which will be displayed in the LCD display will be updates in the web server through the ESP 32 micro controller. This web server dataindicates the amount debited with respect to time and date.

5. CONCLUSION

The proposed IoT-based Smart Parking System presents a technologically advanced solution to the persistent issue of urban parking congestion. By integrating ESP32 microcontrollers, IR sensors, and cloud-based data processing, the system effectively monitors parking slot occupancy in real-time and automates slot allocation, significantly improving parking efficiency and user convenience. The wireless transmission of data to a centralized cloud server ensures seamless updates on parking availability, enabling users to make informed decisions through a mobile application or web interface.

By dynamically allocating slots based on real-time occupancy data, the system not only optimizes parking space utilization but also helps in reducing search time, minimizing traffic congestion, and lowering fuel consumption. This, in turn, contributes to a cleaner and more sustainable urban environment by reducing carbon emissions. The scalability of the cloud-based architecture ensures that the system can be deployed across a variety of parking facilities, making it a versatile and adaptable solution for modern cities.

ISSN: 1934--9955 www.ijise.net
Vol-20 Issue-01 April 2025

Beyond just addressing parking challenges, this project serves as a proof of concept for IoT-driven smart city innovations, demonstrating how real-time automation and intelligent data processing can enhance urban infrastructure and improve overall efficiency. The integration of IoT in transportation management paves the way for future advancements in smart mobility, setting the stage for a more connected, intelligent, and sustainable urban ecosystem.

REFERENCES

[1] Abhirup Khanna, R. A. (2016). IoT based Smart Parking System. International Conference on Internet of Things and Applications (IOTA) (p. 5). Pune: IEEE.

[2] Deng, D. (2015). A Cloud-Based Smart-Parking System Based on Internet-of-Things Technologies. IEEE,

[3] O. Orrie, B. S. (2015). A Wireless Smart Parking System. IECON (p. 5). Yokohama: IEEE.

[4] Khaoula Hassoune, W. D. (2016). Smart parking Systems:A Survey . IEEE,

[5] Wael Alsafery, B. A. (2018). Smart Car Parking System Solution for the Internet of Things in Smart Cities. IEEE,

[6] Rachapol Lookmuang, K. N. (2018). Smart Parking Using IoT Technology. IEEE,

[7] Mohit Patil, R. S. (2014). Smart Parking System Based On Reservation. International Journal of Scientific Engineering and Research (IJSER),

[8] Vishwanath Y, A. D. (2016). Survey paper on Smart Parking System based on Internet of Things. International Journal of Recent Trends in Engineering & Research (IJRTER),

[9] Dr.V. Kepuska, H. A. (2016). Smart Car Parking System. International Journal of Science and Technology,

[10] J. Cynthia, C. B. (2018). IOT based Smart Parking Management System. International Journal of Recent Technology and Engineering (IJRTE),