

# IOT BASED SMART PARKING AND VEHICLE MANAGEMENT SYSTEM FOR INDUSTRIAL CAMPUS

**Y. Vijay Jawahar Paul<sup>1</sup>, A. Saikiran<sup>2</sup>, K. Sagar<sup>3</sup>, S. Sandhya Rani<sup>4</sup>, S. Abhinay<sup>5</sup>**

Asst. Professor, Dept. of Electrical & Electronics Engineering,

Christu Jyothi Institute of Technology & Science, Jangaon, Telangana, India<sup>1</sup>

UG Student, Dept. of Electrical & Electronics Engineering,

Christu Jyothi Institute of Technology & Science, Jangaon, Telangana, India<sup>2-5</sup>

**Abstract:** Parking has become a major issue in modern smart cities due to the rapid increase in the number of vehicles. Drivers often spend a significant amount of time searching for available parking spaces, especially in busy commercial areas, shopping complexes, and educational institutions. This situation leads to traffic congestion, fuel wastage, environmental pollution, and driver frustration. Traditional parking systems mostly depend on manual monitoring and do not provide real-time information about parking availability. Because of this, the process of finding parking spaces becomes inefficient and time-consuming for both users and parking management authorities.

**Keywords:** IoT (Internet of Things), Smart Parking and vehicle management system for industrial campus

## I. INTRODUCTION

In modern industrial campuses, managing vehicle movement and parking space has become a major challenge due to the large number of employees, visitors, delivery vehicles, and service vehicles entering the campus every day. Traditional parking systems usually depend on manual supervision by security staff or simple first-come-first-serve parking methods. These conventional approaches often lead to traffic congestion, inefficient use of parking spaces, longer waiting times at entry gates, and difficulty in monitoring vehicles inside the campus. To overcome these problems, a Smart Parking and Vehicle Management System is introduced as an advanced technological solution.

A Smart Parking and Vehicle Management System is an intelligent system that uses modern technologies such as sensors, cameras, microcontrollers, RFID technology, and cloud-based monitoring to manage parking spaces and vehicle movement efficiently. The main objective of this system is to automate the parking process, monitor vehicle entry and exit, and provide real-time information about available parking spaces within the industrial campus. By using this system, industries can reduce manual effort, improve security, and optimize the utilization of parking infrastructure. Industrial campuses usually have multiple parking zones such as employee parking areas, visitor parking areas, loading and unloading areas for transport vehicles, and reserved parking spaces for management staff. Managing all these areas manually can be difficult and time-consuming. A smart parking system helps in automatically detecting whether a parking slot is free or occupied using sensors like infrared (IR) sensors or ultrasonic sensors. The data collected from these sensors is processed by a microcontroller or central control unit and displayed on digital displays or mobile applications to guide drivers to the nearest available parking slot.

## II. LITERATURE SURVEY

1. **K. B. Yadav, S. Sharma** discussed that the rapid increase in the number of vehicles has created serious parking problems in urban and industrial areas. Their research proposed a smart parking system based on Internet of Things (IoT) technology. In this system, sensors are installed in each parking slot to detect the presence or absence of vehicles. The collected data is sent to a central server through wireless communication. Users can check the availability of parking spaces using a mobile application or web interface. This system helps drivers find parking spaces quickly, reduces traffic congestion, saves fuel, and improves the overall parking management efficiency in large campuses.
2. **Supapong Nutwong, et.al** focused on improving the accuracy of parking space detection using retroreflective photoelectric sensors. These sensors are capable of detecting vehicles more accurately compared to traditional detection methods. The proposed system integrates IoT technology to allow real-time monitoring of parking slots. Data from the sensors is transmitted to a control unit

which updates the status of parking spaces continuously. This information can be accessed remotely by administrators and users. The system ensures better reliability, faster response, and improved operational efficiency in parking management systems.

3. **R. Rajesh and P. Kumar** presented a vehicle management system using RFID technology for automatic vehicle identification. In their system, RFID tags are attached to vehicles and RFID readers are installed at the entrance and exit gates. When a vehicle enters the parking area, the RFID reader automatically detects the tag and records the vehicle details. The system maintains a database of vehicle entry and exit times, which improves security and monitoring. This method is highly suitable for industrial campuses where only authorized vehicles are allowed to enter.

4. **S. Chandra and M. Gupta** proposed a cloud-based smart parking system that uses wireless sensors to detect parking slot availability. The data collected from sensors is stored in cloud servers where it can be analyzed and monitored. The system provides real-time updates about parking spaces through a mobile application. Users can view available parking slots before entering the parking area. This reduces unnecessary vehicle movement and saves time. The cloud-based approach also allows administrators to analyze parking usage patterns and improve parking management strategies.

5. **A. Sharma and D. Singh** introduced a smart parking solution based on wireless sensor networks. The system uses sensors installed in each parking space to detect vehicle presence. The data is transmitted wirelessly to a central microcontroller unit that processes the information and displays available parking spaces on an electronic display board at the entrance. This helps drivers quickly locate empty parking spaces without searching manually. The proposed system reduces traffic congestion inside parking areas and improves parking efficiency.

**III. PROBLEM STATEMENT**

In many industrial campuses, managing vehicle parking efficiently has become a major challenge due to the increasing number of vehicles. Employees, visitors, and transport vehicles often face difficulty in finding available parking spaces. This leads to unnecessary time consumption, traffic congestion inside the campus, fuel wastage, and poor utilization of parking areas. Traditional parking systems mostly depend on manual monitoring and security personnel, which is not efficient for large industrial campuses. Lack of real-time information about parking availability creates confusion for drivers and increases vehicle movement inside the parking area. In addition, the absence of proper vehicle tracking and monitoring systems may also lead to security issues. Therefore, there is a need for an intelligent and automated parking management system that can monitor parking slots in real time, guide drivers to available parking spaces, and manage vehicle entry and exit efficiently. A smart parking and vehicle management system using sensors, microcontrollers, RFID, and IoT technology can improve parking utilization, reduce congestion, enhance security, and provide better parking management in industrial campuses.

**IV. BLOCK DIAGRAM**

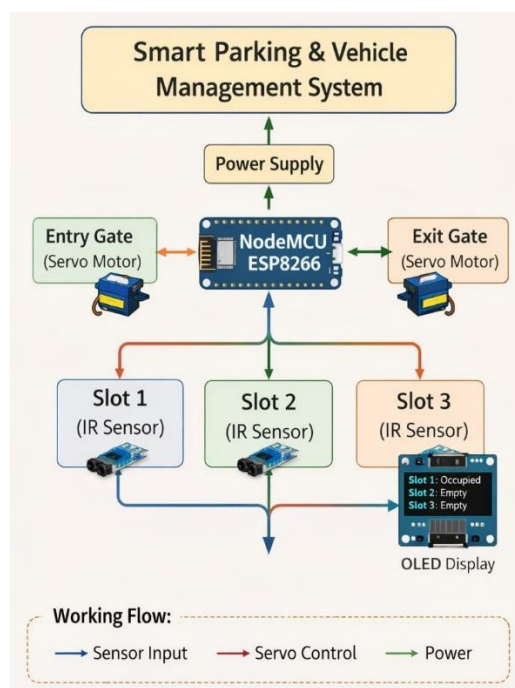


FIG.1: Block Diagram

**V. CIRCUIT DIAGRAM**

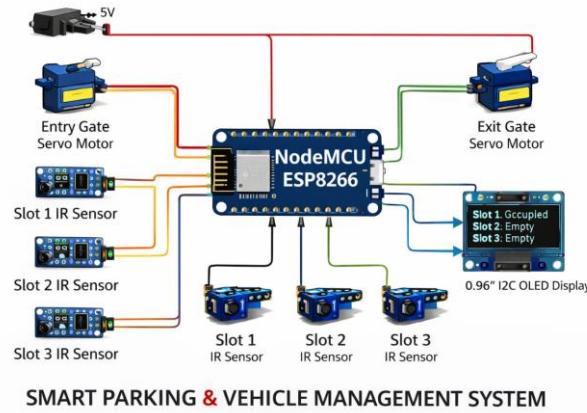


Fig.2: Circuit Diagram

**VI. FLOW CHART**

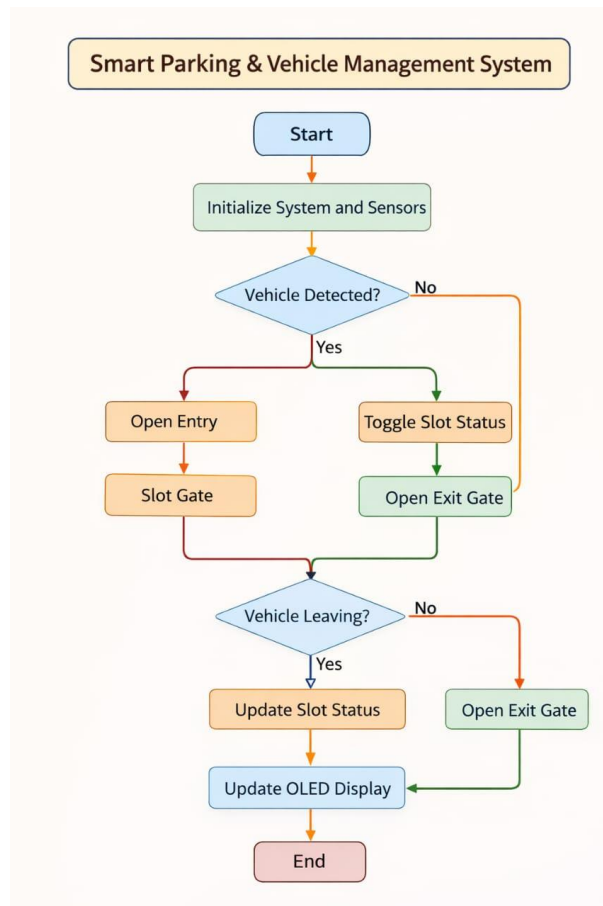


Fig.3: Flow Chart

**VII. SYSTEM ARCHITECTURE OVERVIEW**

The system architecture of the Smart Parking and Vehicle Management System is designed to automatically monitor and manage parking spaces using IoT technology. The NodeMCU ESP8266 acts as the central controller that connects and coordinates all the components in the system. IR sensors are installed in each parking slot to detect whether a vehicle is present or not, and the sensor data is sent to the NodeMCU for processing. Based on this information, the system updates the OLED display to show the availability of parking slots in real time. The NodeMCU also controls

the servo motors used for the entry and exit gates, allowing vehicles to enter or leave the parking area automatically. Through its built-in Wi-Fi capability, the NodeMCU sends parking data to the cloud platform, where the information can be stored and monitored remotely. A user interface, such as a mobile application or web dashboard, allows users or administrators to view parking slot availability and system status from anywhere. This architecture helps improve parking management, reduce congestion, and provide a convenient and efficient parking experience for users.

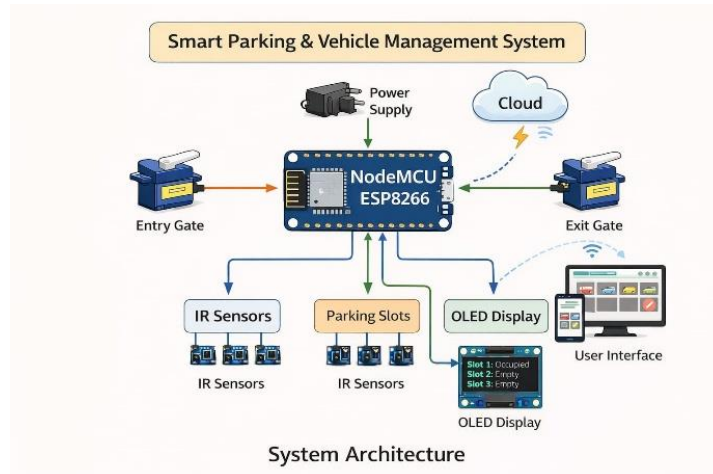


Fig.4: System Architecture

The Smart Parking and Vehicle Management System consists of several important components that work together to automate the parking process and provide real-time information about parking availability. The central unit of the system is the **NodeMCU ESP8266**, which acts as the main controller that manages all operations. It receives signals from sensors, processes the data, and controls other connected devices in the system. The presence of vehicles in each parking slot is detected using **IR Sensors**, which operate based on infrared light reflection. When a vehicle blocks the infrared beam, the sensor sends a signal to the NodeMCU indicating that the parking slot is occupied, and when there is no vehicle the slot is considered empty. The system also uses Servo Motors to control the entry and exit gates of the parking area. These motors rotate to a specific angle based on commands from the NodeMCU, allowing the gate to open when a vehicle enters or leaves and close automatically after the movement is completed. To provide real-time information to users, an **OLED Display** is used in the system. The OLED display shows the status of parking slots, such as whether a slot is occupied or available, helping drivers quickly identify free spaces. In addition, the system can connect to the internet through the Wi-Fi capability of the NodeMCU and send data to a **Cloud Platform**, where parking information can be stored and monitored remotely. Through this cloud connection, a User Interface such as a mobile application or web dashboard can display parking details to users and administrators from anywhere. All these components are powered by a regulated Power Supply, which provides the required electrical energy for the NodeMCU, sensors, motors, and display. Together, these components form an efficient smart parking architecture that reduces manual effort, saves time for drivers, and improves the overall parking management system.

### VIII. WORKING PRINCIPLE

The Smart Parking and Vehicle Management System for an Industrial Campus is designed to automatically monitor and manage parking spaces using sensors, controllers, and IoT technology. The working of the system begins when the power supply is turned on, which provides electrical power to all the components such as the NodeMCU ESP8266, sensors, display, and servo motors. The NodeMCU ESP8266 acts as the central controller that manages the entire system by receiving input signals from sensors and controlling other devices accordingly. In the parking area, IR sensors are installed in each parking slot to detect whether a vehicle is present or not. These sensors continuously monitor the parking slots and send signals to the NodeMCU. When a vehicle enters the parking area, the entry gate is automatically opened by the servo motor after detecting the vehicle. As the vehicle moves into a parking slot, the IR sensor detects the vehicle and sends the information to the NodeMCU indicating that the slot is occupied. The controller then updates the parking status in the system. The real-time parking information is displayed on the OLED display, which shows the number of available and occupied parking slots. This helps drivers quickly identify free parking spaces without searching for a long time. In addition, the NodeMCU uses its built-in Wi-Fi capability to send parking data to the cloud platform. The cloud stores the parking information and allows remote monitoring of the parking system. Through a user interface, such as a mobile application or web dashboard, administrators and users can check the parking slot availability and monitor the system from anywhere. When a vehicle leaves the parking area, the exit gate servo motor

opens automatically, and the IR sensor in the parking slot detects that the vehicle has left. The NodeMCU then updates the slot status as available and displays the updated information on the OLED display and cloud platform.

### IX. RESULTS AND DISCUSSION

The implementation of the Smart Parking and Vehicle Management System in an industrial campus shows significant improvement in parking efficiency, vehicle monitoring, and overall traffic management. The system uses sensors, cameras, and a centralized cloud platform to monitor parking slot availability and vehicle entry–exit in real time. During testing and implementation, the system successfully detected available parking spaces and displayed the information to drivers through a mobile application or digital display boards. This helped drivers quickly find vacant parking slots, reducing the time spent searching for parking. As a result, vehicle congestion at entry gates and inside the campus was reduced, and the movement of vehicles became more organized and smooth. The system also improved security by recording vehicle details such as entry time, exit time, and parking location, which helped in tracking unauthorized vehicles and maintaining proper records. The discussion of the system highlights several important benefits for industrial campuses where large numbers of employees and visitors bring vehicles daily. The smart parking system optimizes the use of available parking space and prevents overcrowding in specific areas by guiding drivers to free slots. It also reduces fuel consumption and environmental pollution caused by vehicles searching for parking spaces. In addition, the vehicle management features help campus administrators monitor traffic flow, generate parking usage reports, and manage parking permissions for employees and visitors. The results show that integrating IoT sensors, cloud technology, and automated monitoring can make parking management more efficient, secure, and user-friendly. Overall, the Smart Parking and Vehicle Management System proves to be an effective solution for improving transportation management and space utilization within large industrial campuses.

In addition to efficient parking management, the vehicle management system improved security and monitoring. Every vehicle entering the campus could be recorded using RFID tags or number plate recognition systems, which store important details such as entry time, exit time, and parking location in a centralized database. This information helps security personnel track authorized and unauthorized vehicles and maintain proper records for safety purposes. The system also allows campus administrators to analyze parking usage patterns and generate reports that show peak parking hours, most-used parking zones, and average parking duration. These insights help management plan better parking infrastructure and allocate parking spaces more effectively for employees, visitors, and service vehicles.

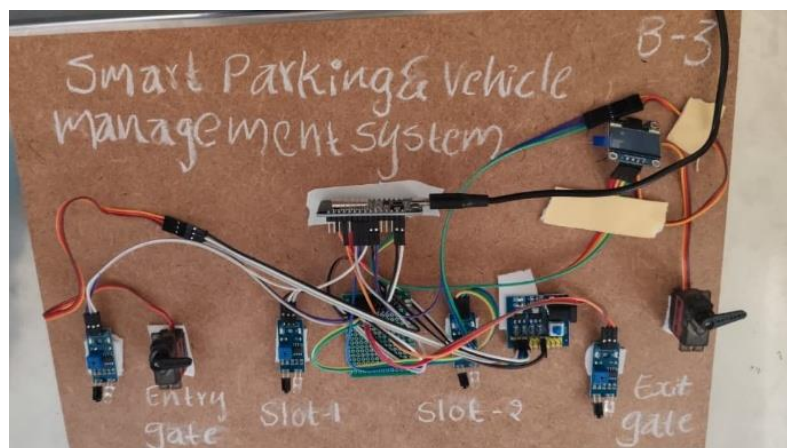


Fig.5: smart parking and vehicle management system for industrial campus

### X. CONCLUSION

The Smart Parking and Vehicle Management System successfully demonstrates the integration of hardware and software using the ESP32 microcontroller to provide an automated, reliable, and efficient parking solution. The system effectively monitors parking slot availability, controls vehicle entry and exit, and authenticates vehicles using RFID, while sensors provide real-time detection. Testing and analysis show that the system reduces traffic congestion, saves time, and improves the utilization of parking space in industrial campuses. The integration of IoT enables remote monitoring and data logging, enhancing management and security. Overall, the system proves to be cost-effective, scalable, and practical for real-world applications, offering a significant improvement over traditional manual parking systems.

## XI. FUTURE WORK

The Smart Parking and Vehicle Management System for Industrial Campus has strong potential for further development and large-scale implementation. In the future, the system can be enhanced by integrating advanced technologies to improve efficiency, security, and user convenience. These improvements will help industries manage vehicle movement more effectively and reduce traffic congestion inside the campus.

### ✓ **Artificial Intelligence and Machine Learning Integration** –

AI and machine learning techniques can be integrated to analyze parking data and predict future parking availability. The system can automatically suggest the best parking slot based on vehicle entry time, traffic conditions, and slot usage patterns. This will improve parking efficiency and reduce the time required for drivers to find a parking space.

### ✓ **Mobile Application with Slot Reservation** –

A mobile application can be developed for employees and visitors to check real-time parking availability and reserve parking slots before arriving at the industrial campus. The application can also provide navigation assistance to guide drivers to the reserved parking location.

### ✓ **Automatic Number Plate Recognition (ANPR)** –

Future systems can use camera-based number plate recognition technology to automatically identify vehicles entering and leaving the campus. This will improve security, reduce manual checking, and maintain accurate vehicle records in the database.

### ✓ **Integration with Cloud and IoT Platforms** –

The parking system can be connected to cloud platforms for real-time data storage and monitoring. IoT-based sensors can continuously send parking slot information to the cloud, allowing administrators to monitor parking status remotely from anywhere.

## REFERENCES

- [1]. Faiz Ibrahim Shaikh, Pratik Nirnay Jadhav, Saideep Pradeep Bandarkar, Omkar Pradip Kulkarni, Nikhilkumar B. Shardoor “Smart Parking System Based on Embedded System and Sensor Network”, International Journal of Computer Applications (0975 – 8887) Volume 140 – No.12, April 2016 International Journal of Pure and Applied Mathematics Special Issue 171.
- [2]. Thanh Nam Pham<sup>1</sup>, Ming-Fong Tsai<sup>1</sup>, Duc Binh Nguyen<sup>1</sup>, ChyiRen Dow<sup>1</sup>, And Der-Jiunn Deng<sup>2</sup> “A Cloud-Based Smart-Parking System Based on Internet-of-Things Technologies”, IEEE Access, Received July 24, 2015, accepted August 16, 2015, date of publication September 9, 2015, date of current version September 23, 2015.
- [3]. El Mouatezbillah Karbab, Djamel Djenouri, Sahar Boukaboul, Antoine Bagula, CERIST Research Center, Algiers, Algeria University of the Western Cape, Cape town, South Africa, “Car Park Management with Networked Wireless Sensors and Active RFID”, 978 147998802-0/15 ©2015 IEEE
- [4]. Mr. Basavaraju S R “Automatic Smart Parking System using Internet of Things (IOT)”, (International Journal of Scientific and Research Publications, Volume 5, Issue 12, December 2015)
- [5]. M. M. Rashid, A. Musa, M. Aatur Rahman, and N. Farahana, A. Farhana, “Automatic Parking Management System and Parking Fee Collection Based on Number Plate Recognition.”, International Journal of Machine Learning and Computing, Vol. 2, No. 2, April 2012, Published 2014.
- [6]. Hilal Al-Kharusi, Ibrahim Al-Bahadly, “Intelligent Parking Management System Based on Image Processing”, World Journal of Engineering and Technology, 2014, 2, 55-67.
- [7]. X. Zhao, K. Zhao, and F. Hai, “An algorithm of parking planning for smart parking system,” in Proc. 11th World Congr. Intell. Control Autom. (WCICA), 2014, pp. 4965–4969. [8] L. Mainetti, L. Palano, L. Patrono, M. L. Stefanizzi, and R. Vergallo, “Integration of RFID and WSN technologies in a smart parking system,” in Proc. 22nd Int.
- [8]. S. Yong Choong Hong, C. C. Kang, J. D. Tan, and M. Ariannejad, “Smart Parking System Using IoT Sensors,” Journal of Engineering Technology and Applied Physics, vol. 5, no. 1, pp. 63–69, 2023.
- [9]. Harkiran Kaur and Jyoteesh Malhotra, “A Review of Smart Parking System Based on Internet of Things,” International Journal of Intelligent Systems and Applications in Engineering, 2018.
- [10]. Roja T. V., Sandhya N., Ashwini, Harshitha Bedre, and Dr. Prabha R., “Smart Parking System Using IoT,” International Journal of Advance Research, Ideas and Innovations in Technology (IJARIIT), vol. 4, no. 3, 2018. 2017.