*International Journal for Modern Trends in Science and Technology*
*Volume 12, Special Issue 01*, pages 1000-1005.
ISSN: 2455-3778 online
Available online at: http://ijmtst.com/ICRCSET2026.html
DOI: https://doi.org/10.5281/zenodo.19613412

# IoT-Powered Embedded Multi-Floor Parking Slot Finder

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**To Cite this Article**
Labana Sailaja, Shaik Madar Saheb, Noorbasha Hassian, Muvva Narayana & Dr K. Kiran Kumar (2026). IoT-Powered Embedded Multi-Floor Parking Slot Finder. International Journal for Modern Trends in Science and Technology, 12(SI01), 1000-1005. https://doi.org/10.5281/zenodo.19613412

**Article Info**
Received: 12 March 2026; Revised: 07 April 2026; Accepted: 10 April 2026.



***KEYWORDS***

*IR SENSORS, Arduino UNO Micro controller, Internet of things*

**ABSTRACT**

*In rapidly developing countries, the surge in vehicle ownership has intensified traffic congestion and worsened the shortage of parking spaces, particularly in urban areas. Most parking facilities are located underground, where continuous lighting significantly increases energy consumption and operational costs. To tackle these challenges, this project presents an IoT-powered embedded system for efficient multi-floor smart parking management. The system integrates IR sensors to detect vehicle presence, RFID technology for vehicle identification and access control, and gear and stepper motors to automate barrier or elevator movement. Real-time parking slot availability is transmitted to a central server via wireless communication and made accessible through mobile applications or on-site displays. Targeted lighting control is enabled to reduce unnecessary energy usage. This intelligent system improves parking space utilization, reduces search time, and enhances energy efficiency. Additionally, this project reviews the key components of IoT-based parking systems, including communication technologies, system architecture, and security concerns. It also outlines future research directions and highlights open challenges, offering valuable insights for further innovation in smart parking solutions.*

## I. INTRODUCTION

The rapid growth of urbanization and industrialization in developing and developed countries has led to a significant increase in vehicle ownership. With expanding populations and rising standards of living, the number of private and commercial vehicles on the roads has increased dramatically over the past few decades. While this growth reflects economic progress, it has also introduced several critical challenges, including traffic congestion, increased fuel consumption, air pollution, and a severe shortage of parking spaces in metropolitan areas. Among these challenges, efficient parking management has emerged as a major concern for smart city planners, municipal authorities, and infrastructure developers.

In densely populated urban regions, the availability of open land for parking infrastructure is extremely limited. As a result, most modern parking facilities are constructed as underground or multi-floor structures to accommodate a large number of vehicles within a limited area. Although these parking systems provide higher capacity, they often suffer from poor space utilization, inefficient vehicle guidance, and excessive energy consumption. Drivers entering such parking facilities frequently spend a considerable amount of time searching for vacant slots, especially during peak hours. This not only increases traffic congestion within parking areas but also leads to driver frustration, unnecessary fuel wastage, and increased carbon emissions.

The emergence of the Internet of Things (IoT) has opened new possibilities for addressing these challenges through smart infrastructure development. IoT refers to the interconnection of physical devices, sensors, and embedded systems through the internet, enabling real-time data collection, communication, and intelligent decision-making. By integrating IoT technologies with embedded systems, it is possible to design smart parking solutions that provide real-time slot availability, automated access control, optimized lighting management, and efficient vehicle movement across multiple floors.represents a practical and efficient solution to modern parking challenges. By leveraging real-time data, automation, and intelligent control, the system enhances parking space utilization, reduces traffic congestion within parking facilities, improves energy efficiency, and delivers a better experience for users. This project contributes to the growing domain of smart city infrastructure and demonstrates the potential of IoT-enabled embedded systems in solving real-world urban problems.

## 1. LITERATURE SURVEY

Satyendra K. et.al (2021) presents a step-by-step procedure of a smart home automation controller. It uses IoT to convert home appliances to smart and intelligent devices, with the help of design control. An energy-efficient system is designed that accesses the smart home remotely using IoT connectivity. The proposed system mainly requires, Node MCU as the microcontroller unit, IFTTT to interpret voice commands, Adafruit a library that supports MQTT acts as an MQTT broker, and Arduino IDE to code the microcontroller. This multimodal system uses Google Assistant along with a webbased application to control the smart home. The smart home is implemented with the main control unit that is connected to the 24-hour available Wi-Fi network. To ensure, that the Wi-Fi connection does not turn off, the main controller is programmed to establish an automatic connection with the available network and connected to the auto power backup. The target scaling factor is efficient throughout the multiple platforms switching 9 Slower transit cycles when compared to CoAP, low scalability, and lack of security encryption

## 2. PROPOSED SYSTEM

The proposed IoT-Powered Embedded Multi-Floor Parking Slot Finder introduces an intelligent, automated, and energy-efficient parking management solution. The system uses IR sensors installed in individual parking slots to detect real-time vehicle occupancy. An embedded controller programmed using Arduino C processes sensor data and transmits parking slot information wirelessly to a central server. This real-time data is displayed on mobile applications or digital display boards at parking entrances, allowing drivers to quickly identify available slots on different floors. RFID technology is incorporated for secure vehicle identification and controlled access, while gear motors and stepper motors automate barriers or movement mechanisms, reducing manual intervention.

In addition to efficient space utilization, the proposed system emphasizes energy conservation and sustainability. Smart lighting control is implemented by activating lights only in occupied or active zones, significantly reducing power consumption in underground parking areas. The system enhances security by maintaining accurate entry and exit records and preventing unauthorized access. Data collected over time can be analyzed to understand parking patterns and optimize resource allocation. Overall, the proposed system reduces parking search time, minimizes congestion, improves energy efficiency, and provides a scalable solution suitable for smart city infrastructure and modern parking facilities.

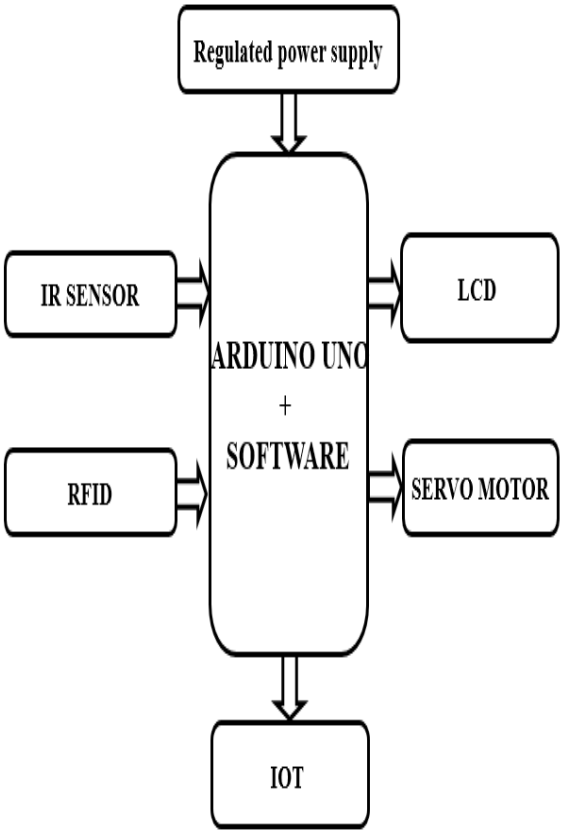


**FIG 1:**Block Diagram

### 3.1 Block Diagram:

The block diagram represents the functional architecture of the **IoT-Powered Embedded Multi-Floor Parking Slot Finder** system. At the core of the system is the **Arduino UNO microcontroller**, which acts as the main processing and control unit. The Arduino UNO is powered by ensuring stable and reliable voltage for all connected components. **IR sensors** are interfaced with the Arduino to detect the presence or absence of vehicles in individual parking slots. These sensors continuously monitor slot occupancy and send real-time signals to the controller. Additionally, an **RFID module** is connected to the Arduino for vehicle identification and access control, allowing authorized vehicles to enter or exit the parking facility securely.

Based on the inputs received from the IR sensors and RFID module, the Arduino processes the data using embedded software written in **Arduino C**. The processed information is displayed on an **LCD,** which shows parking slot availability and system status for users at the parking entrance or within the facility. A **DC motor** is controlled by the Arduino to automate physical mechanisms such as entry/exit barriers or directional gates. Furthermore, the Arduino communicates with the **IoT module,** enabling wireless transmission of parking data to a cloud server or mobile application. This IoT connectivity allows real-time monitoring of parking slot availability from remote locations. Overall, the coordinated operation of sensing, processing, display, actuation, and IoT communication ensures efficient parking management, reduced search time, enhanced security, and improved energy efficiency.

### 3.2Flow Chart

The system begins with sensors detecting available parking slots on each floor, and this information is transmitted to the microcontroller, which updates the data to the IoT server in real time. The processed data is then displayed on a mobile application or digital display, enabling users to view slot availability and guiding them efficiently to the nearest free parking space.

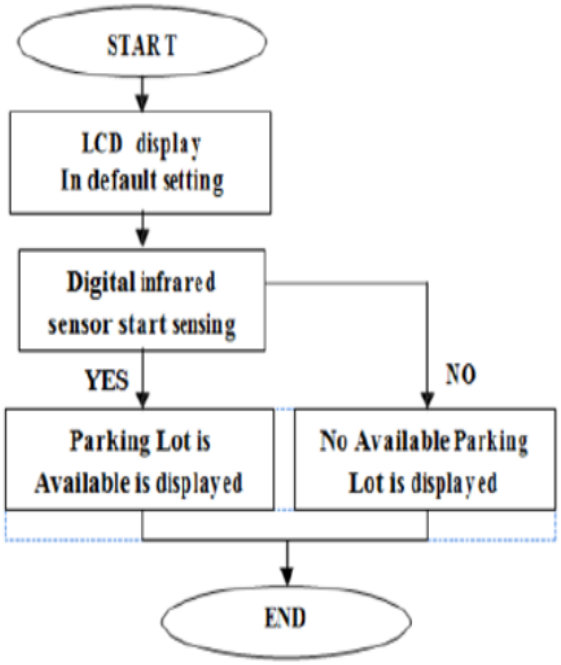


**Fig.2:** Flow Chart

## 3. RESULTS AND DISCUSSION

The IoT-powered embedded multi-floor parking slot finder efficiently detects and displays real-time parking availability using IR sensors, RFID, and embedded controllers. It reduces search time and traffic congestion while improving parking management through IoT-based monitoring and control. Overall, the system offers a scalable, cost-effective, and user-friendly solution for smart urban parking.

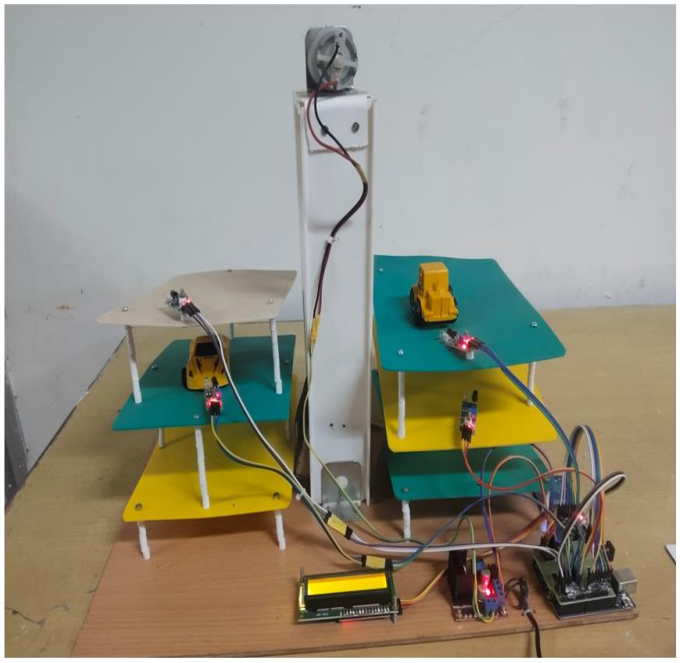

**Fig 3:** Hardware Setup

The prototype uses a pipe frame and plastic platforms to create a lightweight multi-level parking structure. A DC motor with a pulley or lead screw mechanism enables smooth vertical movement of vehicles between floors.

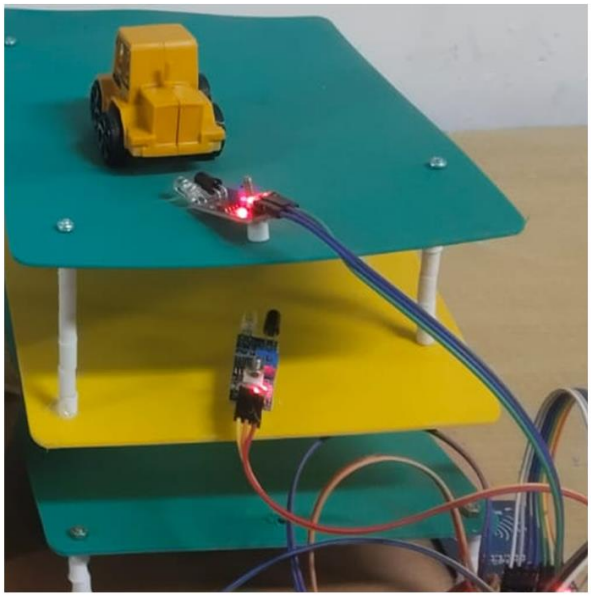

**Fig 4:** Floor parking Detection

The IR sensor detects vehicle presence by sensing interruptions in the infrared beam and sends signals to the microcontroller. The system updates parking availability in real time and displays it on an IoT platform for easy slot identification.

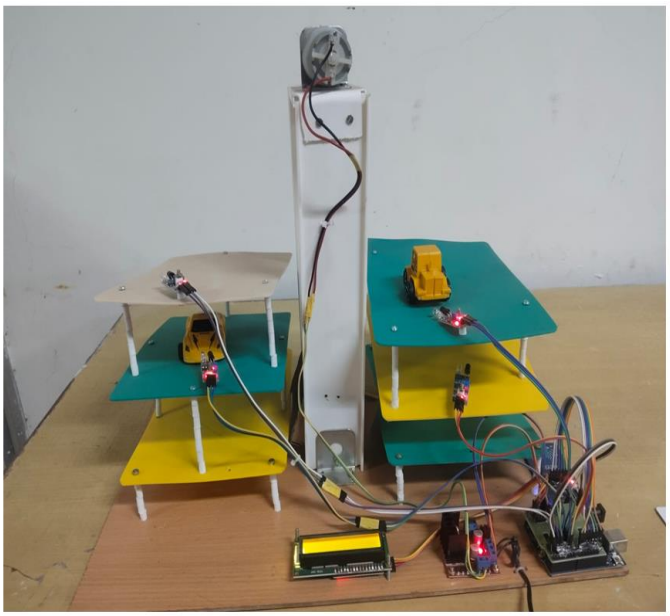

**Fig 5:** Car Parking In Floor Based On RFID with Stepper Motor

The RFID-based system identifies vehicles using tags and assigns them to specific parking floors for secure access. A stepper motor-driven mechanism ensures precise and smooth movement of the platform between levels.

## 4. CONCLUSION

The project presents an efficient and intelligent solution to the growing challenges of parking management in urban environments. By integrating IR sensors, RFID technology, Arduino-based embedded control, automated motors, and IoT connectivity, the system enables real-time parking slot detection, secures access control, and optimized space utilization. The implementation of smart lighting and automation reduces energy consumption and operational costs, while real-time data availability enhances user convenience and minimizes vehicle search time. Overall, this project demonstrates the effective application of IoT and embedded systems in developing sustainable, scalable, and smart parking solutions suitable for modern smart city infrastructure

**FUTURE SCOPE**

The future scope of the IoT-based embedded multi-floor parking slot finder includes integration with mobile applications to provide real-time slot availability and navigation guidance to users. Advanced technologies such as AI-based prediction can be incorporated to forecast parking demand and optimize slot allocation. The system can be expanded with automated billing,

digital payment gateways, and electric vehicle charging management. Additionally, cloud-based analytics and smart city integration can further enhance scalability, efficiency, and urban traffic management.

### Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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