JOURNAL OF DATA SCIENCE | Vol.2025, Issue 1, No.7
eISSN:2805-5160

The Requirement Analysis of the IoT-Based Vehicular Spatial Allocation System

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Abstract

Today's crowded cities often have trouble with parking. More cars are driving than there are places to park. Because of this, effective parking management systems are now required. Consequently, we exhibit the benefits of an IoT-based parking management system for efficiently managing parking spaces. To illustrate how it works, we put in IR sensors for sensing if the spot is taken and message to a DC motor that opens the gate. Currently, internet connectivity is handled by a Wi-Fi modem, and the AVR microcontroller runs the entire system. IOT Gecko supports our project by providing online connectivity and designing an IOT management graphical user interface. IR sensors allow the system to spot if parking slots are currently in use. After reading the available parking slot number, the system notifies the cloud server and lets people verify the available slots online. As a result, people can find free parking spots online from any place and not worry about rushing. OpenBay, as a result, solves the parking shortage for cities and gives users a smart parking management system based on IoT.

Keywords

Automated, IR Sensor, Smart car parking system

Introduction

Because the number of cars on the streets is increasing, traffic issues will always occur. It results from the fact that the existing road systems and car parks cannot accommodate the increase in road vehicles. For this reason, a smart parking system was designed to help address those issues. Thanks to smart parking, visitors can quickly find and reserve an empty place to park their cars at any suitable car park. The new way to pay for parking supports easier movement of cars and people into and out of the facility. A computerized system allows us to assist citizens who want to park at a public organization using IoT-based parking management. Sensors allow the Internet of Things (IoT) to link real parking lots with digital information and technology, offering cloud services to control them efficiently.

Submission: 11 March 2025; **Acceptance:** 14 June 2025; **Available Online:** June 2025

For this concept to be used, a mobile app will be developed. End users can use this mobile application to check if parking is available and reserve a particular lot. A control system in every parking lot ensures tracking of available and full spaces and sends information about the parking lot's status (whether it is open and has free spaces or is fully occupied, or is closed). Also, the system can notice when a vehicle reaches the gate, so the gate can open automatically. Users can now check online anywhere to find out if there are parking spaces available. So, the system deals with the issue of parking.

Materials and Methods

The system integrates both hardware and software components designed for efficient real-time vehicle monitoring and slot management in an IoT-enabled environment.

Hardware Components:

Microcontroller Unit (MCU):

1. The Raspberry Pi Pico W microcontroller was selected for its built-in Wi-Fi capabilities, dual-core processor, and low power consumption, making it ideal for real-time data transmission in an IoT environment.
2. Infrared (IR) Sensors: Deployed at entry and exit points to detect the ingress and egress of vehicles.
3. Power Supply Module: A 5V/12V DC regulated power supply ensures stable operation of sensors and the microcontroller.
4. LCD Indicators: Provide on-site visual feedback about slot availability or system status.
5. Wi-Fi/Bluetooth Module (Embedded in ESP32): Facilitates wireless data transfer between the microcontroller and the cloud server.
6. Software Components
7. Arduino IDE: Used for programming and uploading code to the Raspberry Pi Pico W microcontroller.
8. My SQL Database: A cloud platform for storing real-time data from sensors and syncing it with the user interface.
9. PHP: Used in the development of a responsive web-based dashboard for monitoring and slot reservation.
10. Weblink: Offers users a mobile interface for real-time slot availability, booking, and navigation assistance.

Implementation:

Raspberry Pi Pico W Programming

Python scripts were written for the Raspberry Pi Pico W to read data from IR sensors using the RPi.GPIO library. These sensors detect vehicle presence, and the data is sent over Wi-Fi to the server.

Backend Server Implementation

The backend, built with PHP, processes link data, checks slot availability from a MySQL and sends responses back to the Pico W in JSON or XML format. Secure queries and transactions ensure safe and reliable data handling.

Frontend Web Interface Development

A user-friendly web interface was built using HTML, CSS, and JavaScript. It shows real-time parking slot updates via AJAX/Web Sockets and allows users to select and reserve slots.

Integration of Software Components

RESTful APIs were created to connect the Pico W, backend, and frontend. These APIs were documented (e.g., with Swagger) and tested using tools like Postman and PHP Unit to ensure smooth, secure communication.

Web Link Access to Users

Users can access a web link to view real-time parking slot availability at their desired location, thanks to the integration between the frontend and backend systems.

Result and Discussion

This is the implementation of an IoT-based vehicular spatial allocation system based on the requirement analysis. It shows IR Sensors are connected to Raspberry Pi Pico W and LCD, and the power supply is provided from an external source. Here, the IR sensors will sense the slot availability with an Infrared transmitter and receiver, and the data is transmitted to the Raspberry Pi Pico W and stored in a database, and that information is also shown in the LCD.

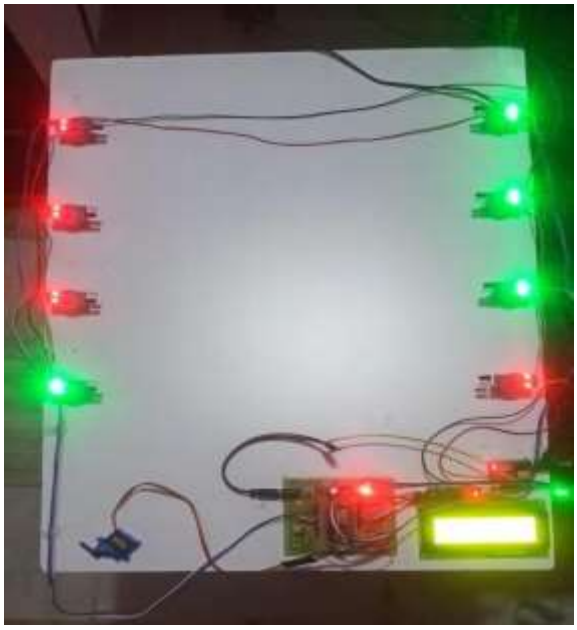

Figure 1. The LCD placement

LCD Display

This the LCD display where the slot availability is shown in terms of empty if there is no car parked and full if car is parked there.

Conclusion

An IoT-based vehicular spatial allocation system has been proposed in this paper to avoid traffic congestion, random parking, and obstruction of traffic in the parking area, as well as to search and wait for a parking space. The proposed system described in this paper is built with four layers: Application, Middleware, Networking, and Sensor Layer. The research paper highlights the comparison of the traditional parking system with the smart parking system using IoT. The project also proposes a framework for a smart parking system.

One of the most significant benefits of IoT based vehicular spacial allocation system is their ability to reduce the time spent searching for available parking spaces. With real-time data collection and processing, these systems guide drivers directly to vacant spots, saving time, fuel, and reducing carbon emissions. By providing live updates on parking availability through mobile apps or digital signage, these systems offer a seamless and stress-free parking experience for users. This level of convenience not only improves user satisfaction but also contributes to reducing traffic congestion in busy areas.

Acknowledgement

We would like to express our sincere gratitude to all those who supported us throughout this project, “IoT-Based Vehicular Spatial Allocation System.” We are especially thankful to Mrs. Swapna for her expert guidance, continuous encouragement, and valuable feedback, which were instrumental in shaping this work. We also extend our sincere thanks to our coauthors G. Sloka, K. Varanitha Reddy, G. Nikhila, and P. Manisha for their collaboration, support, and dedication throughout the project.

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