Innovation e-Proceeding e-ISSN: 2716-6732
International Innovation, Technology & Research Exhibition and Conference
October 1, 2025, Selangor, MALAYSIA

Parking Spotter - IoT-Based Smart Parking System

Ragu A/L Ratnam , Muhammad Aniq Aiman Bin Shamzumi, Ts Zuraidy bin Adnan, Mohd Noor Rizal Bin Arbain, Ts. Izwan Suhadak Ishak, Prof. Madya Dr. Mohd Fahmi bin Mohamad Amran, Muhammad Fairuz bin Abd Rauf

UNIVERSITI SELANGOR, UNIVERSITI PERTAHANAN NASIONAL MALAYSIA

sragu539@gmail.com, aniqamn715@gmail.com, zuraidy@unisel.edu.my, rizal-it@unisel.edu.my,izwan@unisel.edu.my, fahmiamran@upnm.edu.my, fairuz.rauf@upnm.edu.my

1. Product Description

The IoT-Based Smart Parking System, named Parking Spotter, is designed to support smart city initiatives by addressing challenges in traditional parking management such as inefficient space allocation, lack of real-time updates, and delays in locating vacant spots. The system integrates a Raspberry Pi 4B and PiCamera2 to capture live images of parking areas, while image processing algorithms analyze each frame to determine occupancy status in real-time. The processed data is uploaded to a cloud-based platform and synchronized instantly with a Flutter mobile application. Users can view live parking availability, reserve spaces for limited durations, receive countdown-based notifications, and report issues with optional photo attachments. Administrators can manage parking statuses, allocate VIP or maintenance spaces, handle user reports, and generate detailed statistical summaries for operational planning.

2. Innovation Objectives

The IoT-Based Smart Parking System aims to address common challenges in parking management, including inefficient space utilization, lack of real-time updates, and delays in finding vacant spots. The system integrates Raspberry Pi 4B, PiCamera2, and image processing algorithms to automatically detect parking occupancy in real time. Processed data is synchronized with a cloud platform and displayed through a Flutter mobile application, allowing users to view live availability, reserve spots, receive countdown notifications, and report issues. Administrators can manage parking statuses, allocate VIP or maintenance spaces, and generate analytical reports for better planning. Tested on a scaled prototype, the system

demonstrated high detection accuracy, fast updates, and improved user satisfaction. By leveraging affordable IoT components and cloud integration, this project delivers a scalable,

cost-effective, and user-friendly solution that supports smart city initiatives and enhances urban mobility.

3. Problem Statement

In urban environments, parking management continues to face significant challenges due to increasing vehicle density, inefficient space utilization, and the lack of real-time information on parking availability. Drivers often waste considerable time searching for vacant spots, leading to traffic congestion, frustration, and reduced productivity. Existing solutions, such as sensor-based systems and manual monitoring, are either costly to implement, limited in scalability, or fail to provide accurate, timely updates. Furthermore, most current parking management systems lack features such as automated detection, live monitoring, mobile-based reservations, and integrated analytics, which are essential for supporting smart city initiatives. These limitations highlight the need for a cost-effective, IoT-enabled solution that leverages computer vision and cloud integration to provide accurate occupancy detection, real-time data synchronization, and user-friendly mobile access. By addressing these gaps, the proposed IoT-Based Smart Parking System aims to enhance operational efficiency, improve user convenience, and contribute to the development of sustainable urban mobility solutions.

4. Authenticity / Novelty

The IoT-Based Smart Parking System introduces a novel approach to modern parking management by combining IoT technology, computer vision, and cloud integration into a single, efficient platform. Unlike conventional solutions that rely on costly sensors or manual monitoring, this system utilizes Raspberry Pi 4B and PiCamera2 alongside image processing algorithms to accurately detect parking occupancy in real time. Data is instantly synchronized with a cloud platform and displayed through a Flutter-based mobile application, allowing users to view live parking availability, reserve spots, receive countdown-based notifications, and report issues seamlessly. Additionally, administrators gain access to advanced features such as VIP and maintenance space allocation, automated status updates, and detailed analytical reports for better operational planning. This integration of affordable IoT hardware, intelligent computer vision, and user-centric mobile accessibility makes the system cost-effective, scalable, and adaptable for various parking environments while supporting broader smart city initiatives.

5. Implementation Level

a) Analysis Phase of the Problem

The development began with an analysis of existing parking management challenges in urban environments. Surveys and research highlighted common issues such as the lack of real-time parking updates, inefficient space utilization, and the absence of automated monitoring. These findings guided the design requirements, emphasizing

the need for IoT integration, computer vision, and a centralized platform for both users and administrators.

b) Hardware Setup and Integration.

The system utilizes a Raspberry Pi 4B as the core processing unit, connected to a Pi Camera Module for capturing live images of the parking area. A simple LED circuit on a breadboard provides visual status indicators for testing purposes. The captured images are processed using Python-based image processing algorithms to detect parking occupancy. An HDMI connection links the Raspberry Pi to an external monitor for live debugging and real-time visualization during development.

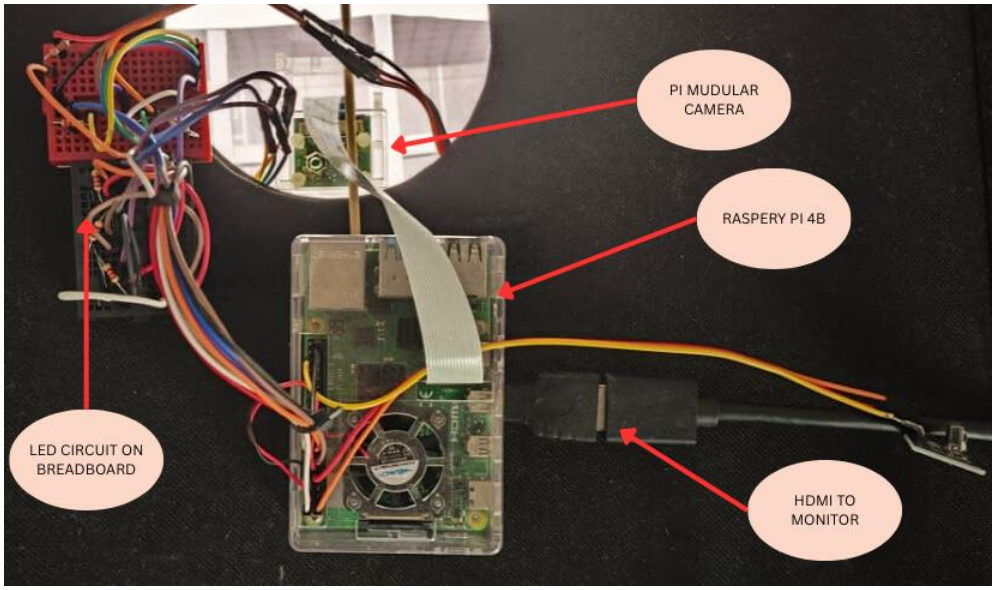

Figure 1: Setup of sensors and processors for Parking Spotter

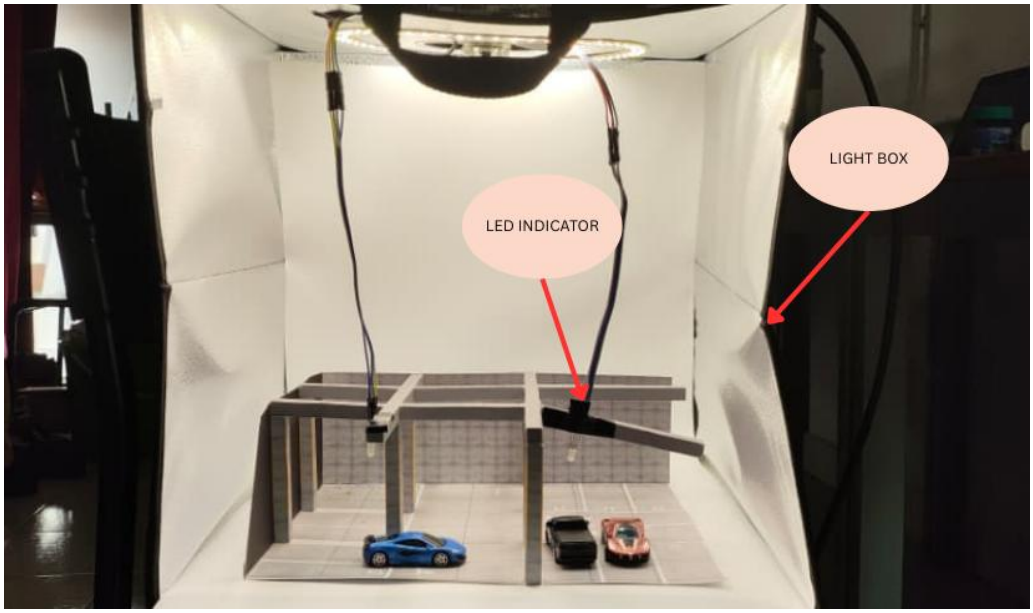

Figure 2: Setup of prototype for Parking Spotter

c) Software Development and Cloud Integration

The image data captured by the Pi Camera is analyzed using computer vision algorithms to determine whether parking spots are occupied or vacant. The results are uploaded to Firebase, ensuring real-time synchronization across the system. A Flutter-based mobile application retrieves data from the cloud, displaying live parking availability and supporting spot reservations, countdown notifications, and issue reporting.

d) Mobile Application Features.

The mobile app provides an intuitive and user-friendly interface, enabling drivers to:

- View real-time parking availability
- Reserve parking spots for a limited duration
- Receive countdown-based notifications when reservations are about to expire or spots are taken
- Report issues directly within the app, with the option to attach photos for better clarity

Administrators have access to additional features, including VIP and maintenance spot allocations, report management, and statistical dashboards for operational planning.

e) Testing and Evaluation

A scaled prototype of the system was developed and tested under various conditions to evaluate detection accuracy, data synchronization speed, and user experience. The testing demonstrated:

- High accuracy in occupancy detection

- Fast and reliable updates to the mobile app
- Positive feedback from users regarding app usability and functionality

Overall, the implementation proved the feasibility of combining IoT, computer vision, and cloud integration to create an efficient, cost-effective, and scalable smart parking solution.

6. Uses and Applications

The IoT-Based Smart Parking System is designed to improve parking management efficiency and user convenience, making it highly adaptable across various environments. By integrating IoT, computer vision, and cloud technologies, the system enables real-time monitoring, automated detection, and centralized control. It can be implemented in smart city initiatives to reduce congestion and enhance urban mobility, as well as in corporate buildings, government facilities, shopping malls, hospitals, universities, airports, and transportation hubs to optimize space utilization and improve accessibility. By providing live availability updates, reservation features, and analytical insights, the system supports better resource management while contributing to sustainable urban mobility and the development of smart city infrastructure.

7. Innovation Product/Project Impact

The IoT-Based Smart Parking System delivers a significant impact by enhancing operational efficiency, improving user experience, and supporting the development of smart city infrastructure. By automating parking spot detection through IoT and computer vision, the system reduces the time spent searching for available spaces, minimizes traffic congestion, and optimizes overall parking utilization. Real-time data synchronization ensures users can access live parking updates, make reservations, and receive timely notifications, resulting in a more seamless and convenient parking experience. For administrators, the system provides valuable analytical insights through statistical dashboards, enabling better decision-making and resource allocation. Furthermore, by leveraging affordable IoT components and cloud integration, the solution remains cost-effective, scalable, and adaptable across various environments, from corporate facilities to urban smart city projects. Overall, this innovation contributes to sustainable urban mobility by improving efficiency, reducing environmental impact, and paving the way for smarter, data-driven transportation solutions.

8. Achievements

The IoT-Based Smart Parking System was successfully developed and tested as a Final Year Project, demonstrating its real-world feasibility in providing accurate, real-time parking occupancy detection and seamless data synchronization. The system showcased its capability to enhance parking management efficiency, improve user convenience, and support smart

city initiatives through IoT and computer vision integration. During the Final Year Project exhibition, the project received positive feedback for its innovation, usability, and scalability, ultimately earning the Best Presentation Award. This recognition highlights the project's potential for wider adoption and its contribution to advancing intelligent transportation and sustainable urban mobility solutions.