
ISSN: 2321-2152
IJMECE
International Journal of modern
electronics and communication engineering
E-Mail
editor.ijmece@gmail.com
editor@ijmece.com
www.ijmece.com

ISSN 2321-2152
www.ijmece.com
Vol 13, Issue 1, 2025

Smart Parking Management System

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***Abstract*— An image-processing-based smart Parking Management created for multistory parking garages, open parking lots, and more is presented in this study. The proposed system architecture determines if a parking spot in the received video is occupied or not by combining edge detection and coordinate bound pixel sections. Using the OpenCV library, it is implemented in Python. It also demonstrates how picture-to-text conversion was put into practice. Tesseract is used to extract text from the image after processing. In order to get the best results for the text, different photographs are processed to different degrees using a variable level of image processing. The suggested system is built on the Prewitt Edge Detection method, which can recognise parking spaces with filled and unfilled spaces, potentially eliminating human labor requirements. The freshly established approach requires exact results to be obtained in real-time to recognise an intelligent parking spot or slot. The tool may also determine whether the car was completely, partially, or inappropriately parked.**

Keywords: Smart Parking Management, Artificial Internet of Things, Raspberry Pi.

I. INTRODUCTION

Smart parking is an AIoT (Artificial Internet of Things) solution that uses sensors and/or cameras in combination with a software to inform users of vacant parking spaces in a certain area. Most of the time, people can also directly reserve the spot and pay for it with an app. If you ever drove through a city and spent 10 or 15 minutes finding a good spot near your destination or if you were at a shopping mall and spent more time searching for a free parking spot than actually buying things, then this technology will be a lifesaver for you.

To locate a specific location for occupation detection, which confirms whether it has been detected, use the automatic parking slot. Either routine management occurs, or manual management occurs. Finding available parking spots is never easy. This problem typically occurs in urban areas where parking spaces are in greater demand than automobiles. Thanks to recent economic progress and the availability of affordable vehicles on the market, any average middle-class person can now buy a car, which is a good thing.

A "smart parking management system using IoT" is a technology that leverages the Internet of Things (IoT) to monitor and manage parking spaces in real-time, providing drivers with immediate information about available parking spots through a mobile app or web interface, ultimately minimizing the time spent searching for parking and optimizing parking space utilization by utilizing sensors placed at each parking spot to detect occupancy status.

smart parking management system utilizes technology like sensors and data analytics to provide real-time information about available parking spaces, enabling drivers to quickly locate open spots, minimize search time, and streamline the parking process, often through a mobile app interface, while also allowing for features like pre-booking and automated payment systems, ultimately reducing traffic congestion and improving parking efficiency in urban areas.

II. RELATED WORK

In the field of smart parking management primarily focuses on developing systems that utilize IoT sensors to monitor parking space availability in real-time, allowing users to locate open spots through mobile applications, often with features like parking space reservation, dynamic pricing based on demand, and integration with navigation systems to optimize driving routes to find available parking; all aimed at reducing traffic congestion caused by circling for parking spaces.

smart parking management using AIoT (Artificial Intelligence of Things) focuses on developing systems that leverage IoT sensors to monitor parking space availability in real-time, utilizing AI algorithms to analyze data, predict parking demand, guide drivers to available spaces, optimize pricing strategies, and provide a user-friendly interface through mobile applications, ultimately aiming to reduce traffic congestion and improve parking efficiency in urban area

ISSN 2321-2152
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Proposed design

Smart parking system would typically include a network of sensors installed in each parking space to detect vehicle occupancy, a central server to collect and process this data, a user-friendly mobile app to display available parking spots, and a payment system allowing users to reserve and pay for parking spaces remotely, all integrated with real-time updates to guide drivers efficiently to available spots and minimize wasted time searching for parking

A proposed design for a smart parking system using Raspberry Pi components would involve utilizing a Raspberry Pi as the central processing unit, paired with Raspberry Pi Camera to detect vehicle presence in each parking space, a Pi camera for visual verification, and a cloud-based database to store parking status information, accessible through a user-friendly mobile app that allows users to locate available parking spots and potentially reserve them in advance; all data would be transmitted via Wi-Fi connection from the Raspberry Pi to the cloud.

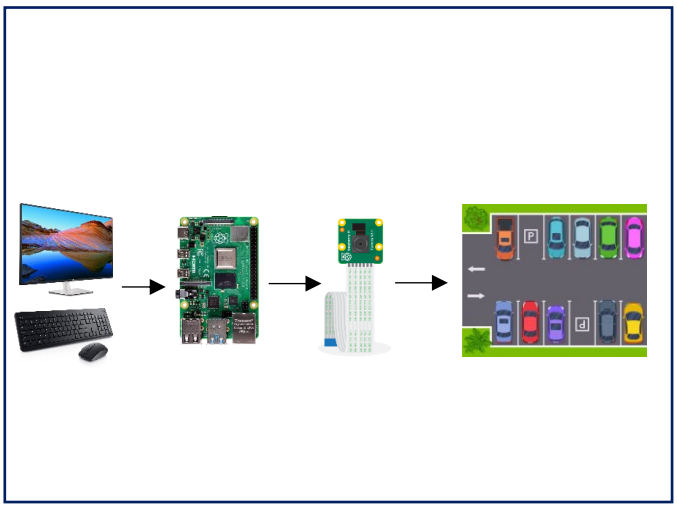

Fig-1: proposed Design

A smart parking system primarily focuses on providing real-time information about available parking spaces to drivers, guiding them to vacant spots, thereby reducing traffic congestion caused by circling for parking, optimizing parking space utilization, and improving the overall parking experience by minimizing time spent searching for a spot.

III. HARDWARE AND SOFTWARE USED

A. Raspberry Pi

Raspberry Pi is a small single board computer. By connecting peripherals like Keyboard, mouse, display to the Raspberry Pi, it will act as a mini personal computer. Raspberry Pi is popularly used for real time Image/Video Processing, IoT based applications and Robotics applications. Raspberry Pi is slower than laptop or desktop but is still a computer which can provide all the expected features or abilities, at a low power consumption. It is the latest model of Raspberry Pi and has many extra features compared to its previous model. Raspberry Pi 4 has a quad-core 64-bit processor. The clock frequency is also increased to 1.8 GHz. Apart from it, SDRAM support is also available in various sizes (1GB, 2GB, 4GB, or 8GB).

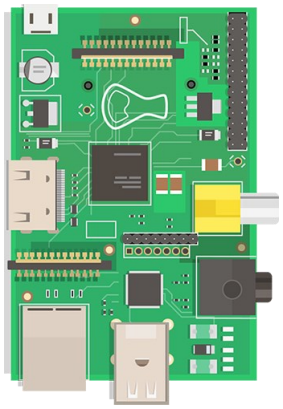

Fig-2: Raspberry pi Pico

Features:

Processor:	64-bit quad-core ARM Cortex-A72 processor
Memory:	1 GB, 2 GB, 4 GB, or 8 GB of LPDDR4-3200 SDRAM
GPIO Pins:	40 GPIO pins
USB connectivity:	two USB 3.0 ports and two USB 2.0 ports
Programming Languages:	Python
Power supply:	Raspberry Pi 15W USB-C Power Supply
Dimensions:	85.6 mmX21mm (compact size)
Built-in LED:	On-board LED for user feed back
I2C, SPI, UART	allow communication between the Raspberry Pi and other devices

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www.ijmece.com
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Applications:

Raspberry Pi include but are not limited to behavioral recording, healthcare monitoring, surveillance, industrial automation, plant phenotyping, and wildlife and ecosystem monitoring.

The Raspberry Pi is a small but versatile prototyping device that has revolutionized scientific research and education. Its low cost, small size, and ease of use make it an ideal platform for a wide range of scientific applications, including data acquisition, control systems, and modeling. Raspberry Pi is also a powerful tool for scientific modeling and simulation. Its high-performance processor and abundant memory make it capable of running complex scientific software.

B. Raspberry Pi camera module

The Raspberry Pi camera module is a small, inexpensive add-on camera that connects to a Raspberry Pi board. It can take photos and videos in a variety of resolutions. The Raspberry Pi Camera Board is a custom designed add-on module for Raspberry Pi hardware. It attaches to Raspberry Pi hardware through a custom CSI interface. The sensor has 5 megapixel native resolution in still capture mode.

Key Features:

The Raspberry Pi 4 camera has a high-speed MIPI CSI-2 interface, supports multiple resolutions, and can record video.

Resolution: Supports VGA, HD, Full HD, and 4K resolutions, **Framerate**: Supports 110 fps at VGA, 72 fps at HD, 60 fps at Full HD, and 15 fps at 4K. **Output format**: UYVY. **Interface**: MIPI CSI-2 interface for connecting to the CPU. **Operating temperature** -30° to 70° C. **Recording**: 1080@30 fps. **Support**: Supports Raspbian OS (Buster and Bullseye), Yocto build (dunfell), and Linux camera driver (V4L2). **Video streaming**: Supports Gstreamer-1.0

Applications:

- ***Reduced traffic**: Smart parking systems can help reduce traffic congestion by guiding drivers to available parking spaces.*
- **Real-Time Availability Updates**: Sensors and cameras detect available parking spots and provide real-time updates to users via mobile apps or digital signage.
- **Navigation Assistance**: GPS and mapping technologies guide drivers to the nearest available parking spots, reducing search time.
- **User Feedback and Ratings**: Platforms allow users to rate parking facilities, helping others make informed decisions and encouraging improvements.

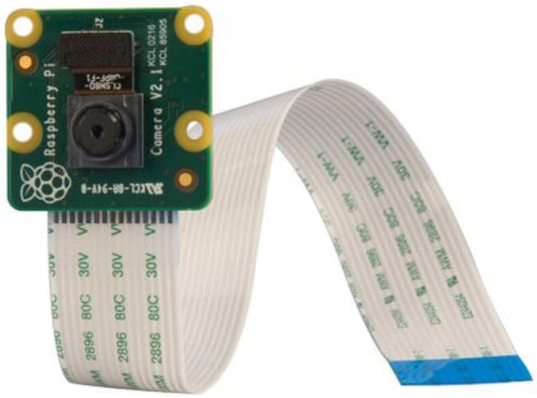

Fig-3: Raspberry Pi Camaera Module

Operation:

A smart parking management system operates by using sensors (Or) Fixed Camera's installed in parking spaces to detect vehicle occupancy, sending this real-time data to a central system which then provides drivers with information about available parking spots through a mobile app, allowing them to quickly locate open spaces and minimizing the time spent searching for parking; this system often includes features like pre-booking spaces, automated payment processing, and data analytics to optimize parking lot utilization.

C. Thonny and opencv-python:

Thonny is an integrated development environment (IDE) designed specifically for beginners in Python programming. It's simple, lightweight, and user-friendly, making it ideal for people just starting out in coding. Highlights include:

Thonny is suitable for beginners and was developed with the idea that less is more by providing a beginner-friendly interface which is rather basic & clear enabling learners to use the language without advanced tools being a distraction. It has what they refer to as stepwise debugging a functional graphical debugger that allows users to program interactively by executing their codes in a stepwise manner and examining variables, control structures and program execution.

Thonny also comes with a variable tracker which helps in understanding how memory is used for objects such as lists & variables. Its code completion helps in suggesting, completing the code for the user so that the user codes faster with fewer mistakes made. Thonny comes along with a built-in Python installation, which means that users do not need to worry about

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Vol 13, Issue 1, 2025

configuring Python environments, making it very convenient for beginners.

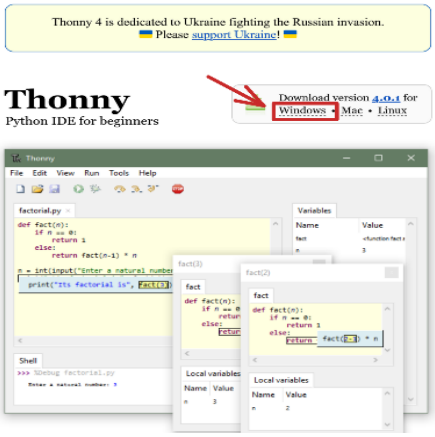

Fig-4: Thonny software

Open-Source Computer Vision Library is a popular library used for real-time computer vision and image processing [7]. OpenCV has Python binding and allows Python programmers to easily add powerful graphics and video processing features to their applications Its capabilities include: OpenCV is a powerful library for image processing, allowing you to efficiently perform tasks such as image resizing, filtering, and color space conversion (e.g., RGB to grayscale) It also supports video capture; that is real -time video from cameras Enables loading, and subsequent image processing. OpenCV's object recognition and background capabilities include tools for recognizing and tracking objects such as faces and pedestrians in a video frame in addition, OpenCV offers machine learning and AI modules together, it enables image classification, object recognition, and other advanced features AI functions offer. Its cross-platform support extends to Windows, Linux, macOS, Android, and iOS, making it a versatile cross-platform tool.

Fig-5: Python with open cv

Both Thonny and OpenCV-Python are commonly used in tutorial settings or start-up projects in graphics and computer vision. Thonny makes it easy for beginners to code and debug, while OpenCV brings advanced graphical processing capabilities to Python.

IV. System Implementation

smart parking management system typically involves installing Camera's at parking spaces to detect vehicle occupancy, transmitting this data to a central server via an AIoT network, and providing real-time parking availability information to users through a mobile app or display, allowing them to locate available spaces and potentially even reserve them in advance; key components include vehicle detection sensors, a communication network, a central server, and a user interface (mobile app or web-based platform) to access parking information.

VI. RESULTS

The primary result of a smart parking system is reduced traffic congestion by efficiently guiding drivers to available parking spaces, minimizing time spent searching and circling for a spot, ultimately leading to less driver frustration and improved traffic flow; additionally, it can provide benefits like enhanced user experience, optimized parking space utilization, reduced emissions, and increased safety due to decreased distracted driving while searching for parking User reviews have unsurprisingly been positive, with most users being able to readily grasp basic movements while doing basic tasks but some usage may be hampered by the users' movements getting repetitive.

Smart parking system utilizing AIoT technology primarily results in reduced traffic congestion, improved parking efficiency by providing real-time availability of parking spaces, quicker parking times for drivers, and a more streamlined parking experience by enabling features like parking space reservation, payment automation, and navigation to available spots, ultimately contributing to better urban mobility and environmental benefits by minimizing unnecessary driving around searching for parking.

An AIoT-based smart parking system provides real-time data on parking space availability, pricing, payments, and beyond, evolving as a helpful tool for businesses and consumers. It positively impacts the environment and traffic. It also ensures efficient parking reservation and management.

smart parking system developed using Python would primarily output real-time information about the availability of parking spaces in a parking lot, allowing users to easily identify empty spots through a mobile app or interface, effectively reducing the time spent searching for parking and minimizing traffic congestion; this is achieved by utilizing image processing techniques like edge detection with OpenCV to analyze camera feeds and determine if a parking spot is

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www.ijmece.com
Vol 13, Issue 1, 2025

occupied or not, with the results displayed as a clear indication of available spaces

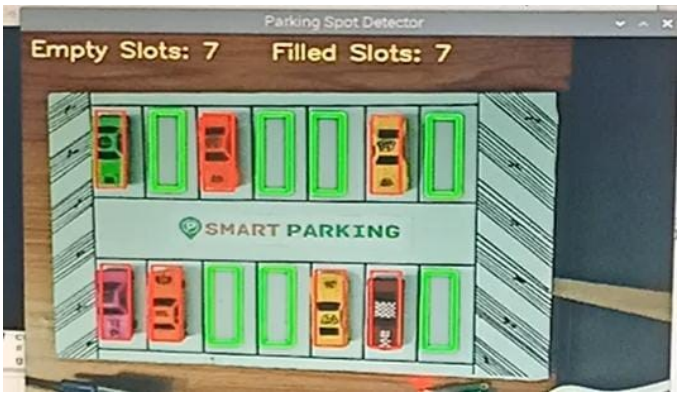

Fig-6: Parking Slots

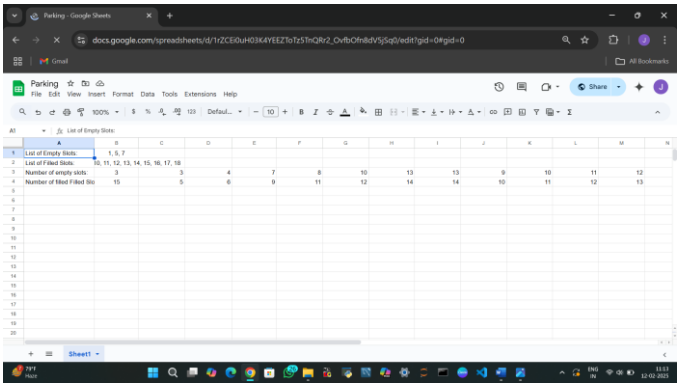

FIG-7: DATA EXPORTING TO GOOGLE SHEET

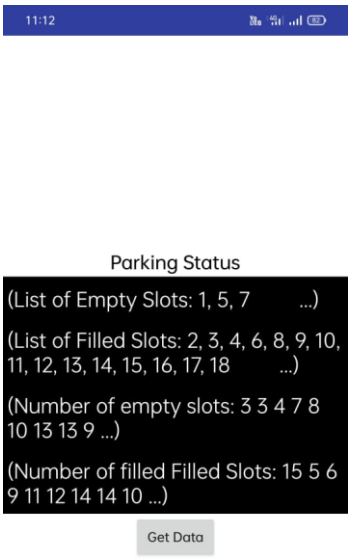

Fig-8: Parking Data Importing from Google Sheets to Mobile Application

A smart parking system is controlled through a centralized software platform that receives real-time data from Camera installed in each parking space, allowing it to monitor availability, manage access, and provide information to users via mobile apps or displays, essentially optimizing parking space utilization by dynamically updating parking status and directing drivers to available spots.

VII. CONCLUSION

In short, parking management systems give smart and easy solutions for today's car park challenges. Using tech, they make parking smoother and better, helping with convenience and safety and looking after the environment. Making parking methods better saves time and money for everyone. There are many good things about parking management systems for car park owners and those who use them. Owners get things done more efficiently, while people parking find it simple and stress-free. These ways of working lead the way in making parking less of a headache, cutting down on pollution, and making our city spaces last longer. An intelligent parking system provides an effective solution to the misuse of parking spaces, reducing concerns such as traffic jams, wasted time, and fuel consumption. Due to the affordability and ease of use of the devices, it is possible to cheaply upgrade existing parking lots in large cities. In addition, the system requires little maintenance due to the availability of cheap and readily available technology. Dependence on manpower is reduced by the introduction of an intelligent parking management system that allows users to immediately identify the availability of a parking space. Various sensors

direct cars to available parking spaces, reducing the time spent searching for empty spaces. This technology has the potential to revolutionize urban life by simplifying the parking procedure and quintuple the current chaotic parking situation, benefiting drivers as well as the entire parking problem.

VIII. References

[1] **Shashi Jain** - Co-founder of ParkMobile, which provides a widely used mobile parking payment app

[2] **Elon Musk** - As CEO of Tesla, he has advocated for advanced automotive technologies, including smart parking features in electric vehicles

[3] **Henry Liu** - CEO of Streetline, a company known for its smart parking solutions that use sensors and data analytics

[4] **Derek McKenzie** - Co-founder of ParkAssist, which specializes in parking guidance systems

[5] **Mohammad Al-Omari**: **Background**: Involved in smart parking projects that leverage IoT and data analytics. **Contribution**: His work focuses on integrating technology to optimize parking space usage and enhance urban planning.