Smart Car Parking System

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***Abstract*— Land transportation in India heavily relies on railway stations,yet these stations face issues with parking due to manual methods, resulting in congestion and inefficiencies. Current approaches also face difficulties such as inadequate real-time parking allocation, a deficiency in digital payment options, and issues related to user-friendliness. To address this, a cutting-edge solution is proposed which harnesses advanced technologies like image processing, Raspberry Pi, OCR for license plate recognition, and cashless transactions. Ultrasonic sensor verify vehicle presence, OCR deciphers license plates, and historical data manages parking logistics, slot detection is done using Pickle.Travelers can conveniently access parking fees on an OLED screen, receive a QR code for exiting , simplifying payments and improving safety. The project places a strong emphasis on environmental sustainability and real-time updates. It is designed with potential for expansion and integration with other station services, offering an effective, eco-conscious parking system that can adapt to evolving transportation needs.**

Keywords—License plate ,Image processing, Organic LightEmitting diode(OLED),Easy Optical Character Recognition (OCR),Parking Facilities, Pickle, Raspberry Pi.

I. Introduction

A. Real-World Scenario

Parking challenges, including limited spaces, unauthorized parking, steep costs, and safety risks, affect both drivers and urban areas. The search for rare parking spots leads to traffic jams and fuel wastage. Illegitimate parking creates traffic blockages and safety worries. Expensive parking places financial strains on residents and hinders public spaces and businesses. Managing parking effectively requires resources and technology, and while contemporary solutions aim to enhance the experience, technical issues and connectivity problems can cause driver frustration.

B. Background

C. Smart Car Parking Systems employ sensors, cameras, and data analysis to efficiently manage urban parking, collecting real-time data on parking availability and occupancy. This information is then processed and transmitted to a central server through communication networks, allowing users to access it via mobile apps and web interfaces for reservations and cashless payments. These systems alleviate traffic congestion, reduce emissions, enhance security, resulting in a more convenient urban parking experience and environmental benefits. They offer up-to-the-minute information to locate available parking spaces, boost safety with surveillance, and ensure inclusivity with designated spots for individuals with disabilities. Smart parking systems optimize space utilization, provide cost savings, and encourage eco-friendly transportation choices. Moreover, they present revenue opportunities for authorities through fees and data sales.

C. Challenges In Implementing Smart Car Parking Systems

The integration of intelligent car parking systems with toll gate systems and image processing brings forth several notable challenges that demand thoughtful attention. . Figure 1 illustrates the Smart Car Parking System.

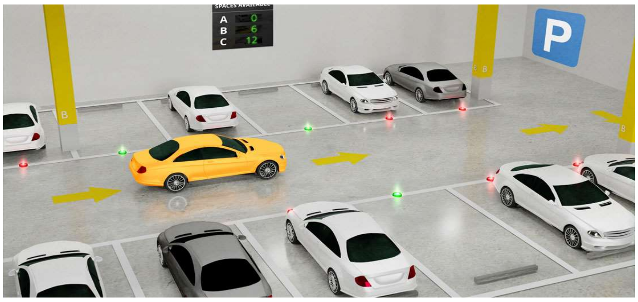


Fig. 1. Smart Car Parking System

One of the primary challenges is ensuring the accuracy of image processing algorithms, which must consistently and precisely identify and track vehicles, decipher license plates, and recognize vacant parking spots.These algorithms need to exhibit resilience in the presence of varying environmental conditions, encompassing changes in lighting and different weather circumstances. Smart car parking systems amass extensive information about vehicles and their occupants, necessitating a strong emphasis on safeguarding the privacy of these vehicles.

II. LITERATURE REVIEW

Suthir S, et al. (2022) [1] proposes a method which involves the use of CCTV cameras and IR sensors to gather data, with MATLAB for recognizing license plates and recording entry times. A mobile application simplifies user pre-booking via license plates, utilizing OTPs for validation upon arrival. Image processing techniques, such as edge detection and character segmentation, ensure precise license plate extraction. IoT technology is employed for real-time vehicle presence detection, while mobile app development enhances user engagement and reservation. However, high implementation costs and complexity may impede widespread adoption, and system reliability depends on stable IoT device operation, potentially leading to disruptions. Overall, the system provides automated parking with image recognition, IoT, and OTP-based authentication, along with pre-booking for user convenience, aiming to automate parking inspections and monitor vehicle movement in various conditions.

I.Nakazato et al.(2022)[2] has utilized the matching theory with the Gale–Shapley algorithm to manage parking allocation and implementing dynamic pricing to alleviate urban traffic congestion stemming from parking search. The methods include applying matching theory with the Gale–Shapley algorithm to ensure stable parking allocation, adjusting pricing dynamically according to parking utilization rates, and enabling rematching to handle situations when parking lots are full.This research effectively tackled the issue of determining preferences for both drivers and parking managers, presenting a holistic parking allocation solution based on matching theory. The incorporation of rematching and a dynamic pricing strategy demonstrated its efficiency in improving parking space usage, decreasing driver waiting periods, and guaranteeing profitability for parking managers, as confirmed by the outcomes of the simulations.

Alharbi et al. (2021)[5] proposed a web-based framework for a smart parking system that uses IoT sensors, cloud computing, and a web application to improve parking efficiency and reduce traffic congestion. The approach described the development of a logistic regression model for weight determination in a data integration algorithm, with the aim of aligning parking payment data with occupancy records. Logistic regression was applied to establish the weights for the integration algorithm, which harnessed metaheuristic optimization techniques to correlate payment transactions and occupancy data. Proximity-based metrics were computed to gauge the resemblance between different timestamps and stay durations. The pivotal role of the logistic regression model was in assigning these weights to the factors within the integration algorithm. This research presented a payment-centric parking occupancy model and data integration system, allowing cost-effective parking management without the need for costly monitoring equipment. While the method is flexible, it necessitates adjustments for various geographical settings and data reliability concerns. The research indicated an accuracy rate of at least 62.4% in matching transactions, signifying the possibility of some unmatched records

Jiren Zhang et al.(2020) [6] adopts a data-centric approach, leveraging real-world parking data and vehicle sensor details. It utilizes machine learning techniques, particularly deep reinforcement learning, to formulate an independent parking strategy. This involves an in-depth examination of actual parking data to comprehend parking dynamics and complexities. Through the application of deep reinforcement learning, an automated parking system is developed, and it incorporates real-time sensor data for decision-making during parking maneuvers. The primary objective is to enhance parking efficiency and reduce the need for multiple maneuvers, ultimately elevating the parking experience. However, it's important to acknowledge that the study's effectiveness could be affected by the quality and dependability of sensor data in diverse parking scenarios.This study presents an innovative model-based reinforcement learning approach for autonomous parking, reducing the need for human expertise and optimizing various aspects of parking, with potential improvements by considering additional environmental factors in future research.

Vikas Hassija et al.(2020) [7] proposed a study which involves examining hourly traffic data to grasp the patterns that influence fluctuations in parking prices. It utilizes the Hungarian Assignment Model for the optimal allocation of parking spaces based on specific user constraints and traffic insights. Additionally, the model employs an Adaptive Pricing Algorithm to dynamically adapt parking rates, taking into account factors like traffic density and time of day.Efficient sharing of information among network members is achieved through the Gossip Protocol, while the study ensures secure consensus in a decentralized network by employing the Hashgraph Consensus Algorithm. The proposed model aims to enhance the parking experience by refining pricing, enhancing resource allocation efficiency, and establishing an equitable and decentralized parking slot allocation system. However, it's important to note that the research's primary focus on New Jersey traffic data may limit its applicability to other regions.

Behrang Assemi et al.(2022)[3]proposed a metaheuristic optimization algorithm to merge parking bay occupancy data from camera snapshots with payment transactions. It fine-tunes algorithm parameters using logistic regression. Metaheuristic optimization combines occupancy and payment data, while logistic regression helps adjust parameters. Machine learning techniques, such as deep learning, gradient boosting, and random forests, are utilized to establish a model for estimating parking occupancy. The study confirms the potential of using cameras and payment information to estimate bay-level parking occupancy. However, inaccuracies may occur due to discrepancies in underpaid, overpaid, or unpaid parking transactions affecting the payment-based occupancy data.This study created a practical payment-based parking occupancy model for efficient management, but its general applicability and the quality of video-based license plate data could pose challenges.

Mahmoud M. Badr et al.(2020) [8] have adopted a consortium blockchain to establish a parking management system with decentralization, safeguarding privacy through cryptographic means. It incorporates Private Information Retrieval (PIR) to enable drivers to access parking offers without compromising their location privacy. The Commitment Technique is implemented to thwart parking lots from gaining an unfair competitive advantage and to maintain equitable pricing. Time-Locked Payments are employed to confirm reservations, encourage driver commitment, and ensure secure payment processes. The elimination of a central authority enhances transparency and security, although system integrity relies on the accuracy of blockchain validators. Additionally, privacy-preserving measures may facilitate the tracking and removal of malicious drivers based on specific behaviors.

Liehuang Zhu et al.(2020) [9] proposed an anonymous smart parking and payment (ASAP) system within vehicular networks to ensure the security and confidentiality of parking management. It employs cryptographic techniques, including short randomizable signatures and E-cash, to safeguard user identities and locations during parking transactions. Short Randomizable Signatures are used in ASAP to ensure the anonymity and conditional privacy of users during parking interactions. A Hashmap Matching mechanism allows the server to efficiently pair parking queries with available spots. For secure and private transactions, E-cash Payment methods are employed to facilitate interactions between drivers and suppliers. User Privacy is a top priority, protecting identities and locations from external threats, fostering trust in parking transactions. A critical aspect of the ASAP system is the use of short randomizable signatures to grant user anonymity and conditional privacy in parking transactions. But the user privacy in this system is dependent on trust in the involved entities, and any breach of trust could potentially jeopardize privacy and security.

Andrew Mackey et al.(2020) [10] utilized BLE beacons to gauge proximity and optimized distance precision through path loss models. User interactions, encompassing parking registration and payments, were facilitated via smartphone applications. This involved the use of BLE beacons to transmit unique IDs and proximity data, the development of path loss models to enhance RSSI accuracy across diverse settings, and the implementation of the particle filter algorithm for refined proximity estimation within a specified range. A noteworthy aspect is that the system offered real-time parking data, while cloud servers played a pivotal role in cost calculations, rendering the parking process more efficient. An algorithm, the Particle Filter, was instrumental in accurately estimating proximity between BLE beacons and smartphones. However, it's important to note that the system's reliance on internet connectivity for registration and payment may present limitations, particularly in areas with poor network access.Thus, the smart parking system delivers a secure and efficient solution for parking location and payment, benefiting both users and facility owners.

A. Summary

The collective research endeavors explore inventive methods to manage parking and address traffic congestion, utilizing cutting-edge technologies like IoT sensors, CCTV cameras, deep learning, and blockchain to improve parking efficiency and the overall user experience. These approaches center around data-driven strategies, leveraging real-world parking data and sensor information to create automated parking systems and adaptive pricing models. Privacy and security measures, including cryptographic techniques and decentralized systems, ensure the protection of user identities and transactions. Focused on user-centric elements, these innovations seek to optimize pricing, resource allocation, and user-specific constraints, ultimately aiming to enhance user satisfaction. Nonetheless, these systems may rely on consistent internet connectivity and face challenges related to varying environmental conditions, data reliability, and regional applicability.

B. Gap Analysis

The analysis of the existing literature on smart parking systems highlights several key areas for further exploration and improvement. A noticeable presence exists in addressing privacy and security concerns within these systems, providing an opportunity for research to delve deeper into developing methods for secure data handling and preserving user privacy in the context of smart parking. The absence of standardized solutions and frameworks across various studies poses a challenge to achieving interoperability and the creation of universally applicable smart parking platforms.

To address this, it is crucial to work towards the establishment of common standards within the field. Another significant problem pertains to the high implementation costs and complexities associated with smart parking systems, which can potentially hinder their widespread adoption.It is required to focus on finding cost-effective solutions to make these systems more accessible and practical. Furthermore, there is limited discussion on the environmental impact and sustainability aspects of smart parking systems, leaving room for the development of eco-friendly components and conducting ecological impact assessments. A considerable number of studies rely heavily on theoretical concepts and simulations, emphasizing the need for real-world validation and user feedback. This would help assess the practicality and user acceptance of smart parking solutions across different conditions and geographical settings.

III. EXISTING METHOD

Indian Railway stations employ various parking systems, selecting them based on factors like station size and traffic flow. These options include "Pay and Park," charging fees based on vehicle type and parking duration, "Season Parking" offering economical season passes, and "Valet Parking" for added convenience. Additionally, Indian Railways is transitioning to smart parking systems, aiming to reduce congestion, boost efficiency, increase revenue, and enhance customer satisfaction by providing real-time parking space information. These systems align with modernization trends but also present challenges, including cost, complexity, reliability, and privacy concerns. Overall, this transition signifies Indian Railways' commitment to improving passenger experiences in the face of evolving transportation needs.When a vehicle enters a railway station parking area, either a manual attendant or automated ticketing booth issues a paper ticket containing entry time, vehicle details, and a unique identifier. The vehicle owner locates an available parking space within the designated area, parks accordingly, and upon exiting, presents the ticket to a manual attendant or automated payment booth. The parking fee is calculated based on the stay duration and vehicle type, and payment is made in cash. After payment, the vehicle can exit, facilitated either by a manual attendant or an automated mechanical system.Although Indian Railways is working towards smart parking systems, the effectiveness of current systems is limited.

Fig. 2. Erode railway station car parking

The introduction of smart parking systems within the Indian Railways network presents a set of formidable challenges and considerations. Figure 2 shows the Erode junction car parking. Foremost among these is the financial burden, as the installation and ongoing maintenance of these systems can be costly, potentially straining the financial resources of Indian Railways. Furthermore, the operation of smart parking systems is intricate, necessitating investments in staff training to ensure their effective management. The reliability of these systems is also a concern, particularly in adverse weather conditions, where malfunctions could disrupt normal operations.Privacy-related risks arise due to the extensive data collection inherent to smart parking systems, opening the door to potential data misuse or hacking. Another noteworthy issue is the lack of awareness among many Indian drivers regarding the functioning of these systems, which may result in confusion and frustration when attempting to use them. Additionally, certain regions in India lack the necessary infrastructure, including dependable internet connectivity and a stable power supply, further complicating the implementation. Security vulnerabilities, including the potential for cyberattacks, must be proactively addressed to safeguard these systems and the data they gather. In summary, these challenges underscore the importance of meticulous planning, strategic investments, and comprehensive measures for the successful deployment of smart parking systems in the Indian Railways, with a focus on ensuring both efficiency and data security.

IV. PROPOSED METHOD

The Smart Car Parking System is a cutting-edge solution that aims to completely transform the management of parking facilities by solving the shortcomings of current techniques and increasing efficiency. The Raspberry Pi, optical character recognition (OCR) algorithms, servo motors, ultrasonic sensors, a Pi camera, a MySQL database, an OLED display, and more are all included in this system.When an automobile is detected, the ultrasonic sensor triggers the mechanism. The license plate number is then extracted by the Pi camera using the EasyOCR method. Additionally, the camera counts the number of parking spaces that are available and shows the result on the OLED display. The database is then used to safely store the vehicle's details. The license plate is detected once again during the payment procedure, and the parking cost is computed.

A. Flow Diagram of the Proposed Car Parking System

The system starts with the vehicle detection using Ultrasonic sensor and ends with the toll gate being opened using the servo motor. Figure 3 shows the complete flow diagram of the proposed system .It is divided into two different sections namely the parking section and the payment section. Figure 4 and Figure 5 shows the flowchart of the parking and payment system.

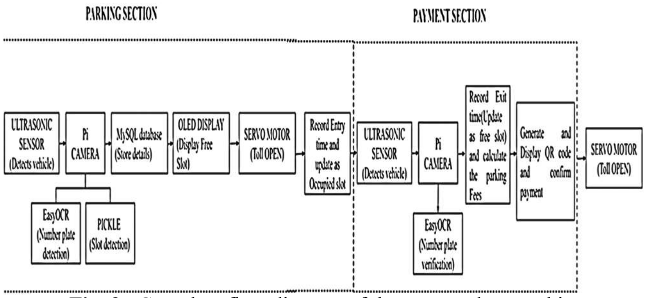


Fig. 3. Complete flow diagram of the proposed car parking system

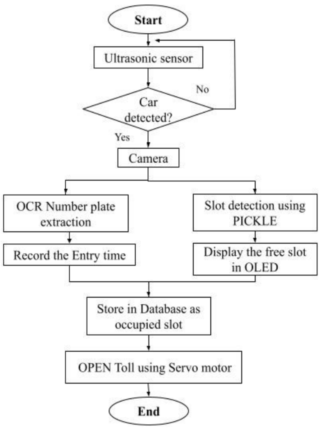


Fig. 4. Flowchart of the proposed parking system

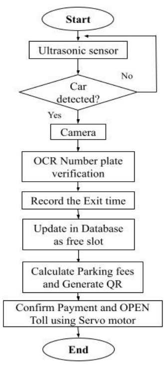


Fig. 5. Flowchart of the proposed payment system

The parking system utilizes ultrasonic sensors for vehicle detection, employs Pickle for tracking available slots, and uses EasyOCR for number plate recognition. The data is stored in a MySQL database. When a vehicle is registered, the toll gate opens, entry time is recorded, and the slot status is changed to "occupied."In the payment section , the system is repeated with vehicle detection and number plate verification. It records exit time, calculates fees, and updates the slot status to "free." A payment QR code is generated and displayed on OLED, and upon successful payment, the gate is opened.All controlled by Raspberry Pi.

B. Working of Raspberry Pi 4

The Raspberry Pi 4 is a versatile single-board computer developed by the Raspberry Pi Foundation. It's powered by a quad-core ARM Cortex-A72 CPU and offers different memory configurations (2GB, 4GB, or 8GB), making it suitable for various computing tasks. It features multiple ports, including USB, Ethernet, HDMI, and GPIO pins, providing connectivity options for a wide range of peripherals and external devices. One notable aspect of the Raspberry Pi 4 is its compatibility with various operating systems, with Raspberry Pi OS, based on Debian, being the most commonly used. This makes it an excellent educational platform for people to learn programming, electronics, and computer science in a hands-on manner.Table 1 describes the features of Raspberry pi 4 model B.The Raspberry Pi 4 comes with built-in Wi-Fi (802.11ac) and Bluetooth 5.0, which enhances its connectivity and is particularly valuable for Internet of Things (IoT) projects.It also supports dual 4K video output through its two HDMI ports, making it suitable for multimedia and display applications. The GPIO pins enable interfacing with sensors, motors, and other hardware components, making it versatile for do-it-yourself (DIY) projects.

TABLE 1. FEATURES OF RASPBERRY PI 4 MODEL B

FEATURES	RASPBERRY PI 4
Processor	Quad-core Broadcom BCM2711 ARM Cortex-A72
RAM	1, 2, 4, or 8 GB LPDDR4X
Storage	MicroSD card slot
Video output	Dual HDMI ports (4K at 60 Hz)
Audio output	3.5mm audio jack
Networking	Gigabit Ethernet port, dual USB 2.0 ports, dual USB 3.0 ports
Operating system	Raspbian, Ubuntu Mate, Fedora, and others
Other features	GPIO header

The Raspberry Pi 4 has a vibrant and passionate community that has created a vast repository of online resources, tutorials, and projects. This abundance of resources makes it accessible to a wide range of users and empowers them to harness its potential for a variety of innovative and practical applications. Moreover, Raspberry Pi peripherals expand the Raspberry Pi's capabilities by allowing the connection of various devices such as displays, input devices, cameras, sensors, actuators, storage devices, and networking devices. These peripherals enable users to extend the Raspberry Pi's functionality and create a diverse range of projects, from media players and security systems to robots and file servers. The Raspberry Pi is a versatile and powerful platform with inbuilt camera module that can be used to create a smart car parking system. It can be used to detect and track vehicles, guide vehicles to available parking spaces, and collect parking fees. The Raspberry Pi can also be used to implement a variety of other features and functionality, such as providing real-time information to parking lot operators and drivers, integrating with other systems, and generating reports.

C. *Working Of MySQL For Database*

MySQL is an open-source relational database management system known for its structured table-based data storage, employing SQL for CRUD operations. It uses the efficient B-tree indexing method and prioritizes data security with features like user authentication, encryption, and secure communication. Concurrency control mechanisms ensure data consistency during simultaneous access. MySQL supports database backup and recovery for data protection. High availability is achieved through replication. Scalability, both vertical and horizontal, is a key feature, accommodating growing data and traffic loads. Seamless integration with various languages and frameworks enhances its versatility, making it a widely adopted solution for data management in diverse applications.Data in MySQL is stored on disk in files, and the system employs an efficient indexing method known as the B-tree (Balanced Tree) structure to facilitate rapid data retrieval. This indexing method enhances query performance by reducing the amount of data that needs to be scanned, making MySQL a fast and reliable choice for data storage.To ensure the security of the stored data, MySQL offers robust features. These include user authentication and authorization mechanisms, allowing administrators to control who can access the database and what actions they can perform. MySQL is a popular database choice for smart car parking systems because it is scalable, reliable, secure, and cost-effective. It can store vehicle, parking space, and parking transaction information and manage vehicle entry and exit, parking space reservations, and parking fee payments. When a vehicle enters a parking lot, its license plate is scanned and sent to MySQL, which retrieves the vehicle's information and assigns it a parking space. When the vehicle exits, its license plate is scanned again, and MySQL calculates the parking fee and updates the vehicle's parking transaction information.

D. *Working of Dweet*

Dweet is a web-based service designed to streamline the process of sharing data from Internet of Things (IoT) devices, sensors, or any data source. It offers a user-friendly and efficient way to publish and access data on the web. The core functionality of Dweet revolves around the concept of a "thing." A "thing" is a container for data, and users can name their things as they see fit. This name is then incorporated into a unique URL, providing a simple and accessible means of publishing and retrieving data. For instance, if one names a "thing" as "mydata," the URL for the data becomes `https://dweet.io/dweet/for/mydata`. This intuitive naming system simplifies data access and sharing.Publishing data on Dweet is as straightforward as making an HTTP POST request with a JSON payload to the thing's URL. Once published, the data can be accessed by anyone who has the URL by simply making an HTTP GET request. Dweet not only provides access to the most recent data but also maintains a historical archive, allowing for data analysis and integration with other services or applications.The real-time nature of Dweet is particularly valuable, making it suitable for applications that require immediate data updates and remote monitoring. However, Dweet's simplicity comes with a limitation – it does not require authentication or security measures. This means that anyone with the URL can access and modify the data. As a result, Dweet is best suited for applications where data security is not a primary concern.Dweet offers both free and paid plans to accommodate varying data retention and usage needs. While the free plan is sufficient for basic data sharing, the paid plans extend data retention and offer additional features, making them ideal for more demanding applications. If the ultrasonic sensor value is below 15cm , it is sent to dweet.io by using urllib3 as a sender and by receiving the sensed value to another program as a receiver. On fetching, the camera will be turned on to capture the license plate.

V. METHODOLOGY AND WORKING

The Smart Car Parking System is a sophisticated and innovative solution designed to revolutionize the way parking facilities are managed. This integrated system employs cutting-edge technology to enhance user convenience, optimize parking space utilization, and automate the billing .process.At its core, the system relies on a camera connected to a Raspberry Pi, Optical Character Recognition (OCR) algorithms,ultrasonic and servo motor for the toll system,MySQL database for storing details and QR for payment. These allow the system to extract license plate numbers from the camera feed with a high degree of accuracy. This capability is instrumental in identifying vehicles entering and exiting the parking facility.Real-time parking monitoring is another critical aspect of the system.

A. *Block Diagram of Proposed Parking System*

The proposed system uses ultrasonic sensors to detect the presence of vehicles in parking slots. The data collected from the sensors is transmitted to a cloud server, which stores the data and provides real-time information about the availability of parking spaces to users through a OLED.

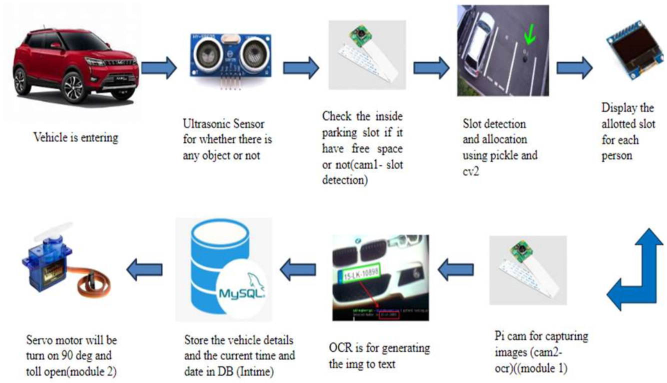


Fig. 6. Block diagram of Proposed parking system

This allows users to view the availability of parking spaces in real time and navigate to the nearest available space.The system also includes a servo motor, which could be used to control a barrier at the entrance to the parking lot. Figure 6 shows the block diagram of proposed parking system . The barrier could be raised to allow vehicles to enter the parking lot when there are available spaces.The smart parking system has the potential to improve parking efficiency and reduce traffic congestion. By providing users with real-time information about the availability of parking spaces, the system can help drivers to find parking more quickly and easily. This can reduce the amount of time drivers spend circling around looking for parking, which can lead to reduced traffic congestion and emissions.

B. Block Diagram of Proposed Parking Bill Payment

The proposed system is a well-designed system that uses IoT technology to improve parking efficiency and reduce traffic congestion. Figure 7 shows the block diagram of

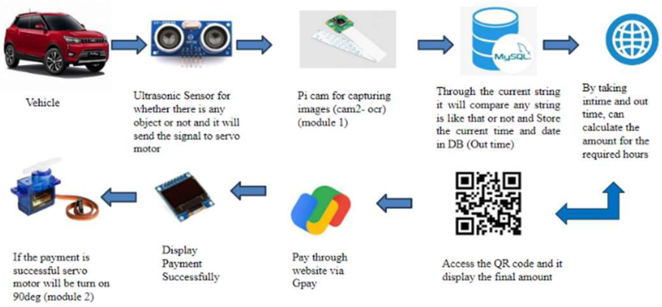


Fig. 7. Block diagram of Proposed system for parking bill payment

proposed system for parking bill payment .The system uses ultrasonic sensors to detect the presence of vehicles in parking slots and provides real-time information about the availability of parking spaces to users through a OLED. This information can help drivers to find parking more quickly and easily, which can reduce the amount of time drivers spend circling around looking for parking. This can lead to reduced traffic congestion and emissions.The system also includes a servo motor, which could be used to control a barrier at the entrance to the parking lot. This could help to further improve parking efficiency by preventing vehicles from entering the parking lot when there are not available.

C. EasyOCR

Easy OCR, which stands for Optical Character Recognition, is a technology designed to effortlessly convert text from images or scanned documents into text that can be edited and searched. This simplifies the handling of text in various applications. It allows printed materials like invoices and receipts to be scanned and transformed into digital text for easy storage and retrieval. Fig.6 shows the Block diagram of EasyOCR. Additionally, Easy OCR can automate data

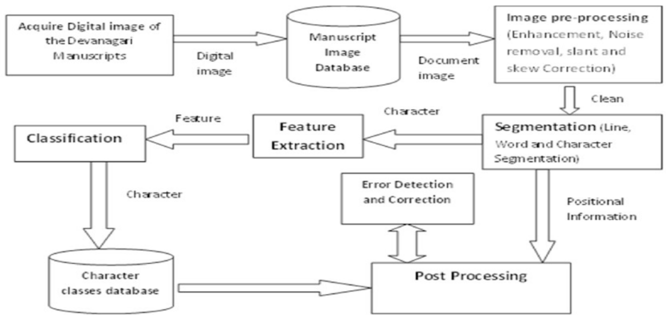


Fig. 8. Block diagram of EasyOCR

entry by extracting text from forms and handwritten notes, improving productivity.

Furthermore ,it helps extract text from images, such as photos and screenshots, and can convert scanned PDF documents into editable and searchable text. It not only offers convenience but also enhances accessibility by making printed or handwritten materials available to individuals with visual impairments. It can store vehicle, parking space, and parking transaction information and manage vehicle entry and exit, parking space reservations, and parking fee payments. When a vehicle enters a parking lot, its license plate is scanned and sent to MySQL, which retrieves the vehicle's information and assigns it a parking space. When the vehicle exits, its license plate is scanned again, and MySQL calculates the parking fee and updates the vehicle's parking transaction information.There are many user-friendly OCR software and APIs available, making it straightforward to integrate this technology into various applications and workflows. Some popular options include Tesseract, Adobe Acrobat, Google Cloud Vision OCR, and Microsoft Azure Cognitive Services.

D. Pickle

Pickle, an essential Python module, functions as a tool for serializing and deserializing Python objects, enabling their state to be encoded into compact byte streams for storage or data transfer. The process of serialization, called pickling, transforms Python objects into byte streams, while deserialization, known as unpickling, restores these streams back into Python objects, retaining their original data and structure. Figure 9 shows the block diagram of Pickle. Pickle is widely used for tasks like storing and loading intricate data structures such as lists or dictionaries, preserving the state of Python objects like machine learning models and application configurations, and facilitating data exchange between

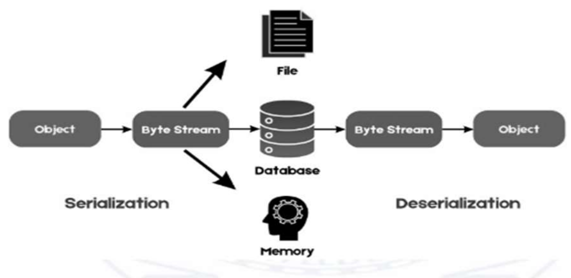


Fig. 9. Block diagram of Pickle

various Python programs or components. Pickle is used for serializing Python object structures, which involves converting an object in memory into a byte stream that can be stored as a binary file on disk. When loaded back into a Python program, this binary file can be deserialized into a Python object. The frames are drawn, deployed into a file, and subsequently loaded from these files. In the current Python file, these frames are imported, and the threshold is determined by counting white pixels in the grayscale image. If the count of white pixels is higher, it indicates an empty slot in the frame. If the count of white pixels is lower, it indicates that the slot is occupied.

VI. RESULT AND DISCUSSION

The smart parking system has been designed and output of the various blocks of the proposed smart car parking system are as follows:

A. Output for Toll System

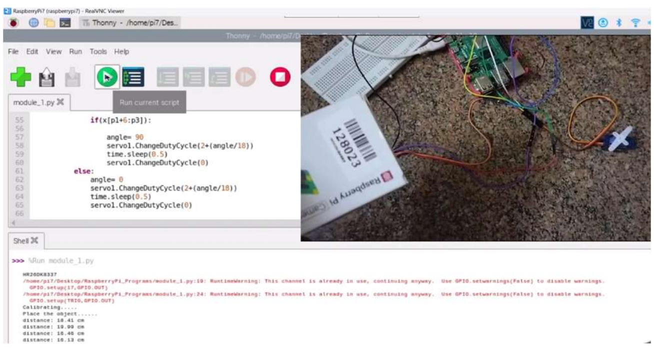


Fig. 10. Output for toll system with ultrasonic sensor and servo motor

Figure 10 Illustrates that when the ultrasonic sensor detects a car in front of it and parallelly if it fetched the license plate means, it will trigger the servo motor to turn by 90 degrees to open the toll system. Afterward, the servo motor will return to its initial position. If the ultrasonic sensor measures a distance less than the predetermined threshold (15 cm in this case), it will send a signal to the Raspberry Pi. Subsequently, the Raspberry Pi will control the servo motor's rotation.

B. Output for License Plate Recognition

Figure 11 depicts the process of extracting a license plate

Fig. 11. Extraction of License plate number using EasyOCR

number using EasyOCR. OCR algorithms analyze the shapes and patterns in the image to recognize and convert them into text characters, making it possible to extract textual information from images. Edge detection and grayscale conversion help enhance the accuracy of this process by isolating and simplifying the text elements.The EasyOCR algorithm employs a two-step process for license plate recognition in the fig. .It begins by detecting the edges of the license plate in the image. Edge detection helps identify the boundaries and contours of the license plate, which is a crucial step in isolating the text.

After edge detection, the image is converted into grayscale. Grayscale images are easier to work with for text extraction because they only contain shades of gray. The text within the license plate is then extracted using Optical Character Recognition (OCR) technology. In this specific case, the license plate number "TN 38 BR 3036" is recognized and converted into the output "TN38BR3036."

C. Output for Slot Detection

The system utilizes image processing to identify vacant parking slots by applying a specified threshold value.The various scenarios of slot detection are as follows:

Figure 12 shows the process of identifying available car parking spaces using Python, OpenCV, and Pickle involves several steps. It relies on OpenCV for image processing and Pickle for storing and retrieving data, such as a trained machine learning model. The occupancy status of each parking space is determined using a car detection model (if trained) and additional image analysis techniques. The information about parking spaces, including their coordinates and occupancy status, is stored with Pickle. Upon loading this data into the program, it's converted to grayscale, and the density of white pixels is calculated. Frames with a high density of white pixels are considered occupied, while the rest are treated as free spaces. Free spaces are marked with green frames, while occupied spaces are highlighted with red frames. This method allows for the counting of the number of available parking spaces in the parking lot .Figure 12 detects the 1 free slot out of 4 slots.

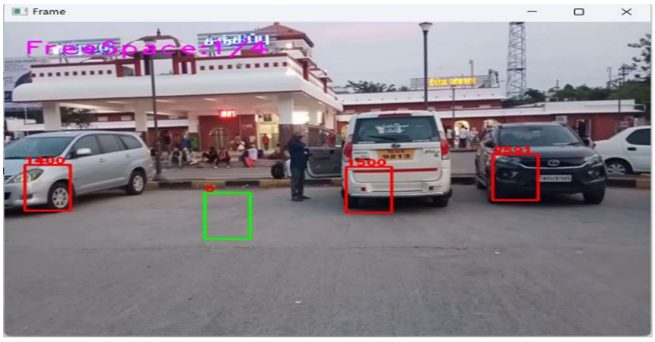


Fig. 12. Free Space Detection in Erode Junction with 1 free space

From the Figure 13 which shows that all slots are occupied, it is inferred that OpenCV and the trained bounding boxes are indicating that all three slots are occupied, it means that the object detection process has identified cars within the predefined regions corresponding to each parking slot. This information is then used to conclude that all three slots are currently in use or occupied.

Fig. 13. All Slots are Occupied

OpenCV analyzes these bounding boxes in the image to identify whether any objects (e.g., cars) are present within

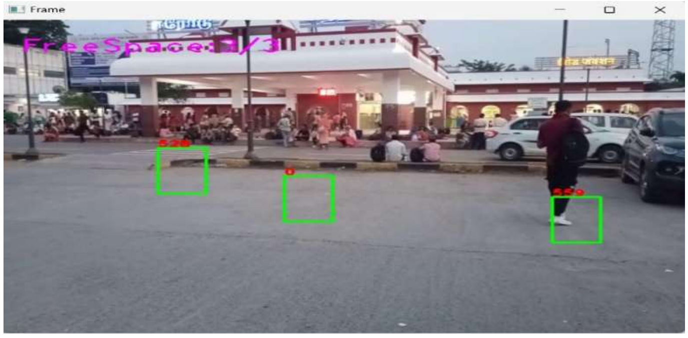


Fig. 14. All Slots are Empty

them. In the figure 14 shows all slots are empty," OpenCV does not detect any cars within the bounding boxes, indicating that all parking slots are empty. There is no car detected in the region of bounding box as the threshold value is not reached.

Figure 15 shows Error detection due to dim light and presence of people and showing false results. The "error detection" mentioned in Figure 15 could refer to situations where OpenCV produces incorrect or false results. In the case

Fig. 15. Error detection due to dim light and presence of people

of dim light, inadequate illumination can lead to challenges in object detection. For instance, if the lighting is too low, OpenCV might not be able to accurately distinguish between objects or may misinterpret shadows and low-contrast areas as objects. Similarly, in the presence of people, OpenCV may misidentify them as other objects due to similar features.

(NOTE:Green coloured boxes represent the free slots and the red coloured boxes represent the occupied slots of car in the figure 12-15)

D. Display the available slots in OLED Display

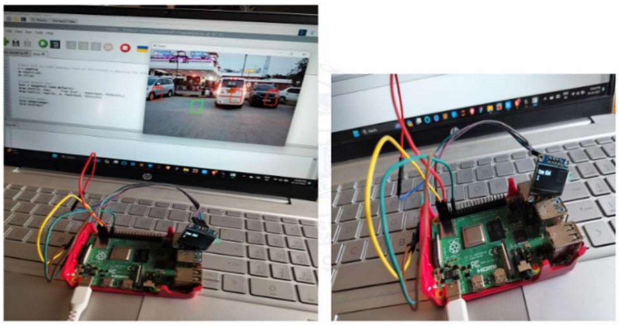
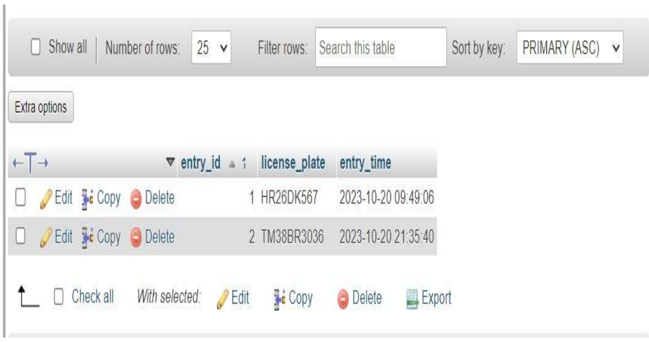


Fig. 16. Detect the free space and Display the value in OLED

Figure 16 shows Interfacing OLED Display in RaspberryPi, the pin arrangement is most commonly GND, VCC, SCL and SDA. The count from the windows thonny python is fetched and used the value in raspberry pi by using urllib3 via Dweet Platform in the manner of transmitter and receiver.

E. Output For Database

Figure 17 depicts the Entry Table in XAMPP Server (car entries) is used to store the entry id, license plate, entry time in the car entries table .This setup allows for efficient data management, retrieval, and analysis related to vehicle entries,

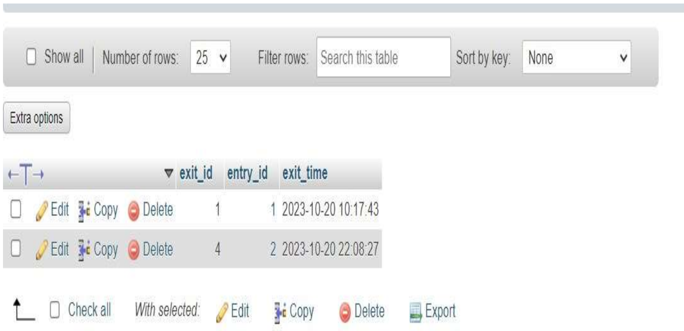


entry_id	license_plate	entry_time
1	HR26DK567	2023-10-20 09:49:06
2	TM38BR3036	2023-10-20 21:35:40

Fig. 17 . Used to store the entry_id, license_plate, entry time in the car_entries table

making it useful for parking management and storing the required data.

In Figure 18, the Entry Table in XAMPP Server (car exits) is used to store information about car exits, including the entry ID, exit ID, and entry time. It's crucial for recording the exit time, which is used to calculate the parking fee based on the duration of the car's stay.The difference between the entry time and exit time gives the total duration.



exit_id	entry_id	exit_time
1	1	2023-10-20 10:17:43
4	2	2023-10-20 22:08:27

Fig. 18. Used to store the entry_id, exit_id, entry time in the car_exits table

F. Output For QR Payment

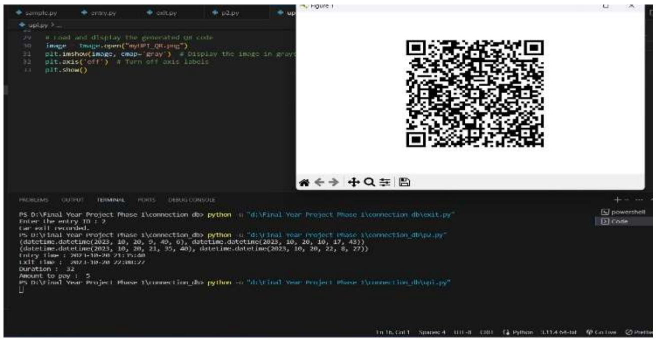


Fig. 19. Scan and Pay the respected amount through QR code using UPI ID

When the entry_id matches, the system retrieves the entry time and exit time from the database. It then calculates the parking duration using datetime functions. After that, it computes the parking fee, (which is set at Rs. 10 per hour in this scenario) based on the duration. Finally, it generates a QR code for payment, containing the UPI ID as shown in Figure 19 which depicts the Scan and Pay the respected amount through QR code using UPI ID and the requested payment amount. The Figure 19 illustrates the output with the entry and exit times, as well as the calculated fare and the QR code for payment

VII. CONCLUSION AND FUTURE SCOPE

A. Conclusion

The Smart Car Parking System, driven by Raspberry Pi and advanced image processing techniques, signifies a significant advancement in parking management automation and optimization. It effectively tackles critical aspects, diminishing the need for human intervention while elevating user convenience and control. It is a multifaceted project that offers a comprehensive solution for modern parking management. It alleviates the workload on parking attendants, enhances the user experience, and shows great potential for overcoming challenges associated with adverse weather conditions through future refinements. This initiative serves as a testament to the capabilities of automation and technology in enhancing everyday tasks and represents a significant innovation in the realm of parking management.

B. Future Scope

The Smart Car Parking System represents a holistic approach to modern parking management. It automates tasks like number plate detection, slot allocation, and toll collection. Challenges related to adverse weather and low-light situations are being tackled through the incorporation of technologies like infrared cameras. There are plans for streamlining payment processing for greater efficiency. The project offers opportunities for further development, with a specific emphasis on enhancing security and the user experience. By integrating solar power and IoT technology, it can reduce its environmental footprint and optimize parking management. Collaborating with smart city initiatives can facilitate wider adoption. To sum it up, this project has the potential to revolutionize parking management, contributing to smarter and more efficient cities.

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