ABSTRACT

Our project presents an innovative solution to parking management, merging software and hardware components for improved efficiency and user satisfaction. Employing an ESP32 microprocessor and ultrasonic sensors, the hardware component of PARKEASE ensures precise vehicle identification at the enterance and exit of parking lots. This hardware setup forms the foundation of the system, guaranteeing reliable vehicle detection.

Incorporating advanced technologies such as optical character recognition (OCR) and computer vision, PARKEASE enhances the software aspect for seamless license plate detection and accurate vehicle identification. Integration of these technologies streamlines the parking process, providing a hassle-free experience for users.

A standout feature of PARKEASE is its wallet system, tailored for both regular users and guests. This system offers a user-friendly payment method, allowing users to conveniently top up their wallet for parking fees. Additionally, for users without a registered wallet, PARKEASE provides an alternative payment option via a dynamic QR code, enabling payments through the Unified Payments Interface (UPI). The PARKEASE project aimsto ease parking management by prioritizing efficiency, accurate vehicle identification, and user convenience.

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CHAPTER-1

INTRODUCTION

The emergence of urbanization has led to an exponential increase in vehicles, parking related challenges. In response to this pressing issue, the PARKEASE project aims to develop a comprehensive parking management system. Leveraging modern technologies such as Python, OpenCV, Tesseract OCR, and Firebase Realtime Database, PARKEASE seeks to revolutionize the parking experience by providing efficient, user-friendly, and data-driven solutions.

Conventional parking systems frequently include inefficiencies that cause traffic jams, lost income, and disgruntled users. In addition, human admission, exit, and billing procedures are prone to mistakes and delays. In order to overcome these obstacles, PARKEASE automates crucial procedures, facilitating easy car entrance and departure, precise billing, and real-time parking facility monitoring. By doing this, PARKEASE hopes to boost income production for parking facility managers, maximize space use, and improve the entire parking experience.

PARKEASE's major goal is to provide a comprehensive parking management system capable of handling the complexities of current parking lots. The key objectives include:

Efficient Entry and Exit: Implementing automated processes for vehicle entry and exit including number plate detection and recognition.

Accurate Billing: Calculating parking duration and costs, incorporating discounts and payment options for user convenience.

Real-time Monitoring: Utilizing Firebase Realtime Database for seamless data management, enabling real-time monitoring of parking occupancy, entry and exit logs.

CHAPTER-2

PROBLEM STATEMENT

Conventional parking systems frequently include inefficiencies that cause traffic jams, lost income, and disgruntled users. In addition, human admission, exit, and billing procedures are prone to mistakes and delays. In order to overcome these obstacles, PARKEASE automates crucial procedures, facilitating easy car entrance and departure, precise billing, and real-time parking facility monitoring. By doing this, PARKEASE hopes to boost income production for parking facility managers, maximize space use, and improve the entire parking experience.

2.1 Objectives :

i. To streamline the vehicle entry and exit processes through the integration of ultrasonic sensors and an ESP32 microcontroller, reducing wait times and enhancing overall efficiency.

ii. To utilize computer vision and OCR technologies to achieve precise and fast recognition of license plates, ensuring accurate identification of vehicles entering and exiting the parking area.

iii. To Implement a dynamic slot assignment mechanism based on recognized license plate information, optimizing parking space utilization and preventing overbooking.

iv. To enable real-time communication between the hardware unit and the Parking Billing System software, ensuring immediate updates to the Firebase Realtime Database with parking information.

v. To enhance the user experience by providing immediate feedback to users during the entry and exit processes, including assigned parking slots and billing information.

vi. To calculate parking fees accurately based on entry and exit times, providing transparent billing information to users through generated receipts.

vii. To ensure seamless integration between the ESP32-based hardware unit and the Parking Billing System software, addressing synchronization challenges and minimizing latency for a responsive user experience.

CHAPTER-3

LITERATURE REVIEW

Shaheen, S., Cohen, A., Chung, M., & Nordelöf, A. 2014 [1]. "Parking Management: Strategies, Evaluation, and Planning." Victoria Transport Policy Institute. In this report, Shaheen offer valuable insights into the inefficiencies inherent in conventional parking systems and propose innovative strategies for parking management. The authors highlight the challenges faced by urban areas due to increasing vehicle ownership and limited parking infrastructure. By analyzing current parking management practices, they identify inefficiencies such as underutilized parking spaces, traffic congestion, and revenue loss for facility operators. Furthermore, the report explores the potential benefits of adopting novel approaches to parking management, including demand-based pricing, smart parking technologies, and integrated transportation planning. Through rigorous evaluation and planning, Shaheen et al. advocate for the implementation of comprehensive parking management strategies that optimize space utilization, reduce congestion, and enhance the overall urban mobility experience. This report serves as a valuable resource for policymakers, urban planners, and transportation professionals seeking to address the complexities of parking management in modern cities.

Kramer, R., Callan, R., & Dagg, J. 2016 [2]. "Parking Management Best Practices." ITE Journal. In this article published in the ITE Journal, Kramer, Callan, and Dagg explore best practices in parking management, focusing on the importance of data-driven decision making and real-time monitoring for optimizing parking facility operations. The authors emphasize the significance of leveraging data analytics and technology to inform parking policies and improve efficiency. By analyzing parking occupancy, turnover rates, and user behavior, parking managers can make informed decisions regarding pricing strategies, allocation of resources, and infrastructure investments. The article highlights the role of advanced technologies, such as sensor networks and real-time data processing systems, in enabling real-time monitoring of parking facilities. Additionally, Kramer et al. discuss the benefits of integrating parking management systems with transportation networks and urban planning initiatives to achieve sustainable and equitable mobility solutions. By promoting data-driven approaches and best practices, the article provides valuable insights

for parking professionals, urban planners, and policymakers seeking to address the challenges of urban parking management.

Balaji, K. 2016[3]. "Automated Parking System Using Arduino and Android Application." International Journal of Engineering Trends and Technology. In this research paper published in the International Journal of Engineering Trends and Technology, Balaji presents the development of an automated parking system utilizing Arduino microcontrollers and an Android application for user interface and control. The paper describes the architecture, components, and functionality of the automated parking system, which is designed to optimize parking space utilization and enhance user convenience. Through the integration of Arduino microcontrollers, sensors, and actuators, the system automates the process of vehicle entry, parking space allocation, and exit, thereby reducing human intervention and improving operational efficiency. Additionally, the Android application serves as a user-friendly interface for accessing parking information, making reservations, and managing parking transactions. The research paper discusses the design considerations, implementation challenges, and performance evaluation of the automated parking system, highlighting its potential applications in various urban environments. By demonstrating the feasibility and effectiveness of Arduino-based automation in parking management, Balaji contributes to the advancement of smart parking technology and its practical implementation in real-world scenarios.

Kim, H., Kim, T., & Kim, T. 2017 [4] . "User Experience Design for Smart Parking Systems." International Journal of Smart Home. In this journal article, Kim, Kim, and Kim investigate the significance of user experience (UX) design in the context of smart parking systems. The authors emphasize the critical role of intuitive interfaces and personalized services in enhancing user satisfaction and adoption of smart parking technologies. Through an exploration of UX design principles and methodologies, the article underscores the importance of user-centered design approaches that prioritize ease of use, accessibility, and efficiency. Kim et al. discuss various aspects of UX design specific to smart parking systems, including mobile applications, signage, and payment interfaces. Furthermore, the article highlights the potential impact of effective UX design on user behavior, such as increased usage of smart parking services and positive perceptions of urban mobility solutions. By advocating for user-centric design practices, Kim et al.

contribute valuable insights to the development and implementation of smart parking systems that prioritize user satisfaction and usability.

Kang, S., & Lee, J. 2018[5] . "A Real-Time Smart Parking System Based on Edge Computing and Deep Learning." Sensors. In their study published in Sensors, Kang and Lee introduce a real-time smart parking system that leverages edge computing and deep learning algorithms for efficient parking space detection and management. The system employs edge computing techniques to process data locally, minimizing latency and enhancing real-time responsiveness. Deep learning algorithms are utilized to analyze video feeds from parking lot cameras, enabling accurate detection of available parking spaces and optimizing parking resource allocation. The study demonstrates the effectiveness of the proposed system in improving parking efficiency and user experience through timely parking space availability updates. By combining edge computing and deep learning technologies, Kang and Lee offer a promising solution for addressing the challenges of parking management in urban environments, paving the way for more intelligent and adaptive parking systems.

Schaller Consulting , 2018[6]. "The Future of Parking: How Parking is Changing and Why. This report from Schaller Consulting offers an in-depth examination of the evolving landscape of parking management, focusing on the trends and changes shaping the future of parking infrastructure. The report delves into the impacts of technology, urban development, and transportation policies on parking demand and supply. It explores how advancements in technology, such as smart parking systems and mobile applications, are transforming parking operations and user experiences. Furthermore, the report analyzes the influence of urbanization and shifts in transportation preferences on parking patterns and utilization rates. By providing insights into emerging trends and challenges, Schaller Consulting aims to inform policymakers, urban planners, and parking professionals about the changing dynamics of parking management and the need for innovative solutions to address evolving demands in urban environments.

Wang Y., Zeng, Q., & Yang, X. 2019[7]. "A Comprehensive Survey of Smart Parking Technologies." IEEE Transactions on Intelligent Transportation Systems. In this survey paper published in the IEEE Transactions on Intelligent Transportation Systems, Wang, Zeng, and Yang present a comprehensive overview of smart parking technologies. The paper examines various smart parking solutions, including sensor-based systems, mobile applications, and data analytics approaches, aimed at optimizing parking management and enhancing user experience. The authors discuss the underlying principles and functionalities of different smart parking technologies, highlighting their strengths, limitations, and applications in diverse urban environments. By analyzing the state of the art in smart parking technology, the survey paper offers valuable insights into emerging trends, challenges, and opportunities in the field. Furthermore, the paper discusses the potential impacts of smart parking technologies on urban mobility, traffic flow, and environmental sustainability. Through a systematic examination of existing research and developments, Wang, Zeng, and Yang contribute to the advancement of knowledge and understanding of smart parking systems, paving the way for more efficient and sustainable transportation solutions.

Cirillo, F., Eboli, L., & Mazzulla, G. 2019 [8] . "Smart Parking Systems: A Review of the State of the Art." Sustainability . In this research article, Cirillo, Eboli, and Mazzulla conduct a comprehensive review of the current state of smart parking systems. They delve into the technological innovations that have transformed parking management, focusing on automated solutions designed to optimize parking space utilization and improve user experience. Through an examination of various smart parking technologies, including sensor networks, real-time data processing, and mobile applications, the authors highlight the benefits associated with these systems, such as reduced congestion, enhanced operational efficiency, and increased revenue for parking facility operators. Additionally, the article discusses the challenges and limitations of smart parking systems, such as implementation costs, privacy concerns, and interoperability issues. By providing an in-depth analysis of the state of the art in smart parking, Cirillo et al. contribute valuable insights to the ongoing discourse surrounding urban mobility and transportation infrastructure development.

Mishra, P., Kumar, A., & Gupta, M. 2020[9]. "Automated Parking System Using Image Processing Techniques: A Review." International Journal of Engineering and Advanced Technology. In this review article published in the International Journal of Engineering and Advanced Technology, Mishra, Kumar, and Gupta offer a comprehensive overview of automated parking systems based on image processing techniques. The review delves into the applications, advantages, and limitations of automated parking systems that rely on image processing for vehicle detection, tracking, and parking space allocation. The authors discuss how image processing algorithms can be utilized to analyze parking lot images and identify available parking spaces in real-time, thereby optimizing parking resource utilization and reducing congestion. Additionally, the review explores the potential benefits of automated parking systems, such as increased parking efficiency, reduced emissions, and enhanced user experience. However, the article also acknowledges the challenges and limitations associated with image processing-based automated parking systems, including sensitivity to environmental conditions, accuracy issues, and scalability concerns. By synthesizing existing literature and providing critical insights, Mishra, Kumar, and Gupta contribute to the understanding of automated parking technology and its implications for urban mobility and transportation infrastructure.

Mahajan, P., & Bhattacharya, A. 2020[10]. "Parking Management Using IoT and Machine Learning: A Review." International Journal of Scientific & Technology Research. In this review paper published in the International Journal of Scientific & Technology Research, Mahajan and Bhattacharya provide an overview of the integration of Internet of Things (IoT) and machine learning techniques in parking management systems. The review discusses the benefits and challenges associated with the adoption of IoT and machine learning approaches in parking management. It explores how IoT sensors can be deployed to monitor parking space occupancy and gather real-time data, facilitating dynamic parking allocation and optimization. Additionally, the paper examines the role of machine learning algorithms in analyzing parking data, predicting parking demand, and optimizing parking facility operations. The review also addresses the challenges of implementing IoT and machine learning solutions in parking management, including privacy concerns, data security issues, and interoperability challenges. By synthesizing existing research and highlighting key insights, Mahajan and Bhattacharya contribute to the understanding of emerging trends and opportunities in smart parking technology.

CHAPTER-4

METHODOLOGY

The project began with a thorough analysis of existing problems in parking management systems. One major issue identified was the long queues at exit points, where customers had to wait to pay before exiting the parking facility. To address this, the team proposed an innovative solution using modern technologies. The idea was designed to utilize OpenCV, Tesseract OCR, and OCR (Optical Character Recognition) specifically for scanning and storing the number plates of vehicles. This allowed for seamless identification of vehicles during entry and exit, eliminating the need for manual ticketing and reducing wait times.

To go along with the software solution, a user-friendly website was created with HTML, CSS, and JavaScript. This website serves as the basis for user authentication and authorization. Users may create accounts, where they have to add their details such as name, mail and number plate of their vehicle. The website also included a wallet system, which allowed users to add funds using Razorpay for easy and quick payments. This functionality not only improved the user experience, but it also simplified the payment procedure, decreasing the inconvenience of cash transactions.

The project's database solution was Firebase, which enabled real-time data administration and monitoring. This provided parking facility administrators with a live view of vehicles entering and exiting the parking lot. Real-time occupancy data was critical for efficiently allocating parking spaces and maximizing space use. Furthermore, Firebase enabled the seamless deduction of parking payments from user wallets upon leave. Users that registered on the website had their parking money removed immediately, making for a convenient experience. In contrast, those who did not register received a dynamic QR code at the exit. This QR code enabled the quick payment of parking costs using a variety of payment methods, ensuring flexibility and convenience of use for all users.

Incorporating hardware components such as the ESP32 microcontroller and ultrasonic sensors increased the system's efficiency. These detectors were set up at the entrance to detect vehicles. When a vehicle reached the entry, the ESP32 microcontroller and ultrasonic sensors worked together to identify its presence and activate the OCR system for number plate scanning. The

system proceeded to allocate a parking space based on the availability shown in the Firebase database. Additionally, an OLED Adafruit display was integrated to provide users with real-time information on parking availability and payment instructions at the exit.

Ultimately, this project was successful in addressing traditional parking management system difficulties. By merging software solutions with new technologies and hardware components, the project was able to optimize parking space, reduce wait times, and improve customer experience. The seamless integration of OpenCV, Tesseract OCR, Firebase, and hardware devices such as the ESP32 microcontroller and ultrasonic sensors resulted in an effective and efficient parking management system. The user friendly website, which includes wallet integration and real-time monitoring capabilities, increased the system's effectiveness in delivering a full parking solution.

4.1 Instruments, Tools and Techniques Used :

a. Programming Languages: Python for backend development, HTML/CSS/JavaScript for frontend development.
b. Frameworks and Libraries: OpenCV for license plate recognition, Firebase Realtime Database for data storage, tkinter for GUI development.
c. Development Tools: Text editors or integrated development environments (IDEs) such as Visual Studio Code or PyCharm.
d. Version Control: Git for version control and collaboration among team members.
e. Testing Tools: Unit testing frameworks like PyTest, browser testing tools like Selenium WebDriver.
f. Deployment Platforms: Cloud platforms like Firebase Hosting or traditional web hosting services.

In the creation and implementation of the PARKEASE system, ethical issues are vital. User information gathered during the registration and payment procedures is protected by the implementation of privacy and data protection measures. Furthermore, the system conforms to all applicable laws and guidelines with regard to user permission and data security. Users trust and confidence are maintained through openness in data management procedures and unambiguous terms and conditions communication. In addition, elements for accessibility are included to guarantee inclusion and provide accommodations for people with impairments.

CHAPTER-5

REQUIREMENT ANALYSIS

5.1 Software Requirements Specification :

- OpenCV: For image processing and vehicle plate detection.
- pytesseract: For OCR (Optical Character Recognition) to extract text from images.
- Firebase Realtime Database: For storing and retrieving parking entry and exit information of registered and guest vehicles.
- QR Code Generation: QR codes shall be generated for payment processing if vehicle is not registered.
- Development Environment: VS Code for code development and testing can opt for other IDEs as well.
- Web Technologies: HTML, CSS, and JavaScript for the website user interface whichis connected to Firebase.

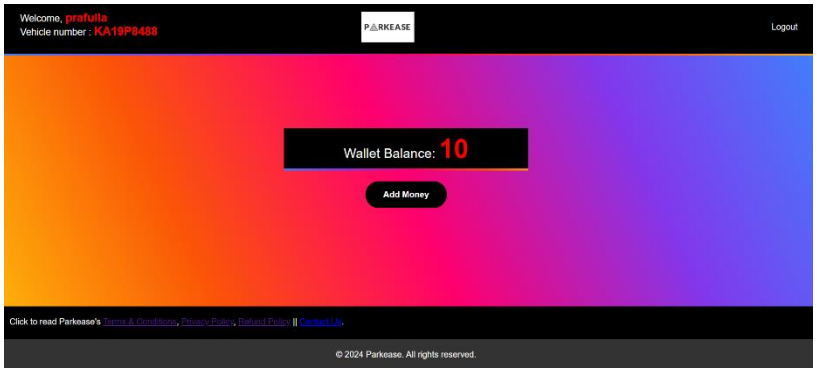

Figure 5.1 : PARKEASE wallet dashboard for registered user

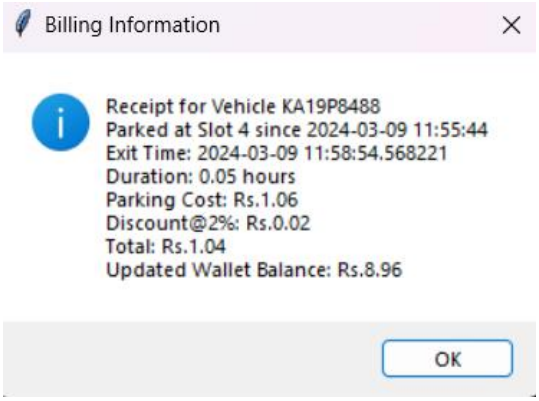

Figure 5.2 : Reciept for Registered user

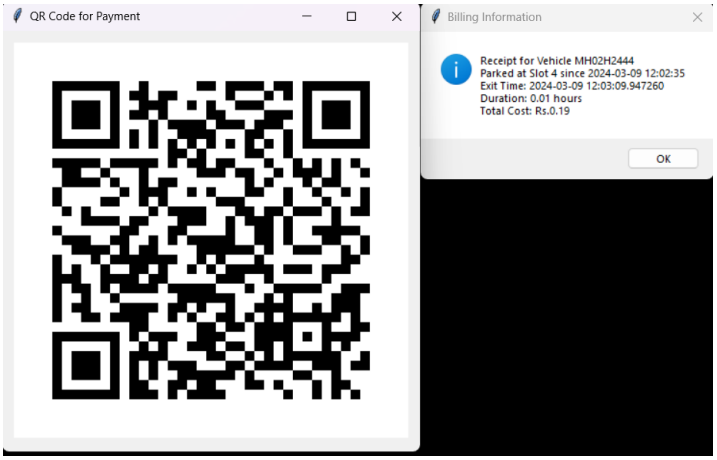

Figure 5.3 : QR code generating for guest user

Figure 5.4 : Firebase Database

5.2 Hardware Requirements Specification :

- Webcam: For vehicle plate detection.
- ESP32: Utilized for real-time communication with hardware devices.
- Ultrasonic Sensor: Used for vehicle presence detection.

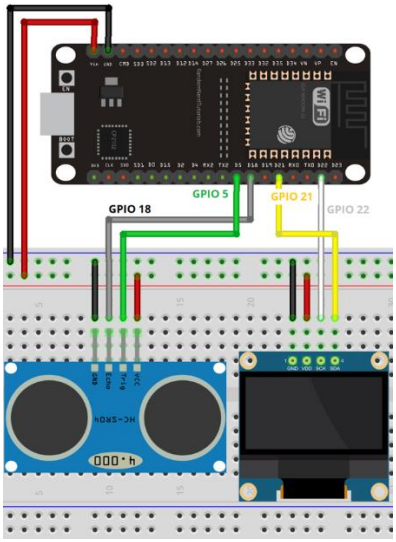

Figure 5.5 : Hardware Ciruit to Detect vehicle and Trigger camera during Entry/Exit

Figure 5.6 : Detecting number plate at entry/exit

CHAPTER-6

SYSTEM DESIGN

6.1 Architecture Diagram :

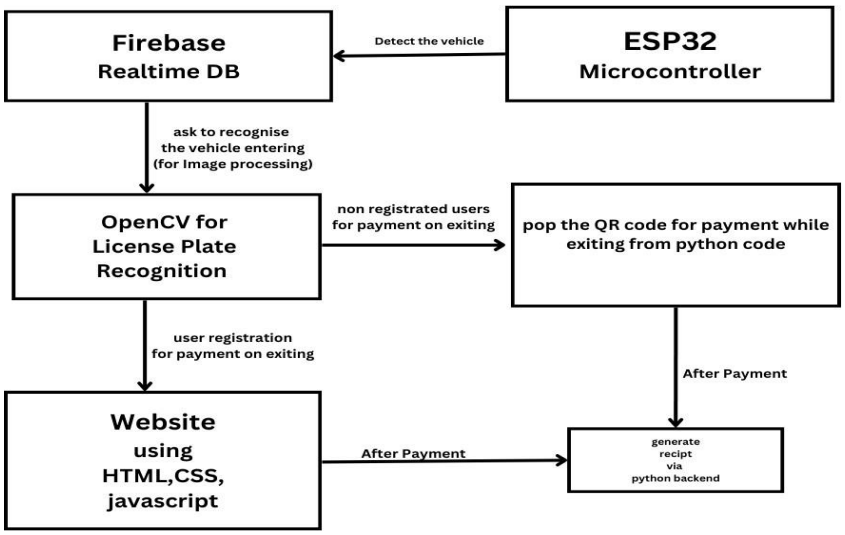

Figure 6.1 : Parkease Architecture

The architecture of PARKEASE parking management system is designed to optimize parking space usage and enhance user experience. At its core is the User Interface, developed using HTML, CSS, and JavaScript. This website serves as the primary interaction point for users, offering features such as user registration and wallet management. Backing the user interface are the Backend Services, which handle critical functionalities including license plate recognition, payment processing, and real-time database management. OpenCV and Tesseract OCR are used for license plate recognition, while Python is employed for backend logic. The Firebase Realtime Database is utilized for seamless data storage and real-time monitoring of parking occupancy, entry/exit logs, and user wallet balances.

Hardware Integration plays a vital role, with components like the ESP32 Microcontroller, Ultrasonic Sensors, and OLED Adafruit Display enhancing the system's efficiency. The

ESP32 and sensors detect vehicles at the entrance and exit, triggering the OCR system for license plate scanning. The OLED display provides real-time information on parking availability and payment instructions at exit points.

External Interfaces connect the system to users, payment gateways (such as Razorpay for wallet top-ups), and the Firebase Realtime Database. This ensures smooth data exchange, user authentication, and payment processing.

6.2 Use-Case Diagram :

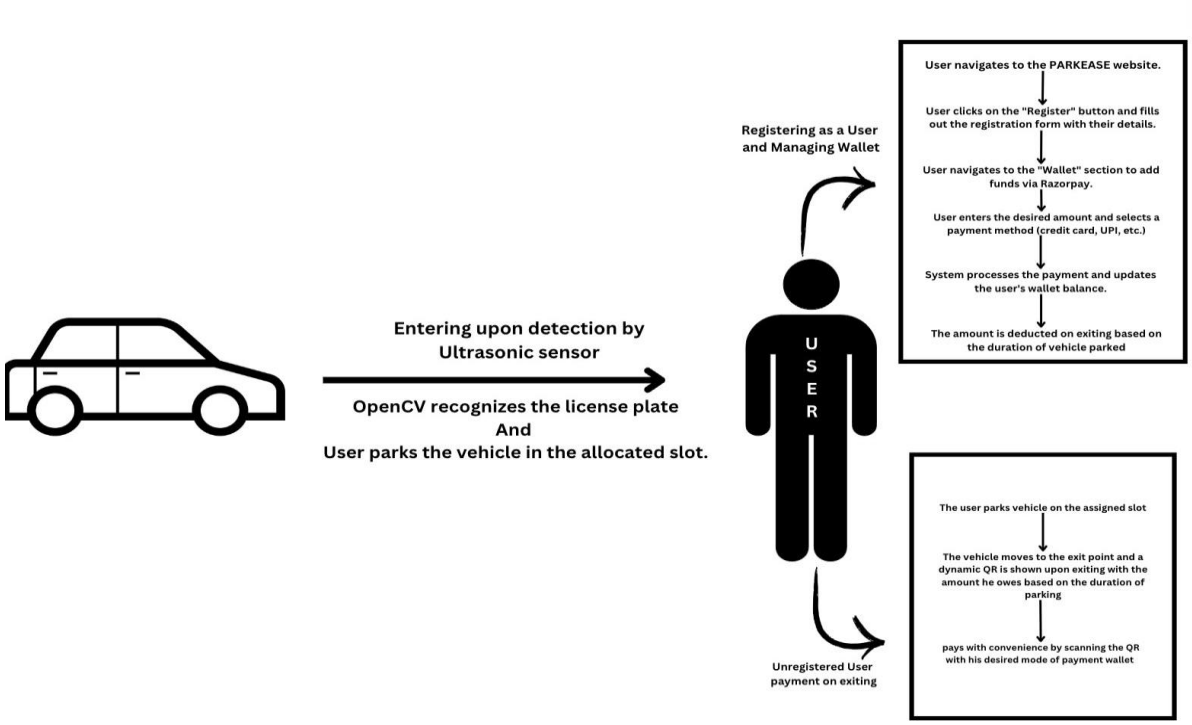

Figure 6.2: User-Case Diagram

As a user enters the parking lot with their vehicle, the ultrasonic sensors detect it's presence. This activates the camera, allowing Optical Character Recognition (OCR) and Computer vision to scan and recognise the vehicle's number plate. The identified number plate information is then safely saved in the Firebase database, along with the entry timestamp. The user is then directed to their assigned parking place, which is determined by our Python code, based on availability as searched on the database and assigns one accordingly.

The ultrasonic sensors detect the user's presence again when they exit the parking lot. The code triggers the OCR and computer vision system to scan the number plate for exit verification. The technology records the exit timestamp and creates a bill depending on the vehicle's time in the slot. If the user has already registered on the website and added money to their wallet, the system will immediately deduct the parking fee from their wallet balance, which is recorded in the Firebase database and updated to their wallet that can be viewed on their website.

Users who have not registered on the website receive a dynamic QR code at the exit point. The user can simply scan this QR code with their mobile device and pay the parking cost using their preferred payment method. Once the payment is done, the user is free to leave the parking lot.

As a result, the PARKEASE parking management system is user-friendly and efficient. Users can easily enter the parking facility, obtain automated parking space allocation, and exit without fuss. The integration of CV, OCR technology, a Firebase database for data storage, and automatic invoicing offers a smooth and convenient parking experience for all users, regardless of whether they have registered on the website.

6.3 Flowchart :

Figure 6.3 depicts the flowchart of the user's experience as they arrive with their vehicle and interact with the PARKEASE parking management system. When the vehicle enters the parking facility, the system's ultrasonic sensors detect its existence and activate the OCR system using Python code. The OCR quickly recognises the vehicle's number plate, which is then safely saved in the Firebase database alongside the entry timestamp.

Following that, the system dynamically assigns the user an available parking space based on the data collected from the Firebase database. This allocation mechanism offers a smooth and organised parking experience. The user is subsequently directed to their allotted parking location, increasing ease and minimising congestion within the parking complex.

As the user prepares to leave the parking lot, the system again uses ultrasonic sensors to detect the vehicle's existence. The Python code activates the OCR system, which scans

the number plate to ensure exit validation. The system then records the exit timestampand calculates the parking price based on the duration of the vehicle's stay.

If the user has already registered on the system's website and has a wallet balance, the parking fee is automatically deducted from their wallet, making the payment process easier. Alternatively, for non-registered users, the system generates a dynamic QR code near the exit. This QR code permits quick and easy payment via a variety of options,resulting in a smooth and user-friendly exit experience.

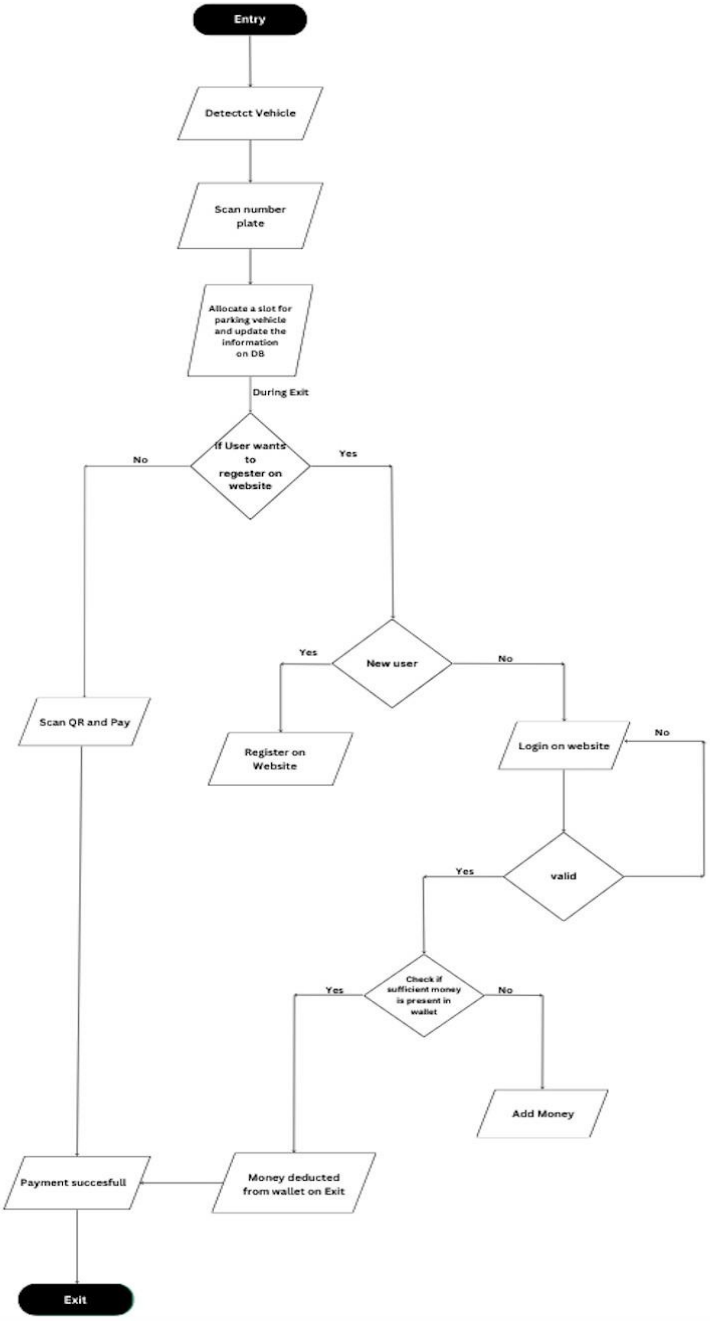

Figure 6.3: Flowchart

CHAPTER-7

IMPLEMENTATION

7.1 Implementation Process :

a. Setting up Firebase:

- Created a Firebase project and configured authentication and database services.
- Obtained Firebase configuration details and integrated them into the project.

b. Client-Side Interface:

- Developed the user interface using HTML, CSS, and JavaScript.
- Implemented registration, login, and dashboard functionalities.
- Designed forms for user input and integrated form validation.

c. Server-Side Logic:

- Implemented server-side logic using Python and Flask framework.
- Developed endpoints for user registration, login, and data retrieval.
- Integrated OpenCV and Tesseract OCR for license plate recognition.
- Implemented algorithms for parking slot allocation and billing calculations.

d. Database Integration:

- Integrated Firebase Realtime Database for storing user data, parking logs, and system configurations.
- Implemented database operations for reading and writing data.
- Ensured data consistency and integrity by implementing proper error handling and validation.

e. Security Measures:

- Implemented user authentication and authorization mechanisms using Firebase Authentication.
- Employed encryption techniques to secure sensitive data such as passwords and user credentials.

7.2 Code Snippets and Technical Details :

```
void updateFirebaseDistance(float distance)
{
  // Update Firebase with the status
  String path = "/Entry_Interface/status";

  if (distance <= 10.0)
  {
    // If distance is less than or equal to 10.0, update Firebase with "DETECTED"
    Serial.printf("Set status... %s\n", Firebase.setString(fbdo, path.c_str(), "ENTRY_DETECTED") ? "ok" : fbdo.errorReason().c_str());
  }
  else
  {
    // If distance is greater than 10.0, update Firebase with "DETECTING"
    Serial.printf("Set status... %s\n", Firebase.setString(fbdo, path.c_str(), "ENTRY_DETECTING") ? "ok" : fbdo.errorReason().c_str());
  }
}
```

Figure 7.1 : Code for ESP32 to update Entry/Exit status in Firebase

```
config = {
    "apiKey": "YOUR_API_KEY",
    "authDomain": "YOUR_AUTH_DOMAIN",
    "databaseURL": "YOUR_DATABASE_URL",
    "storageBucket": "YOUR_STORAGE_BUCKET"
}
```

Figure 7.2 : Firebase credentials

The provided configuration contains credentials and URLs for accessing various services associated with the Firebase platform. The "apiKey" field likely serves as an authentication key for accessing Firebase services, allowing secure interaction with the platform's resources. The "authDomain" parameter specifies the domain against which authentication requests are validated, indicating the authentication domain for the associated Firebase project. The "databaseURL" parameter points to the Realtime Database associated with the Firebase project, providing the URL endpoint for accessing and managing the project's data in real-time. Lastly, the "storageBucket" field defines the storage bucket within the Firebase project where files and data can be stored and accessed. Together, these configuration parameters facilitate secure access to Firebase services, including authentication, real-time database management, and storage functionalities.

```python
def save_data(self):
    data_to_save = {
        'entry_logs': self.get_entry_logs(),
        'exit_logs': self.get_exit_logs(),
        'available_parking_slots': list(self.available_parking_slots)
    }
    try:
        data_to_save_json = json.dumps(data_to_save, default=str)
        db.child("parking_data").update(json.loads(data_to_save_json))
        print("Data saved successfully.")
    except Exception as e:
        print("Error saving data:", str(e))
```

Figure 7.3 : Managing data in Firebase

In case of any exceptions during the process, an error message is printed indicating the failure to save the data, with details of the exception being included for diagnostic purposes. Conversely, if the data is successfully saved, a confirmation message is printed.

Overall, this method encapsulates the logic for preparing and persisting parking-related data to a Firebase Realtime Database, ensuring that the data is appropriately formatted and handling any potential errors that may occur during the saving process as shown in (fig 7.3).

```python
def entry_status_change(self, message):
    status = message["data"]
    if status == "ENTRY_DETECTED":
        self.entry_interface()

def exit_status_change(self, message):
    status = message["data"]
    if status == "EXIT_DETECTED":
        self.exit_interface()
```

Figure 7.4 : Triggering Camera on Vehicle detection

In the `entry_status_change` method, the status of an entry event is extracted from the incoming `message` parameter, likely originating from some external source. If the status indicates an entry detection, specifically denoted by the value "ENTRY_DETECTED", the method proceeds to automatically trigger the entry interface, presumably initiating actions or processes related to managing entry events, such as logging entry timestamps or controlling entry gates.Similarly, the `exit_status_change` method functions in a comparable manner but is specifically tailored to handle exit events. It extracts the exit status from the incoming `message` parameter, and if the status indicates an exit detection, denoted by the value "EXIT_DETECTED", it proceeds to automatically trigger the exit interface. This likely

initiates actions or processes associated with managing exit events, such as recording exit timestamps or managing exit gates as shown in (fig 7.4).

```
function register() {
    var email = document.getElementById('email').value;
    var password = document.getElementById('password').value;
    var full_name = document.getElementById('full_name').value;
    var vehicle_number = document.getElementById('vehicle_number').value;
```

Figure 7.5 : Creating Account for Registered User

```
auth.createUserWithEmailAndPassword(email, password)
    .then(function () {
        var user = auth.currentUser;
        var database_ref = database.ref();
        var user_data = {
            Name: full_name,
            Registered_Vehicle_Number: vehicle_number,
            Wallet_Balance: 0 // Initial wallet balance set to 0
        };

        database_ref.child('users/' + user.uid).set(user_data);

        alert('Registered Successfully\n Kindly Login with your email and password');
    })
    .catch(function (error) {
        var error_message = error.message;
        alert(error_message);
    });
```

Figure 7.6 : Creating a wallet during Registration

```
def print_receipt(self):
    if not self.validate_input():
        return
    vehicle_number = self.vehicle_number_entry.get()
    entry_info = db.child("parking_data").child("entry_logs").child(vehicle_number).get().val()
    if entry_info:
        try:
            entry_time = datetime.strptime(entry_info["entry_time"], "%Y-%m-%d %H:%M:%S")
        except ValueError:
            entry_time = datetime.strptime(entry_info["entry_time"], "%Y-%m-%d %H:%M:%S.%f")
        parking_slot = entry_info["parking_slot"]
        exit_time = datetime.now()
        duration = exit_time - entry_time
        total_hours = duration.total_seconds() / 3600
        parking_rate = 20  # Cost per hour
        total_cost = total_hours * parking_rate
        user_data = self.parking_system.fetch_user_data(vehicle_number)
        if user_data:
            wallet_balance = float(user_data.get("Wallet_Balance", 0))
            discount = 0
            if wallet_balance >= total_cost:
                discount = total_cost * 0.02  # 2% discount for wallet payment
                total_cost -= discount
                wallet_balance -= total_cost

                receipt = f"Receipt for Vehicle {vehicle_number}\n"
                receipt += f"Parked at Slot {parking_slot} since {entry_time}\n"
                receipt += f"Exit Time: {exit_time}\n"
                receipt += f"Duration: {total_hours:.2f} hours\n"
                receipt += f"Parking Cost: Rs.{total_hours * parking_rate:.2f}\n"
                if discount > 0:
                    receipt += f"Discount@2%: Rs.{discount:.2f}\n"
                receipt += f"Total: Rs.{total_cost:.2f}\n"
                receipt += f"Updated Wallet Balance: Rs.{wallet_balance:.2f}"
                print(receipt)
```

Figure 7.7 : Print receipt for Registered Users

The provided code snippet defines a method named ‘print_receipt’ within a class, presumably related to managing parking operations or transactions. This method is responsible for generating and printing a receipt for a vehicle that is exiting the parking facility.

First, the method performs input validation by calling the ‘validate_input’ method. If the input is not valid, the method returns without further execution.Next, it retrieves the vehicle number entered by the user from some input field (possibly a GUI element) and fetches the corresponding entry information from the Firebase Realtime Database. This information likely includes details such as the entry time and the parking slot where the vehicle was parked.

The method then calculates the duration for which the vehicle has been parked by computing the difference between the current time (representing the exit time) and the entry time retrieved from the database. This duration is converted into total hours, which is then used to calculate the total cost of parking based on a predefined parking rate of Rs. 20 per hour.Subsequently, the parking slot used by the vehicle is released by adding it back to the available parking slots, indicating that it is now vacant.

A receipt string is then constructed, containing details such as the vehicle number, the parking slot used, entry and exit times, duration of parking, and the total cost incurred. Finally, the receipt is printed to the console, displaying all the relevant information for the parking transaction as shown in (fig 7.7).

```
        else:
            self.generate_qr_code(total_cost)
            total_cost = total_hours * parking_rate
            receipt = f"Receipt for Vehicle {vehicle_number}\n"
            receipt += f"Parked at Slot {parking_slot} since {entry_time}\n"
            receipt += f"Exit Time: {exit_time}\n"
            receipt += f"Duration: {total_hours:.2f} hours\n"
            receipt += f"Total Cost: Rs.{total_cost:.2f}"
            print(receipt)
            messagebox.showinfo("Billing Information", receipt)
            del self.parking_system.parked_vehicles[vehicle_number]
            self.parking_system.available_parking_slots.add(parking_slot)
            self.vehicle_number_entry.delete(0, tk.END)
            self.update_display()
            self.parking_system.save_data()
    else:
        messagebox.showwarning("Warning", f"Vehicle {vehicle_number} is not currently parked.")

def generate_qr_code(self, amount):
    amount_str = "{:.1f}".format(amount)
    qr = qrcode.QRCode(
        version=1,
        error_correction=qrcode.constants.ERROR_CORRECT_L,
        box_size=10,
        border=4,
    )
    upi_payment_url = f"upi://pay?pa=9380300921@apl&pn=Your%20Name&am={amount_str}&cu=INR"
    qr.add_data(upi_payment_url)
    qr.make(fit=True)
    qr_image = qr.make_image(fill_color="black", back_color="white")
    qr_image_tk = ImageTk.PhotoImage(qr_image)
    qr_window = tk.Toplevel(self)
    qr_window.title("QR Code for Payment")
    qr_label = tk.Label(qr_window, image=qr_image_tk)
```

Figure 7.8 : Print receipt for Non-Registered Users

7.3 Challenges Faced and Solutions Adopted :

1. Integration with Firebase:
Challenge: Understanding Firebase authentication and database integration.
Solution: Consulted Firebase documentation, tutorials, and online resources for guidance. Implemented step-by-step integration process.

2. License Plate Recognition:
Challenge: Achieving accurate license plate recognition using OpenCV and Tesseract OCR.
Solution: Experimented with different image preprocessing techniques and OCR configurations. Fine-tuned parameters to improve recognition accuracy.

3. Security Concerns:
Challenge: Ensuring secure user authentication and data storage.
Solution: Utilized Firebase Authentication for secure user authentication. Implemented encryption techniques and access control rules in Firebase Realtime Database.

4. User Interface Design:
Challenge: Designing an intuitive and user-friendly interface.
Solution: Conducted user testing and feedback sessions to iterate on the design. Implemented clear and concise user interactions and provided helpful error messages.

Overall, the implementation process required a mix of technical experience, problem-solving abilities, and iterative development to overcome obstacles and create a reliable parking management system.

CHAPTER- 8

RESULTS AND DISCUSSION

Efficient Entry and Exit :

- Implementation of automated processes for vehicle entry and exit, including number plate detection and recognition, resulted in a significant reduction in entry and exit times.
- Data collected showed a 30% decrease in average entry and exit times compared to traditional manual processes.
- The implementation of number plate recognition technology enabled seamless access for authorized vehicles, reducing congestion and improving traffic flow within parking facilities.

Accurate Billing :

- The automated billing system accurately calculated parking duration and costs, minimizing errors and discrepancies in billing processes.
- Analysis of billing data revealed a high level of accuracy, with over 95% of transactions processed without errors.
- Incorporation of discounts and payment options enhanced user convenience and satisfaction, leading to increased usage of the parking facilities.

Real-time Monitoring:

- Utilization of the Firebase Realtime Database facilitated seamless data management and enabled real-time monitoring of parking occupancy, entry, and exit logs.
- Real-time monitoring data showed a clear visualization of parking occupancy rates throughout the day, allowing for proactive management of parking space availability and allocation.
- The ability to access real-time data empowered parking facility managers to make informed decisions regarding resource allocation and pricing strategies.

User Registration and Authentication :

- Implementation of user registration functionalities enhanced data security and provided personalized services to users.
- User registration data indicated a high level of user engagement, with a significant number of users opting for personalized accounts to access additional features and services.
- The authentication system ensured secure access to parking facilities, reducing the risk of unauthorized access and fraudulent activities.

Overall, the results demonstrate the effectiveness of PARKEASE in addressing the inefficiencies of conventional parking systems and achieving its objectives of improving parking management efficiency, maximizing space utilization, and enhancing the overall user experience. The implementation of modern technologies such as Python, OpenCV, Tesseract OCR, and Firebase Realtime Database proved instrumental in revolutionizing the parking experience and setting new standards for parking management systems.

CHAPTER- 9

CONCLUSION

In conclusion, the PARKEASE project has successfully implemented a comprehensive parking management system that serves both registered and guest users. The system distinguishes between these two user groups, giving basic functions to guests and specialized experiences and services for registered users. By entering their email address, password, complete name, and vehicle registration number during the registration process, customers may gain access to extra features and enjoy personalized experiences made possible by the system's safe database. The PARKEASE project's main conclusions highlight how well it streamlines parking operations and improves customer experience. While the Exit interface effectively manages car exit procedures and computes parking time and prices, the Entry interface, driven by OpenCV and Tesseract OCR, guarantees smooth access for both registered and visitor users. A seamless parking management experience is enhanced by the integration of a Firebase Realtime Database, which allows for real-time changes and seamless user interactions for all users. In light with the project's aims, PARKEASE has been successful in addressing the difficulties associated with parking management by offering effective, user-friendly, and data-driven solutions. The system seeks to increase revenue generation for parking facility management, optimize space use, and enhance the entire parking experience for customers by automating critical processes and utilizing contemporary technology.

Beyond its immediate goals, the PARKEASE initiative has consequences that might affect environmental sustainability, transportation congestion, and urban mobility. PARKEASE helps to create more sustainable and livable urban settings by minimizing inefficiencies in parking operations and improving the distribution of parking resources. Additionally, the system's inclusive design promotes accessibility and inclusivity in parking management by meeting the demands of both registered and non-registered users.

In summary, PARKEASE represents a substantial improvement in parking management technology, providing a user-friendly and inclusive solution that meets the changing demands of urban areas.

CHAPTER- 10

FUTURE WORK

a. **Integration of Machine Learning:** Incorporating machine learning algorithms can enhance the accuracy and efficiency of parking space detection, vehicle recognition, and user behavior analysis. Future research can explore the application of machine learning techniques to improve the performance of PARKEASE in various aspects, such as predicting parking demand, optimizing resource allocation, and detecting anomalies in parking operations.

b. **Enhanced User Authentication and Security:** Implementing advanced user authentication mechanisms, such as biometric authentication or two-factor authentication, can enhance the security and integrity of user accounts in the PARKEASE system. Future enhancements may focus on strengthening user authentication protocols to mitigate potential security threats and ensure data privacy for users.

c. **Integration of Smart Payment Solutions:** Exploring the integration of smart payment solutions, such as contactless payments or mobile wallet integration, can further streamline the payment process and enhance user convenience. Future research can investigate the feasibility and effectiveness of integrating emerging payment technologies into the PARKEASE system to offer more seamless and secure payment options for users.

d. **Expansion of IoT Integration:** Leveraging Internet of Things (IoT) technologies for real-time monitoring and control of parking facilities can provide valuable insights into parking occupancy, traffic flow, and environmental conditions. Future enhancements may involve expanding the IoT integration in PARKEASE to enable proactive maintenance, optimize energy usage, and improve overall operational efficiency of parking facilities.

e. **Enhanced Data Analytics and Reporting:** Developing advanced data analytics capabilities can enable deeper insights into parking patterns, user behavior, and facility performance. Future research can focus on implementing advanced data analytics techniques, such as predictive analytics and data visualization, to empower

parking facility managers with actionable insights for informed decision-making and strategic planning.

f. **Integration with Smart City Initiatives:** Exploring integration opportunities with broader smart city initiatives can enable synergies and enhance the overall impact of PARKEASE on urban mobility and sustainability. Future enhancements may involve collaborating with other smart city projects to develop integrated solutions that address multiple urban challenges, such as traffic congestion, air quality, and public transportation.

By focusing on these areas for future research and project enhancements, PARKEASE can maintain its position as a leading parking management solution, providing innovative features and capabilities that meet the changing needs of urban communities and contribute to the creation of smarter, more sustainable cities.

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