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IOT BASED SELF OPERATED PETROL BUNK MANAGEMENT SYATEM WITH ENHANCED SECURITY AND EFFICIENCYUSING RFID AND RASPBERRY PI

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Abstract: This paper emphasis on designing a system which can spontaneously dispense the fuel and deduct the amount from prepaid RFID card. Here, all users will have their own RFID cards which are recharged by prepaid amounts. The dispenser in the fuel station is installed with RFID reader which reads the RFID card and displays the available balance on LCD display unit. The user will enter the desired amount of fuel using the keypad, the system will calculate the time of operation for the electrical fuel pump and initiates the operation of fuel dispensing. The system will automatically shuts down the pump after reaching the user's desired value. It is combined with raspberry pi module which sends notification to the user through mobile application. Added to that, this system has fire sensor to detect fire accidents and purity sensor to check the purity of the fuel. Hence this work will make the petrol bunk management system with no boundaries and reduced manpower. ALPR, also known as Automatic Number Plate Recognition (ANPR), is a technology that enables automated identification and extraction of license plate information from images or video streams. The system uses computer vision techniques, neural networks, and pattern recognition algorithms to detect license plates, extract alphanumeric characters, and associate them with vehicle records.

Index Terms **-** Raspberry Pi , Relays , LCD display ,Keypad , Fire sensor , Power Supply , RFID reader, Optical character recognition , OpenCV

I. INTRODUCTION

In the contemporary era of technological advancement, the Internet of Things (IoT) has emerged as a transformative force, driving innovation across various sectors. One such application of IoT is in the automation of petrol bunk management systems. This paper delves into the design and implementation of an IoT-based self-operated petrol bunk management system that leverages Radio-Frequency Identification (RFID) and Raspberry Pi technology to enhance operational efficiency and security. The traditional petrol bunk operations are often marred by manual interventions, leading to inefficiencies and increased susceptibility to errors and fraud. To address these challenges, the proposed system introduces a seamless, automated solution that not only streamlines the fuel dispensing process but also fortifies the security measures. At the heart of the system lies the integration of RFID technology, which facilitates the identification and authentication of vehicles and customers. Each customer is provided with a unique RFID tag, which, when scanned by the RFID reader installed at the petrol bunk, triggers the fuel dispensing process. This method not only expedites the transaction but also minimizes human error and enhances the accuracy of fuel delivery. Complementing the RFID technology is the Raspberry Pi, a compact yet powerful microcontroller that serves as the central processing unit of the system. It is responsible for orchestrating the various components of the system, including the RFID reader, fuel dispensers, and user interface. The

Raspberry Pi also enables real-time monitoring and control, ensuring that the fuel dispensing is executed precisely as per the customer's request. Furthermore, the system is equipped with advanced sensors to monitor fuel quality and detect any potential fire hazards, thereby ensuring the safety and integrity of the operations. The integration of a user-friendly interface allows customers to interact with the system effortlessly, selecting the desired amount of fuel and initiating the transaction with ease.In essence, the proposed IoT-based petrol bunk management system represents a significant leap towards modernizing fuel stations. It promises enhanced efficiency, robust security, and a superior customer experience, paving the way for a new era of self-service petrol bunks.

II. RESEARCH METHODOLOGY

A. "IoT-Based Smart Gas Station Management System" - Ahmad et al. (2018) Ahmad et al. proposed an IoT-based smart gas station management system that leverages sensor networks and cloud computing for real-time monitoring and remote management. This paper emphasizes the potential of IoT applications in enhancing operational efficiency and maintenance in petrol bunks

B. Identification System for Gas Stations" - Chen et al. (2019). Chen et al. introduced an RFID-based automatic vehicle identification system designed specifically for petrol bunks. The system streamlines access control, fuel dispensing, and payment processing, showcasing the efficiency gains and improved customer experience facilitated by RFID technology.

C. "Design of a Smart Oil Filling Station Based on the Internet of Things" - Li et al. (2017) **.**Li et al. presented the design of a smart oil filling station that incorporates IoT technologies, including RFID and biometric authentication, to ensure secure operations and prevent unauthorized access. This paper highlights the importance of integrating security measures into IoT-based petrol bunk management systems.

D. "Smart Gas Station Management System Based on Raspberry Pi and ZigBee Wireless Network" - Zhang et al. (2020).Zhang et al. proposed a smart gas station management system utilizing Raspberry Pi as the central processing unit and ZigBee wireless network for communication. The integration of RFID technology enables automated transaction processing and inventory management, contributing to enhanced efficiency.

E. "IoT-Based Remote Monitoring and Control System for Oil Tanks in Gas Stations" - Kim et al. (2019). Kim et al. developed an IoT-based remote monitoring and control system for oil tanks in gas stations, employing RFID tags and sensors to monitor oil levels and detect leaks remotely. This paper underscores the role of IoT in improving operational efficiency and reducing maintenance costs in petrol bunks.

F. "Design and Implementation of a Real-Time Remote Monitoring System for Petroleum Storage Tanks" - Wang et al. (2018). Wang et al. described the design and implementation of a real-time remote monitoring system for petroleum storage tanks using IoT technologies. By integrating RFID and wireless sensors, the system enables remote monitoring of tank levels and environmental conditions, enhancing safety and efficiency.

G. "Blockchain-Based Secure Petrol Pump Management System" - Gupta et al. (2021).Gupta et al. proposed a blockchain-based secure petrol pump management system to address security concerns in petrol bunk operations. By ensuring tamper-proof transaction records and transparent accountability, the system mitigates risks associated with fraudulent activities and unauthorized access.

H. Automatic Number Plate Recognition: A Detailed Survey of Relevant Algorithms**".** Authors: Lubna, Naveed Mufti, and Syed Afaq Ali Shah . In their paper, Lubna, Naveed Mufti, and Syed Afaq Ali Shah provide a detailed survey of algorithms relevant to Automatic Number Plate Recognition (ANPR). The authors aim to comprehensively review the current state of ANPR technology, focusing on the algorithms used for number plate recognition. They explore various techniques employed in ANPR systems, including computer vision (CV) algorithms and machine learning approaches. The paper likely covers topics such as image acquisition, number plate extraction, segmentation, and recognition, discussing the challenges and advancements in each stage. By analyzing relevant algorithms, the authors provide insights into the effectiveness and limitations of existing ANPR systems.

I. "Automatic Number Plate Recognition System (ANPR): A Survey" - Patel, Shah, & Patel (2013) Patel, Shah, and Patel present a comprehensive survey on Automatic Number Plate Recognition (ANPR) systems, addressing their significance in traffic control and vehicle owner identification. The paper discusses the challenges associated with identifying violators and highlights the need for ANPR solutions. Various ANPR approaches are reviewed, considering parameters such as image size, success rate, and processing time. The authors outline the four main steps of ANPR algorithms and discuss different method Figure 1 shows the block diagram of next generation petrol pump. It mainly consists of LCD, keypad, relays, purity sensor, power supplyLM317, Raspberry pi, RFID card reader, WI-FI modem, fire sensor, server with database and RFID Tag ,Camera and Mobile Application .

III. PROPOSED METHODPLOGY

Figure 1 shows the block diagram of next generation petrol pump. It mainly consists of LCD, keypad, relays, purity sensor, power supplyLM317, Raspberry pi, RFID card reader, WI-FI modem, fire sensor, server with database and RFID Tag ,Camera and Mobile Application .

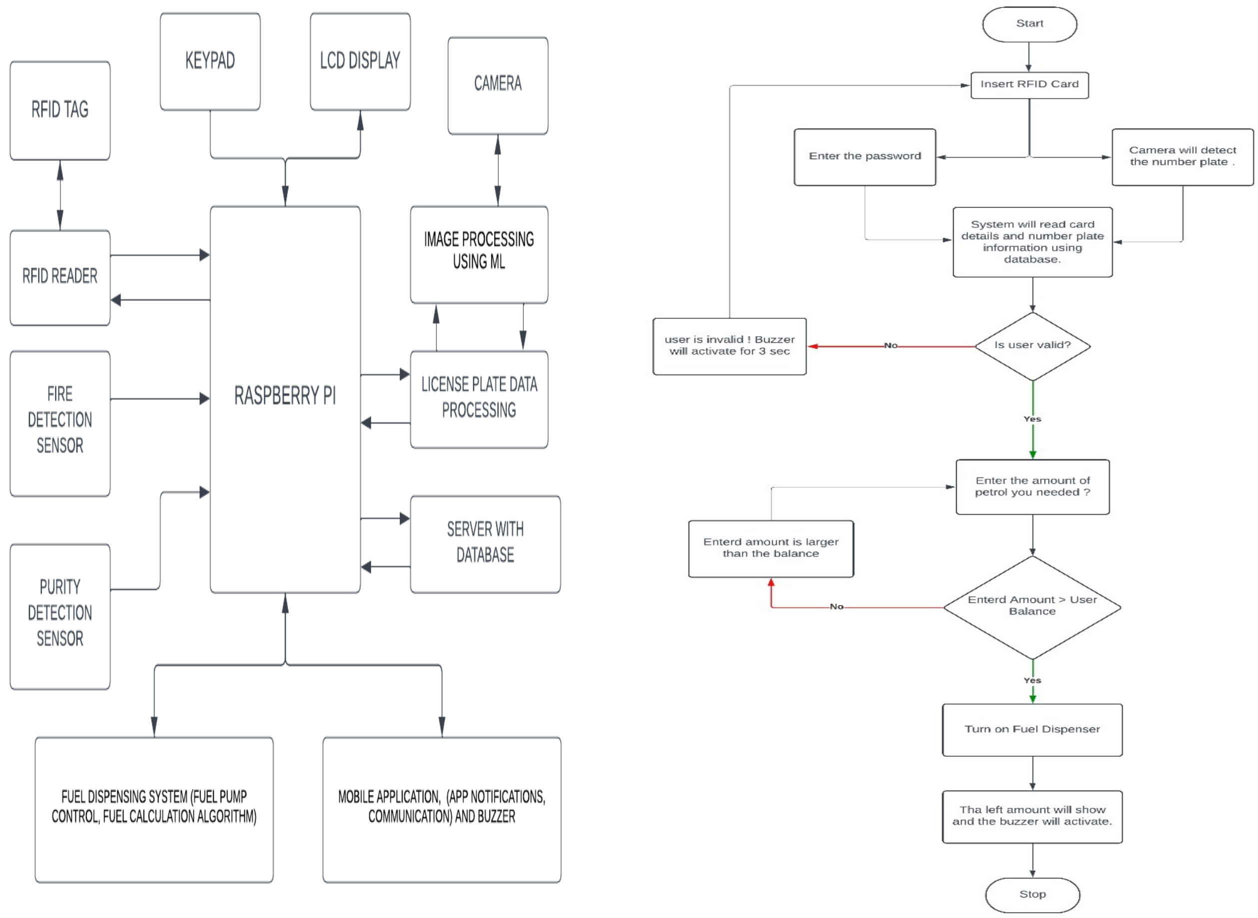

Figure 1: Block Diagram of Next Generation Petrol Pump and Flowchart of process

IV. PRINCIPLE COMPONENT OF THE SYSTEM

1.RFID Technology:

RFID (Radio Frequency Identification) serves as a fundamental component of the system for efficient vehicle identification and authentication. RFID tags are attached to vehicles and customers, containing unique identification information. RFID readers installed at entry and exit points of the petrol bunk communicate with these tags wirelessly, enabling seamless and automated identification of vehicles and customers as they enter and exit the premises.

2.Raspberry Pi: Raspberry Pi acts as the central processing unit (CPU) of the system, responsible for orchestrating communication between various components. As a versatile single-board computer, Raspberry Pi is capable of running the necessary software applications, interfacing with RFID readers, fuel dispensers, payment gateways, and the central database. It provides the computational power and connectivity required to facilitate real-time monitoring, transaction processing, and data management within the petrol bunk.

3. Central Database: The central database serves as the repository for storing critical information related to transactions, inventory, customer data, and security logs. It allows for centralized management and retrieval of data, enabling petrol bunk operators to track fuel sales, monitor inventory levels, and analyze customer preferences. The database also stores transaction records for audit purposes and facilitates reporting and analysis to support decision-making processes.

4. Fuel Dispensers: Fuel dispensers are equipped with RFID readers and actuators to facilitate automated fuel dispensing based on vehicle identification and transaction authorization. When a vehicle is identified at the fuel dispenser, the system verifies the transaction details, authorizes the fueling process, and controls the dispensing of the appropriate fuel quantity. This automation minimizes manual intervention and ensures accurate and efficient fueling operations.

5.Security Measures: Enhanced security measures are integrated into the system to safeguard against unauthorized access, fuel theft, and fraudulent activities. This includes features such as real-time monitoring of premises through surveillance cameras, authentication mechanisms for accessing fuel dispensers and payment gateways, and anomaly detection algorithms to identify suspicious behavior. Additionally, the system may incorporate encryption techniques to secure communication channels and prevent data tampering or interception.

V. HARDWAARE IMPLEMENTATION

The hardware implementation of the **IoT-based Self-Operated Petrol Bunk Management System** using RFID and Raspberry Pi. Here are the key steps for setting up the hardware components:

Raspberry Pi Setup:

- Begin by setting up your Raspberry Pi. Install the Raspbian operating system, configure Wi-Fi or Ethernet, and ensure you have a compatible power supply.

RFID Reader Integration:

- Connect the RFID reader module to the Raspberry Pi's GPIO pins.
- Typically, RFID readers have three pins: VCC (3.3V), GND (ground), and data pins (usually SDA and SCL).
- Refer to the RFID reader's datasheet for specific pin details.

Keypad Connection:

- Connect the keypad matrix to the Raspberry Pi's GPIO pins.
- Each key on the keypad corresponds to a specific GPIO pin.

LCD Display Integration:

- Connect an I2C-based LCD display to the Raspberry Pi.
- Use the display to show relevant information, such as fuel quantity, price, and messages.

Fire Sensor and Purity Sensor:

- Connect the fire sensor and purity sensor to the GPIO pins
- These sensors play a crucial role in safety monitoring.
- The fire sensor detects any potential fire hazards, while the purity sensor ensures the quality of the fuel.

Relay Control for Fuel Dispensing:

- Connect a relay module to the Raspberry Pi.
- Wire the relay to control the fuel pump.
- When a valid RFID card is detected and the user enters the desired fuel quantity, activate the relay to dispense fuel.

Testing and Troubleshooting:

- Test the entire system thoroughly.
- Verify RFID card reading, keypad input, LCD display functionality, and sensor alerts.
- Ensure that the fire sensor and purity sensor work as expected.
- Debug any issues that arise during testing.

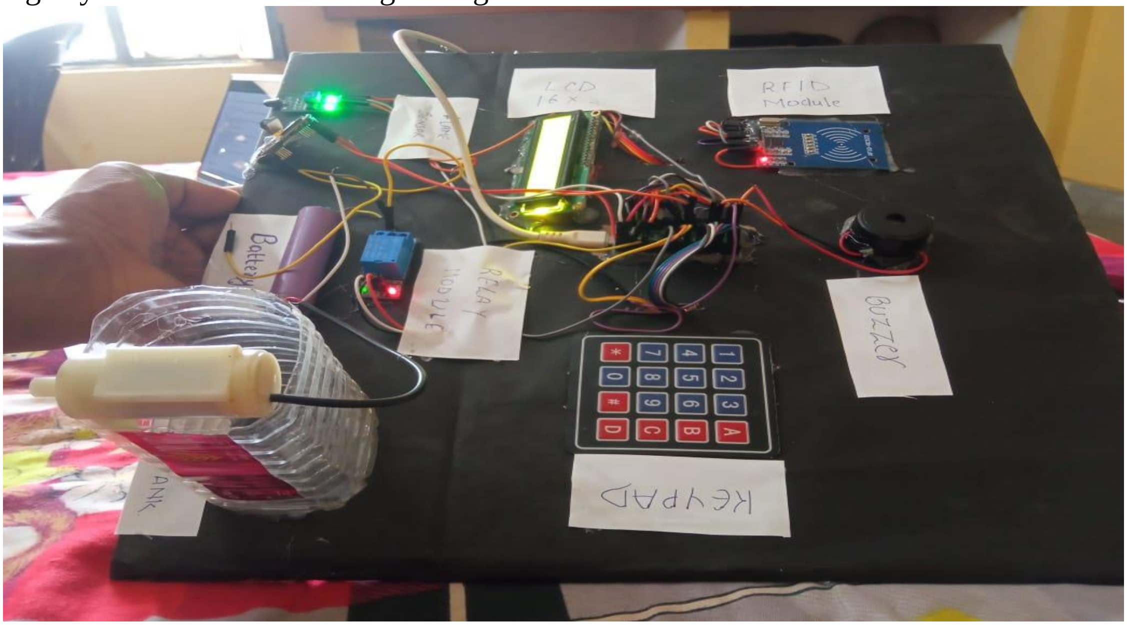

Figure 3: Hardware Design of Automated Petrol Pump

VI. AUTOMATIC LICENCES NUMBER PLAT RECOGNITION

License Plate Recognition with OpenCV and Tesseract OCR: We will use the Tesseract OCR An Optical Character Recognition Engine (OCR Engine) to automatically recognize text in vehicle registration plates.

Python-tesseract: Pytesseract is an optical character recognition (OCR) tool for python. That is, it'll recognize and "read" the text embedded in images. Python-tesseract is a wrapper for Google's Tesseract-OCR Engine. It is also used as an individual script, because it can read all image types like jpeg, png, gif, bmp, tiff, etc. Additionally, if used as a script, Python-tesseract will print the recognized text rather than writing it to a file. It has ability to recognize more than 100 languages.

Installation: Pip installed Pytesseract

OpenCV: OpenCV is an open source computer vision library. The library has more than 2500 optimized algorithms. These algorithms are often used to search and recognize faces, identify objects, recognize scenery and generate markers to overlay images using augmented reality, etc.

Installation: pip install opencv-python

Procedure:

```
# Loading the required python modules
import pytesseract # this is tesseract module
import matplotlib.pyplot as plt
import cv2 # this is opencv module
import glob
import os
```

Code: Perform OCR using the Tesseract Engine on license plates

```
# specify path to the license plate images folder as shown below
path_for_license_plates = os.getcwd() + "/license-plates/**/*.jpg"
list_license_plates = []
predicted_license_plates = []

for path_to_license_plate in glob.glob(path_for_license_plates, recursive = True):

    license_plate_file = path_to_license_plate.split("/")[-1]
    license_plate, _ = os.path.splitext(license_plate_file)
    '''
```

```
    Here we append the actual license plate to a list
    '''
    list_license_plates.append(license_plate)

    '''
    Read each license plate image file using openCV
    '''
    img = cv2.imread(path_to_license_plate)

    '''
    We then pass each license plate image file
    to the Tesseract OCR engine using the Python library
    wrapper for it. We get back predicted_result for
    license plate. We append the predicted_result in a
    list and compare it with the original the license plate
    '''
    predicted_result = pytesseract.image_to_string(img, lang ='eng',
                    config ='--oem 3 --psm 6 -c tessedit_char_whitelist =
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789')

    filter_predicted_result = "".join(predicted_result.split()).replace(":", "").replace("-", "")
    predicted_license_plates.append(filter_predicted_result)
```

Now we have the plates predicted but we haven't seen what is the prediction, so to view the data and prediction we do a bit of visualization as shown below. we are also calculating the accuracy of prediction without using any built-in function.

```
print("Actual License Plate", "\t", "Predicted License Plate", "\t", "Accuracy")
print("--------------------", "\t", "-----------------------", "\t", "--------")

def calculate_predicted_accuracy(actual_list, predicted_list):
    for actual_plate, predict_plate in zip(actual_list, predicted_list):
        accuracy = "0 %"
        num_matches = 0
        if actual_plate == predict_plate:
            accuracy = "100 %"
        else:
            if len(actual_plate) == len(predict_plate):
                for a, p in zip(actual_plate, predict_plate):
                    if a == p:
                        num_matches += 1
                accuracy = str(round((num_matches / len(actual_plate)), 2) * 100)
                accuracy += "%"
                    print("        ", actual_plate, "\t\t\t", predict_plate, "\t\t    ", accuracy)
calculate_predicted_accuracy(list_license_plates, predicted
```

Output:

Actual License Plate	Predicted License Plate	Accuracy
OLA1208	OLA1208	100%
OYJ9557	OYJ9557	100%
PJG0783	PJG0783	100%
OUP9563	OUP9563	100%
OLC4728	OLC4728	100%
ODJ1599	ODJ1599	100%
GWT2180	GWT2120	86.0%
OKV8004	QKV8004	86.0%
PJB2414	PJB2414	100%
AYO9034	AYO9034	100%
JSQ1413	JSQ|413	86.0%
OKS0078	OKS0078	100%
NTK5785	NTK5785	100%
PJD2685	PJD2685	100%
NZW2197	NZW2197	100%
PJB7392	PJB7392	100%
NYY1710	NYY1710	100%
OCX4764	OCX4764	100%

We see that the Tesseract OCR engine mostly predicts all of the license plates correctly with 100% accuracy. For the license plates, the Tesseract OCR Engine predicted incorrectly (i.e. GWT2180, OKV8004, JSQ1413), we will apply image processing techniques on those license plate files and pass them to the Tesseract OCR again. Applying the image processing techniques would increase the accuracy of the Tesseract Engine for the license plates of GWT2180, OKV8004, JSQ1413.

Code: Image Processing Techniques

```
# Read the license plate file and display it
test_license_plate = cv2.imread(os.getcwd() + "/license-plates / GWT2180.jpg")
plt.imshow(test_license_plate)
plt.axis('off')
plt.title('GWT2180 license plate')
```

Output:

```
Text(0.5, 1.0, 'GWT2180 license plate')
```

Image resizing:

Resize the image file by a factor of 2x in both the horizontal and vertical directions using cv2.resize

```
Resize_ test_license_plate = cv2.resize(
        test_license_plate, None, fx = 2, fy = 2,
        interpolation = cv2.INTER_CUBIC)
```

Converting to Gray-scale: Next, we convert our resized image file to gray scale to optimize the detection and reduce the amount of colors present in image drastically which will help in the detection of license plates easily.

```
grayscale_resize_test_license_plate = cv2.cvtColor(
   resize_test_license_plate, cv2.COLOR_BGR2GRAY
```

DenoisingtheImage:

Gaussian Blur is a technique for denoising images. it makes the edges more clearer and smoother which in-turn makes the characters more readable.

```
gaussian_blur_license_plate = cv2.GaussianBlur(
   grayscale_resize_test_license_plate, (5, 5), 0)
```

Now, pass the transformed license plate file to the Tesseract OCR engine and see the predicted result.

```
new_predicted_result_GWT2180 = pytesseract.image_to_string(gaussian_blur_license_plate, lang ='eng', config ='--oem 3 -l eng --psm 6 -c tessedit_char_whitelist = ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789')
filter_new_predicted_result_GWT2180 = "".join(new_predicted_result_GWT2180.split()).replace(":", "").replace("-", "")
print(filter_new_predicted_result_GWT2180)
```

Output: GWT2180

Similarly, do this image processing for all other number plates that didn't get 100% accuracy. Finally, the license plate detection model is readyologies employed, including artificial neural networks, optical character recognition, and feature salient techniques. Challenges such as high vehicle speed and non-uniform number plates are examined. The paper categorizes and surveys techniques for number plate detection, character segmentation, and recognition, with a focus on image segmentation methods. It concludes by suggesting areas for future research and emphasizes the importance of continued advancements in ANPR technology.

VII. RESULTS

The implementation of an IoT-based Self-Operated Petrol Bunk Management System utilizing RFID technology alongside Raspberry Pi has yielded promising results. This innovative system has significantly enhanced both security and operational efficiency within petrol bunks. By integrating RFID tags with vehicles and Raspberry Pi-based control units, the system ensures seamless and automated fuel dispensation while preventing unauthorized access. this solution represents a notable advancement in petrol bunk management, offering a secure, efficient, and technologically-driven approach to fuel distribution.

The Automatic License Plate Recognition (ALPR) system has demonstrated remarkable effectiveness in accurately identifying license plates in real-time. Leveraging advanced image processing algorithms and machine learning techniques, the system swiftly captures license plate data from vehicle images, enabling seamless integration with various applications such as law enforcement, toll collection, and parking management. Its ability to rapidly and accurately recognize license plates contributes significantly to enhancing security, improving traffic management, and streamlining various administrative processes.

VIII. CONCLUSION

The project is to develop an advanced and efficient fuel station management system by harnessing the potential of the Internet of Things (IoT) and image processing technologies. By integrating IoT capabilities and utilizing strategic image capture and processing. The project seeks to streamline fuel dispensing processes, enhance security through RFID authentication, and elevate user experience through personalized interactions. The project's goal is to create a smarter, more efficient, and secure environment within self-operated petrol bunks, aligning with the demands of modern technology-driven landscapes. To maintain secure and accessible records, all transaction data is stored in a server database. Users can conveniently access their transaction history via a dedicated mobile application. The pivotal role of the Raspberry Pi central control hub is highlighted, orchestrating voltage regulation communication with peripheral devices, and overall system operation. ALPR, also known as Automatic Number Plate Recognition (ANPR), is a technology that enables automated identification and extraction of license plate information from images or video streams. The system uses computer vision techniques, neural networks, and pattern recognition algorithms to detect license plates, extract alphanumeric characters, and associate them with vehicle records.

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