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REAL-TIME PETROL AVAILABILITY REPORTING SYSTEM (RPARS) FOR NSUKKA TOWN, NIGERIA

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ABSTRACT

As the number of vehicle owners grows continually, the challenge of searching for petrol availability increases, as not all petrol stations may have petrol available at all times. This is owed to the fact that petrol as a commodity remains relatively scarce. Therefore, this project aims to provide a platform for reporting in real-time petrol availability in Nsukka town. Hence, vehicle owners and public transporters need not waste more petrol and time searching for filling stations with petrol availability. A mobile application is developed to capture relevant real-time information about petrol availability in sampled petrol stations in Nsukka town. The application is a real-time petrol availability reporting system. The system shows a Graphic User Interface (GUI), of a simulated real-time display of petrol availability in sampled filling stations in Nsukka town. This system will help public road vehicle transporters and private vehicle owners make informed decisions on refilling their vehicle tanks from petrol stations with petrol availability closest to the users of the system when they are running out of petrol in their vehicle. Object-Oriented Analysis

and Design (OOAD) methodology was used for the analysis and design while JavaScript (JS) and DART programming languages, MongoDB, a no-SQL database, were used to implement the simulation of wireless capacitive fuel level sensor reading on a mobile App, using flutter SDK.
Keywords: Realtime, Petrol Availability, Reporting System, Petrol Stations.

INTRODUCTION

The word "real-time" is commonly used in technical and non-technical situations. Most people would generally understand the phrase "in real time" to mean "at the same moment" or "instantaneously."

Every real-world entity can be modelled as an organic or manufactured system. Digital data from hardware devices or other software systems are represented as inputs in computing systems. Sensors, cameras, and other devices that offer analog inputs transformed to digital data or direct digital inputs are frequently connected with the information. Computer systems' digital outputs, on the other hand, can be transformed into analog outputs to control external hardware devices like actuators and displays, or they can be used directly without any conversion. Computer systems' digital outputs, on the other hand, can be transformed to analog outputs to control external hardware devices like actuators and displays, or they can be used directly without any conversion (Laplante & Ovaska, 2012).

Real-time systems have gained continual adoption even as their application areas broaden. Business application areas have recorded wider adoption of real-time systems, especially as intelligent systems continue to increase even as we here phrase such as smart petrol stations, smart cars, and smart homes among other instances, for monitoring, control, increasing safety, increasing business efficiency and for several different purposes.

Petrol is one of the major energy sources, hence a vital commodity in the modern world. Presently, many vehicles worldwide, especially in developing countries, depend on petrol as an energy source. The number of vehicles and machines on the road worldwide grows every day. In recent years, gasoline demand has risen due to automobiles and equipment that have become an integral part of man's daily existence (Gohil & Desai, 2018)(Bahar et al., 2016). The long line in front of petrol stations is a common scenario in daily life that wastes petrol users' valuable time.

Petrol is an indispensable requirement of every vehicle for use. Although, when someone's vehicle requires refilling of petrol, an indicator is in red, information about the nearest filling station and availability of petrol product can save vehicle users from being stranded on the road (Haridas & Pillai, 2019).

Currently, in some big cities, the only way of knowing whether a filling station has petrol is by an announcement over the radio, which requires sitting close to your radio all the times of the day. But radio announcements sometimes cannot cover all the filling stations in town cities. Therefore, besides announcements on the radio, there is no practical way of telling whether a filling station has petrol or not. Our capacity to capture visual vision with sensors has resulted in massive volumes of raw data, but successfully utilizing this data in a task-specific manner necessitates sophisticated computational modelling. This project addresses this issue by developing a real-time petrol availability reporting system for filling stations in Nsukka Town.

Real-time data about petrol availability is captured and processed at regular intervals from sampled functional filling stations in Nsukka town and sent as a client to the server for management and reporting on a website. The application can provide necessary information on petrol availability in Nsukka town, while it saves car owners and transporters from unnecessary movement in search of petrol.

Today, the scarcity of petrol that hardly matches the consumption rate due to the growing number of vehicles and machines continues to multiply; hence, filling stations do not always have petrol to service the increasing demand for petrol and other petroleum products. Furthermore, vehicle owners are also faced with the challenge of conveniently topping up their petrol tanks when they are running out of petrol in their vehicles or machines, as they may not know which filling station has petrol at a particular time, thus, wasting the remaining petrol in their tank while searching for filling stations with petrol availability. The outcome of the above-stated situation is that it leaves commuters and vehicle owners stranded at critical junctions when travelling or moving from one place to another.

LITERATURE REVIEW

Many frameworks have been developed and utilized for smart petrol inventory and related technology in different research works. However, few such systems in the literature were altogether reviewed to characterize the extension and importance of this work. In addition, the divergent points in the literature reviewed were also examined.

Gohil and Desai (2018) used a microcontroller-based fuel monitoring and vehicle tracking system in their research. This solution attempts to address the issue of inconsistent records of real fuel-filled and consumption. Embedded technology, which blends software and hardware, is used in this project. Both a GPS and a GSM module were used in the system. Both GPS and GSM modules use the Universal Asynchronous Re-Transmitter Protocol to receive data from satellites and send it via SMS (UART). All of the hardware linked to the system was controlled by the Arduino UNO, which is a single-chip microcontroller. The design used both GSM and GPS module simulators and an Android application to illustrate all of the specifics of data collection. The system assists a vehicle owner in a remote area, precisely detecting fuel theft and vehicle tracking and continually measuring real-time gasoline monitoring.

According to Bahar et al. (2016), the automation of the petrol station management system maintains the account of the petrol stations by monitoring transactions from a remote place via the internet, then automatically printing a receipt after each transaction is completed. This system has helped curb the increasing challenge of waiting in a long queue for several hours in front of petrol stations to just top-up petrol. This challenge is caused by the growing demand for petrol consumption as the number of vehicles and machines increases. This petrol management system takes input from the petrol dispenser via a parallel port interface and at the same time stores up information about completed transactions in a database. This information generates daily, weekly, monthly and yearly reports known as iReport. Unfortunately, this technology adopted by the system significantly reduced the system's flexibility. However, the author proposed USB technology interfacing for future study to increase the system's flexibility with operating systems like Windows 8, Linux, and other more recent operating systems (OS).

The study by Haridas and Pillai (2019) seeks to create and install a smart petrol pump based on the internet of things (IoT), where the quantity of petrol in the station is measured and the value is relayed to a central server. The outlet will be refilled with petrol when the supply runs out. The main goal is to create a website that uses the amount of gasoline as input data to determine where the hardware should be located.

According to Roy (2018), the author proposed the development of a system using an open-source capacitive sensor, GSM or GPRS enabled controller mounted on the back of a car engine for transferring data from a remote location and GPS tracker to monitor and track the location of construction vehicles from a centralized place. The system monitors different parameters like location, engine run hours, and petrol consumption, amongst other parameters. The proposed approach, a real-time remote petrol monitoring system, ensures that construction vehicles used in construction sites are secure by monitoring specific essential parameters.

A published an article titled "Design and implementation of an IoT based real-time monitoring system for agriculture using Raspberry Pi". The paper explored the rapidly growing field of IoT for delivering the social and economic benefits tied to it. With sensors, the system could continuously monitor the water quality. Real-time data was transmitted to the aqua farmers' mobile device via cloud technology. This helped the farmer take preventive measures to sustain the quality of life of the aquatic organisms cultured. In addition, the aqua system, which was automated using IoT, reduced energy consumption and labour cost (Chavan et al., 2018).

In Kaushik et al. (2017), an automated petrol station management system was developed, which addressed the challenge of time wastage due to long queues and other shortcomings attributable to manually controlled petrol stations. The developed system integrated a fingerprint module into a computer system via a web application for user authentication and verification. To a great extent, this system introduced a secure and cashless system, hence avoiding petrol theft.

A review of the advantages of digitalized petrol station management by Anayo *et al.* (2016) was done, and a computerized system was developed to help curb the problem of fraud among petrol station staff, mismanagement and diversion of petroleum products, amongst other challenges. Through the automation of a petrol retail station, this computerized system monitors the operations/activities of all attendants to construct an enterprise station that allows the monitoring of petroleum products with a focus on retail. The technologies used to develop the web-based system are PHP/MYSQL, Java and HTML languages.

In a paper, IoT was used for filling fuel quantity measurement to solve the problem of petrol bunk fraud. This form of fraud persisted even after petrol bunks were digitized, hence the adoption of IoT. The IoT application's sensing unit comprises an Arduino kit and a flow sensor. The Arduino kit is open-source software and hardware that allows you to communicate with sensors and actuators. The flow sensor operates based on a change in fuel velocity, causing a change in flow rate. The pressure of the entering fuel from the fuel filling pump determines the speed. Fuel bunk cheating was reduced thanks to the suggested IoT application "Filling Fuel Quantity Measurement Systems" (Shanthan and Arockiam, 2016).

Komal *et al.* (2018) provided a hardware platform for petrol management for petrol-carrying cars, with the design goal of designing a system capable of monitoring the petrol level in real-time. This technology was developed for gasoline-carrying road tankers that transport gasoline from oil depots to end customers such as gas stations. Hardware innovations such as petrol level circuits, onboard Arduino, GSM, and GPS modules were used in the system. The system also used software technologies such as LabView for database management. The technology measures the amount of gasoline in the tank and communicates the information to the owner's mobile phone and PC over the GSM network. It also has a device for detecting petrol theft or leakage, depending on the situation. The technology can also track the whereabouts of each petrol-carrying truck, reducing the cost of analyzing and monitoring the quantities of gasoline in the trucks.

According to Komal *et al*. (2018), the authors created an automatic petrol station model using GSM and RFID. The system makes the fuel refilling process more secure and reliable by preventing unauthorized refilling and distributing a specific amount of petrol for registered vehicles based on their kind. Customers will receive a rechargeable RFID or smart card at this location. A smart card reader will be installed at the retail establishment, reading the amount on the card and displaying it on the liquid crystal display (LCD). Keypad, RFID, LCD, relay, GSM, and electronic machinery are among the system's physical components. In addition, the outlet offers information about the car and its account balance through a centralized database system. The add-on features include an infrared sensor for determining the amount of gasoline and a smoke sensor for detecting smoke particles in the region.

Another article by Shanthan and Arockiam (2016) described filling fuel quantity systems using IoT. The design provided ways to avoid loopholes for cheating even though the petrol bunks were already digitized. As a result, the study proposes an IoT application that uses a sensor to detect the amount of petrol in a tank as it is being refilled and delivers the information to the user's mobile phone.

In Khatun *et al.* (2019), The authors developed an IoT gadget that uses an ultrasonic fuel sensor to measure the amount of fuel consumed. When the vehicle's fuel tank reaches a specific level, the driver receives a warning via mobile application and searches for a nearby pump to refuel. The suggested system used GPS tracking to display the vehicle's current location and locate the nearest pump. The system is a real-time and accurate gasoline monitoring device. According to the inventors, the device may be installed in any car to prevent gasoline theft, locate the nearest fuel pump, and track the whereabouts of the vehicle. In addition, the authors employed a mobile application as a central monitoring system to regulate all cars.

In the works of Haridas and Pillai (2019), the authors conducted a statistical survey to find out the operational efficiency of petrol pumps when IoT is deployed. This study aimed to see if deploying IoT apps improves product quality, sales, and customer satisfaction, among other things. A paired t-test was used to analyze the data collected, and the parameters evaluated for the test included cost, accuracy, security, time, and simplicity of payment. As a result, the study found that deploying IoT can boost operational efficiency.

In a related study by Narwade and Patil (2018), the authors proposed a device to identify individual levels of fuel adulteration, refuelling quantity accuracy, and engine performance such as fuel economy and emissions caused by refuelling intervals. Using IoT and linked automobile technologies, all data collected by the system will be shared among vehicle users. Users can analyze the information provided by the device using a smartphone interface. The Global Positioning System (GPS), GPRS wireless connection, Bluetooth communication protocol for information exchange with a smartphone, and a sensor system for detecting the number and quality of refuelled cars are part of this technology. The system is powered by a software algorithm and works on an automotive gradient controller. This system can improve engine parameters to limit harmful emissions, according to. It can also enhance the regulation of tainted fuel intake. Other advantages of the system include more extended engine and component life, increased user awareness of the dangers of using contaminated fuel, and better control of town pollution, to name a few.

In a study by Naveen Kumar *et al*. (2017), the authors focused on the automation of a fuel station retail store, which provides an hourly sales and inventory report to the owner. The system employs Internet of Things (IoT) technologies, such as sensors, other electronic components, and a web application to give users capabilities to check fuel temperature, sales, and stock levels. When users enter their login credentials, they are validated and routed to the agency's main page. The system's security was secured using One Time Password (OTP) technology. If a service expert wishes to fix a pump, he must first request an OTP from his registered mobile number. As the security level in the fuel station was enhanced, fuel theft by pump personnel or owners was considerably reduced. All gadgets and devices were transformed into IoT-enabled devices, resulting in invaluable data then analyzed utilizing IoT platforms and information and communication technologies. As a result, work time was drastically cut while profit was increased.

However, among the literature reviewed, not one was concerned with reporting in real-time to vehicle owners, petrol stations with petrol availability per time.

METHODOLOGY

The Object-Oriented Analysis and Design technique was employed in this project (OOAD). The architecture and details of achieving the system requirements are developed and communicated using object-oriented principles in this design. The following are some of the features of the UML technique employed in this study: use case diagram, class diagram, activity diagram, system architecture and database design tools.

A combination of more than one research approach was used to enable this study to meet the aims specified in chapter one. First, a survey research method was used to obtain insight into the existing system's offers, and then simulation methodology was used to meet the outlined goals.

DEVELOPED FRAMEWORK

This real-time data stream processing framework underpins a database, business rationale and user interface as the real areas of design, as depicted in figure 1. The mobile user device is the gadget used to get to the pages and forms utilized for the mobile application, such as smartphones, tablets, etc. The server is the node-JS which enables the application to run and act as if it is hosted on the web. The back-end constitutes MongoDB, a no SQL database system. The Mongoose, an Object Relational Mapping (ORM) tool, offers a simple, schema-based method for modelling our application data. It comes with built-in type casting, validation, query construction, business logic hooks, and more. It holds and manages the data pool (petrol information) obtained from the physical world via sensors and, subsequently, the application. The Pusher service controls information trading between the front-end and the application back-end.

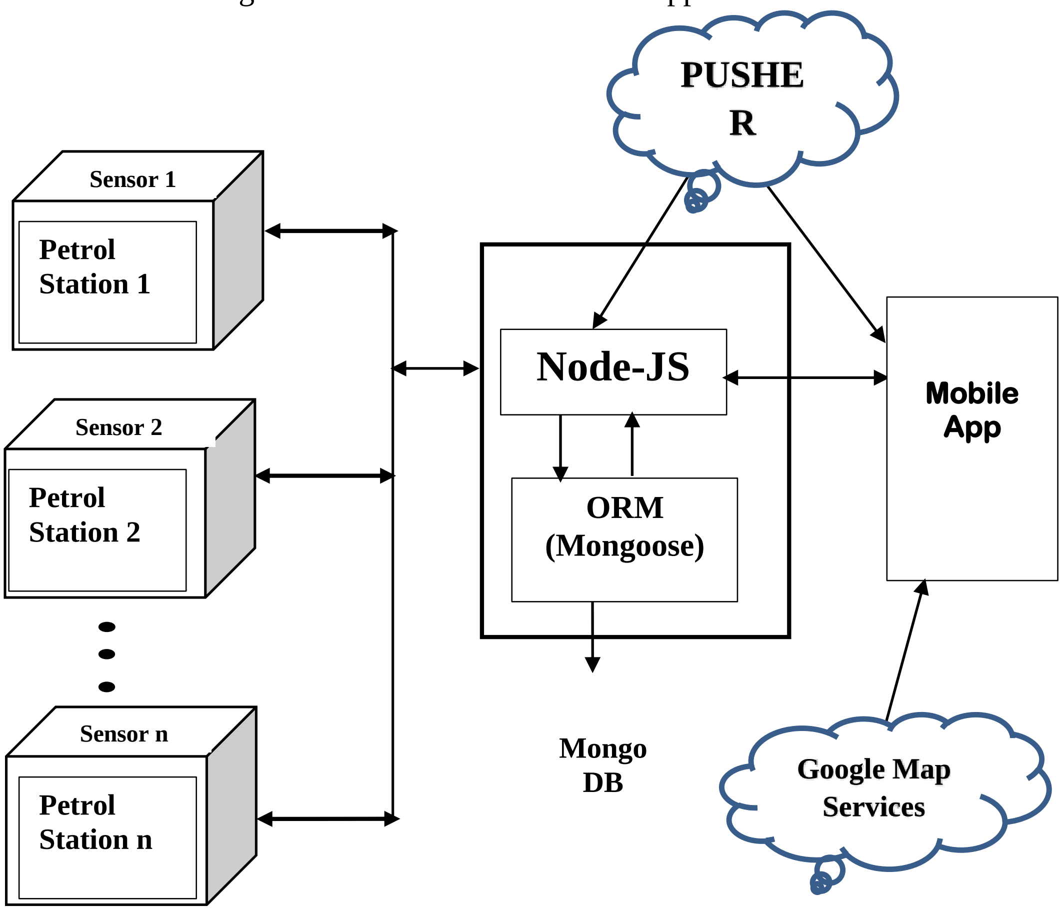

Figure 1: Block diagram of the RPARS

Use cases and relationships among actors and the framework are captured in a use case model. It represents the framework's practical requirements, how outside entities (actors) interact at the framework's limit, and its reaction. For example, figure 2 and figure 3 show a use case diagram for a real-time petrol availability system. The administrator and the users are the two actors who interact with the system.

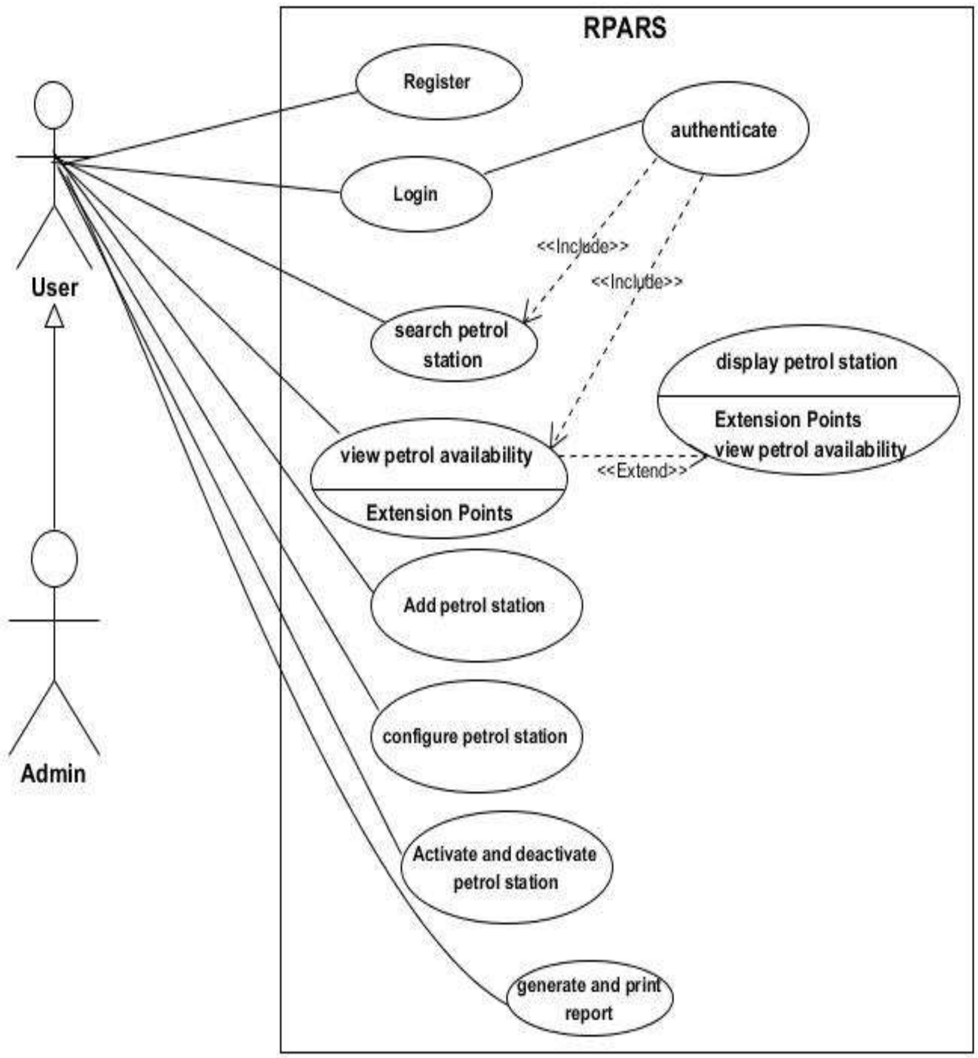

Figure 2: Use Case diagram of the RPARS

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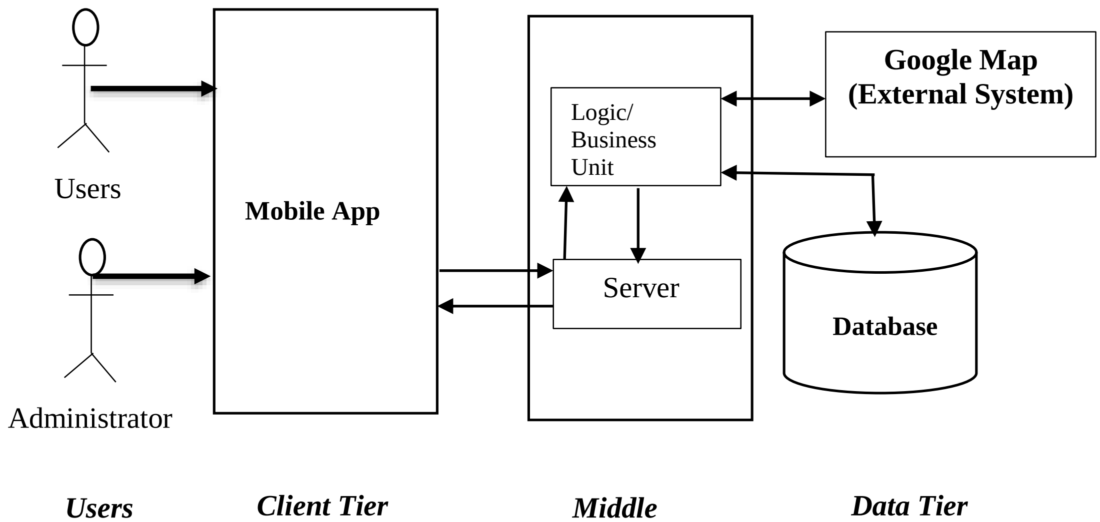

Figure 3: Architecture of the RPARS

The user interface of a mobile app is considered the client level. The administrator and various framework clients interact directly with the program through this user interface. To make requests and recover data from the database, it talks with the web/application server. The data retrieved from the database is then displayed to the user. The application server and the business logic are both parts of the real-time data stream processing infrastructure at the middle level. The application server (node.js) processes all client-side requests in Representational state transfer (REST) requests. For example, the demand could be to view petrol stations in Nsukka town with petrol availability or for a petrol station. The data is processed by the business logic, which sends it to the database or back to the application server, depending on the required service. Data storage and persistence are dealt with at the data level layer. It is implemented using a no-SQL database.

DEVELOPED RPARS SYSTEM

The test outcomes were gotten from the different testing stages conducted during system implementation. Figures 4, 5 and 6 are screenshots showing the RPAR system home page, search output display, and google map integrated into the system.

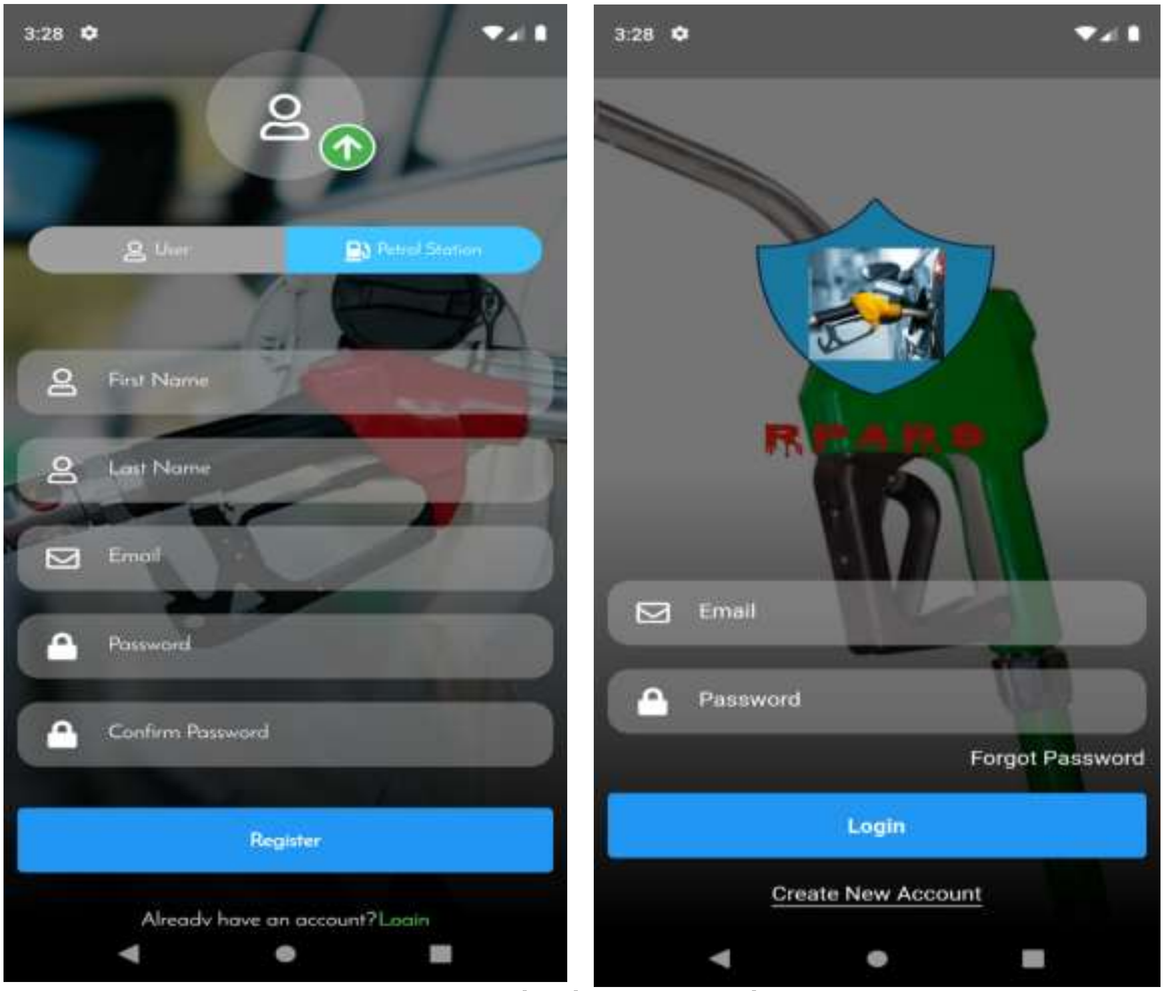

Figure 4: Screenshot showing RPARS home page

Search output display of sampled petrol filling station information is achieved by hierarchical search, i.e. from the petrol station with the least volume of petrol availability to the one with the highest volume of petrol availability and vice versa. The search output could also be done by displaying petrol stations with petrol availability closest to the user to those farthest to the user and vice versa. This is achieved with just one click, as shown in figure 5 below.

Figure 5: Screenshot showing RPARS Search output display

During the program testing, once a user or petrol station logs into the system, the names and addresses of petrol stations that are registered with the system alongside their petrol availability status and respective distances from the current location of the user is displayed on the mobile app as shown in Figure 5 above.

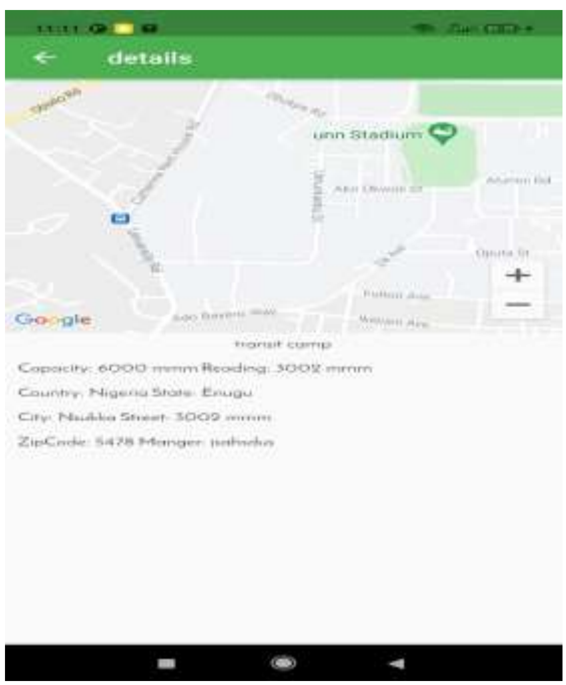

Figure 6: Screenshot showing google map integrated to RPARS

The google map integrated into the RPARS provides easy aid for navigating Nsukka town to arrive at the nearest petrol station with petrol availability received from the search result displayed by the RPARS. This is shown in figure 6 above.

RESULT DISCUSSION

Real-time petrol availability reporting system (RPARS) Framework was developed to actualize an observatory system to monitor and report real-time petrol availability, particularly in petrol stations located in Nsukka town. This system provides a real-time data feed on petrol availability in Nsukka town and can visualize the volume of petrol in the petrol station underground bunks/tanks from data feeds supplied by wireless capacitive fuel level sensors, rate of petrol depletion on a real-time basis, enable guided navigation to the nearest petrol stations with petrol availability via google map which was integrated to the RPAR system. Furthermore, the system can enable users to search for petrol stations with petrol availability in real-time to make the most efficient petrol top-up decision. In addition, there was a need to improve the quality of service, reduce operational cost, mitigate redundancy and irregularity of data, reduce time utilization, increase data centralization and security. All these were accomplished in the new framework and helped real-time information reporting and managing petrol availability in petrol stations across Nsukka town.

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