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ReFuelSmart: Online Booking System

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Abstract - ReFuelSmart is an online CNG refueling slot booking system designed to reduce long waiting times and improve the efficiency of CNG stations. In many cities, CNG users face significant delays due to unpredictable queues and manual ticket distribution. This system provides a smart solution by allowing users to check real-time slot availability and book a convenient time for refueling through a mobile application.

The platform offers features such as user registration, vehicle management, station selection, slot booking booking history, and notifications. By scheduling visits in advance, users can avoid long queues, save time, and manage their travel more effectively. CNG station operators also benefit from better crowd management, improved service flow, and data-driven insights.

ReFuelSmart aims to create a seamless, user-friendly, and efficient refueling experience by digitalizing the entire process. The system enhances convenience, reduces congestion at fuel stations, and supports smarter resource utilization, making it a practical solution for modern urban transportation needs.

Key Words: CNG refueling slot booking system, Online CNG Booking, Digital refueling booking, Time saving,Crowd management for stations.

1.INTRODUCTION:

The growing use of CNG-powered vehicles has increased the demand for efficient refueling services. However, most CNG stations still follow manual queue systems, leading to long waiting times, crowding, and lack of proper time management. Users often have to wait for hours without knowing how long the line will take, causing frustration and wastage of time. Station operators also struggle to manage the flow of vehicles effectively.

CNG vehicle owners face major inconvenience due to long queues, unpredictable waiting times, and the absence of a proper scheduling system at refueling stations. The manual process leads to:

- Time wastage and customer dissatisfaction
- Congestion at fuel stations
- Inefficient management of vehicle flow
- Lack of transparency in slot availability

There is a need for an automated system that allows users to conveniently book refueling slots and helps stations manage their operations more efficiently. ReFuelSmart aims to solve these problems through a smart, user-friendly, and time-saving digital platform.

To address these issues, ReFuelSmart is developed as an online CNG refueling slot booking system. The platform allows users to book a time slot for filling CNG, view real-time availability, receive confirmations, and avoid unnecessary waiting. By digitalizing the process, the system improves convenience for users and provides better control and planning for station operators.

2. LITERATURE REVIEW:

Several commercial and research efforts have explored digital solutions to reduce waiting times and manage congestion at fuel (including CNG) stations. Mahanagar Gas Limited's MGL Tez is a production mobile app that allows users to pre-book CNG refueling slots at selected BEST bus depots; it uses dedicated dispensers for booked customers and has been expanded from pilot depots to multiple locations in Mumbai.

Nawgati / Aaveg is a fuel-tech platform that focuses on real-time congestion detection and station discovery; it uses analytics (and in some deployments, vision/queue-estimation techniques) to help users choose less-crowded stations and to provide operators with actionable insights for traffic management. The platform has been commercially deployed at many stations and is expanding its footprint.

Academic and prototype systems (e.g., FuelMaster: Smart Automated Fuel Booking System for CNG and several conference/journal projects) commonly propose web/mobile booking interfaces, GPS-based station search, admin dashboards for slot management, and simple queuing or appointment logic to allocate time slots and reduce idle waiting. These studies show feasibility and user benefit in controlled pilots but are often limited by small deployments or convenience sampling in evaluations.

Technical approaches reported in the literature include: (1) fixed time-slot booking and capacity management to ensure ordered service, (2) GPS/location services for nearest-station discovery, (3) integration of digital payments and booking confirmations, and (4) use of analytics/AI for congestion prediction and dynamic slot adjustment. Recent work also experiments with FASTag integration and AI-driven recommendations to improve throughput.

3. PROBLEM ANALYSIS:

CNG vehicle owners often face long queues and unpredictable waiting times at refueling stations due to the absence of a proper scheduling system. The existing manual process creates several issues, such as: Time wastage as users wait for long periods without knowing their turn. Congestion and crowding at CNG stations, especially during peak hours. Poor resource management by station operators due to uneven vehicle flow. Lack of transparency, as customers cannot check slot availability or plan their refueling in advance. These challenges reduce user satisfaction and make the refueling process inefficient. Therefore, there is a need for a digital solution that allows users to book a refueling slot in advance, view real-time availability, and avoid unnecessary waiting. ReFuelSmart aims to solve this problem by providing an online, organized, and time-efficient CNG slot booking system.

Figure: Real time CNG refueling problem.

4. SYSTEM ARCHITECTURE:

The architecture of ReFuelSmart is designed to ensure smooth communication between users, CNG station operators, and the backend system. It integrates mobile application interfaces, backend services, a centralized database, and real-time slot management components.

ReFuelSmart follows a client–server architecture consisting of a mobile app for users and a dashboard for station operators. The frontend communicates with the backend through secure APIs. The backend includes modules for authentication, slot management, booking processing, notifications, and station management. A centralized database stores user details, vehicles, stations, slots, and booking records. Real-time slot updates ensure accurate scheduling and prevent double bookings. The system also integrates optional services like GPS/maps and SMS notifications. Overall, the architecture ensures fast, reliable, and efficient refueling slot management.

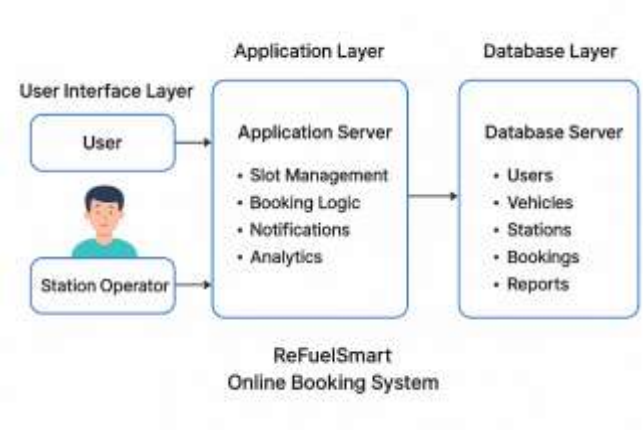

Figure: System architrecture

5. PROPOSED SYSTEM DESIGN:

The proposed system is designed as a digital platform that allows CNG users to book refueling slots in advance and avoid long queues. It uses a mobile application interface for users to register, add vehicles, view station availability, and book slots in real time. A backend server manages authentication, slot creation, booking validation, and notification services. Station operators can update slot availability and monitor vehicle flow through a dedicated dashboard. A centralized database stores user, station, and booking data for smooth operations.

The system ensures real-time synchronization to prevent overlapping bookings. Notifications are used to confirm bookings and remind users of their scheduled slot. By digitalizing the refueling process, the design improves convenience, reduces congestion, and enhances operational efficiency at CNG stations.

6. IMPLEMENTATION DETAILS:

1. Frontend Implementation

The frontend is developed using a mobile application interface that allows users to register, log in, view stations, check slot availability, and book refueling times.

It includes clean UI screens for booking history, notifications, and vehicle management. The operator dashboard enables station staff to update slots and monitor bookings in real time.

2. Backend Implementation

The backend is built with APIs that handle authentication, slot generation, booking logic, and real-time updates. It connects to a centralized database storing users, vehicles, stations, and booking records. Backend services validate bookings, prevent conflicts, and trigger confirmation notifications. Secure communication ensures smooth interaction between the app and server.

7: RESULTS:

System Capabilities

1) Allows users to book CNG refueling slots conveniently through a mobile app. 2) Provides real-time slot availability for all registered CNG stations. 3) Manages user profiles, vehicles, and booking history efficiently. 4) Sends instant notifications for booking confirmations and reminders. 5) Prevents double-booking through real-time synchronization and validation. 6) Offers improved crowd management and operational insights for stations.

Representative Workflows

Two representative workflows demonstrate system functionality:

Workflow 1: Frontend User Interaction

1) User Registration & Login – Users create an account, provide personal details, and log in securely.
2) Vehicle Management – Users can add, edit, or remove vehicle information associated with their account.
3) Station Selection – Users browse and select nearby CNG stations using search or map features.
4) Slot Availability Check – Users view real-time availability of refueling slots at selected stations.
5) Slot Booking – Users select a convenient time slot and confirm the booking through the app.
6) Booking History & Management – Users can view past bookings, upcoming slots, and cancel if needed.
7) Notifications – Users receive confirmations, or updates about slot changes.

Workflow 2: Backend Core System Processing

1) Authentication & Authorization – Backend validates user/operator credentials and manages roles.
2) Slot Creation & Management – Generates time slots based on station capacity and updates in real-time.
3) Booking Processing – Confirms or cancels bookings while preventing overlapping or double bookings.
4) Real-Time Synchronization – Ensures slot availability is updated instantly across all frontend apps.
5) Notification Handling – Sends booking confirmations, reminders, and alerts via push notifications, SMS, or email.
6) Data Storage & Retrieval – Centralized database stores user details, vehicles, station info, slots, and booking history securely.
7) Analytics & Reporting – Tracks bookings, peak hours, and user trends to provide insights to operators.
8) Integration Services – Connects with external services like GPS, maps, or SMS gateways for enhanced functionality.

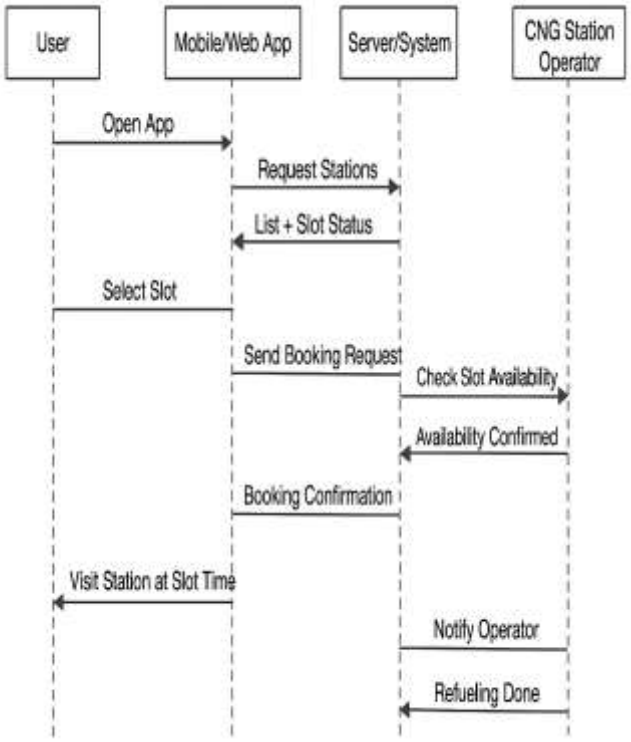

Figure: Sequence Diagram

CONCLUSION:

The project successfully demonstrates how a structured and automated system can improve the overall efficiency of fuel station operations. By replacing traditional manual methods with a digital workflow, the system ensures faster service, accurate fuel dispensing, transparent billing, and reliable record-keeping. The activity flow clearly shows how users can refuel, make payments, and receive confirmations with minimal effort.

Through this project, we understood the importance of system design concepts such as activity diagrams, data flow, and interaction between different modules. The solution not only enhances customer experience but also helps fuel station owners manage resources, prevent errors, and maintain smooth day-to-day operations. Overall, the project proves that a well-designed management system can significantly reduce operational challenges and support smarter, more efficient fuel station management.

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