Smart Management of EV Charging Stations

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Abstract— In recent years, electric car companies such as TATA and Tesla have introduced new electric cars to the market. However, the current charging time of these cars is at least 15 minutes to half an hour, which can be a hassle if all the charging stations are already occupied. To address this issue, we propose a system that connects all the electric car charging stations together, making it easier for users to find a station according to their preference and save time, especially for long-distance travel.Our system will allow users to book a charging slot, and if the given time slot is not available, the system will suggest a new schedule. Users will need to pay a percentage of the amount online to confirm their booking. Additionally, our system will provide a shortest route to reach the charging station using Google maps API for direction sensing.The system will be developed for Android-based devices and will utilize time-slot allocation techniques. It will also provide an interface for charging stations to view all available and booked slots, as well as manage slot timing. Users will be able to control the software via vocal commands, and the online payment gateway will enable quick payment transactions. Overall, our system aims to save time for users and make it easier for them to locate and book an appropriate charging station.

Keywords: Smart management, charging slot, EV Cars, Map.

I. INTRODUCTION

Recent years have seen the emergence of two major global challenges: global warming and the depletion of fossil fuels as a result of unsustainable energy use. In response, sustainable renewable energy systems have emerged as an effective remedy. Since the government implemented Feed-in Tariffs (FIT), the installation of photovoltaic (PV) systems has rapidly increased in Japan. However, the expansion of PV systems has resulted in an overabundance of power production, which may be detrimental to the system frequency. This problem is especially important for stations that source the majority of their energy from PV systems, provide services to smart homes, and act as an energy aggregator for electric vehicles (EVs) and smart homes. The EV charging station needs a stationary battery to enable power trading.

It is commonly understood that EVs will be essential to the development of transportation in the future. However, the growth of EVs calls for the creation of a substantial charging infrastructure. In this project, we want to develop a system that lets customers reserve charging times at available stations based on their requirements. To improve the user experience, the system will provide a number of features, such as an AI chatbot for voice-controlled station reservations, map integration for navigation, digital payment choices, and email and SMS alerts for each action.

By putting in place such a system, we hope to overcome the difficulties brought on by the expanded use of PV systems, guarantee effective power trading, and aid in the expansion of EVs as a sustainable means of transportation.

II. PROBLEM STATEMENT

This project's goal is to develop a unique Android web application that lets customers easily schedule charging spots for their electric cars. When making a reservation, the system will have a function that allows users to choose particular charging socket types. Users will benefit from this's versatility and convenience depending on their vehicle's charging needs.

III. MOTIVATION

We have learned valuable lessons about the management of reservations and the scheduling of charging station time slots throughout the course of our research. In order to

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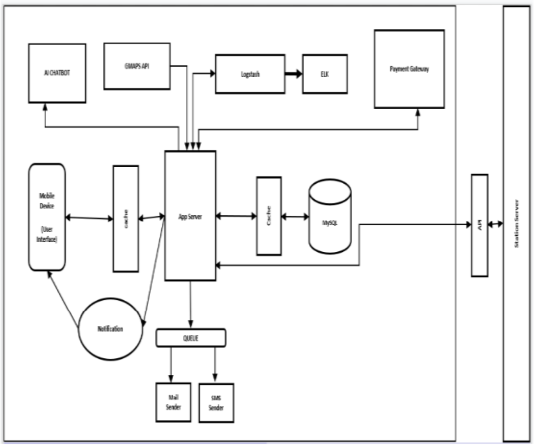
improve user engagement and experience, we also built a Virtual Personal Assistant (VPA). The construction of a



shortest route search system using the combination node method to dynamic locations often utilized in online transportation services, such as mobile phones, is one of the remarkable outputs of this research. Additionally, we now possess the knowledge and skills necessary to create a reliable and effective payment gateway within the system, assuring smooth financial transactions.

IV. PROPOSED MODEL

The suggested system seeks to provide a time-slot allocation technique-based Android application for effective charging slot management. The modules that make up the system will be as follows:

1. User Module: With the help of this module, EV owners will be able to sign up, log in, view a list of charging locations, schedule charging times, schedule payments, and get SMS notifications and alerts.
2. Charging Station Module: Charging stations may register, log in, examine a list of available and reserved slots, control slot timings, and access booking history using this module.
3. Reservation Management Module: The reservation procedure will be handled by the reservation management module, which will also provide real-time data on open and reserved charging slots.
4. Google Maps API: Maps API from Google This module, when integrated into the system, will make direction sensing possible and determine the quickest path to the chosen charging station.
5. AI Chatbot Module: Users will find it convenient to reserve charging spots using voice commands thanks to the AI chatbot module.
6. Online Payment Gateway: For customers who are scheduling billing slots, this secure module will enable quick and easy payment transactions.

To store user data, charging station data, reservation information, and other pertinent data, the system will rely on a centralised database. This guarantees effective data management and retrieval for the application's efficient operation.

V. METHODOLOGY

Global worries about global warming and the shortage of fossil resources have recently become serious issues. To counteract these issues, renewable resources have arisen as a blessing to humanity. Feed-in Tariffs (FIT) have resulted in a fast proliferation of solar installations in Japan. However, the increasing power output of these systems may have an impact on frequency and distribution voltage, causing the Japanese government to reconsider the FIT system.

To address this issue, a Smart EV Charging Station System has been developed. This system operates as an aggregator and trades electricity using a fixed battery. According to their battery needs and the particular type of outlet they require, electric vehicles (EVs) can be charged. The length of time needed to charge a device varies based on several elements, including the battery capacity and charging speed.

Certain fundamentals and characteristics are required for EV chargers in order to satisfy the demands of EV charging. Compatibility with various types of sockets, charging protocols like CCS (Combined Charging System) or CHAdeMO, power rating choices, and safety features like overcurrent prevention and insulation monitoring are a few examples. The installation of ubiquitous EV charging connections is also necessary due to the high demand for EV charging infrastructure.

By providing a slot booking system for charging EVs that is organized by the different types of charging sockets, the proposed Smart EV Charging Station System responds to these needs. This enables consumers to locate the best charging station depending on the specifications of the sockets on their vehicles.

The system uses the GMAPS API to provide customers the quickest path to the selected charging station, increasing user convenience and effectiveness. Additionally, chatbot support using AI technology helps customers with chores like scheduling charging slots and responding to inquiries. MySQL databases are used to store system logs and manage the available charge slots, ensuring efficient system management and operation.

A useful feature is continuous battery monitoring, which alerts users when their electric vehicle (EV) battery is depleted and requires recharging at the closest charging station. The suggested solution uses an ESP32 microcontroller to do this.

Every five seconds on average, the ESP32 microcontroller is configured to continually check the battery level. As a result, it collects real-time battery level information and using Bluetooth connectivity to provide it to the system.

The system evaluates the information and compares it to predetermined criteria, such as 20% or 10%, after receiving the battery level data. Additionally, users have the freedom to choose their own unique percentage criteria. The system sends the user an alert signal when the battery level drops below the predetermined threshold, warning them that the EV battery needs to be charged right away.

The gadget also has an LCD interface, which enables users to simply check the battery's state while driving. Users are able to keep track of the battery level without exclusively depending on the system interface thanks to the LCD display's real-time information.

This system improves user awareness and assures timely charging, resulting in a smoother and more effective EV charging experience. It does this by combining continuous battery monitoring, Bluetooth connectivity for data transfer, and an LCD interface for on-the-go charge status visibility.

A. *Architectural Overview*

Figure 1 shows the booking system architecture that we have used in the designing of the system.

Fig. 1. Booking System Architecture

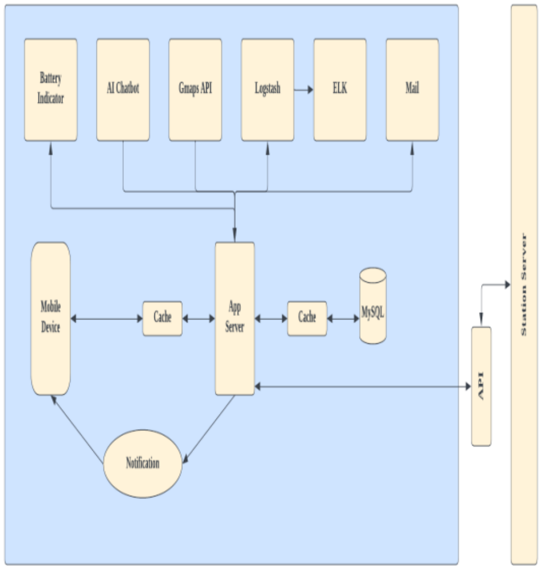


Figure 2 shows the flow of events in our slot booking system from registration till confirmation.

Figure 3 shows the architecture of the station system

Fig. 2. System Flowchart

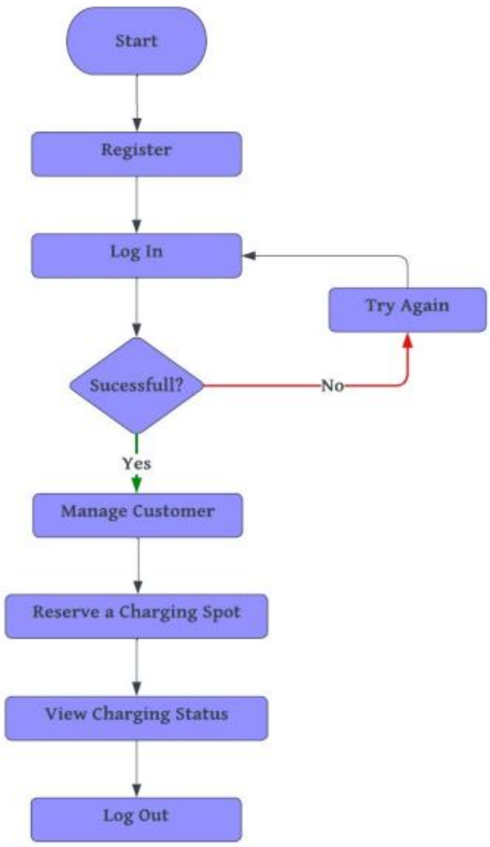
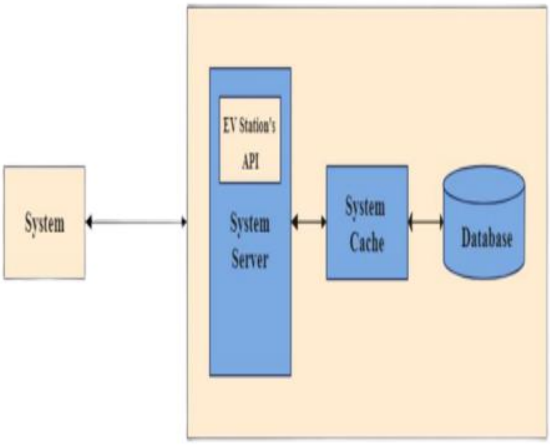


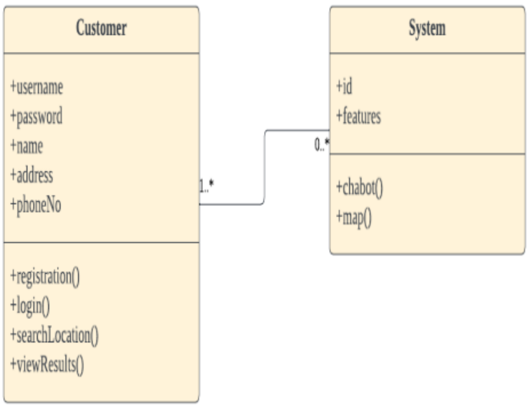
Fig. 3. Station System Architecture



B. *UML Diagrams*

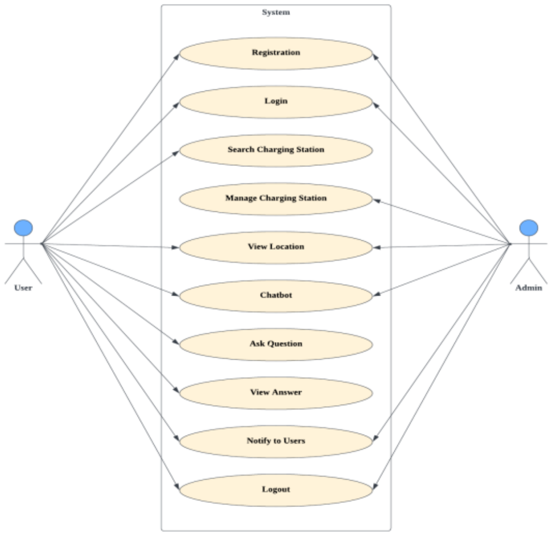
Figure 4 is the class diagram of our system. Here in this diagram, There are 2 classes. The User and the System. Each class has its attributes and operations. The user registers in registration and logins into the system. He can search the locations and view the results. And the system displays the chatbot and shows the map.

Fig. 4. Class Diagram



Use case dig of our system is depicted in Figure 5. The use case diagram of our system has two actor that is the user and the admin. The user is directly related to registration, log in, searching charging slot, asking question, using chatbot and receiving notifications and the admin handles the registration, slot booking, etc. activities.

Fig. 5. Use Case Diagram



Component diagram of our system is displayed in Figure 6. In the diagram components communicate with each other using interfaces. The interfaces are linked using connectors. In our system we have 6 components namely JDK, Client, MySQL, .jar and .exe that is connected with the main web server. These components interact with each other when required and revert back to the main web server.

Fig. 6. Component Diagram

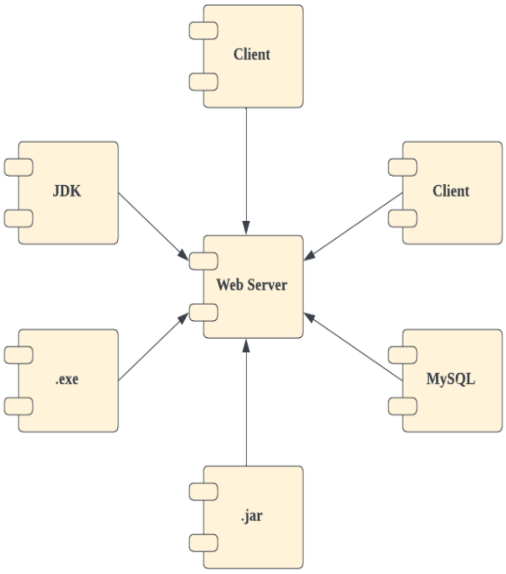
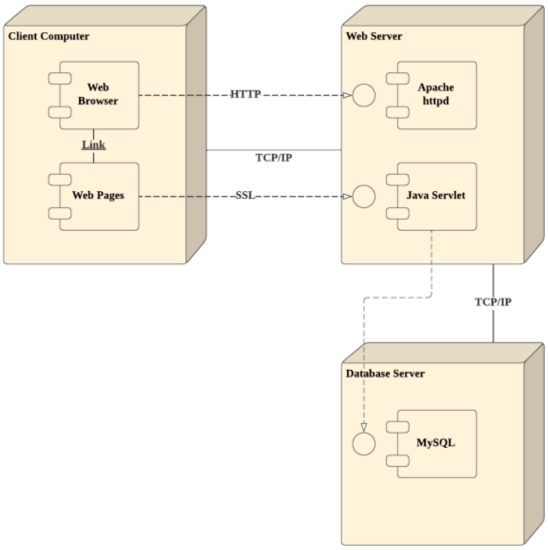


Figure 7 shows the deployment of the system. In this diagram, a node represents the client's computer. A component represents the web browser that is linked to the web pages. There's an interaction between the Clients computer and the web server. Web browsers and web pg depend on the web servers' HTTP and SSL. And java servlet depends on MySQL as a database server. These 3 nodes i.e. a client computer, web server, and database server are connected with a TCP/IP connection.

Fig. 7. Deployment Diagram



VI. RESULT

Figure 8 shows the LCD display that is connected with the battery that displays the current battery percentage of the battery.

Fig. 8. LCD Display

Figure 9 is the final system that shows the LCD display along with the system sdk present in the mobile. Both the LCD screen and the system displays the battery percentage. The system sdk also has the feature of slot booking, GMAPS API to guide you to the nearest charging station.

Fig. 9. LCD Display and Mobile SDK Connectivity

Figure 10 displays the Main page of the system from where we can navigate different menus present on the page such as :

- About
- Contact Us
- Admin Login
- User Login
- Connect To ChatBot

Fig. 10 Main Menu

CONCLUSION

In this paper, we have proposed a system that connects all the electric car charging stations together, making it easier for users to find a station according to their preference and save time, especially for long-distance travel. The system will allow users to book a charging slot, and if the given time slot is not available, the system will suggest a new schedule. Our system will provide a shortest route to reach the charging station using Google maps API for direction sensing. Additionally, the system will utilize time-slot allocation techniques and provide an interface for charging stations to view all available and booked slots, as well as manage slot timing. With the help of our system, users will be able to save time and locate and book an appropriate charging station with ease.

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