Electric Vehicle Charging Station Automation

U.R. Patole [1], Abhishek Deshmukh [2], Vaishnavi Karpe [3], Prathamesh Nimbalkar [4], Snehal Ugale [5]

[1] Assistant Professor, [2,3,4,5] Students,
Department of Computer Engineering, Sir Visvesvaraya Institute of Technology,
Nashik, Maharashtra, India.

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Abstract

Electric vehicles (EVs) are a promising class of drive trains in the coming years especially in urban regions it is revolution helpful in shifting the decentralized exhaust emission in megacities to centralized power plants in rural areas. Electric vehicles are growing in popularity since they are good alternatives to traditional vehicles. Nowadays, due to the increase in prices and the environmental pollution of fossil fuels, individuals and governments are tending towards the concept of electric vehicles. With the development of technologies, the number of electric vehicles raised the required quantity of charging stations. An intelligent system can be used to manage all the systems using automation technology. Searching for charging stations for electric vehicles is an important issue for drivers which needs the implementation of a smart charging infrastructure network. The automation helps to check the charging slot availability and booking slot for electrical vehicle charging. It is important to reduce waiting time as well as provide improved efficiency. Our system is intended for locating nearby charging stations and slot booking according to waiting time and availability of charging stations. The booking process is automated to improve efficiency in accessing the charging station facilities.

Keywords: Electric Vehicle, Charging Station Automation, Online Slot Booking, EV Charging Station Search, Smart Charging.

1. Introduction

Over the few years ago, electric vehicles (EV) have gained significant attraction because of their appeal as a possible alternative to gas-powered vehicles. Since 2008, In US more than 4,10,000 EVs have been sold till December 2015, it represent 33% of the global sales. The electric vehicle is expected as major sores of transportation in future. The main advantage of electric vehicle is pollution free. Electricity is used to charge there battery the power is taken from traditionally fossil flue power plants. It reduces their environment-friendly mode of transfer. Recently solar power base electric charging station is designed that provides clean electricity and improves efficiency of solar. While installation of power vehicle system can be on roof top of a building and solar canopies can also install on parking slot. It will make an excellent choice for solar power electric vehicle charging station. It will provide clean electricity as well as provide shade to vehicles.

The increasing exhaustion of fossil energy and depletion of global energy reserves in a major worldwide concern at economic, environmental and industrial levels. Potentially, the greenhouse gas emissions are changing the climate which would be major threat to human society. PHEV is considered as an option to reduce gas emissions and depletion of energy reserve. Considering that PEVs will play a major role in the future transport sector, governments, power systems operators, and automakers, have shown great interest in building an efficient charging network for parking place in residence, downtown and industrial park. With the popularization of PEVs, charging PEVs is large and vary over time when PEV penetration becomes significant, which increases the electric demand and changes the demand curve. From a distribution planning perspective, plug-in electric vehicles (PEVs) are an unknown quantity representing potential demand which varies both spatially and temporally across the system. In order to accurately assess potential distribution systems impacts, these load diversity characteristic must be accounted in the system analyses.

In this system whenever the users car battery is low it will search for nearby station for charging his battery. After searching for the nearby station it will display map of nearby station. User will search for station which has minimum waiting time and will book his slot there. The User will get notified when his request will be accepted by the Head Operator of the Station. The Head Operator of the Station will see the entire request for the customers. He can accept or keep in waiting the request of the customer. After the confirmation by the station operator the customer will go to station at his time slot and the head operator will give command for customer charging.

2. Literature Review

We have studied previous Researchers innovation to know more about the system which we are developing.

A.Aljanad et al. [1]: This paper presents the impact study of plugin electric vehicles (PHEVs) on a power distribution system and investigates how it would affect the distribution systems from different perspectives. PHEVs are modeled as storage energy systems in which its dispatch mode will follow the load shape patterns for charging behavior.

W. Deng et al. [2]: This paper provides a comprehensive study on using multiterminal low voltage direct current (MT-LVDC) to connect multiple feeders or transformers, which can solve network constraints efficiently to improve the ability of the power supply for more PEV integration. This paper proposes an adaptive droop control for the MT-LVDC distribution system, and presents a probabilistic evaluation method to analyze the PEV integration capacity. To illustrate the potential of using MT-LVDC to improve PEV integration in an existing distribution network, a case study is performed, and the results show that MT-LVDC based on the proposed adaptive droop control can share the charging power demand during steady state and dynamic conditions between multiple feeders or transformers.

J. Stojkovic et al. [3]: This paper analyses the optimal operation of a commercial PV charging station with 10 chargers for electric vehicles. The charging station is connected to the main distribution network and can buy and sell electricity to the grid. A multi-objective optimization algorithm that minimizes the operational costs of the charging station and costs related to the power losses in the distribution grid has been proposed. In the proposed method, the interests of the charging station owner and distribution system operator were considered. Constraints related to user comfort in terms of the minimum level the

state of charge when the vehicle leaves charging station and the technical limitations of the grid were also considered.

M. Tabari et al. [4]: This paper proposes a mathematical model for a stabilityenhanced dc distribution system, for charging plug-in electric vehicles. The stability of the dc distribution system is enhanced through a nonlinear control strategy exercised locally by each battery charger. The proposed model is of the matrix form and can be used for small-signal analysis of a dc distribution system that hosts an arbitrarily large number of battery chargers. The paper also presents a set of computationally efficient equations for calculating system eigenvalues.

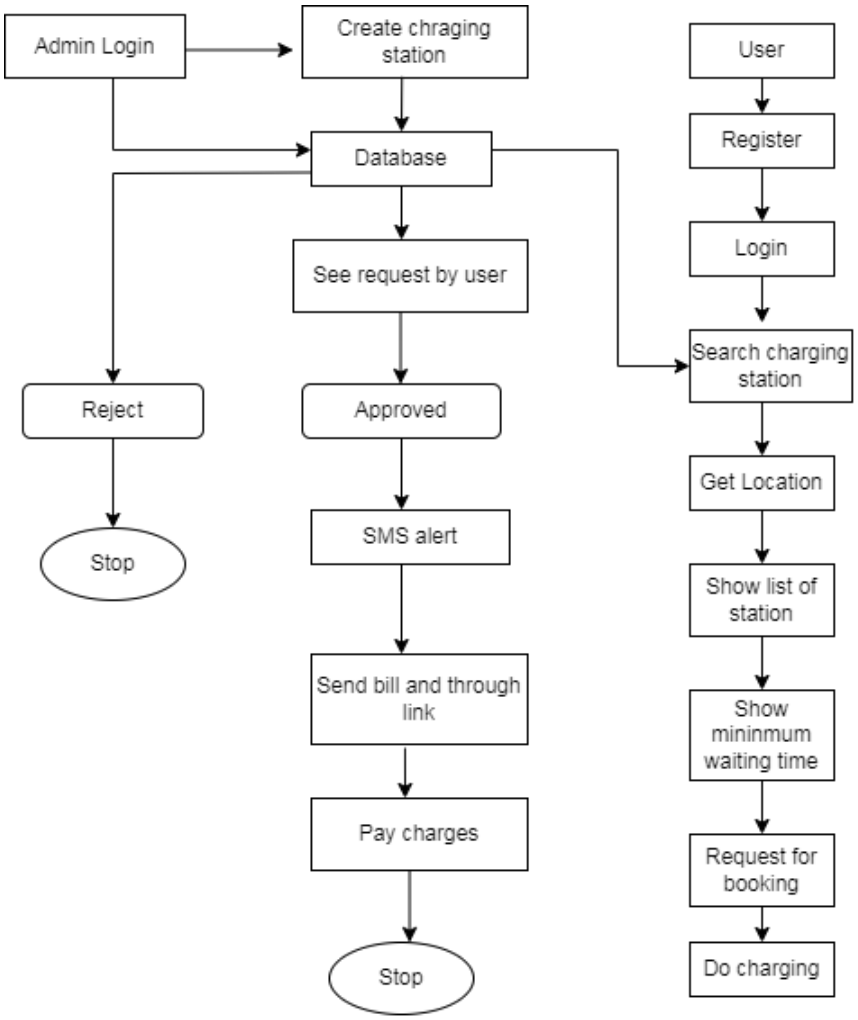
K. Peng et al. [5]: Firstly, a stability model of DC power distribution system integration of electric vehicles under different charging and discharging modes is established, and the stability of DC power distribution system is compared according to Nyquist stability criterion, when electric vehicles are charged and discharged in different ways. Finally, a DC power distribution system time domain example with electric vehicle is made in DIgSILENT simulation software, and simulation results verify the correctness of theoreticalanalysis.

Y. Li et al. [6]: Firstly, the impacts of on-board charging devices with different electrical characteristics on alternating current power supply were discussed. Additionally, the electrical effects of electric vehicle integration into three typical residential communities were demonstrated. By evaluating harmonic in residential distribution system, three-phase unbalance degree and voltage deviation, two suitable power supply mode for electric vehicle charging devices in residential community and possible entry approval standards of on-board charger were proposed.

3. Methodology

This Section introduces the methodologies used by the developer. It also describes in detail steps used by the user. Our system is based on few stages that connects both admin and user to website and works on real time data. Since the user needs to register before accessing the website, the credentials and user information is saved to database. On the other hand, charging station details are displayed and continuously updated for availability of charging slots. Other details like rates of EV charging, address are stable.

Figure 1: Block Diagram of Proposed System



User

Step 1:

- **Register:** User can register using personal details.
- **Login:** User can login in his personal account using id and password.

Step 2: Find Stations

- Choose station
- Choose slot

Step 3: Book Slot

- Send request

Admin

Step 4: **Confirm Slot**

- Login: Admin can login using id and password.
- View Bookings:
  - View registered users
  - Cancel booking if station is occupied
  - Confirm booking if station is available

Step 5: Generate bill

- Insert available slot time
- Generate bill

User

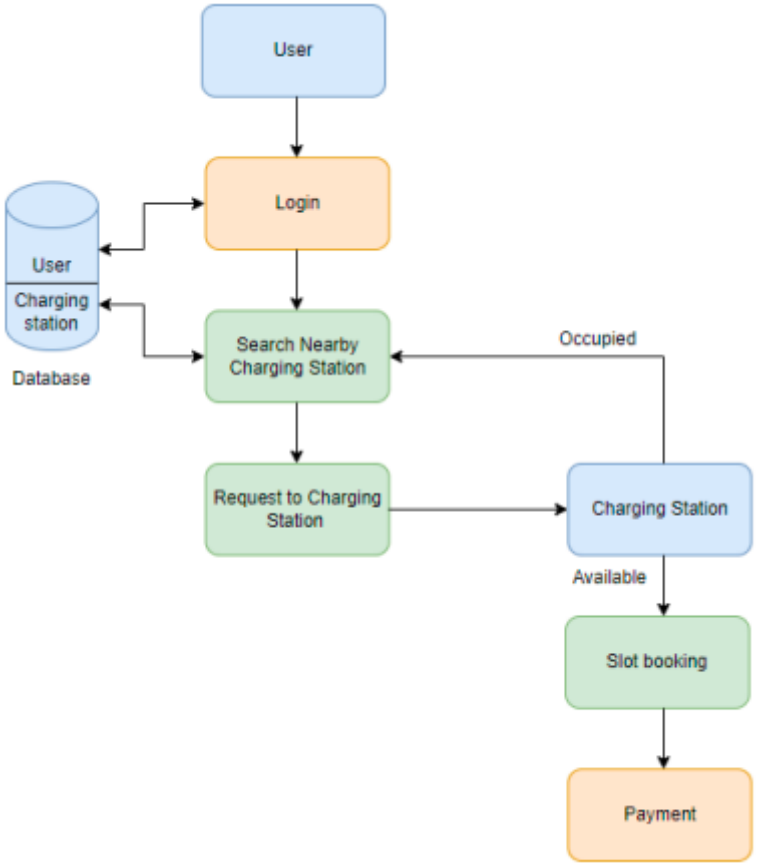
Step 6: Payment

- Check status
- Make payment if slot confirmed and bill generated

3.1. Architectural Design

A description of the program architecture is presented below. A figure of architecture shows the server database, user activity and charging station reply. A system is designed to locate charging stations which need user location on the network. The nearby stations are presented on the map accordingly. Since the database is important part of the system, it is implemented with basic details of charging stations and user activities. A new user should register the system and log-in credentials are saved to the database. The database also contains charging station details like address, slot availability, charging rates etc. with waiting time. Our system provides facility to check the availability of charging slots by sending a request to the charging station. The request is either accepted by charging station with slot details or denied.

Figure 2: Architecture Diagram



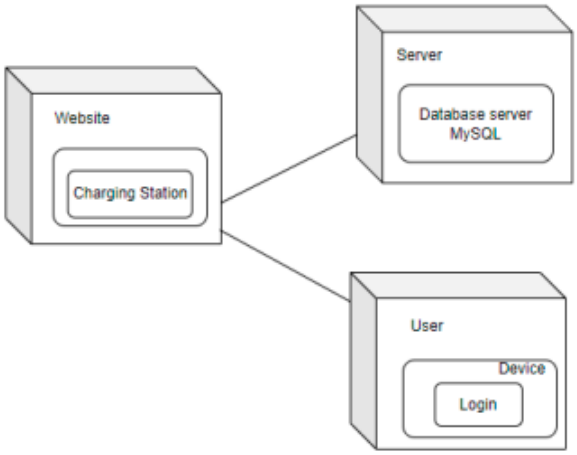
The above figure shows the flow of slot booking activity. In case of a request, the user gets a message for the status of the request. If the request is accepted, the user books a slot with successful payment to

the charging station, otherwise, needs to request another charging station. The database is constantly updated for engaged slots and waiting time.

Figure 3: Flow of Charging Station Slot Booking

The above figure shows the deployment diagram of charging station slot booking system. In this diagram, system is classified into three main sections including website, database server and user device. Website has access to both user and charging station admin while the server is intermediate element to provide details of charging stations and login credentials.

Figure 4: Deployment Diagram of Charging Station Slot Booking



3.2. Hardware and Software Specifications

Hardware Resources Required

Table 1: Hardware Requirements

Sr. No.	Device	Parameter	Minimum Requirement	Justification
1	Laptop or Desktop	CPU Speed	2 GHz	High speed system required
		RAM	4 GB	Higher RAM capacity
2	Android Phone	Version	6.0 and above	Compatible to web application
3	iPhone	Version	iOS 9 and above	Compatible to web application

Software Resources Required

- **Platform:** JSP
- **Operating System:** Windows 10, Server
- **IDE:** Apache Netbeans 15
- **Programming Language**: Java, HTML, CSS
- **Database:** MySQL

4. Outputs

- **Stage 1: User Registration and Log-in**

Figure 5: User Registration

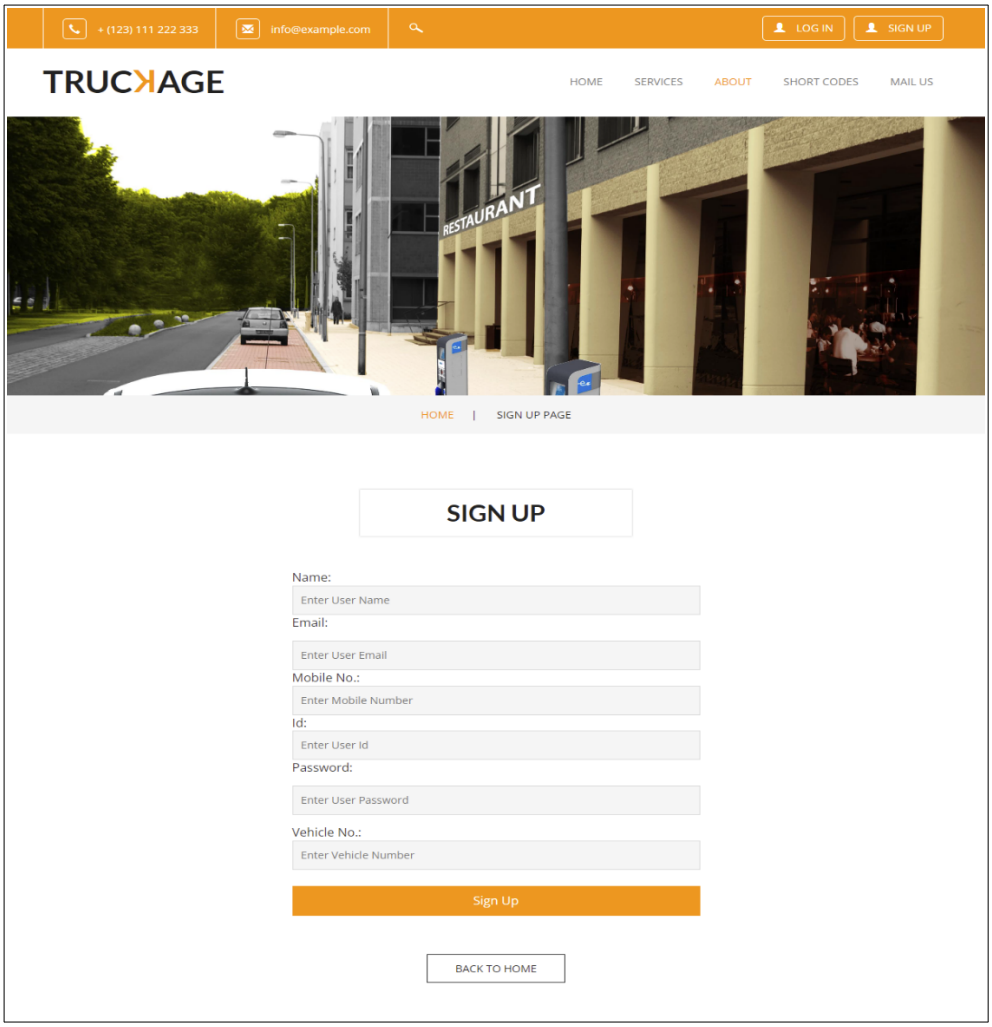
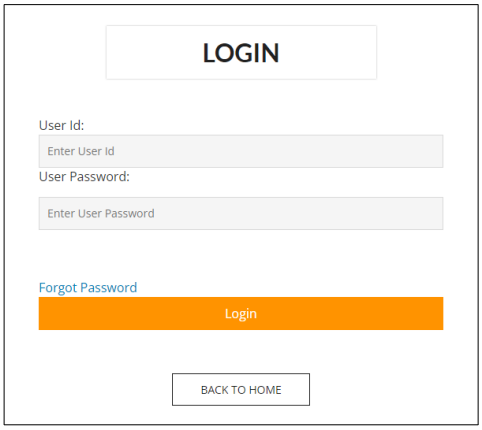


Figure 6: Log-in Page



- **Stage 2: After Log in**

Figure 7: User Information

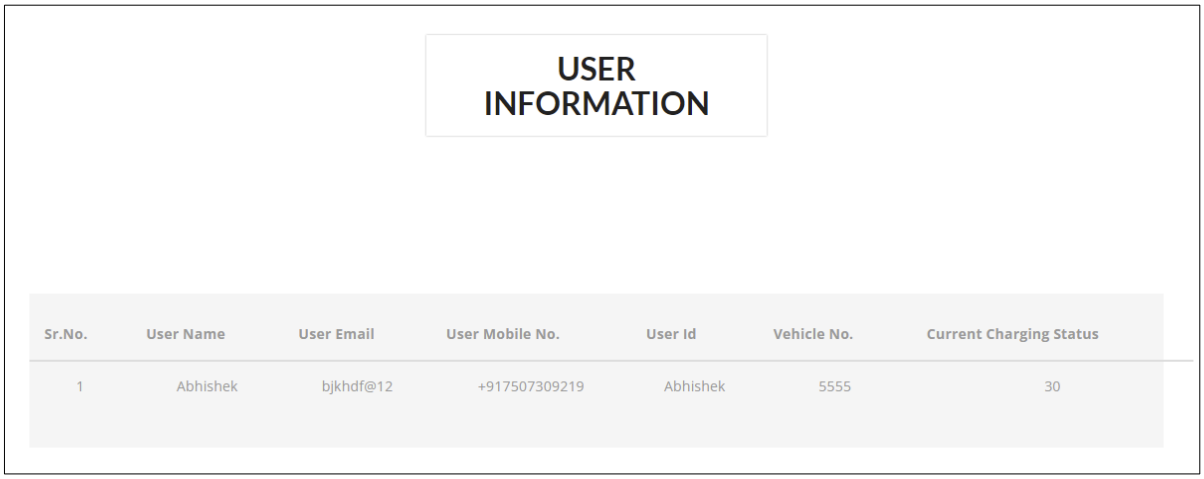
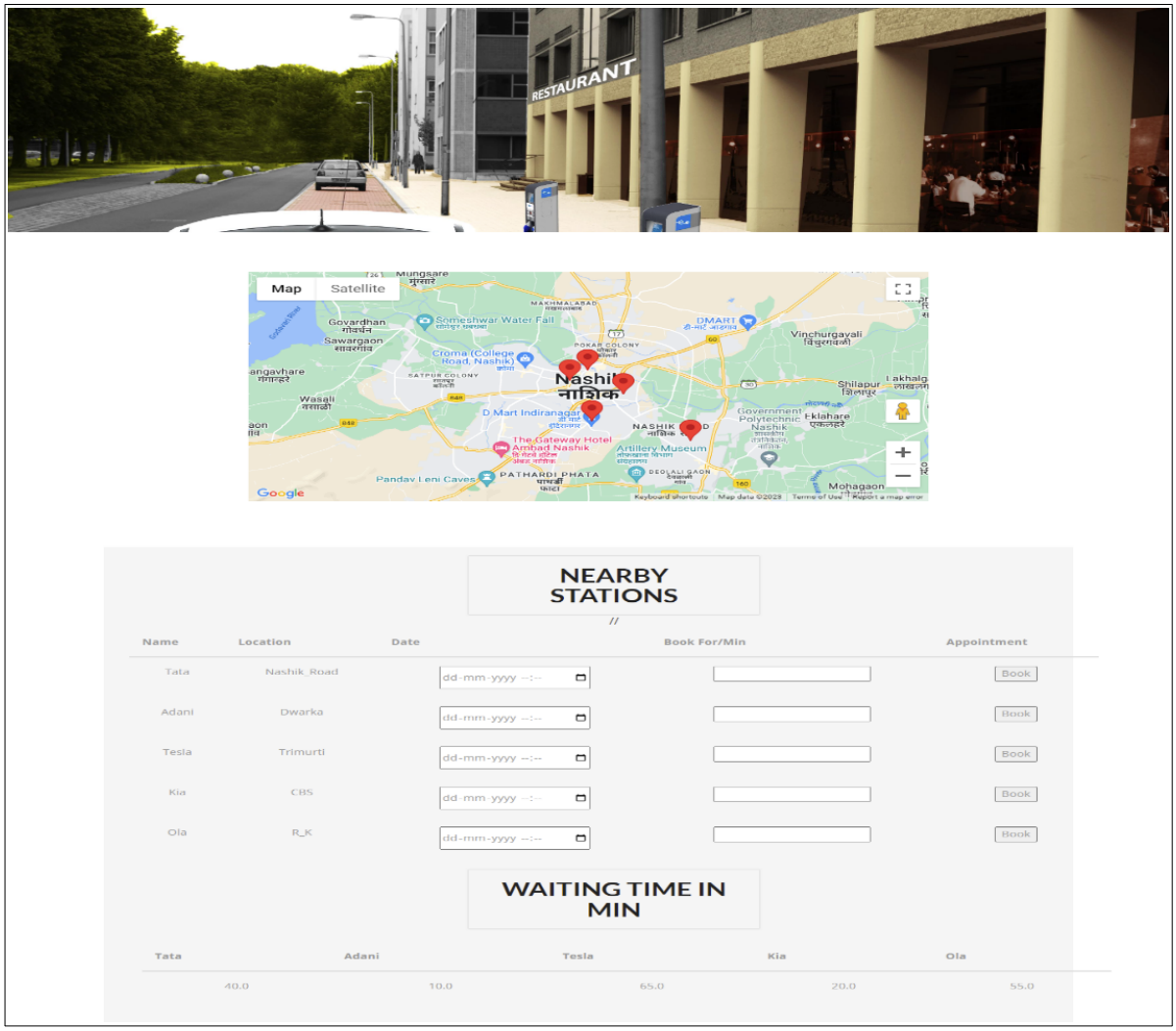


Figure 8: Locating Nearby Charging Stations and Waiting Time with Booking Option



- **Stage 3: Booking Request**

Figure 9: Booking Display at Admin-side

REQUESTS

Sr.No.	User Name	Station name	Booking Date	BookFor/Min	Confirmation	Cancel
1	pw	Adani	2023-04-03 06:57:00	10	Confirm	Cancel
2	Abhishek	Adani	2023-04-29 18:09:00	50	Confirm	Cancel

Figure 10: Booking Accepted

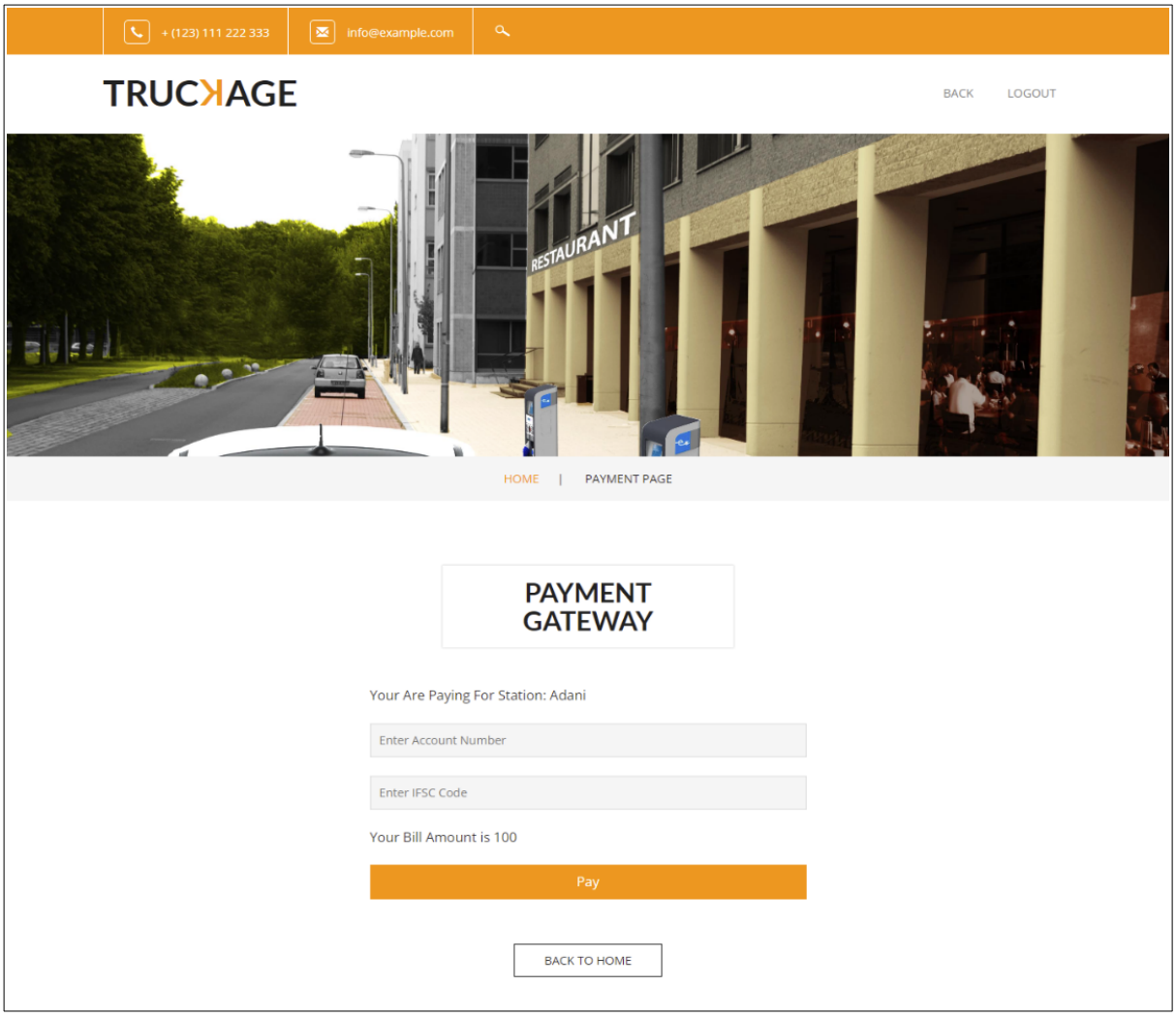
PAYMENT NOW | SERVICES

Booking Accepted

View Details

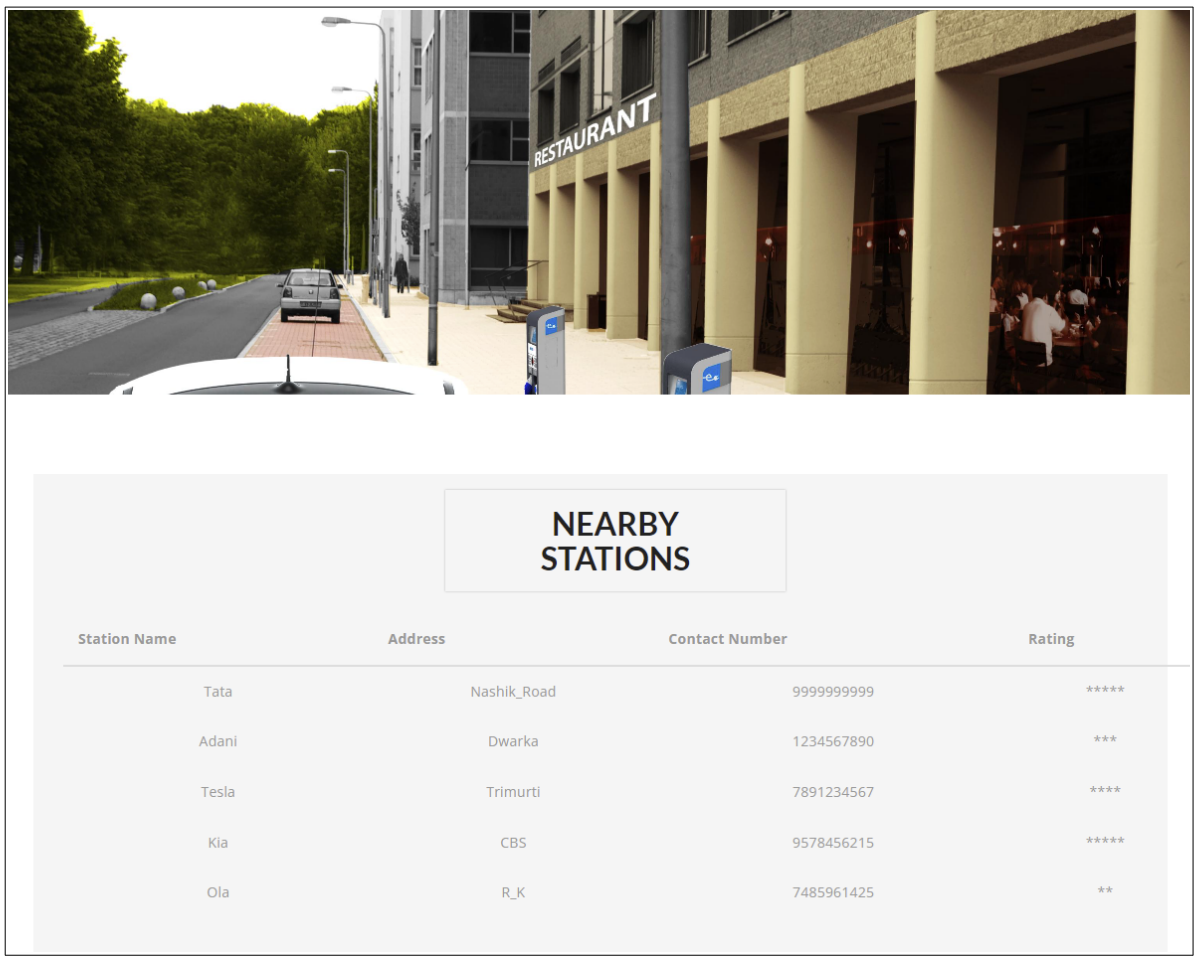
User Name	Station Name	Location	Date-Time	BookFor/Min	Pay_Bill
Abhishek	Adani	Dwarka	2023-04-29 18:09:00	50	Pay_Bill
Abhishek	Adani	Dwarka	2023-04-29 18:09:00	50	Pay_Bill

Figure 11: Bill Payment Gateway



- **Stage 4:** After successful payment, EV reach to CS and charging is done in booked slot. User can call for battery by direct contact with charging station.

Figure 12: Call for Battery



5. Future Scope

A Smart system developed for charging station search and slot booking has wide scope in automation of charging stations. It is important in the enhancement of service performance as well as time and cost efficiency. The future scope of the project will extend the range of details on the map and automatic selection of the most convenient CS.

The system can be further implemented to increase the number of charging stations. It will encourage to use EVs instead of conventional vehicles with increased efficiency of facilities and infrastructure of charging stations. Also, the cost will reduce with large number of EVs on road. In short, we can define the scope of project as below.

- Encourage users to use more electric vehicles with eco-friendly approaches.
- The global imperative to cut carbon pollution and oil dependency
- Budget friendly for consumers
- More variations in the features of the car.

6. Conclusion

As India is a country with a vast road network, if the country wants to boost the popularity of EV's it need to install as many charging stations as possible. Installation of charging is much easier but lack of knowledge makes it difficult to handle. Proper knowledge will surely improve Current Situations. Charging of EV from solar energy provides a sustainable gateway for transportation in the future. It

provides a direct utilization of the PV power during the day and exploits the solar potential rooftops of buildings. Our System will ease the problem depleting resources and increase in pollution caused by the non-electric cars. The system is cost efficient as the user can charge his car through 3 modes i.e. Wind, Solar and Power Supply. If user will book prior a slot for his car charging to the nearby station helping him to avoid long queue.

The user can also find nearby stations by entering his current location and it will display all the convenient options feasible for users. Also, the option of battery change facilitates to contact with charging station directly in case of battery discharged. However, the user has choice to select station of choice according to charge rates. It is easier and convenient to both user and charging stations to reduce the rush. Even the operator at CS can reject the request if unavailability of charging slot. This reduce time and hurdle to search new CS after reaching at the CS. Our web application can be accessible from anywhere and any device including laptop or mobile. Thus, the system is convenient and efficient in locating CS and booking slot with details of charging cost, waiting time and location of charging stations.

7. References

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