IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 10, Issue 5, May 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.165

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |

|| Volume 10, Issue 5, May 2022 ||

| DOI: 10.15680/IJIRCCE.2022.1005117|

An Interactive Mobile application for Nearest Charging Station Locator and Port Availability Checker for Electric Vehicles

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ABSTRACT: Most of these technological developments in recent years have been developed to exist in a self-sustaining environment. The electric automobile conception is becoming a hot issue as a response to growing concern about fossil fuel sources and anthropogenic climate change. As a consequence, the proportion of electric cars on the road has been steadily increasing. Electric vehicles will reduce carbon emissions and footprints, which would be beneficial to the environment. Electric vehicles, in other words, will have an influence on people's lives in the coming days. Electric automobiles, while there are advantages, they also have several disadvantages when compared to other modes of transportation, such as a restricted range. Range anxiety is a problematic occurrence that can be effectively circumvented through the establishment of a robust recharging infrastructure. Therefore, there is a need for an application that can provide the user with the location of the Electric Vehicle charger and the availability of the charging ports. To this end, this utilizes the Codename One platform on the java programing language to achieve a cross platform interactive application that has been effective in the realization of the Nearest Charging Station Locator and Port Availability Checker for Electric Vehicles. The experimental results have been extensive to achieve highly positive results.

KEYWORDS: Codename One, Android Application, Electric Vehicles Charging Station.

I. INTRODUCTION

Urban areas are about to undergo a change that will be based on innovative initiatives that are supported by the resiliency and environmental responsibility. The transportation sector plays a vital role, especially concerning the environment, since it accounts for nearly a third of all energy-related emissions. Private automobiles, which are primarily cars with internal combustion engines, have monopolized traditional transportation networks, resulting in serious environmental effects such as oil shortages, deterioration of environmental quality, and greenhouse emissions. Additionally, the use of fossil fuels, such as petrol and diesel, not only causes environmental difficulties but also has a substantial impact on people's wellbeing. As a result, measures and regulations to improve cities' productivity and reliability must be implemented. New approaches and possibilities develop as a result of technological advancement. Now, in urban contexts, a change from traditional to more ecologically responsible vehicle fleets might be an appropriate engine for a more sustainable future. Renewable energy and cutting emissions should be major cornerstones in this path, and electric mobility, especially the proliferation of electric cars, is critical to this transformation. Electric cars, despite they have long history, are quickly becoming the next automobile breakthrough to be broadly adopted in society.

Electric cars, which are described as any passenger vehicle which draws power from the energy infrastructure and retains it on board for operation, are a significant opportunity to minimize fossil fuel usage, air pollution, and greenhouse gas emissions. The electric propulsion system is eco-friendly, does not produce local pollutants, and minimizes noise, therefore electrification of automobiles is a solution that considerably reduces the negative environmental consequences of transportation while also increasing its productivity. In recent times, rechargeable battery technology has evolved rapidly, enabling electric cars to go longer on a single charge. Regrettably, this progress

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is inadequate for a long journey without stopping to recharge. Electric cars, as a necessity, must be recharged promptly and frequently. In the future years, a big number of electric automobiles will also have a substantial impact on total energy use. Whenever these scenarios arise, there must be a considerable amount of charging infrastructure accessible to meet the demand. The zones must be well and strategically placed to allow the expanding number of electric automobiles to travel about with ease. Nevertheless, because the increasing popularity of electric cars is projected to present both technological and economic hurdles, further study should be undertaken in the long term to appropriately measure levels of flexibility to change. Economic constraints and cost considerations, as well as developing charging networks, strengthening the power distribution grid, project feasibility challenges, and security and ethical concerns involving synchronized "smart" charging systems, are the most significant roadblocks. The frequency and distribution of electric cars appear to be crucial in this regard. Owing to several relevant investigations, the absence of charging infrastructure or its delayed rollout impedes the development and dissemination of electric vehicles in the automotive industry. Electric Vehicle Charging Stations may be considered a need, especially around this time when the shift to electric transportation is quickening. Although e-mobility is a complicated ecosystem, establishing a sustainable electric car charging infrastructure that prioritizes these automobiles as well as the usage of alternative energy sources which is a critical move in the right direction. According to consumer research from throughout the world, a lack of proper refueling facilities will be a major barrier to the acceptance of electric vehicles. The range anxiety phenomenon is caused by the lack of an effective electric car charging infrastructure. Drivers' anxieties and concerns when operating a vehicle are referred to as range anxiety. Range anxiety, on the other hand, is defined as the dread of not having enough power to reach one's destination. As a result, offering users of electric cars simple and convenient recharging facilities would be useful in this regard.

Therefore, for this purpose, an effective charging station management approach must be realized for improving the state to achieve electric vehicle adoption. This is achieved through the in-depth analysis of past research on the topic of smart electric vehicle charging infrastructure. The analysis has been stipulated in the section given below which has been useful in the development of our approach which will be elaborated in the upcoming editions of this research. This research paper's Literature Review section portion looks at past work. Section 3 digs more into the methodology, whereas Section 4 emphasizes on the examination of the result. Section 5 concludes this study and offers some suggestions for further research.

II. RELATED WORK

Tohid Harighi [1] expresses that the paradigm of electric vehicles have been getting increasingly popular. This is due to the fact that the electric vehicles have been useful for a variety of reasons. The electric vehicles are useful in preserving the environment and also keeping the atmosphere clean. There are various problems that have been major obstacles towards the adoption of this technology in a largescale manner. One such problem is the lack of adequate charging stations on strategic locations. Therefore, the authors have proposed the use of an effective and useful mechanism for the determining the location of the charging stations through the use of grid availability in Ankara, Turkey.

Yutaka Motoaki [2] states that there has been an increase in the number of electric vehicles across the globe. This has been due to the immense affordability of the electric vehicles in the long run. The electric vehicle platform has become highly popular with a large number of interested individuals which is improved due to the tax benefits offered by the governments. There is a lack of an effective charging station network to facilitate effective long range journeys which can be a problematic occurrence as most Electric Vehicles lack a long range. To provide a solution to this problem, the authors have presented an effective strategy for the development of fast chargers for electric vehicles. The authors have proposed the use of location allocation to determine the locations for these type of chargers.

Hongsheng Chen [3] builds an optimization model with the purpose of reducing the discrepancy between the charging station's overall cost and the user's full expenses. The charging station's operational range is divided using the Graph representation, the smallest distance between the supply point and the charge controller is calculated using the Dijkstra shortest path method, and the real outcome is determined using the dynamic particle swarm technique. The calculations reveal that incorporating the entire costs and advantages of the charging stations, as well as the user's ability to pick the rechargeable battery location technique, is viable and beneficial from an investment perspective.

Christos Karolemeas [4] explains that there has been noticed a radical shift towards sustainable development in the world. This paradigm shift has allowed the users to witness an enormous transformation in the cities across the globe towards the electric vehicles that have been one of the most useful in reducing the greenhouse emissions. The main aim is to achieve the replacement of the conventional fossil fuel based vehicles with the electric vehicles. This is only possible when there is an effective network of chargers that can be utilized by the electric vehicle users. For this purpose the authors have proposed the use analytical hierarchy along with thematic analysis for the purpose of

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achieving sustainable charging station location in Greece. The approach utilizes a collection of weights and parameters to a spatial function to achieve the estimate of sustainability of the charging point precisely.

Prasetyo Aji [5] discusses that the development and research on electric vehicles has been increasingly consistently in the past few years. This has been accelerated due to the increase in the reliance on fossil fuels which has led to a considerable increase in the greenhouse gas emission that cause an increased damage to the environment. This is highly undesirable as the conventional fossil fuel vehicles contribute a large section of the greenhouse gasses that can be reduced if there is a shift towards electric vehicles. The main drawback for the majority of the individuals for shifting to the electric vehicles is the lack of a good charging infrastructure. Therefore, the authors have proposed the use of an effective approach for the management of charging stations in cities that has been based on the level of activity on the charger and the location of the charger in the city.

Arunkumar P [6] describes that most of the major cities across the world are suffering from the lack of air quality and increasing pollution which is quite detrimental to the health of the residents. There have been a change towards electric vehicles to offset the damage done to the air by conventional vehicles that utilize fossil fuels for their operations. The increased popularity of the electric vehicles can be attributed to the large number of subsidies and other benefits. There are a number of different charging stations across a large area. The state of the charger isn't actually visible to the users until they interact with in person, this leads to a lot of problem which can be debilitating. Therefore, the researchers in this approach have presented a smart charging station that utilizes the IoT devices to store data related to the station and enable users to remotely check if the charging station is working properly.

S. Lupu [7] states that the environmental effects of using fossil fuels have been considerable in the deterioration of the climate and can have very lasting effect on the planet as a whole. This has been recognized by major countries across the world that have been pledging their support to reduce the damages. The countries have been reducing their dependency on fossil fuels and are providing incentives to switch to electric vehicles. This has led to an increase in the number of vehicles that run on electricity which has pushed for the demand of charging stations. The location of charging stations is extremely crucial as the infrastructure is quite expensive to deploy. Therefore, the authors in this publication have proposed an effective technique for management of electric vehicle charging stations.

Kulsomsup Yenchamchalit [8] expresses that there has been a boom in the electric vehicle market across major cities in the entire world. This is due to the increasing need for alternative forms of energy to power the transportation. The electrical vehicles have to be charged to continue driving when the battery runs out. This is highly difficult as there has to be an effective charging station network to allow for regular usage of the electric vehicles. The location of the charging stations is one of the most critical aspects as it determines its usage and availability to the consumers. Thus, the authors in this publication have proposed the use of particle swarm optimization to achieve the optimum location of the charging stations. The proper location of the charging station can be highly beneficial as it allows for improved charging time and ample available charging slots.

Hongyue Ma [9] elaborates that the world is experiencing an environmental as well as energy crisis, these are the signs that there will be an energy revolution eventually. Conventional vehicles are the primary source of pollution in the atmosphere. In order to limit any use of fossil fuels and the discharge of emissions into the environment, many governments have developed energy replacements for vehicles. Countries all over the world, as well as major automakers, have announced a calendar of gasoline transport termination strategies and are actively accelerating the development of alternative fuel vehicles. There have been incidents of incorrect charging stations as the popularity of electric vehicles has gone up significantly. As a result, the research proposes an economic load dispatch approach based on urban people' travel behavior scheduling. This kind of forecasting can forecast the city's particular circumstances and increase prediction performance. The ideal location of power outlet may be successfully determined using the propensity transmission clustering method to decrease the passive journey times of hybrid vehicles and boost the charging point utilization.

Yongjun Ahn [10] narrates that in the initial stages of attaining a reliable Electric vehicle, the quantity of charging station are very limited. Electric car drivers may have driving range concerns or particular charging behaviors due to a restricted number of charging points. This research looks at the driving habits of electric taxis as a result of a lack of charging outlets in metropolitan areas. Depending on where the charging station is located, electric car driving patterns may change. The objectives of this paper was to discover the EV operating trend by contrasting the driving habits of conventional taxis fueled by LPG and electric taxis with charging station constraints. Trip durations and orientation from taxis' Global Positioning data are used to assess driving habits. After comparing and contrasting various driving trends between conventional taxis and electrical taxis, a special driving pattern phenomena was discovered, which helped in quickly locating charging station locations.

Kerem Can Arayici [11] states that increased usage of fossil fuels indicates the overall fossil fuel supply will steadily diminish in the coming years, and that fossil fuel supplies will finally be fully depleted. Because the globe is grappling with the challenge of global warming, innovation in the fields of sustainable power, smart grid networks, and electric

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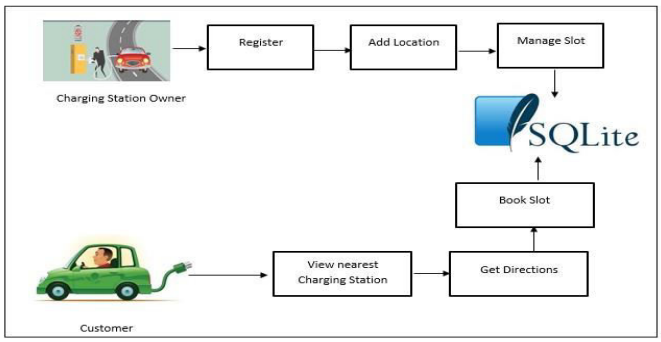
cars is on the rise. However, there is a lack of an efficient and practical strategy for locating charging stations. Because of the growing number of electric vehicles, the best location for charging stations is a hot subject in investment management. Developing optimization algorithms to find the optimal sites for charging stations can help investors make better investment decisions.

Terapong Boonraksa [12] states that the ABC algorithm is a novel way for locating the finest electric car charging stations. This article concentrates on rapid charging stations and employs a reworked IEEE 33 nodes radial distribution system as a prototype. The road traffic of electric cars from the supply terminals to the electric vehicle charging facility attached to the power distribution network was deemed a crucial component. The simulation results indicate that the charging point for electric vehicles in the best location has the minimal power loss, line impedance inside the specification, and stability index inside the spectrum. The findings also show that the ABC algorithm is successful in finding the best position for a rapid charging station associated to a radial distribution network..

III. PROPOSED ALGORITHM



The presented approach for the purpose of achieving an effective mobile application for electric vehicle charging station has been depicted in the system overview diagram in the figure 1 above. There are certain steps that have been utilized for the purpose of achieving the approach are given below.

Step 1: Charging Station Registration – The proposed system is designed using the Codename One through the Java Programming language. The Codename One is an extremely useful cross platform paradigm that allows for the creation of android and iOS applications using the java programming language. The NetBeans IDE has been used to generate the application and achieve the apk for the same. The Interactive Interface is used by the owner to register by providing valid details such as charging station name, address, email id, mobile number, username, and password. The charging station owner has to also provide the location of the charging station to be provided for the registration. There are two different ways the charging station owner can do that, firstly if the owner is at the location of the charging station he/she can just utilize the GPS of their mobile device to register their location, secondly the owner can utilize Google Maps to drop a pin at their charging station's location. After successful validation and registration the user can log into the system by providing the username and password used at the time of registration.

Step 2: Slot Maintenance – Once the charging station owner logs into the system it is greeted by an operation frame that contains several options in the form of a hamburger menu that can be accessed by tapping on the top left corner of the screen. These options include, edit station info, add slot info, edit slot info, view slot info, view book info, and logout. The owner can edit the parameters of their charging station entered during registration, through the edit station info option. The add slot option allows the owner to add the charging slot availability, this option requires the charging point numbers, the status of the charging point and the date and time. The view slot info option allows the owner to view the information regarding the charging point, its status, date and time.

Step 3: Customer Registration – The customer can also register on the application. This is done by selecting the customer option form the drop down menu in "you are?" and then tapping on the register option. The register form is then displayed to the customer that can then provide their details to be entered into the form. The details provided at the registration by the customer include, driver name, mobile number, username, and password. These details provided by the customer which taps on the save button, this triggers the validation process and after successful validation the customer profile details are stored on the SQLite database on the mobile device and a dialog box with successful registration is shown to the customer. The customer can now access the application by logging into the system with username and password provided earlier and selecting the customer option from the drop down menu. After successful

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login by the customer a welcome page is shown that contains several options in the form of a hamburger menu that can be accessed by tapping on the top left corner of the screen. These options include, edit profile, view location, book, book info, and logout. The customer can edit the parameters of their profile entered during registration, through the edit profile option.

Step 4: Slot booking – After the customer logs into the application, the customer can search for the nearest charging station with an available slot in the database by the view option. Once the customer selects this option, the location of the customer is implicitly captured by the application, with the attributes such as latitude and longitude. Now the application identifies the charging stations with available slot and gathers it into a list. This list is then utilized to achieve the distance evaluation from the customer's location to each of the available charging stations with vacant slots through the algorithm 1 given below.

IV. PSEUDO CODE

// Input: User latitude and longitude U_{LT} U_{LG}
// Input: Available slot Charging Station List AC_{SL}
// Output: Nearest Charging Station N_{CS}
Function distanceEvaluation (U_{LT}, U_{LG}, AC_{SL})

1: Start
2: Initialize S_D =100
3: *for* i = 0 to size of AC_{SL}
4: row= $AC_{SL[i]}$
5: S_{LT}=Row[0]
6: S_{LG}=Row[1]
7: D_{LT}=toRadians (U_{LT}-S_{LT})
8: D_{LG}= toRadians (U_{LG}-S_{LG})
9: A=sin(D_{LT}/2)*sin(D_{LT}/2)+ cos(toRadians(U_{LT}))*cos(toRadia ns(S_{LT}))*sin(D_{LG}/2)*sin(D_{LG}/2)
10: b=sqrt (a)
11: d= sqrt (1-a)
12: c=2*atan (b, d)
13: dist= c*6371
14: *if* (dist<S_D), *then*
15: S_D=dist
16: N_{CS}= row
17: *end if*
18: end for
19: *return* N_{CS}
20: STOP

The algorithm returns the nearest charging station with available slots which is displayed to the customer. The customer can now book the available slot on the charging station for the respective charging stations. This completes the procedure of finding nearest charging station for the electric vehicles.

V. SIMULATION RESULTS

The proposed approach was developed using the Codename One framework using the Java programming language and the NetBeans IDE to locate the Nearest Charging Station and Port Availability for Electric Vehicles. The development laptop operates on the Windows operating system, supplemented with 8 GB ram, and 1 TB of storage capacity. Database administration is handled using the SQLite database. The proposed technique's practicality has been carefully evaluated over a wide range of factors. The experimental inquiry's observations are described underneath. Scalability Analysis of SQLite Database Transactions The technique for an Interactive Mobile application for Nearest Charging Station Locator and Port Availability Checker for Electric Vehicles through the framework of Codename One is used to assess the scalability of SQLite Database. For this objective, substantial examination is being conducted, including the realization of a number of tests on the database to understand the capability of the system to handle database transactions. The amount of SQLite Database transactions performed for the testing purposes have been successfully documented and presented as seen in Table 1 below.

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S. no	No of SQLite Database Transactions	Time Taken (in Milliseconds)
1	15	9
2	20	15
3	25	12
4	30	17
5	35	18

Table 1: SQLite Database Transaction Time Estimation Table

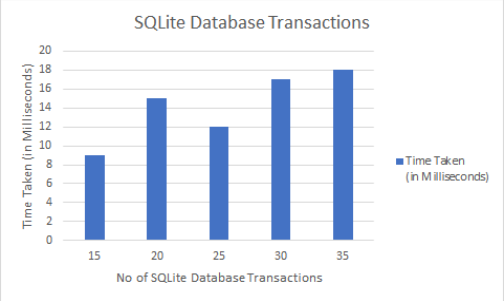

Figure 2: SQLite Database Transactions

VI. Conclusion and Future Work

Due to the increased usage of fossil fuels, the entire reserves of fossil fuels will steadily diminish in the next years, and fossil fuel reservoirs will ultimately be fully depleted due to their finite availability. Human usage of fossil fuels has risen tremendously, resulting in increased carbon emissions, climate change, and other environmental issues. Electric cars have been being developed across the world as a mode of transportation that may efficiently cut fossil fuel usage. Furthermore, because the world is grappling with the problem of global warming, technologies in the fields of renewable power, smart grid networks, and electric cars are expected to gain momentum. The main drawbacks associated with widespread implementation of electric vehicles have been the limited range of the vehicle. This problem can be successfully avoided through the use of smart charging infrastructure that can provide information about the nearest charging station and the availability of the charging slots. As a result, this proposed research makes use of the Codename One framework and the Java programming language to create a cross-platform interactive application that has been successful in realizing the Nearest Charging Station Locator and Port Availability Checker for Electric Vehicles. The extensive experiments were thorough in order to achieve extremely favorable outcomes.

The future directions to this research can be improved through the implementation of this mobile application in a real time scenario by integrating the Google Maps API and a payment gateway.

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INNO SPACE
SJIF Scientific Journal Impact Factor

Impact Factor: 8.165

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ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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