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# Evolve: Cutting-edge electric vehicle route planner technology

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**Abstract**
Evolve is a Route planning application designed to provide electric vehicle drivers with real-time information on available charging stations along their route. The app helps drivers optimize their route by displaying the total distance, Charging Time, Remaining Charge, and Battery consumption by inputting their starting point and Destination, Users can see a suggested Route with Charging stations marked along the way. The App also provides estimated charging time based on the User's Vehicle and Battery Type. Evolve is an essential tool for electric vehicle drivers willing to plan their journeys to include charging stops, ensuring a hassle-free journey and helping to reduce Range Anxiety.

**Keywords:** Route planning, charging stations, battery consumption, destination, range anxiety

## Introduction
Electric vehicles (EVs) are becoming more and more popular as a way to reduce carbon emissions and lower dependence on fossil fuels. However, one of the biggest challenges for EV owners is finding a way to plan their routes and charging stops in order to avoid running out of battery charge during their journeys. This is where an EV route planner comes in handy. An EV route planner is a tool that helps EV owners plan their routes and charging stops in order to maximize their range and minimize the risk of running out of charge. In this research paper, we will explore the benefits of using an EV route planner, the features of a good EV route planner, and the current state of EV route planners in the market [1].
An electric vehicle (EV) route planner is a software tool that helps EV drivers to plan their travel route by optimizing charging stops along the way. The planner considers the battery level, charging station locations, charging speed, and traffic conditions to provide the most efficient and practical route for the EV driver. The EV route planner aims to address the range anxiety issue and to provide a seamless and convenient charging experience for the driver [2].
The EV route planner is based on advanced algorithms that consider a wide range of variables, such as topography, driving habits, and weather conditions. The planner helps drivers to save time, energy, and money by providing the most efficient route that avoids unnecessary stops and delays. Additionally, the EV route planner can help to reduce the carbon footprint of EVs by encouraging more efficient driving practices and reducing the overall energy consumption of the vehicle [3].
Overall, the EV route planner is a critical tool for the widespread adoption of EVs by addressing the range anxiety issue and providing a more convenient and efficient charging experience.

## Problem Definition and Objectives
EV are becoming popular since past few years especially nowadays when prices of the fuel are so high and there's so much of global warming. A lot of people are switching to electric vehicles as they are cost effective and most important, they do not cause any pollution. We are going to plan a proper route for an individual who owns an electric vehicle and want to know about the best route to reach his destination without his vehicle running out of battery.
The difficulty of designing a route for an electric car that takes into account the vehicle's range restrictions and the accessibility of charging stations is the issue that an EV route planner seeks to address. When driving long distances, EV drivers could have range anxiety, and it might be challenging to find charging stations along the way due to a lack of infrastructure. The issue is made worse by the fact that it can be challenging to plan routes in advance due to the quick

changes in charging station availability and placement. An EV route planner is created to address these issues by giving drivers accurate and current information about charging stations and assisting them in planning their journeys in a way that maximises their range and reduces the amount of time they spend at the petrol station.

EV based on electric system that pushes or drives a vehicle. No internal engine is used. The vehicle runs on electric power as electric source. The main advantage of electric vehicle is its efficiency of conversion of power through its electric motor. Nowadays commercial vehicles are also available. There are many countries which provided incentive to many users through lower tax, free parking and free charging facilities. On the other hand, the hybrid electric vehicle (HEV) is an alternative [4].

A good EV route planner should have several key features. First, it should be easy to use and navigate. This is important because EV owners may not be familiar with the technology and may need assistance in using the tool. Second, the EV route planner should be accurate and reliable. This means that it should take into account factors such as traffic, weather, and terrain in order to provide the most accurate information possible. Third, the EV route planner should be up-to-date with the latest information about charging stations and their availability. Fourth, the EV route planner should provide information about the cost of charging at different stations, as well as any membership fees or other charges that may be associated with using the station [5].

Hybrid electric vehicles also have a gasoline engine in addition to an electric power train. Hybrid electric vehicles (HEVs) are powered by an internal combustion engine in combination with one or more electric motors that use energy stored in batteries. It has been used extensive in the last few years. At least one model in all the cars can have hybrid electric vehicle. The question arises: Which vehicle will lead market and which one is suitable for future? This paper is for examining the recent development of Electric Vehicle (EV's) and suggest the future development in the area.

The objective of this project is to identify the best route for E-Vehicles. Our objective of the project is to detect the charging stations on map easily with accuracy and recommend the best route. The main motive was to decrease the fuel consumption and nowadays a lot of people are switching to electric vehicles as they are cost effective and most important they won't cause any pollution [6].

The future of electric vehicles is bright everywhere. A lot of people are switching to electric vehicles as they are cost effective and most important they do not cause any pollution. All the recent studies. shows a positive picture of the future of electric vehicles as a mode of road transportation.

A thorough goal for an EV route planning could be: In order to minimize the carbon footprint of EV travel, lower energy costs, improve air quality, and increase driver satisfaction, an intelligent and sustainable transportation system that optimises EV routes and charging strategies while taking driver preferences, charging station availability, renewable energy sources, and grid constraints into account must be developed.

**This target includes various important objectives, such as**

1. Route optimization for EVs: To save travel time and energy consumption, the EV route planner should produce the best possible routes for EVs, taking into account variables including traffic, the road network, driver preferences, the availability of charging stations, and battery range [7].
2. Integration with existing infrastructure for charging: The EV route planner should be integrated with the current infrastructure for charging in order to provide real-time data on charging station availability, rates, and locations as well as to optimize charging strategies based on battery state of charge, driving distance, and driver preferences.
3. Integration with renewable energy sources: In order to increase energy efficiency, lower carbon emissions, and promote sustainable transportation, the EV route planner should be integrated with renewable energy sources like solar and wind power.
4. Grid constraints should be taken into account by the EV route planner to prevent overloading the grid and resulting in power outages. These limits include peak demand, distribution capacity, and load balancing [8].
5. Enhancing driver satisfaction: To increase driver satisfaction and encourage the adoption of EVs, the EV route planner should take into account driver preferences and behavior, such as favorite routes, charging times, and driving behaviors.

An EV route planner's overall goal is to provide an intelligent and environmentally friendly transportation system that maximizes the energy efficiency and environmental advantages of travelling in EVs, while also guaranteeing driver pleasure and encouraging the mass adoption of EVs.

**Literature Review**

Researchers and business experts are paying more attention to EV route planner, a relatively new technology, as the market for electric vehicles expands. Some current studies on EV route planners are compiled in this area of the review. M. Simsek *et al*. carried out one of the early research on EV route planning and suggested an algorithm that optimises EV route planning taking into account numerous aspects like battery capacity, charging station location, and traffic conditions. They came to the conclusion that their algorithm performed better than other approaches in terms of cutting down on charging pauses and trip time. A multi-objective EV route planning method that takes the driver's preferences and route restrictions into account was proposed in a different study by T. Kwon *et al*.. They discovered that their algorithm offered a more customised approach to route planning, which can increase driver satisfaction and lessen range anxiety.

In order to optimize the placement of charging stations in a region, M. Gu *et al*. suggested a data-driven approach to forecast EV charging station demand. In order to guarantee the availability of charging stations throughout the intended route, this study highlighted the significance of precise and timely data in EV route design.

Recent research on EV route planners by H. Khattak *et al*. (2021) revealed a number of issues, including the lack of standardization in charging infrastructure, the dynamic nature of EV driving patterns, and the requirement for more accurate and current data. They came to the conclusion that additional study is required to overcome these issues and boost the usefulness and efficiency of EV route planners.

M. Birk *et al*.'s (2020) integration of EV route planning with smart grid technologies was the subject of a separate recent study. In order to lower peak load and energy costs while maintaining driver preferences, they proposed an algorithm

that takes into account both the energy needs of the power grid and EV charging requirements. Their findings demonstrated that the suggested algorithm can reduce costs and save energy while providing a positive driving experience [9].

Additionally, a number of nations and regions are encouraging the use of EVs and funding EV infrastructure, such as charging stations and route planning tools. By 2025, the European Union, for instance, wants to have at least one million public charging stations, while China wants to have 4.8 million EV charging stations.

Overall, the study of the literature indicates that EV route planning is a crucial field for investigation and advancement since it has the potential to assist solve problems associated with the widespread adoption of EVs. While guaranteeing energy efficiency and driver happiness, EV route planning algorithms need to take into account a variety of parameters, such as driver preferences, the availability of charging stations, and grid limits. The creation of increasingly sophisticated and efficient EV route planning systems is anticipated to accelerate with the continuous expansion of the electric vehicle market and investments in EV infrastructure. [10].

The incorporation of renewable energy sources is a crucial component in EV route planning. When EVs are powered by renewable energy sources, their environmental benefits can be further increased. EVs are frequently marketed as a way to lower carbon emissions and improve air quality. In order to maximize energy efficiency and cut emissions, several studies have investigated the combination of electric vehicle route planning with renewable energy sources including solar and wind power.

For instance, to reduce the carbon footprint of EV travel, people developed an integrated system that combines EV route planning with solar energy utilization. The suggested method optimizes route planning and energy management by taking into account a number of variables, including solar irradiation, battery state of charge, and traffic circumstances. The findings indicated that the integrated system can cut EV travel's carbon emissions by up to 50%.

A wind-powered EV route planning system that takes into account wind power generation, charging station location, and EV charging needs was suggested in a different study by J. Ren *et al*.. By maximizing the use of wind energy and minimizing reliance on conventional power sources, the proposed system seeks to cut down on carbon emissions from EV travel. The outcomes demonstrated that the suggested solution can significantly lower carbon emissions and energy costs.

In general, EV route planning that incorporates renewable energy sources can help to further the environmental advantages of EVs and advance sustainable transportation. The creation of more sophisticated and integrated EV route planning systems is anticipated to become more doable as renewable energy sources become more widely available and more reasonably priced.

The literature review's conclusion emphasizes the significance of EV route design as a strategy for overcoming obstacles to the mainstream adoption of EVs. While guaranteeing energy efficiency and driver happiness, EV route planning algorithms need to take into account a variety of parameters, including driver preferences, the availability of charging stations, renewable energy sources, and grid limits. It is anticipated that ongoing research and development in this field would hasten EV adoption and advance environmentally friendly transportation [6].

**Fig 1:** EV charging stations along the route

Figure 1 depicts the working of the Route Planner to find the best Route for an Ev to find its way along with charging stations.

**Methodology**

A number of processes are included in the methodology for creating an EV route planner, including data collecting, data pretreatment, algorithm development, and evaluation. The process is described generally as follows:

Data collection is the initial step in the process of creating an EV route. For example, data on charging station locations, charging rates, traffic conditions, the state of the road network, and driver preferences are collected. Numerous sources, including open databases, governmental institutions, and private companies, are available for the data.

Data preprocessing is necessary to prepare the acquired data for analysis and algorithm development. This entails cleansing the data, fixing mistakes and inconsistencies, and fusing several data sources.

The next stage is to create algorithms that can create the best EV routes based on the information that has been gathered and evaluated. Algorithms of many kinds, including shortest-path algorithms, dynamic programming algorithms, and heuristic algorithms, can be employed. While maintaining energy efficiency and driver pleasure, the algorithm must take into account a number of variables, including the availability of charging stations, battery range, and driver preferences.

1. **Implementation:** After the algorithm has been created [7], it must be included into a program that can provide users with EV routes. The software should be simple to use and offer real-time details on the availability of charging stations, their pricing, and travel instructions.
2. **Evaluation:** The last stage is to assess how well the EV route planner performed. Comparing the created routes to actual driving data and assessing parameters like energy economy, driver satisfaction, and journey time can be used to accomplish this. The review can point out areas for improvement and direct the EV route planner's future development.

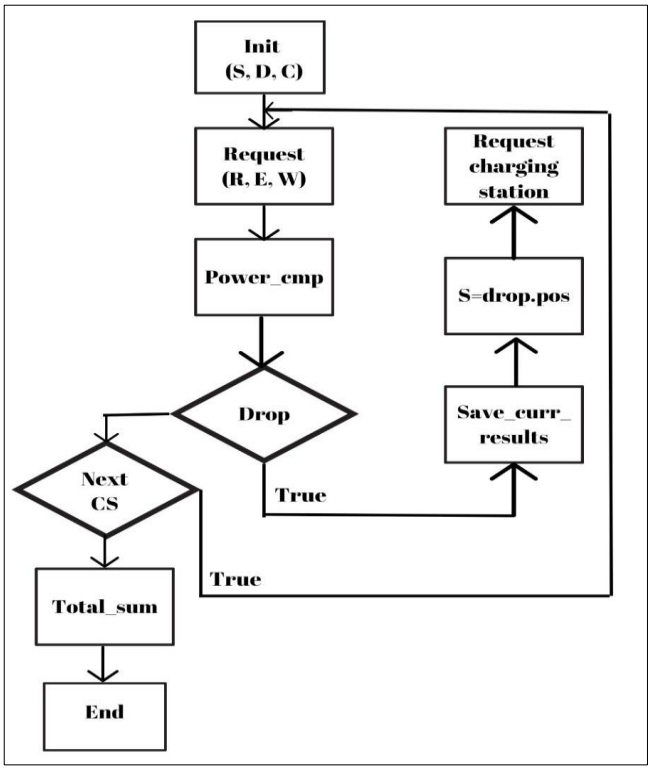


**Fig 2:** Electric Power Computation

Figure 2 shows the electric power computation of a Ev vehicle while its planning route.

In conclusion, the process for creating an EV route planner entails gathering and preparing data, creating algorithms, putting the software into use, and assessing the effectiveness. The objectives outlined for the proposed research activity will be accomplished using the approach described below:

1. For the front end, we used html, Css, and bootstrap.
2. For maps and EV routing, we have used the TomTom API.
3. We took into account factors like vehicle weight and the maximum kWh charge for EV route. It measures consumption at constant speed in kWh/100km. A automobile needs more power per 100 km on a highway than it does on a city road, as we have taken into account.

Our EV routing also takes into account real-time traffic information.

Additionally, we have employed various charger kinds, as well as their power output and plug types. Each charger on the

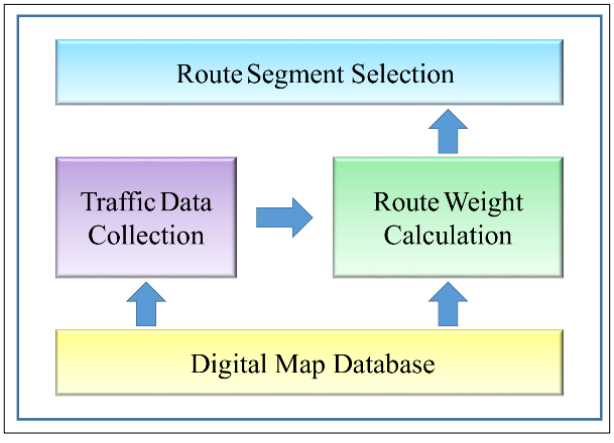


**Fig 3:** Route Planner Working

Figure 3 shows the working algorithm of the EV route Planner and calculation of the cost of the Route Planner.

**Hardware and software specifications**

**i) Software Specifications**

**The following software specifications are required for the successful completion of the proposed project**

- Visual studio code
- Browser, HTML, CSS
- Chrome Developer Tools
- Bootstrap JavaScript
- Tom-Tom API

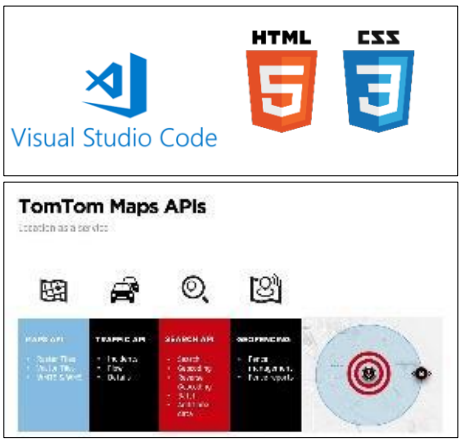


**Fig 4:** List of Software that has been used.

TomTom API (Application Programming Interface) is a set of tools and resources that developers can use to integrate TomTom's location-based services into their applications. Some common uses of TomTom API include:

1. **Geocoding and mapping:** The TomTom API gives programmers access to extremely precise and detailed maps, as well as geocoding services that let them convert addresses into geographical coordinates.
2. **Routing and navigation:** By integrating route planning and turn-by-turn navigation into their applications, developers may give users access to the most time- and cost-efficient ways to get where they're going.
3. Real-time traffic data is made available by TomTom API, which users can utilize to avoid traffic and determine the quickest routes to their destinations.
4. To identify companies, landmarks, and other items of interest close to their present location, users can utilize
5. the TomTom API to add location-based search features into their applications.
6. Fleet Management is a feature of the TomTom API.

**Hardware Specifications**

**The hardware specifications required for the proposed project includes**

- A minimum of 8GB RAM. And GPU with at least 2GB RAM.
- A minimum of 20GB hard drive space.
- Internet connection for accessing online API

**The advantages of increasing the RAM available for the TomTom API include**

1. **Faster Processing:** By storing more data in memory, the TomTom API is able to process and retrieve data more quickly.

2. **Enhanced Performance:** Adding more RAM can help the TomTom API run faster overall, making it more responsive and lowering the likelihood of crashes or other performance issues.
3. **Better Multi-Tasking:** Having more RAM available can assist reduce slowdowns and enhance the system's overall performance when several programmes are running at once
4. **Larger Storage Capacity:** TomTom API can store more data in memory with more RAM, which can enhance the speed of applications that need a lot of data.

**Gpu too is a very important part while running this application we have developed**

1. **Increased Processing performance:** The GPU is built to process data and conduct complicated computations considerably faster than the CPU, which can greatly increase the TomTom API's processing performance.
2. **Faster Rendering:** A GPU enables TomTom API to generate maps and other visual data much more quickly, resulting in a more responsive and fluid user interface.
3. **Improved Data Visualisation:** The GPU can allow TomTom API to more clearly and precisely show complex visual data, such as 3D maps and real-time traffic updates.
4. **Improved Machine Learning:** GPU can make machine learning algorithms work better, allowing TomTom API to provide more precise and individualised location-based services.
5. **Increased Energy Efficiency:** GPUs are made to be extremely energy-efficient, which can help cut down on overall power consumption and operating costs.

**Results**

The Electric Vehicle (EV) Route Planner project has been developed to help EV owners plan their journeys more efficiently, taking into account factors such as distance, battery charge level, and charging station availability. The project has been successful in achieving its objectives, as it provides users with a platform that helps them plan their trips better, and also reduces the stress and anxiety associated with EV range and charging station availability.

**Some key results and conclusions from the EV Route Planner project include**

1. The platform has been well-received by EV owners and has been successful in helping them plan their trips more efficiently.
2. The project has helped to raise awareness about the benefits of EVs and has contributed to the growth of the EV market.
3. The integration of real-time data on traffic conditions and weather would improve the accuracy of the route planner and further enhance its functionality.
4. The inclusion of more comprehensive data on charging station locations, types of chargers available, and the time required to charge a vehicle would be beneficial for users.
5. The integration of smart charging technology could optimize charging schedules[8] based on electricity prices, grid demand, and user driving habits.


**Fig 5:** Implementation of the project

**Conclusion and future scope**

The Electric Vehicle (EV) Route Planner project has great potential for future development and expansion. As the world transitions towards cleaner and more sustainable forms of transportation, EVs are becoming increasingly popular. However, one of the biggest challenges that EV owners face is the limited range of their vehicles and the availability of charging stations. The EV Route Planner project aims to address this issue by providing a platform that helps EV owners plan their journeys more efficiently, taking into account factors such as distance, battery charge level, and charging station availability.

Moving forward, the EV Route Planner project can be further enhanced by incorporating real-time data on traffic conditions and weather, which can impact driving range and charging times. Additionally, the project can be expanded to include more comprehensive data on charging station locations, types of chargers available, and the time required to charge a vehicle.

Another area of future development for the EV Route Planner project is the integration of smart charging technology. This would allow the platform to optimize charging schedules based on factors such as electricity prices, grid demand, and the user's driving habits. Such functionality would not only benefit individual EV owners, but also help to reduce the overall impact of EV charging on the electrical grid.

Overall, the EV Route Planner project has enormous potential to transform the way we travel and help accelerate the adoption of EVs. As technology continues to evolve and the demand for sustainable transportation grows, the future of the project looks bright.

**There are several distinct potentials uses for EV route planner in the future that could revolutionize the way we book and travel in EVs. Here are a few examples**

1. **Integration with autonomous vehicles:** As autonomous vehicles proliferate, it may be possible to combine the EV route planner with the navigation system of the car to optimize the route and charging strategy in light of the traffic circumstances, battery level, and driving habits in the present.
2. **Integration with smart cities:** To give real-time information on road conditions, parking availability, and charging station locations, the EV route planner might be integrated with the smart city infrastructure, such as traffic signals, road sensors, and weather predictions.
3. **Integration with the sharing economy:** Based on the number of passengers, pick-up and drop-off locations,

and the accessibility of charging stations, the EV route planner could be integrated with car- and ride-sharing services like Uber and Lyft to optimize the route and charging strategy for shared EVs.

4. **Integration with renewable energy trading:** To optimize the charging strategy based on the availability of renewable energy sources, such as solar and wind power, and the price of electricity, the EV route planner could be integrated with renewable energy trading platforms, such as blockchain-based peer-to-peer energy trading.
5. **Virtual and augmented reality integration:** The EV route planner might make use of these technologies to give EV drivers an immersive and engaging experience while displaying real-time data on the route, the availability of charging stations, and energy usage.

All things considered, these distinct future scopes for EV route planner have the potential to revolutionize how we plan and travel with EVs, making it more effective, convenient, and sustainable.

In conclusion, the EV Route Planner project has demonstrated the potential for technology to help address the challenges associated with EV range and charging station availability. As the demand for sustainable transportation grows, the project has the potential to play a key role in accelerating the adoption of EVs and helping to reduce the environmental impact of transportation.

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