विश्वजीवनामृतं ज्ञानम्

Atal Bihari Vajpayee Indian Institute of Information Technology and Management Gwalior

INTEGRATED POST GRADUATE MASTERS IN INFORMATION TECHNOLOGY

Minor Project

ELECTRIC VEHICLE ROUTING BY USING AI ALGORITHMS

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by

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Under the supervision of

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ACKNOWLEDGEMENT

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Finally, I am grateful to my Institution and colleagues whose constant encouragement served to renew my spirit, refocus my attention and energy and helped me in carrying out this work.

{Shashwat Anand}

Contents

List of Figures

1 INTRODUCTION

One of the biggest problems nowadays is traffic.In the report from the Texas AM Transportation Institute, researchers determined the average American commuter wastes 54 extra hours a year in traffic delays. [1] This data shows us how much of productive hours are wasted because of traffic.Being exposed to the daily hassles of traffic can lead to higher chronic stress.[2] So, traffic is bad for both the physical and mental health.My project is focused on this problem and our model provides a simpler solution for the problem of traffic.

In this project we will try to make a system in which vehicles can travel from one place to other with better efficiency and takes optimal time to reach their destination.
We will use A* and Dijkstra's algorithm to route vehicles from starting point to the destination point.We will try to make the vehicle to travel from starting station to the destination in optimal time while maintaining the charge level and also taking care.

2 MOTIVATION

I have had this since I was in my 9 th grade and was stuck in traffic. I used to think that , could there be a better way for transportation? so that we don't need to get stuck in a traffic jam for long hours. I also missed one of my examinations because I was half an hour late due to heavy traffic. Many Peoples lose their life because of being stuck ed in traffic. The primary motivation for the project is to make transportation hassle-free. So, people don't have to waste time being in traffic jams.

3 OBJECTIVES

- Our goal is to find the optimal time for our vehicle while ensuring that other vehicles should also have the least amount of travel time.

- We are also finding the optimal path for our vehicle to minimise the amount of time it takes to travel from starting station to destination.

- We will also take care of the Battery status of our vehicle. So, our vehicle won't stop in the middle of the travel due to battery drainage.

4 LITERATURE REVIEW

Title	Source/Journal	Findings	Drawbacks
The Influence of Traffic Congestion	I July 2000Journal of Applied Biobehavioral Research 5(2):162 - 179	Study on the mental stress of a driver in both low and high traffic congestion	It only tells us the details about the stress of driver. [2]
Electric Vehicle Routing Problem	Transportation Research Procedia, Volume 12, 2016, Pages 508-521, ISSN 2352-1465,	It tells us about the optimal route finding strategy with minimal travel time	The application is restricted only to the roads of Austin TX. [3].
Mathematical Model for the Electric Vehicle Routing Problem Considering the State of Charge of the Batteries	Sustainability 2022, 14(3), 1645	It shows about the use of more power efficient methods for electric vehicles.	It doesn't focuses much on Routing the electric vehicles. [4].

5 DETAILS OF THE PROJECT

In order to solve the problem of traffic. We will consider a city as a sample in which we will try to implement our model -

- we will have n different stations (V1,V2 .....Vn).
- the distance between two stations will be (eij) and a station would be connected to at least 1 more station.
- After that we have k different electric cars which will have their stating station and destination station.
- We will route the vehicle from their starting station to destination and taking care of their charge. We will also check that whether a station's charging is being used by other vehicle or not.

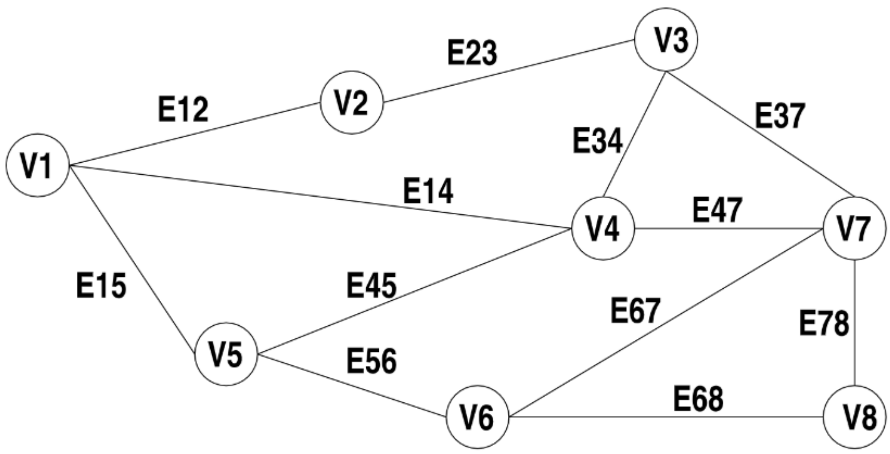

Figure 1: Station and Road between them a city.

6 METHODOLOGY

Our Goal – Is to make all the electric vehicles to reach their destination station in the least possible time. We also need to take care of the status of battery in the car and when we have to charge it.

Below are the few key variables which is used in the project –

- Sr - Source node
- Dr - Destination node
- Br - Battery charge status initially
- dr - Discharging rate of battery while traveling (distance travel per unit charge)
- Cr - Charging rate for battery at a charging station (energy per unit time)
- sr - Average traveling speed .
- Mr - Maximum battery capacity

Figure 2: Road map of a city for electric vehicle[4]

7 ALGORITHMS USED IN THE PROJECT

- Heuristic Algorithm
- Optimal Algorithm

Heuristic Algorithm

To pre calculate shortest routes (and related distances) between all pairs of nodes, a slightly modified yet optimum version of Dijkstra's Algorithm (using min-heaps) is utilized.

For each vehicle, a heuristic underestimation of time is determined as the sum of the time it takes to cross the shortest path at average speed and the time it takes to charge the vehicle just enough to traverse the distance.

Optimal Algorithm

The approach uses a state-space search that is optimized.

We will see for all the possibilities for each vehicle:

- you can charge at the current station (if it is not occupied, and if not enough charge left in vehicle to reach the destination node from the present node via the shortest route between those two nodes, as given by the heuristic algorithm, without stopping for charging anywhere in between),
- waiting to charge at present station, or,
- going on to any neighboring node, provided that the vehicle has sufficient charge to do so, that the nearby node has not previously been visited by the vehicle, and that the shortest path from that node to the vehicle's destination does not cross via the current node (where the vehicle presently is).

The algorithm verifies whether the current state is a legitimate solution, i.e., whether all cars have arrived, after executing passes across all of them.

- If the current state is a valid solution, the algorithm compares the timestamp of the current state with the current solution (a global variable), and if the former is found to be lower, it is set as the new timestamp, and the current state is deep copied to the solution state (also a global variable), after which the algorithm returns and continues the search.
- The algorithm increases the state timestamp and resumes the search if the current state is not a valid solution.

8 RESULTS

Some constraints related to input format –

- All values in a single line should be separated by a space.
- The number of stations (n), the number of connected highways (any one direction), and the number of electric vehicles should all be listed on the first line (k).
- The time period utilised to discrete time should be on the second line. Lesser values produce more precise findings, but they are also more prone to mistakes.
- Then, in order, write n lines detailing the routes, each with the source, destination, and distance between them.
- Finally, insert k pairs of lines describing the vehicles, with the first line having the source and destination, in order, and the second line containing the initial battery charge, charging rate, discharging rate, maximum battery capacity, and average vehicle speed, in order.

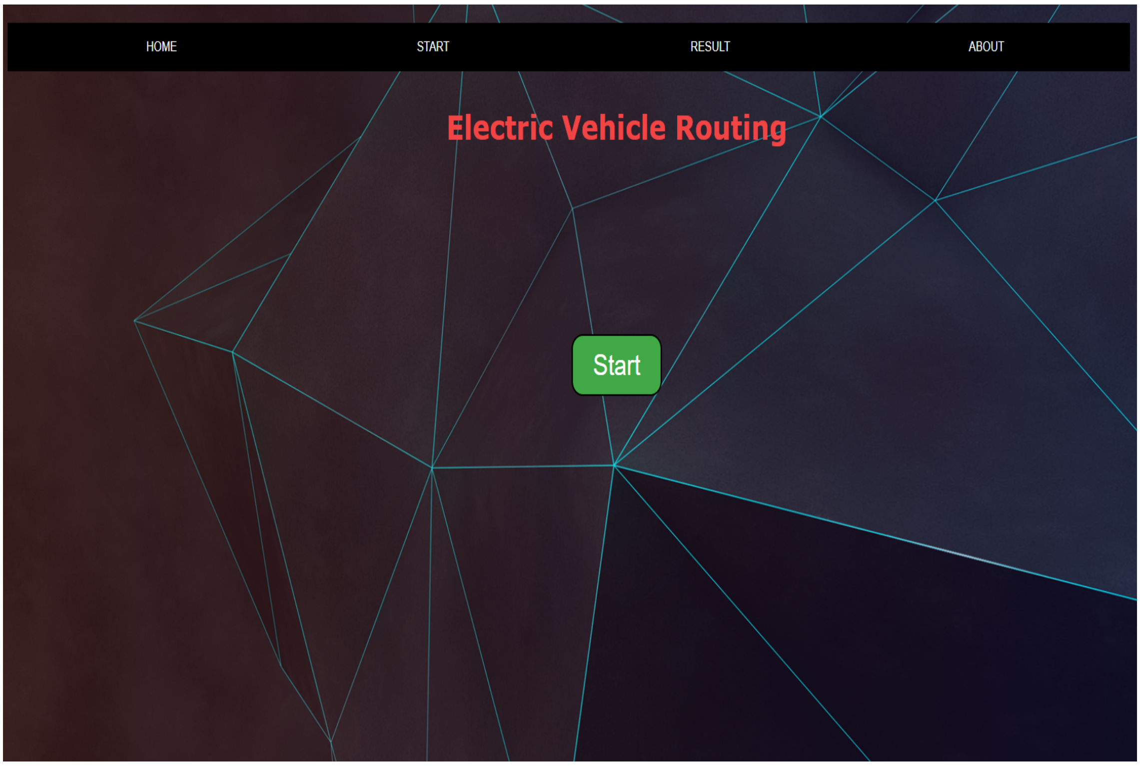

Figure 3: Home Page

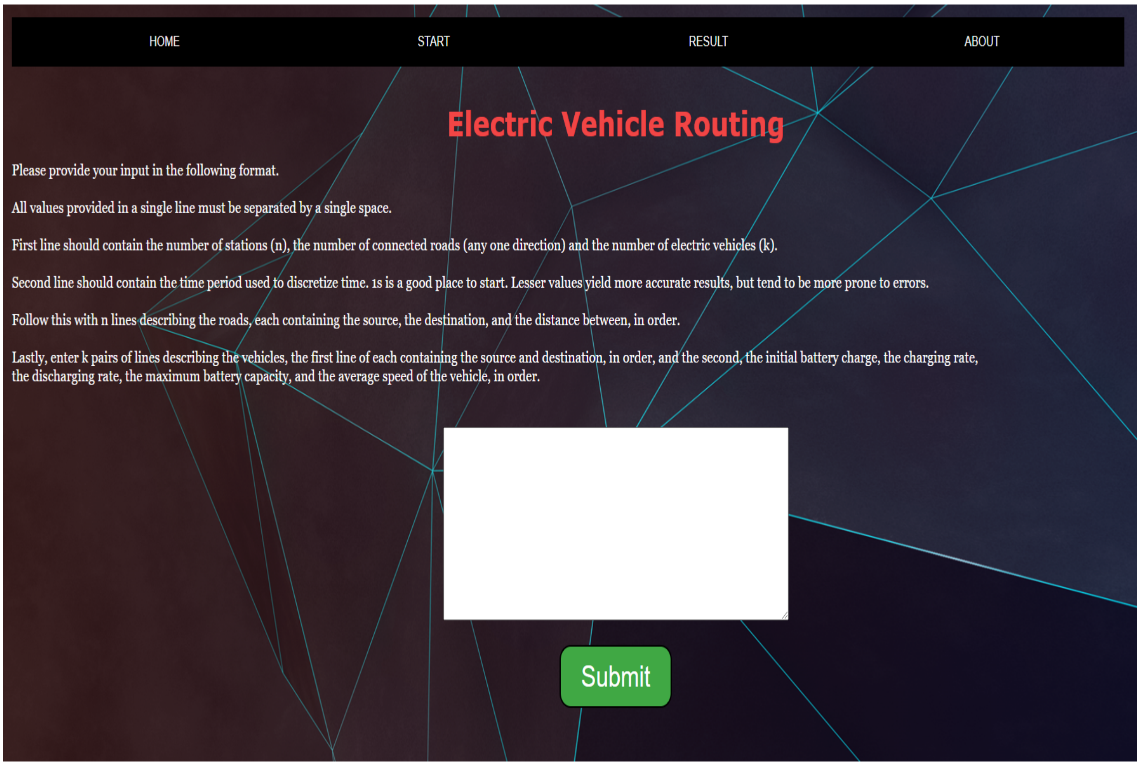

Figure 4: Input Given to the system

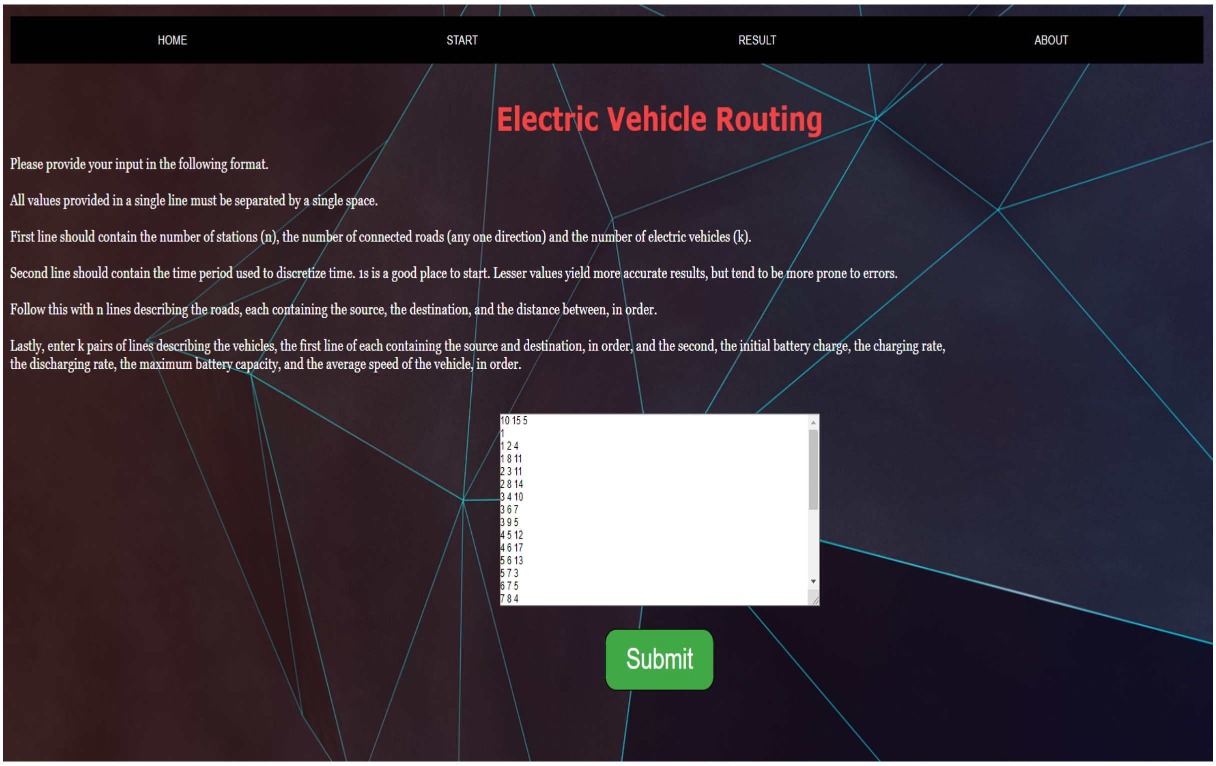

Figure 5: Results Page

9 CONCLUSION

We can see that the model accurately gives us the optimal path and time for all the vehicles. We can apply this model on a big cities with thousands and thousands of vehicle.

One of the key factor is that we can even add non electric vehicles in model by putting their fuel efficiency and instead of charging station we can check for fuel pump.

10 FUTURE SCOPE

Some Further Advancements possible in the project are –

- We can integrate this model with IoT. We can use sensors and actuators to make our data reading more accurate and optimal. We can add other possible scenarios which can hamper our vehicle's route, like any interruption in the path. It will allow us to better communicate with other cars on the road.
- We can improve the model by using Machine Learning and Computer Vision and making the system learn from the data, and making predictive decisions on which path to choose for and how much speed to maintain for the optimal time.

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