LOCATING ELECTRIC VEHICLE CHARGING STATION DEPENDS ON VEHICLE COUNT/DENSITY

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Abstract

The electrical vehicles development has produced significant effect in the utilization of sustainable energy resources. However, the unreasonable/ unplanned construction of electric vehicle charging stations produces problems like low user satisfaction, natural resources wastage, power systems instability, and so on. Reasonable placement and capacity of electric vehicle charging stations planning provide great significance to users, power grids and investors. This paper discuses 3 factors user satisfaction: charging cost, charging convenience and charging time. The model of electrical vehicle charging station location and volume is established in that paper with consideration of the load and charging requirements and to get optimized answer, the model supported artificial immune algorithm is employed. An empirical analysis was applied to the typical regional survey. This research indicates that locating the charging stations with minimized charging price and shortening the charging time/period can improve user satisfaction. The location and capacity optimization of the model can guide electric vehicle charging station resource allocation under the various limitations like optimal user requirement, etc. To improve the ability of scientific planning we need regional electric vehicle charging stations and it promotes large-scale application of electric vehicles.

Keywords: Electric vehicle, Immune algorithm, User satisfaction, charging cost and Charging time.

I. INTRODUCTION

With the prominent problem of sustainable development and utilization of fossil energy, the environmental and development problems caused by the atmospheric phenomenon are getting more and more serious. Countries round the world are actively fulfilling their energy conservation and emission reduction commitments. China joined the Paris temperature change Agreement on 3 September 2016. The Chinese government has actively taken various measures to optimize energy environment management and resources. As a kind of transportation with less energy consumption and fewer pollution, electric vehicles are supported by the Chinese government’s policy subsidies, and that they are more and more attractive to consumers.

The number of electrical vehicles within the world has increased rapidly within the past five years. China is one in every of the representatives. It is calculated that the annual average rate of electrical vehicles in China within the past five years is 126.62%, and also the number of electrical vehicles in China has increased sharply. At present, the proportion of electrical vehicles and charging piles in China is comparatively low in keeping with the international standard, the proportion of electrical vehicles and charging piles is a minimum of 1.5:1 or higher.

The amount of charging piles is much from meeting the wants of the present market. Due to the inadequate configuration of China's electric vehicle charging infrastructure and uneven distribution among regions, the issues of long charging time and high charging cost are exacerbated, which reduces the passion of users to buy electric vehicles. This phenomenon is especially evident in large cities and has gradually become a key factor constraining the event of China's electric vehicle industry. Additionally, because of the big footprint and high load of the electrical vehicle charging station, it's a specific impact on the rational use of natural resource and also the safe and stable operation of the ability grid. Therefore, so as for the municipal department to form an affordable charging station plan, it's necessary to conduct an in-depth study on the situation and capacity model of the electrical vehicle charging station to attain the aim of promoting the event of regional electric vehicles.

From the user's point of view, this paper first reviews the prevailing research results of students in related fields, and so establishes a model of location, capacity and resource optimization allocation of regional charging stations under the constraints of comprehensive user satisfaction, and validates it with an example

II. LITERATURE SURVEY

With the rise of sustainable energy sources, such as wind power, the energy production, and thus the energy price, fluctuates. Meanwhile, we are witnessing an increasing amount of electric vehicles, which soon will represent a substantial fraction of the electricity demand.[1]

With the development of the new energy vehicle industry, the problem of energy consumption has gradually attracted attention. The existing researches on energy consumption of new energy vehicles are mainly based on clustering methods. However, clustering does not construct a direct relationship between energy consumption and other factors. This paper will explore the relationship between driving behavior and energy consumption.[2]

The automotive industry is moving toward a cleaner energy source one of the major problems of the electric vehicle is the driving range covered with a fully charged battery. The main reason for this is the power consumption by different electronic components in the vehicle. The major source of power consumption is an electric motor, and apart from this, there are many other electric units in the vehicle which consumes power.[3]

Limited range and charging infrastructure leads to range anxiety of electric vehicle drivers. Current range estimation algorithms are deemed unreliable and large safety margins are re-served to prevent the risk of stranding. Range estimation in general depends on two factors: current battery energy content and the energy consumption forecast on the route to destination. This paper aims at improving the latter by enhancing the forecast with a notion of uncertainty. The prediction algorithm itself learns from driver and traffic data in a training set to generate accurate, driver-individual energy consumption forecasts.[4]

Electric Vehicles has recently been gaining increased worldwide interest since they result in far less climate pollution than their gas-powered counterparts. The main challenges in adoption of EV are insufficient charging stations, long charging time, high initial cost and limited range Making India an All EV market by 2040 also ushers in incentives for the development of EVs like the Faster Adoption& Manufacturing of Electric Vehicles Scheme in 2015to incentivize manufacturing of Eco-friendly vehicles including Hybrid Electric Vehicles.[5]

III. PROPOSED SYSTEM

We chose Trichy city for implementation. To find out the total number of vehicles in that city we approach the national highway department and we got information on how many vehicles arrived in that city on a month. And then we received data from the government RTO department for the how many vehicles were registered by the government within the same city up to now. We entered that information using the MATLAB software to find out where the high vehicle density and displayed it in the form of both graphical and numerical form. This had led to me to achieve where we have the highest number of vehicles in that city. With this, we have been able/decide to locate the Electric vehicle charging station in which part/place of that city.

IV. RESEARCH TOPOLOGY

The location and capacity model of electric vehicle charging station were established during this paper. We considered the opportunity cost, user charging time cost and self-charging demand of user , we will arrange the charging station layout in the specified coverage planning area. Due to this constraint, a user satisfaction function is introduced. Through that we must guaranteed the regional distribution network as a constraint condition. Because of that the user's willingness to consume and the load coefficient of each sub-goal were decided. Due to the synthetic immune algorithm (SIA), 3 single targets were solved to obtain the lower and upper limits of the 3 indicators.

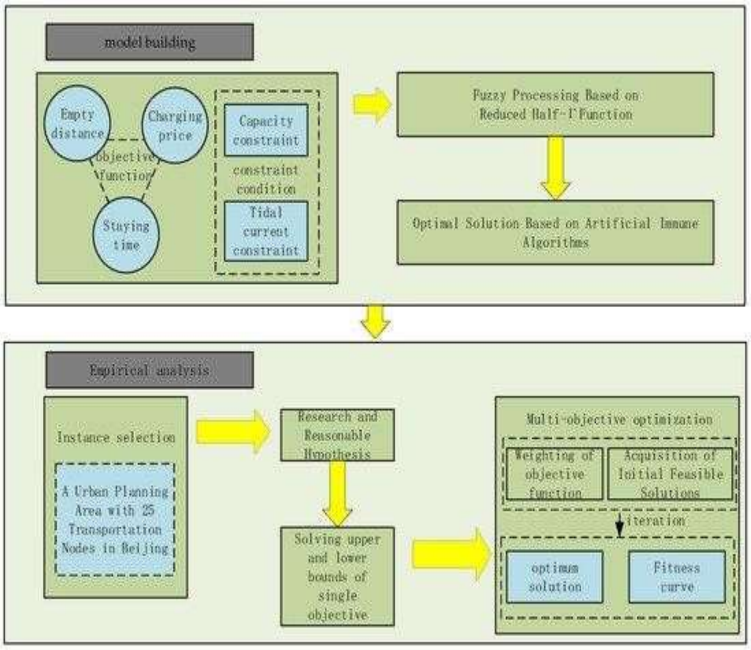

Fig 1. Shows System Parameter

V. FUZZIFICATION OF OBJECTIVE FUNCTION

In that optimization problem, the objective functions of empty driving distance, charging time and charging price are inconsistent. In this paper, the optimal solution of every sub-object is solved first. Then the every sub-object is fuzzified by the optimal solution and the upper limit is tolerable to the user. The membership function is intended and then the solution with that membership function is calculated. This solution is the optimal solution of the multi-objective optimization problem. In this paper we select the reduced half Γ distribution function.

For the above 3 suboptimal targets, the membership function is mentioned like this:

$$U(F_k) = \begin{Bmatrix} 1, Fk < Fmin \\ \frac{Fmax-Fk}{Fmax-Fmin}, Fmin < Fk < Fmax \\ 0, Fk > Fmax \end{Bmatrix}$$

Where F_k is the 3 objective functions, F_{min} is the 3 objective functions lower bound, and F_{max} is the upper limit tolerable to the user. Then that multi-objective optimization problem is transformed to a single- objective optimization problem is mentioned below:

$$\max(u),s.t.\begin{Bmatrix} u \le u(Dr) \\ \sum Prs = Pc + Po \\ u \le u(P) \\ u \le u(Ws) \\ \sum_{i=1}^{n} Si \ge Smax \end{Bmatrix}$$

5.1. Flow chart

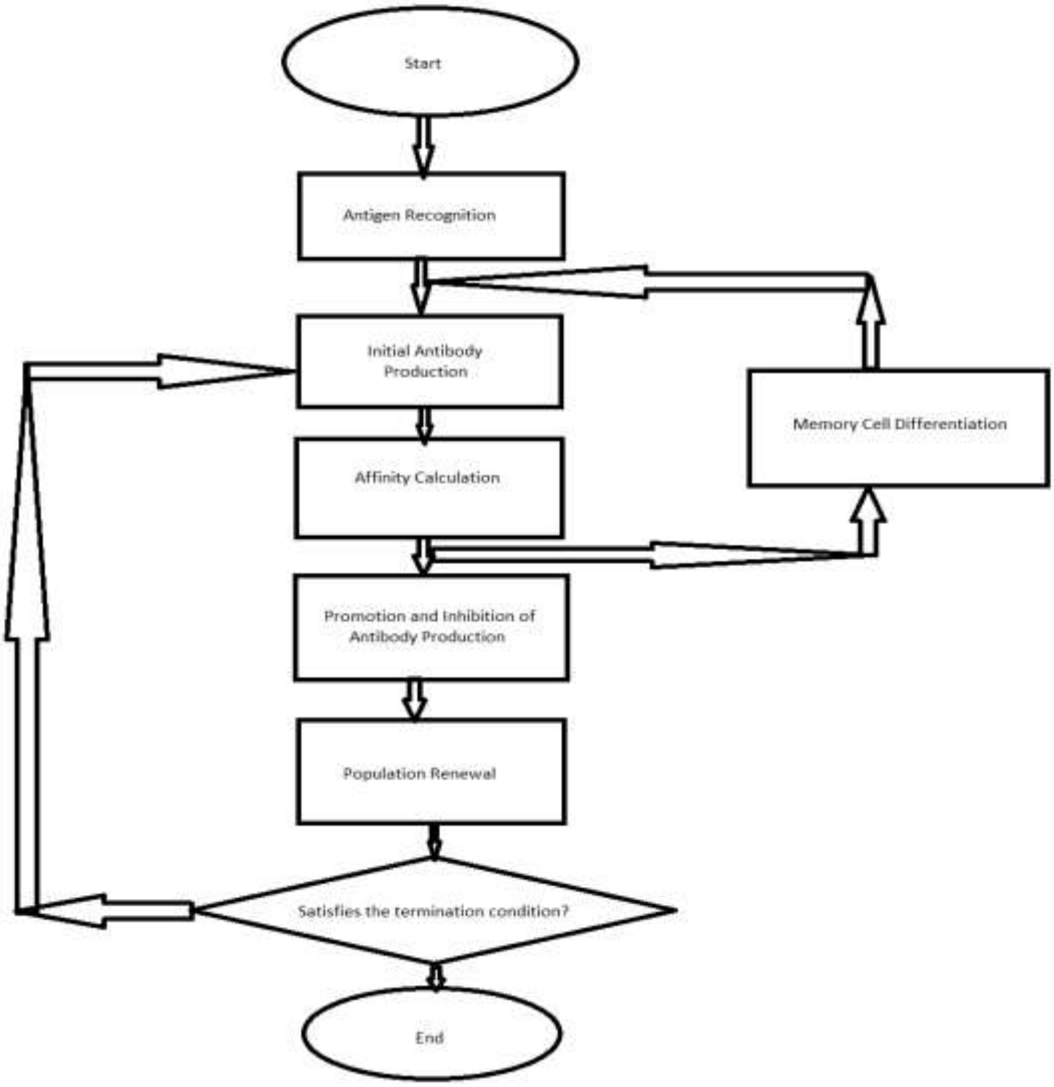

Fig 2. Flow Chart

5.2. Regional Traffic Characteristics

According to the survey conducted in the specific area of Beijing, valuable assumptions are made with the suitable proportion involving area income, and people's awareness of energy conservation and environmental protection. Within the planning area ,there are 25 traffic nodes, and the number of electrical vehicles is 2000.

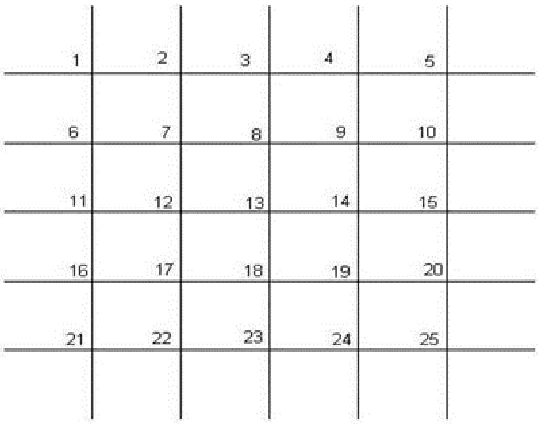

Fig 3. Planning area

The fuzzy provides relationship between every sub-objective and multi- objective optimal solutions. From the fuzzy modeling and maximizing satisfaction index support, the multi-objective programming problem is transformed to single-objective programming(nonlinear) problem. After blurring, every target is normalized to omit the incompatibility of the initial objective function. In that paper, the reduced half-Γ distribution membership function is chosen. Here u is the user satisfaction, and also the satisfaction under every single target is u(Fk). In line with the results of the questionnaire, the 3 single target weights are respectively 0.25, 0.5 and 0.25. Then it will be written as*:*

$$u=0.25u(F1) +0.5u(F2) +0.25u(F2)$$

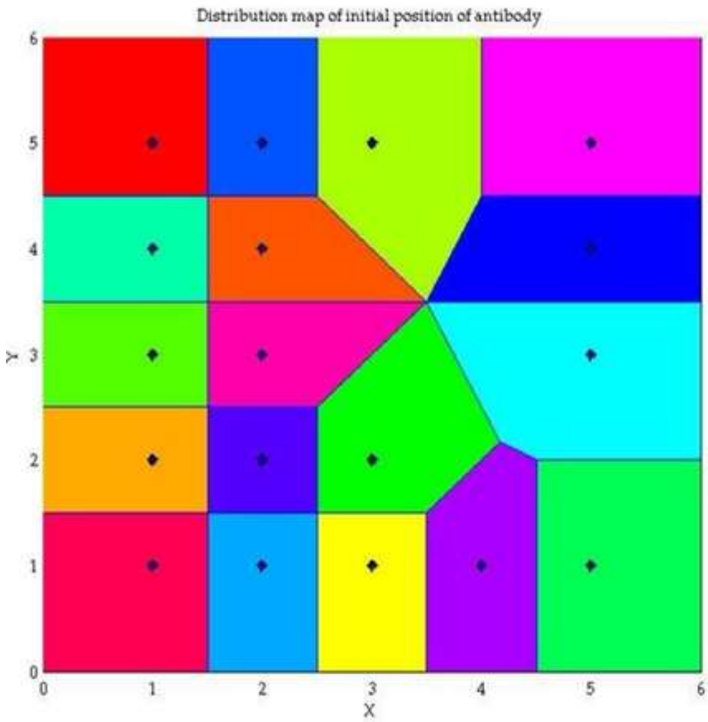

Fig 4.Distribution map

In the synthetic immune algorithm (SIA), u was used to resolve the objective function which was iterated 1000 times. In each generation, 0.25u(F1), 0.5u(F2) and 0.25u(F3) were compared, and so that the smallest values of the three was selected from the lot of various mutation operations to realize the rise of satisfaction under this goal. In Voronoi diagram, we draw the distribution of the initial position of the antibody.

VI. SOFTWARE IMPLEMENTATION

MATLAB is developed by MathWorks for multi-paradigm numerical computing environment and it is proprietary programming language. MATLAB also used for manipulations of matrix, functions and data plotting, algorithm implementations, user interfaces creation and interfacing with programs written in C, C++, Java, Fortran, C# and Python. Although MATLAB is primarily used for numerical computing. The MuPAD symbolic engine (optional toolbox) is allowing to access to the symbolic computing abilities. Simulink (additional package) in MATLAB adds the graphical multi-domain simulation and model-based design for dynamic and embedded systems.

6.1. MATLAB IMPLEMENTATION OUTLINE

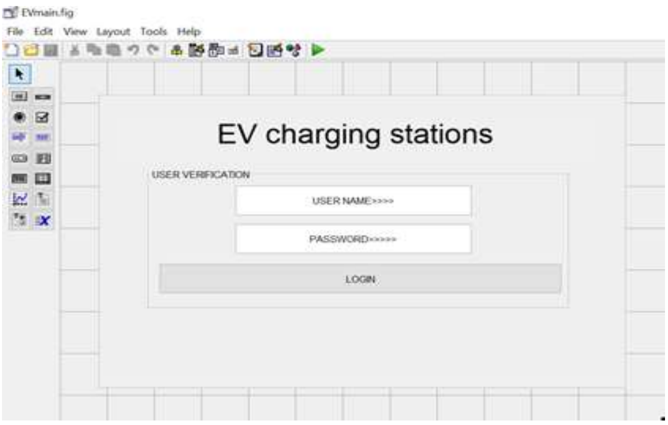

Fig 5. Front page of MATLAB Implementation

After implementing the MATLAB program, the following page opens in the editor as a result.

6.2. DATA LOADING IN THE MATLAB

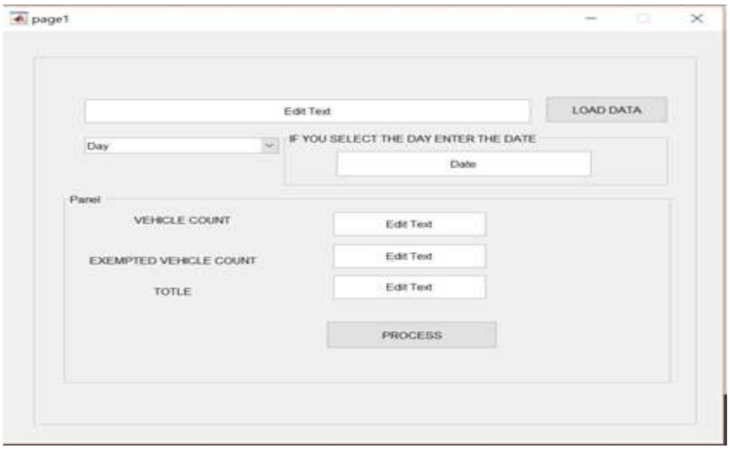

Fig 6. Data loading in MATLAB

For the insertion of the survey data the above mentioned dialog box gets open (for the chosen city).

VII. EVALUATION AND OUTPUT

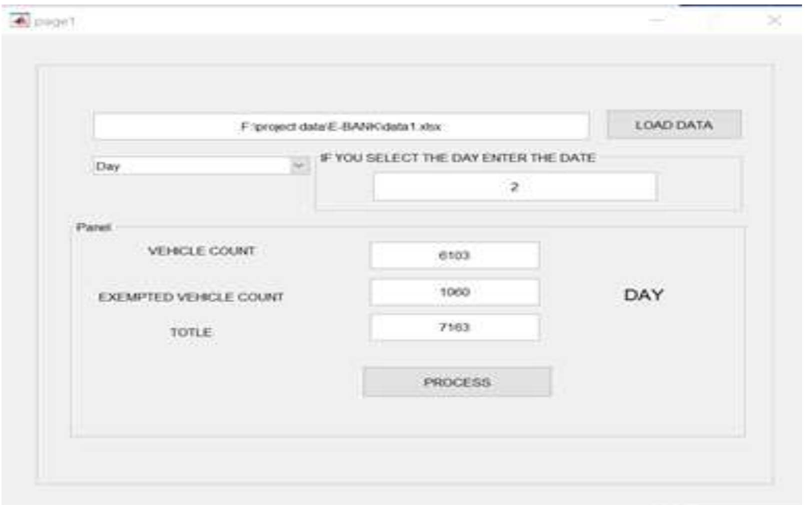

Fig 7. Numerical Output

We took the data from the National Highway Department of a particular city chosen. We loaded that information into the above-mentioned software. so that, we could be on a date. We observed that the number of vehicles and the what type of vehicles had arrived in that city.

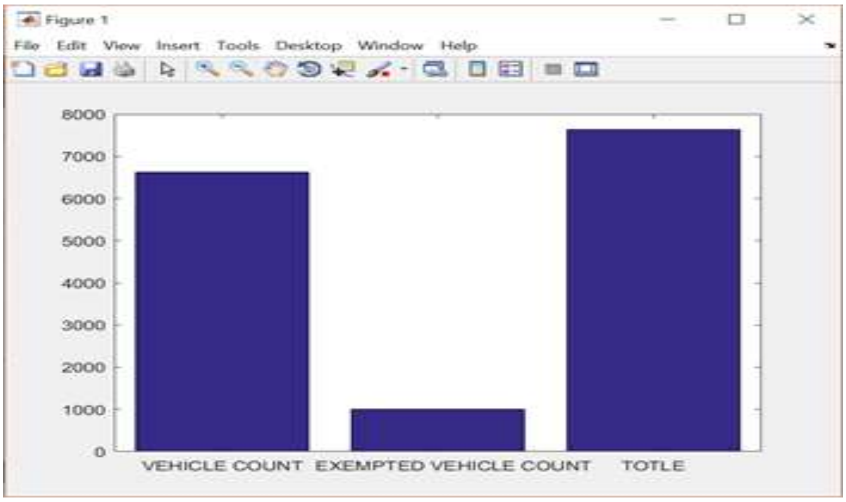

Fig 8. Graphical output

For finding out which type of vehicle and which type of vehicle have in higher density, we draw a map for the loaded vehicle data.

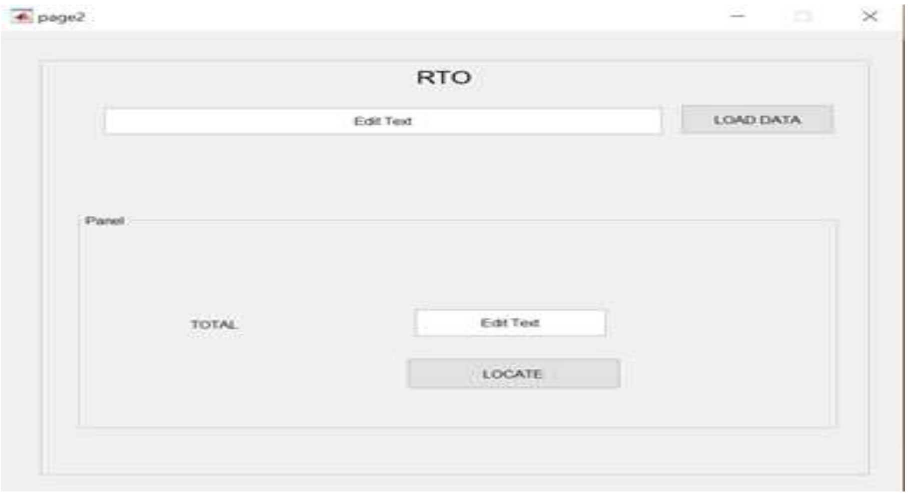

Fig 9. Importing Data

We added the RTO office data of the particular city to determine the exact vehicle density of that city we took.

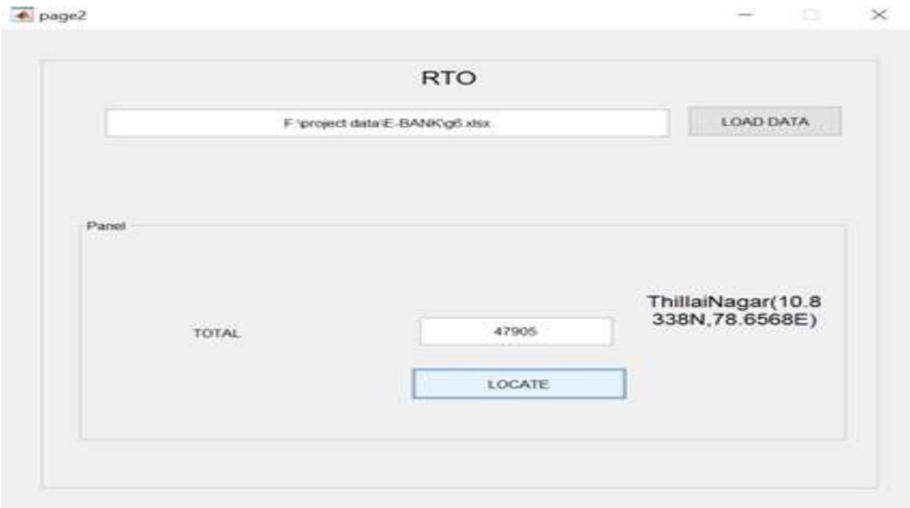

Fig 10. Locating EV

It's the area where we specified latitude and longitude for the placement of electric vehicle charging station. With the available vehicle densities, we locate the charging stations of electric vehicles.

VIII. CONCLUSION

This paper intimated that the optimal placement of Electric Vehicle Charging Station at Trichy city based on the vehicle count/ density. For getting vehicle count/ density, we approached the national highway department to get information on how many vehicles were arrived in that city on a month. And we received information from the government RTO department to get data of how many vehicles are registered by the government in the same city up to now. The NH data and RTO data is used to finer placement of charging station using MATLAB Software.

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