A GUIDE TO ECO-FRIENDLY OPTIMAL ROUTE

[1]Athira Balagopal, [2]Dr. Surekha Mariam Varghese
[1]Mtech. Student, [2]Head of the Department
Department of Computer Science and Engineering
Mar Athanasius College of Engineering, Kothamangalam, India

Abstract— Every person needs to travel from one place to another to reach at a destination. It is always a major part of the world. One of the major problems faced today with travelling is traffic congestion. It will consume most of the valuable time in the congestion. The best way to solve the traffic congestion problem is to reroute the vehicles to a lesser congested route. Also when human beings are exposed to a congested and polluted route for longer time period it causes many of the breathing and health problems to them. So the aim of this work is to find out a route with less congestion and pollution. System uses Google maps API to get real time route information. It uses ant colony optimization to obtain the best path from a set of multiple routes.

***Index Terms*— Ant colony optimization, Traffic congestion, Googlemaps API.**

I.INTRODUCTION

Travelling is always a major part of daily life. Travelling is the movement of people from one geographical location to another. This includes travelling by cars, public vehicles, bicycles or by walking. In today's world as development occurs at a faster rate, vehicles on the road are increasing day by day. But the major problem faced is that the development in road infrastructure is happening at a very low rate.

The major problem the people are facing today is difficulty in managing the traffic in roads. People have to wait for hours to reach at their destination point. The best way to reduce the traffic and manage the traffic is to reroute the vehicles. The vehicles must be rerouted to a less congested route.

Another major issue faced by the people is health issues. While travelling through a congested route, the chance of getting affected is higher. It causes many health issues like breathing difficulties, asthmas etc. The better way to reduce the chance of being affected by these problems is rerouting itself.

The aim of this work is to propose a system that does vehicle rerouting. System ensures the user to travel through least congested and polluted route. The congestion of an area could be found out using the velocity of the vehicles in a route. Air quality is measured by determining the amount of carbon dioxide, nitrogen dioxide and other pollutants present in that area.

The best route among multiple set of routes will be selected using the ant colony optimization method. Google map APIs are used in order to get the real time route information.

II.RELATED STUDIES

Many previous works were done for detecting the traffic congestion. There were many works that concentrated on the identification of congestion at a particular point by a dedicated device [1]. In such works, a dedicated device was installed which could determine the velocity of the vehicle or the number of vehicles. Devices such as inductive loops were used as such devices. But the installation and maintenance of such devices were difficult.

Other method included a camera device installed in an airplane which is at a high altitude [2]. The images taken at regular intervals and the processing of such images were done to determine the congestion rate. Involving such tasks also makes the system more tedious and expensive.

Video data was also used to collect such information. In [4] RFID and GSM technologies were used. In this technique, the vehicle congestion is detected using signals send from an active beacon. This paper also discussed about the various techniques to prevent the congestion.

In [6] the technique used was change in earth's magnetic field. The movement of vehicles was taken as a measure to determine the congestion conditions.

In [7] a real time routing of vehicles during traffic congestion was considered. The shortest path between a pair of nodes was considered. But to be exact, stochastic shortest paths were to be considered. But the integration of stochastic shortest path problem with the dynamic vehicle routing problem was difficult.

In [16] the proposed method only aims at simplifying the solution construction, that is, the second phase of ant colony optimization algorithm. It does not provide any guarantee to the solution quality.

III.PROPOSED METHODOLOGY

This system aims at finding a least congested and polluted route. The major factors considered for finding the optimal route includes congestion of a route, air quality value of the route along with the distance of the route. Multiple paths are considered for this work. The source and destination points could be located with the help of online map services like Google maps. The congestion detection is done with the help of probe vehicular data. The air quality is determined with the help of APIs. The best path out of the multiple set of paths is obtained by applying ant colony optimization technique.

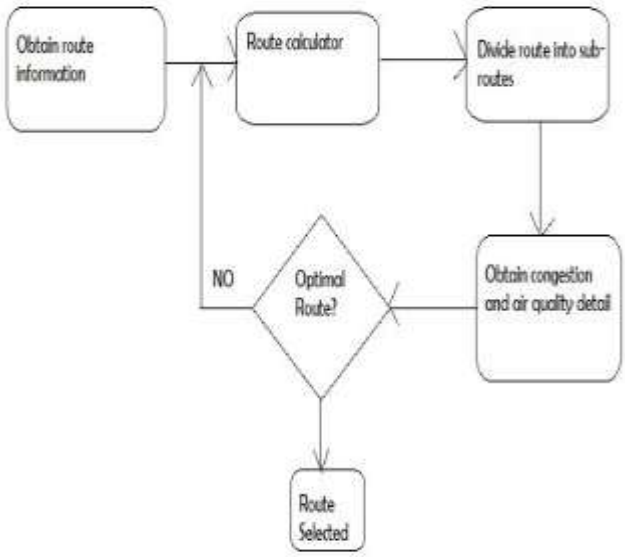

Fig.1 Proposed system architecture

3.1 Determining the route

There may be many routes between a source and a destination. The routes from a source to a destination could be determined using map services like Google map. Google map provides APIs and many other location based services to determine the route. In order to include maps to our website, the JavaScript code used for the Google maps API could be easily integrated to the HTML page. The Google map provides services like DirectionsService to provide the route information and PlacesService to provide information about a particular area. It also helps to identify the junction points in the route using services like waypoints.

3.2 Route subdivisions

To determine the congestion and pollution for the entire route and then to determine the best route from the set of routes, the congestion and pollution of each points along a route must be determined. For this the entire route from a source to a destination may be very lengthy. It would become difficult to manipulate best route from such a big data. So in order to be efficient, the entire route is subdivided into smaller segments. The intermediate points may be divided considering time or distance as a factor for division. The way points obtained from route information will be useful in segmenting the entire route. With the help of Google map APIs the latitude longitude pair values of the intermediate points could be easily identified. Traffic congestion and air quality in each segment is estimated and the decision is taken based on that.

3.3 Map Matching

Map matching is the process to match a sequence of real world coordinates into a digital map. It can be used for tracking vehicles' GPS information, important for further digital analysis.

Map matching technique is used for coordination of map data and trajectory data. The points are mapped to nearest road segment data available. After map matching process, vehicles needed to be considered for obtaining speed information could be identified.

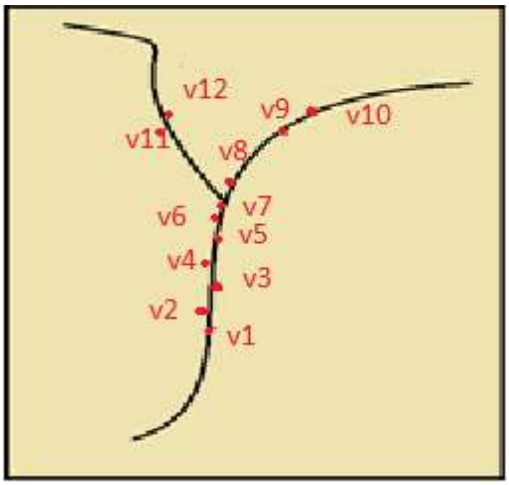

Fig.2 Map matching technique

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3.4 Congestion Detection and estimation

The number of vehicles is increasing day by day. But the road developments are happening at a lower rate. Traffic congestion is caused due to the increase in the number of vehicles. As the number of vehicles at a particular region is high, and the roads are not much developed, the individual speed of the vehicles decreases. As a result of which the time taken to travel increases. This can lead to loss in time, effort, fuel etc. Congestion is considered as a decrease in speed of the probe taxis in a particular area. The system reads the vehicle data and matches it with the segment and identifies the vehicle travelling in that route. The velocity of the vehicle can be identified by tracking the latitude-longitude pairs shared by vehicles at adjacent time intervals.

There occur some situations where there is no vehicle data available at a region. Such a condition is known as sparseness of data. In order to deal with the sparse data, multiple linear regression concepts is used. Solution is to employ geographical hash to characterize the regions of Earth's surface and study the speed of central region by means of the speed of eight neighbour regions with multiple linear regression approach.

3.5 Estimating quality of air

Air quality depends upon the amount of pollutants present at a particular area. The harmful pollutants include carbon dioxide, carbon monoxide, nitrogen dioxide, CFC etc. The amount of these pollutants varies from one particular region to another.

The system uses the help of an API called Breezometer API to determine the amount of various pollutants. It is an API used for providing the air quality detail of a particular area. Given the latitude-longitude pair of an area, the API returns information such as fair air quality, good air quality etc. Breezometer has created a new unified index for determining air quality. The value ranges from 100 (Excellent air quality) to 0 (Poor air quality) and are determined based on concentrations of predefined air pollutants depending on local standards.

3.6 Least travel time route

The travel time for optimal path will be the one with less congestion and good air quality index. Once velocity of a particular route is obtained, it is easy to determine the time from distance and velocity. Also the route with less air pollution should be selected. The time a person breathes in particular environment can be considered as a travel time for pollution less route estimation. The travel times of each of the available routes are comparable. Thus can be used to select the congestion less and pollution less route.

3.7 Optimal path

One best path must be selected from the available set of paths which will be less polluted and congested. To obtain the optimal path from available set of paths, ant colony optimization is considered. It works similar to the natural behaviour of ants. Ant colony optimization requires a graph network where each of the nodes represents the intermediate points of a route and the edges represents the sub-routes. Optimization can consider the distance as the cost matrix for the links between the cities. The main advantage is that any parameter can be included other than distance with the help of pheromone updates.

There should be a network structure for road. The ants consider several possible routes in the network from source to destination. Distance is the major decision parameter. But the average speed in the route segment and the air quality level at the route segment could be considered and affect the amount of pheromone updated. The ants select the route based on pheromone content in a link. So the average velocity and the air quality can also influence the selection of route. In this, a network is identified and using distance, congestion and air quality, and applying ACO best route is selected. The major steps in applying ant colony optimization includes:

1) Initializing ants: A number of artifcial ants are located at each source node and a specific value is assigned to each link of the problem graph. The link weight is the distance of each link in a shortest path finding problem.

2) The node transition rule is defined and used for next node selection. Probability of choosing j as the next node from i by ant k is:

Probability[nextlocation] = $pher^{alpha}/dist^{beta}$

Parameters alpha and beta indicates the relative importance that can be used to stress the importance of pheromone intensity and route cost. In this work the probability of selecting an edge between city x and y by the k^{th} ant is given by:

$$p_{xy}^{k} = \frac{(\tau_{xy}^{\alpha})(\eta_{xy}^{\beta})}{\sum_{z \in \text{allowed}_y} (\tau_{xz}^{\alpha})(\eta_{xz}^{\beta})}$$

Here, the τ parameter is considered as the distance parameter of the route. η parameter is used as the parameter for indicating congestion rate of a particular route and also the air quality value of that route.

3) Pheromone update: With the help of node transition rules, ants move from one node to another. They also keep track of the visited nodes in their memory. Once the destination is reached, ants backtracks to the original position using its memory and update pheromone in its link. The pheromones in the links not traversed are reduced to reduce the chance of selection of those links by other ants. This is pheromone
evaporation. On the other hand, the pheromone value of the links traversed by ants should be increased to increase the probability of their selection by other ants and is called pheromone reinforcement in the ACO algorithm.

Pheromone content = (1 - Pheromone evaporation coefficient) * Pheromone content

4) Stopping procedure: The ACO algorithm is completed by reaching a predefined number of iterations whereas, an ant is dropped by arriving at a pre-defined maximum number of hops before reaching its destination.

The best path would be the one with less congestion and air pollution value. ACO is used to select an optimal path aong the multiple set of paths.

IV.CONCLUSION

Travelling is part of our daily life. To meet the time requirements of travel, congestion must be avoided. The best method to solve it is by rerouting the vehicles to a less congested route. Also due to heavy pollution during the travel, it can cause major health issues to human beings. In order to save people from such situations, rerouting is the better option. This work aimed to determine pollution less and congestion less route from a source to a destination. Since Google map API is used, it provides a real-time system. Also ant colony optimization method is used to obtain the optimal
route with less congestion and pollution.

REFERENCES

[1] Cherrett, T., Waterson, B. and McDonald, M. “Remote automatic incident detection using inductive loops”. Proceedings of the Institution of Civil Engineers: Transport, 158, (3), 149-155, 2005.

[2] Palubinskas, G., Kurz, F., and Reinartz, P., 2009. “Traffic congestion parameter estimation in time series of airborne optical remote sensing images”. In: Proc. of ISPRS Hannover Workshop 2009 – High Resolution Earth Imaging for Geospatial Information, 2-5 June, 2009.

[3] CHEN Wenjie, CHEN Lifeng, CHEN Zhanglong, TU Shiliang, “A realtime dynamic traffic control system based on wireless sensor network,” in Proc. IEEE ICPPW '05, Oslo, Norway, pp. 258 – 264, June 2005.

[4] Siuli Roy, Somprakash Bandyopadhyay, Munmun Das, Suvadip Batabyal, Sankhadeep Pal, “Real time traffic congestion detection and management using Active RFID and GSM technology”, LAP Lambert Academic Publishing (2012-10-09)

[5] Pradip Singh Maharjan, Ajay Kumar Shrestha, “Automatic Vehicle Detection and Road Traffic Congestion Mapping with Image Processing Technique”, International Journal of Computer Applications (0975 – 8887)

[6] Nitish R Chavan, Ravinarayana .B, Ravikumar .D, “Wireless Sensor Networks for Traffic Congestion Monitoring”, International Journal of Science and Research (IJSR) ISSN (Online), 2013

[7] Xinyu Wang and Tsna Ming Choi, A novel Hybrid Ant Colony Optimization Algorithm for Emergency Transportation Problems during Post-disaster Scenarios ,
IEEE Transactions on Systems, man and Cybernetics, April 2016.
[8] Michalis Mavrovouniotis, Felipe M. Mller, Shengxiang Yang, Ant Colony Optimization With Local Search for Dynamic Traveling Salesman Problems, IEEE Transaction
on Cybernetics, 2016.
[9] Muhammed Usman Shahid Kan, Osman Khalid, Ying Huang and Rajiv Ranjan, Macroserv: A Route Recommendation Service for Large scale evacuations, IEEE
Transaction, 2015.
[10] Gitae Kim, Yew Soon Ong, Teasu Cheong, and Pauy Siew Tan, Solving the Dynamic Vehicle Routing Problem Under Tra_c Condition , IEEE Transaction on In-
telligent Transportation Systems, 2016.
[11] J. J. Bentley, Fast algorithms for geometric traveling salesman problems, ORSA J. Comput., vol. 4, no. 4, pp. 387411, 1992.
[12] J. Branke, Memory enhanced evolutionary algorithms for changing optimization problems, in Proc. IEEE Congr. Evol. Comput., vol. 3. Washington, DC, USA, 1999, pp. 18751882.
[13] W. J. Cook, In Pursuit of the Traveling Salesman: Mathematics at the Limit of Computation. Princeton, NJ, USA: Princeton Univ. Press, 2011.
[14] W. Dazhi and L. Shixin, An agent-based evolutionary search for dynamic travelling salesman problem, in Proc. WASE Int. Conf. Inf. Eng. (ICIE), vol. 1. 2010, pp. 111114.
[15] A. M Riad, M. E. A. El-Mikkaway, B. T. Shabana (2012) Real Time Route Recommendation for Dynamic Road Congestions, IJCSI International Journal for Com-
puter Science Issues, Vol. 9, Issue 3, no 2.
[16] Xinyu Wang and Tsna Ming Choi, Novel Ant Colony Optimization Method for Simplifying Solution Construction in Vehicle Routing Problems , IEEE Transactions on Intelligent Transportation Systems, April 2016.
[17] Sumit Kumar, Gautam Srivastava, Md. Shameem, Amber Khan, Vehicle Positioning System using GPS, GSM and GIS.
[18] Saurav Ranjit, Masahiko Nagai, Itti Rittaporn, Thanomsak Ajjanapanya, Fredrik Hilding, Apichon Witayangkurn, Ryosuke Shibasaki (2014) GPS enabled taxi probe's big data processing for tra_c evaluation of Bangkok using Apache Hadoop Distributed Syetm.
[19] Joydip Dhar, Gaurav Garg (2014) Real time Traffic Congestion Detection and Optimal Path Selection using Smartphones, IEEE.
[20] Hong-En Lin, Rocco Zito, M Taylor (2005) a review of travel time prediction in transport and logistics, In Proceedings of the Estaren Asia Society for transportation studies, volume 5, pages 1433-1448.