DESIGNING AN INTELLIGENT TRAFFIC MANAGEMENT SYSTEM

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ABSTRACT

In the current scenario the use of motor vehicles is growing rapidly where energy consumption and time of movement stands as a major point of concern. During moving in any city, the drivers usually know the path from the source to the destination. However, the driver can't get aware the current status of the scheduled path. The accidents or the unfortunate incident that has occurred just before some times are acknowledged to the vehicles which are about to cross that path. Hence, it creates an avoidable congestion of traffic and kills the time of the passengers and consumes more petroleum energy as it has to wait there or has to cross with a heavy jam and slow motion. In order to minimize travelling time and consumption of less petroleum energy, a smart trafficking system is needed. Thus, our project aims at designing and simulation smart traffic management system. The deliverable things of the project include:

1. Designing and modelling the smart traffic management system.
2. Simulation of the model using Java programming language.
3. Analysis of energy consumption and travelling time in different traffic loads.
4. Comparison of the model with existing traffic system.

1. INTRODUCTION

During last few years, progress in wireless communication has taken place rapidly. The wireless connection is providing network connectivity to the areas where wired network connectivity are not possible. Now a day's wireless communication has become integral part of our life. For an example, beginning from small one like Bluetooth connection to the smart traffic system and even beyond that one. It is playing a vital role in our day to day life. In the field of traffic it is playing an important role. No one wants to
wait in heavy traffic, everyone wants to be in their destination as early as possible. By the concept of smart cities, now we are thinking "how to minimize the traffic?". As wireless communication is playing vital role, so **Vehicular Ad hoc networks (VANETs)** is helping in reducing traffic and increasing road safety.

1.1 VANETs

The VANET is a technology which uses moving cars as a node in a network to create a mobile ad-hoc network. VANET are created by applying the principles of mobile ad hoc networks which shares spontaneous data with the connected cars in the network. At the beginning of developments of VANETs the primary objective was to have more efficient and safer roads. Due to the development of wireless technologies at large scale we can think of their applications in vehicles which will improve road safety as well as enhance the emergency services. VANETs may allow vehicles to have communication in between them. Some of main objectives of VANETs is to reduce Car accidents, safer road driving etc. The motive of this to provide real time traffic stats to the different drivers who are going to use the particular areas road. It will be helpful in reducing traffic, so trip time will reduce as well as pollution [1].

1.2 Intelligent Traffic Lights

In this project, Smart city framework has been developed where **intelligent traffic lights (ITLs)** are sets in crossroad of a city. The ITLs are responsible for gathering traffic density and depending upon the gathered traffic information ITLs will send traffic report to the neighbor ITLs as well as driver assistance device used in the vehicles [1].

1.3 Smart City

Smart City is urban development vision to integrate Information and Communication Technology in order to manage the assets of city. Smart city is able to functionally and structurally improve the city's sustainability and efficiency, which ensures quality of life and health. In order to realize smart city, Wireless Sensor Networks (WSNs) are required to be widely deployed in the city to monitor our living environments.

Data collection and transmissions both consumes energy at sensor Networks. Since the capacity of the batteries are less or limited, old batteries required to be replaced or need to recharge the battery periodically. Updating or frequently charging the batteries may not feasible some times. For example SNs placed in dangerous positions are not possible to update or recharge.

1.4 Energy Models

Management and monitoring of resources and infrastructures are getting more important today. There are two ways by following or using which the problem of charging batteries or replacing old batteries and installing new batteries can be overcome. They are Energy Efficient (EE) Communication Design and Energy Harvesting (EH) Technology [2].

1.5 Energy Efficiency

In EE communication depending upon the user quality of service requirement transmitting bits per Joule is maximized or the transmit power is minimized.

1.6 Energy Harvesting

In EH technology energy can be harvested from environmental energy resources such as solar, wind, tide, RF (Radio Frequency) etc. RF EH is widely regarded as solution for supplying power to low powered wireless devices because they are ubiquitous, sustainable and controllable.

Since information as well as power can be transferred by the same RF signals, simultaneous wireless information and power transfer was proposed for RF, EH which has attracted much attention in wireless communication system. Due to complex receiver architecture required in this, In 2014 new network paradigm was proposed namely wireless powered communication network [2].

2. METHOD

In order to develop the project following process has followed:

2.1 Design the Scenario

Architecture design of the project is done in this section. The architecture of smart city is designed for VANETs as shown in the figure (Refer Figure 2.1).

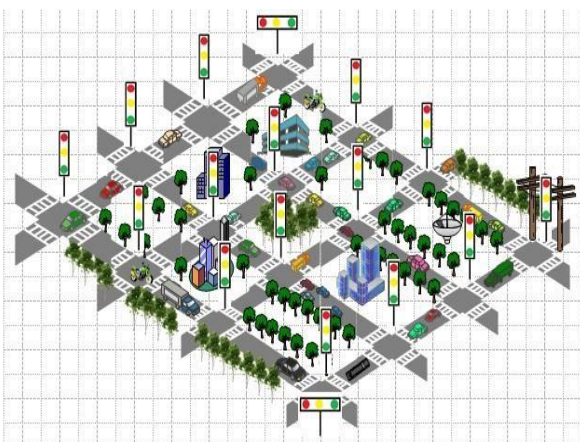

Figure 2.1 Illustration of Smart City

2.2 Deployment of traffic towers and initiations of the connectivity

As shown in the figure (Refer Figure 2.1) after designing the architecture of the smart city the traffic towers are deployed in the city. Towers are deployed in the cross junction (meeting point of two or more roads).

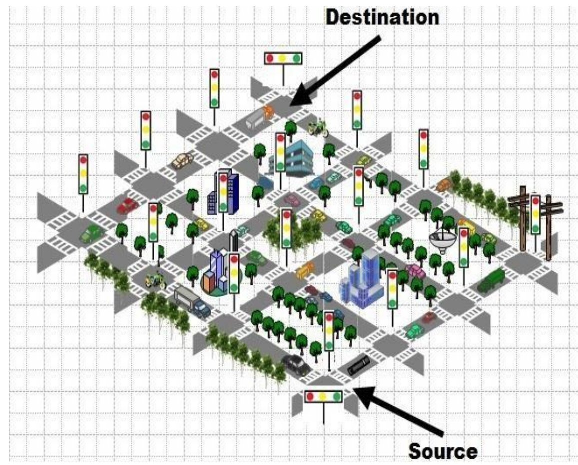

Figure 2.2 Source and destination indication of a vehicle

2.3 Path indication to the registered vehicles at initial phase

The figure (Refer Figure 2.2) indicates the source and destination of a vehicle. First of all driver need to enter the source and destination before starting the journey. Depending upon the entered data (source and destination), the driver will be updated with the optimal route to reach particular destination and he/she need to follow the optimal path indicated by the device in order to reach the destination in shorter period of time.

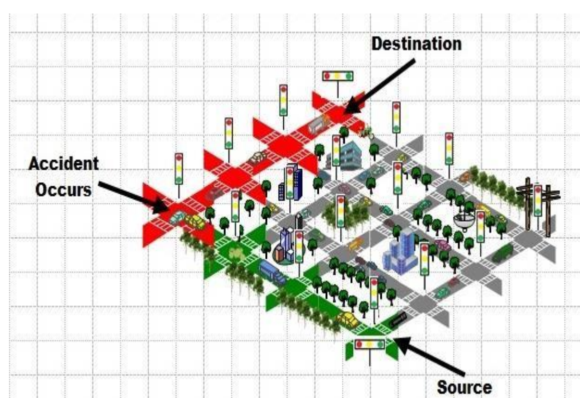

Figure 2.3 Indicating mishaps (accident) in indicated route

2.4 Updated warning message if any mishap occurs

If any mishaps occur (As indicated in Figure 2.3) in the path which is being followed by the driver in order to reach destination, he/she will get update message of mishaps. As soon as drivers get updated warning message, driver will be updated next optimal path in order to reach destination.

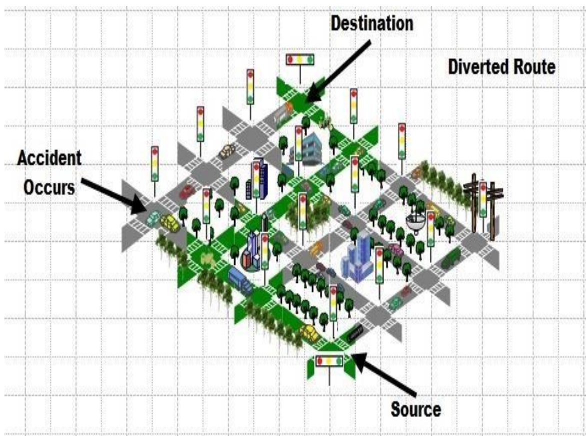

Figure 2.4 Indicated new updated path

2.5 Indication of new optimal path from current position of vehicle

The driver will be updated with the next optimal path from current location after any mishaps occurs like accident. So from that point of time driver need to follow the updated route (Refer Figure: 2.4) leaving behind the route which driver was following. The ITLs will also update the density of traffic to the driver within the range of 100m-300m from particular ITLs in the city. So that driver can avoid that heavy traffic.

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III. SHORTEST PATH ANALYSIS

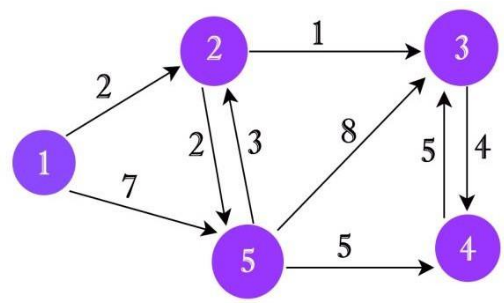

Figure 3.1 Input graph

Case I:

For the test case I, source point is node 1 and destination point is node 3. So as shown in the Figure: 3.1 there are following paths:

i) Path: 1->2->3
Distance: 3

ii) Path: 1->2->5->3
Distance: 12

iii) Path: 1->2->5->4->3
Distance: 13

iv) Path: 1->5->2->3
Distance: 11

v) Path: 1->5->3
Distance: 15

vi) Path: 1->5->4->3
Distance: 17

Hence from the above data, shortest path between node1 to node 3 is 3, so the path to follow is: 1->2->3.

Compiled input:

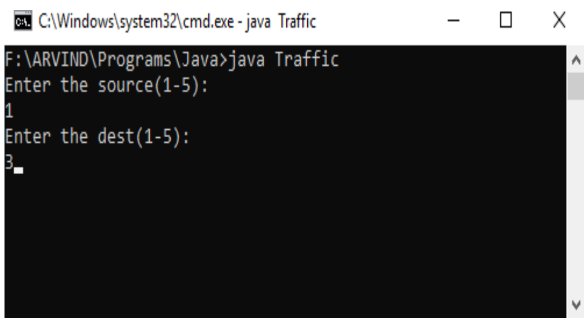

Figure 3.2 Compiled input

Compiled output (When path between 2-3 is connected):

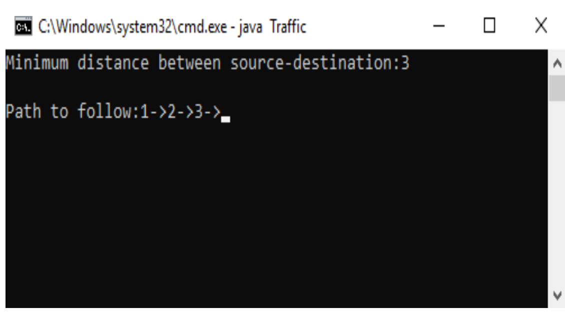

Figure 3.3 Compiled output (When path between 2-3 is connected)

Case II:

Compiled output (When path between 2-3 is disconnected):

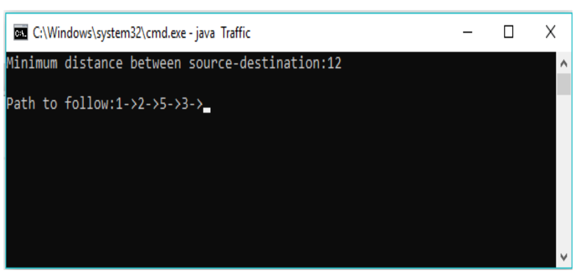

Figure 3.4 Compiled output (When path between 2-3 is disconnected)

4. COST ANALYSIS

Cost of the path opted by a driver in order to reach destination from source can be determined by considering the following factors:

1. Distance of the opted path (from source to destination).
2. Congestion of the path
3. Congestion at intermediate vertex

Cost Estimation:

Let, the total cost is denoted by C, the distance of the opted path denoted by d, congestion of the path denoted by C_p, and congestion of the intermediate vertex denoted by C_v.

$$C = d(i,j) + d(i,j) * Cp(i,j) + Cv(i) \quad \text{------------------------(4.1)}$$

Where, d(i, j) is distance between node i to j.

Cp(i, j) = Congestion at path of vertex i to j.

Cv(i) = Congestion of vertex(traffic source point)

$$C_v(j) = \frac{1}{\beta}\sum_{p=1}^{k}(Cp(i,p)) \quad \text{------------------------(4.2)}$$

Where β = Threshold

5. DATA MAINTENANCE

5.1 Data Collection

In smart traffic management system real time traffic data collection place an important role. The presence of vehicles near a particular ITLs is detected by the help of magnetic sensor placed under the roads. So in order to detect the vehicles, magnetic sensors are deployed inside the road, near to each ITLs used in the system. Each sensor node has power to capture the presence of vehicle within the defined range. Connection between the sensor and intelligent traffic light is to be established. ITLs then take the necessary response from the base station and whenever any vehicles comes within that range it detects the presence of vehicles, hence the data collection is done.

5.2 Data Propagation

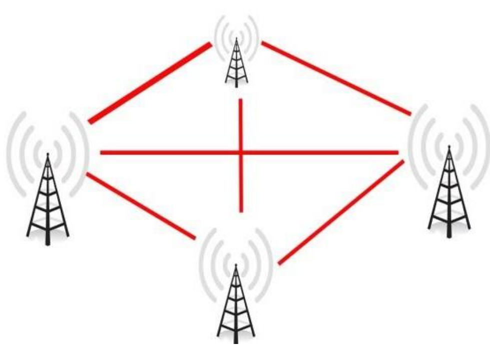

Figure 5.1 Data transmission in between nodes

Once the magnetic sensor detects the presence of vehicles, it sends update of presence of vehicle to the ITLs through which the particular magnetic sensors are associated. Each ITL sends data to base station individually and each base station control a group of ITLs and send them instructions. All the ITLs kept the information of numbers of vehicles sent by the magnetic sensors associated with them. Each base station controlling at least of 4 nodes sends acknowledgements to all the nodes, when any of the node doesn't accept acknowledgement the base station gives the instruction to stop the traffic. After collection of data from magnetic sensors the ITLs sends this information to other ITLs (Refer Figure: 5.1) and to the base station through which they are connected

5.3 Data Update

Once the respective base station collects the information from ITLs, they sends the updated report to the Central Traffic Management System. All the data collected from different base stations are stored in the database and updated information is transmitted to all the ITLs.

Data Update is done by-

- Sensor Nodes
- By authorized individual, data is updated manually.

5.3.1 Data update by sensor node

Source node Id	Destination node Id	Current time	Number of incoming vehicles

Figure 5.2 Node-node data transmission packet format

Data update is done automatically among all the sensor nodes. Each sensor nodes sends the data to other sensor nodes in the form of a packet (Refer figure 5.2) in some time interval. Each packet of data contains 4 information's which are

- Source node id of the particular node.
- Destination node id.
- Current time: The time at which data update information is sent to the node.

- Number of incoming vehicles from source node to destination node.

Graphical representation of congestion at node:

The congestion level at each node can be determined by finding the number of incoming vehicles to that node. For an example: If a node is connected by 05 other nodes, so the congestion level at that particular node will be total number of vehicles incoming from all other 05 nodes. The congestion at all nodes can be represented in the form of 2-D matrix (Refer Figure 5.3).

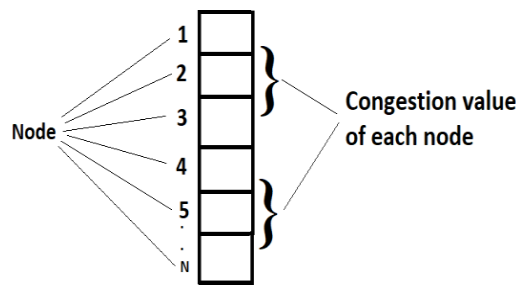

Figure 5.3 Graphical representation of congestion at node

Hence, by accessing this matrix, the congestion value of particular point/traffic due to other traffic point, can be easily find out.

5.3.2 Data update by authorized user:

Data is updated by authorized user. Here the authorized user refers to traffic police. The respective person will have valid user-Id and password. The person need to login into the database system. Once the login is successfully done, the traffic police will be allowed to update the traffic route status using their mobile phones. They can activate/deactivate the status of their traffic point depending upon the current scenario.

Case 1: Deactivate the activated path

If any mishaps occurs in between two traffic points, the traffic police need to update the status of the path, whether vehicle can pass through that route or not. If not, then policeman need to deactivate the particular route so that driver can opt for the next optimal path in order to reach destination node or point, which will help to reduce traffic congestions and other related aspects like fuel consumption, pollution etc.

Case 2: Activate the deactivated path

When the deactivated path is available for use, in such situations the traffic police need to change the status of the particular path so that depending upon requirement the driver can follow the cleared optimal path in order to reach destination.

6. SUMMARY AND FUTURE WORK

In this project we have designed "Intelligent Traffic Management using Sensor Networks" for VANETs which includes intelligent traffic light (ITLs) that communicate traffic statistics to the driver assistant device which helps driver to take appropriate path in order to reach destination. The driver assistant device helps drivers to avoid congested path, which results in time management, reduction of pollution in the city, fuel energy consumption, reduction of road accidents etc.

In future, under this project in future data analysis can be done like

1. Analysis of traffic consumption hour wise.
2. Analysis of traffic consumption day wise.
3. Analysis of traffic consumption season wise.

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