A Traffic Advisory System for Islamabad

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Abstract:

Traffic congestion is an increasing problem in urban environments. As cities develop, more traffic is featuring on the roads. However, adequate and timely measures are required in terms of infrastructure development to facilitate smooth flow of traffic. In this research we have designed and implemented a traffic advisory system for Islamabad, Pakistan. This system advises the commuter of the shortest route to destination, alternative route in case of congestion or when an incident has occurred. In addition it can provide information about major landmarks on the route, so that commuter can be advised of necessary information of the city if required. This system can also advise the civil authorities of particular traffic bottle necks in order for necessary road or traffic rectifications to be made.

1.0 Introduction:

Islamabad being the capital of Pakistan built in the 1960s is a planned city, where the road network has been carefully designed and implemented to cater for a growing population. Furthermore it features a regular road grid infrastructure that helps the traveler reach his desired destination in an easy manner. Essentially the city is divided into sectors, and each sector is further partitioned into four sub sectors. Each sub sector has a regular road layout, numbered in a consistent way so that navigation is simplified and easy to carry out [1].

Since traffic congestion pose an increasing problem in most parts of urban development, including Islamabad, it is bound to affect any planned city where the population is increasing and consequently the number of vehicles will be steadily on the rise. To the daily commuter congestion means valuable time lost, frustration due to missed opportunities and waste of resources. Also businesses are affected as workers do not report to work on time. As a consequence productivity is compromised and invariably cost of various products and services is increased [2].

The idea behind this research is to take advantage of the planned setup of Islamabad, and develop a traffic advisory system that helps the commuter reach his destination in shortest route or time. However if traffic is restrained due to poor road conditions, high traffic flow or simply due to bad weather and visibility, then an alternate route is required. Furthermore a system is desired that can provide step by step guidance to the commuter on how to reach his destination by providing full directions with graphical support. Table 1 below shows the main features of the proposed system:

Table 1: Proposed features of the traffic advisory system

Feature	Comments
Desktop Application	Initial application to be deployed
Shortest route Finder	With respect to distance and time
Road information	Displays information about the road selected like its name, condition, mileage, lanes, direction etc
Number of stops missed on the alternative path for public transport users	In case a diversion is needed due to road work or otherwise
Major landmarks	Shows hospitals, schools, police stations etc on the route
Location finder like road, hospitals, police station etc	Guide to the exact location e.g. hospital where name is known
Road information like PHF (Peak Hour Flow), AADT (Average Annual Daily Traffic flow)	This information is required when diversions are needed due to some event
Shows Directions of the Roads	In case of unidirectional roads

The types of users who can benefit from the proposed system are as follows:
General commuters will be able to use this system to plan a journey to any part of Islamabad where the system will provide them with road situation, weather conditions as well as the best route to follow in terms of minimizing distance or time as required. Bus drivers can use the proposed system when they are diverted from their scheduled bus route due to road diversions arising from road maintenance etc. They will be able to ascertain how many stops have been missed and inform the passengers ahead of the diversion.

The system will also be able to assist those road users who are new to Islamabad and notify them of major landmarks, e.g. hospitals, schools, police stations as well as sightseeing options as desired. Furthermore the civil authorities can take advantage of the traffic advisory system when revising road layouts, adding new lanes or simply wanting to know the traffic bottle necks in the city and devise a rectification plan accordingly.

2.0 Model of Traffic Advisory System
The system is modeled using the following players, as described in figure 1 below. It should be noted that some properties of a player (class) may contain attributes that are not intrinsic to that class.

Each class presented is modeled using the UML Static diagram [3] and the Traffic Advisory System is briefly described as follows:

Road
This class instantiates the Road object to store road information like road name etc. It contains two methods, one is to enter new road particulars and the other modifies them.

Arc
An Arc basically denotes a road section between two nodes, where a node is represented by a traffic or road junction. It creates and facilitates the entry and editing of details regarding the Arc e.g. number of lanes on the Arc, length of the Arc in kilometers, condition, Annual Average Daily Traffic (AADT) flow, Light Transport Vehicle (LTV) and Heavy Transport Vehicle (HTV) speed limits of the Arc etc.

Landmark
This class provides the interaction for creation and editing of the Landmarks on the particular route. Its data members are Landmark Identification, Landmark name and its details.

Node
Node class data members are the node identification and average delay at a particular node. The node delay represents the traffic signal or junction, where a user may be stopped. Average delay time for each node will be used to calculate the minimum travel time on the route.

Route
The Route class covers almost all the functionality of the traffic advisory system. It interacts with the user for queries and generates a response using its data and function members through map class. The user will be asked to tell the system about the origin, destination and vehicle weight i.e. HTV or LTV, which leads to computation of shortest route or travel time between given origin and destination points.
The methods of this class facilitate the user to see (1) the shortest route drawn on a map, (2) route guide which helps the user to follow the landmarks between the origin and destination, and (3) the route details like hospitals, police station, bus stops etc, and (4) damaged roads. Marking and removing of events like VIP movement, accidents, road maintenance and special events are provided.

Map
The map class is used to render the route on a digitized map of Islamabad. This is as accomplished through the interaction with the route object, and other objects like Node and Arc.

User
The user class is used to initiate a user object, which describes the current position of the user, the desired destination and other related information.

In summary the flow of information and operations in the traffic advisory system are as follows:

1. User conveys his current position, desired destination and vehicle weight to find the shortest route on the map.

2. Best route will be calculated and drawn on the map using operations performed by the route object.

3. The route operations will be performed using information provided by the Node and Arc objects.

4. The Arc object will provide details about the road and landmarks between the given origin and destination.

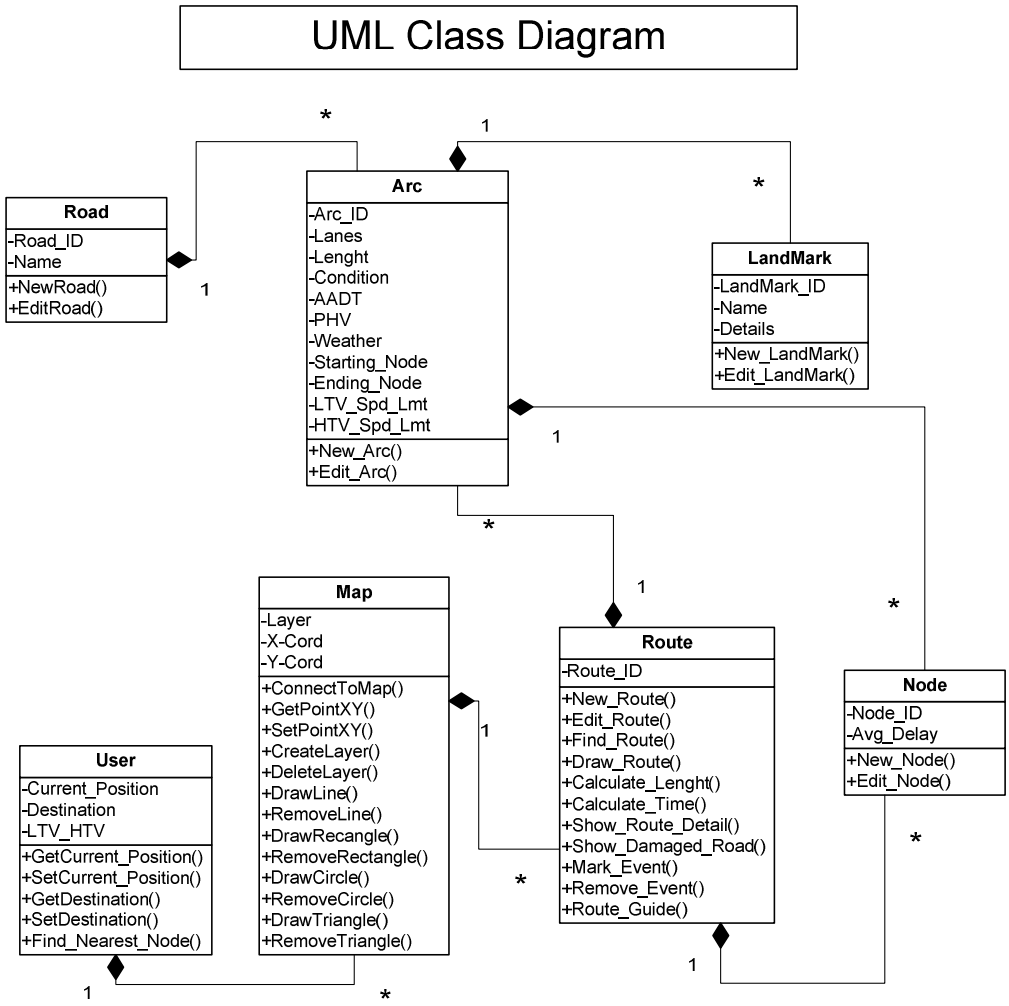

Figure 1: This figure shows the UML model for the Traffic Advisory System

3.0 Implementation

The implementation strategy was devised as follows: (1) A preprocessing stage where information was converted into a usable form. (2) The data handling stage consisted of API's facilitated by the Map Object software from ESRI [4] to communicate with the VB.NET platform [5]. (3) During system implementation all programming was accomplished using the VB.NET platform integrated with an Microsoft Access backend database. The particulars of the various stages are summarized below.

Preprocessing

Digitization is a process of converting analog data into digital format. The Map of Islamabad city was digitized, so that location of each point on the map along with its titles and characteristics were recorded. The ArcView software from ESRI was used to accomplish this task [6].

Data Handling

Digitized information obtained from Arc View was associated with VB.Net through Map Objects control to resolve the user queries. Map Objects API was used to empower VB.NET to handle the number of Graphics like Map Layers in their Map Frames simultaneously.

A properly organized data storage design was required to process user queries, which empowers the proposed system to generate optimum results.

System Implementation

Combination of Map Objects Control, MS Access database [7] and VB.NET enabled us to provide a user friendly interactive interface and to resolve the queries of the user effectively and efficiently.

Finding a route either alternative or shortest (distance, time) required an efficient as well as effective algorithm to achieve the ultimate goal of the proposed system. Dijkstra algorithm [8] was found comparatively better in this scenario from

others competitive algorithms. Last task was to analyze and process the stored data to generate route information for the user. This would facilitate the user to choose the best route as per requirements or other prevailing circumstances.

4.0 Results and conclusion

The Traffic Advisory System was successfully developed using the toolset and processes of section 3 and the design as laid out in section 2 of this paper. In order to verify the accuracy and purposefulness of the advisory system the following tests were made:

1. A arbitrary origin (starting point) within Islamabad was chosen
2. A desired destination was selected
3. Light Transport Vehicle (LTV) was selected
4. The best route in terms of distance was required from the system

The following screenshots show the various features of the traffic advisory system. It should however be noted that a similar system can be developed for any planned city where there exist some regular road pattern.

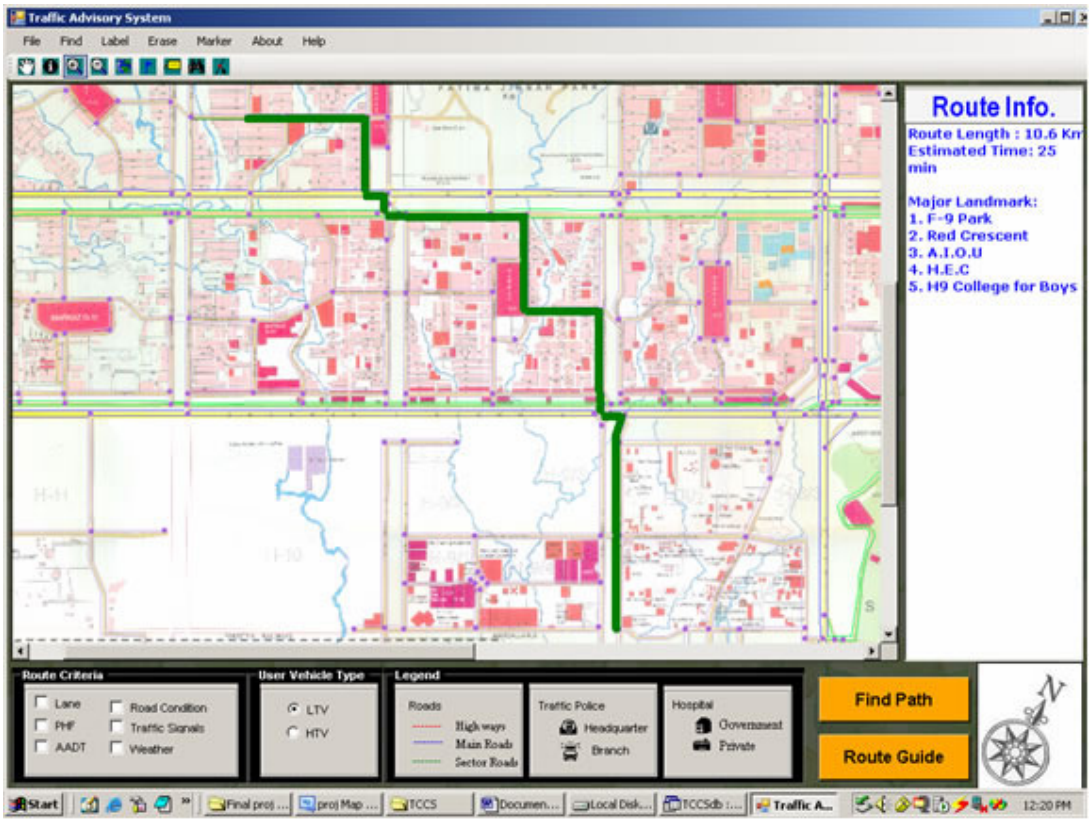

Figure 2: This figure depicts the route as computed by the advisory system

The chosen origin was "Salafia University" located at sector H-8/1 and desired destination was "Sumbal Road" at sector F-10/3 all in Islamabad. Figure 2 shows the route computed by the system and depicted in bold green on the map of Islamabad. Furthermore some route information is also depicted (RHS of figure) such as the major landmarks on the route. It is shown that F9-Park, Red Crescent and other institutions are on the path.

We can also click on a road of the route and some useful information about that road can be gathered: Figure 3 shows the road name, its length, number of lanes and Peak Hour Flow (PHF) as well as Average Annual Daily Traffic (AADT). The information such as PHF and AADT are particularly useful information when road alteration are made or when new routes are planned for the city.

If the user of the Traffic Advisory System is unfamiliar with the city then the system can also provide a detailed step by step guide of how to navigate to the desired destination. Figure 4 shows how the system provides guiding information to facilitate the user / commuter of the destination.

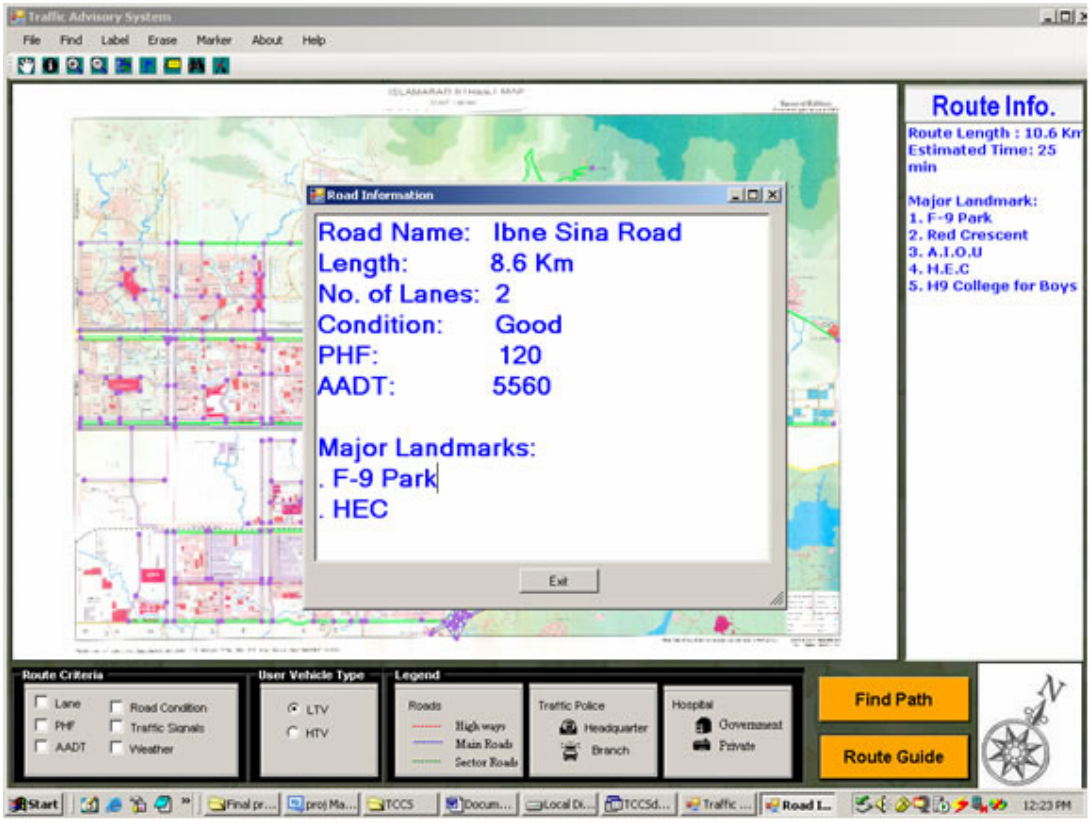

Figure 3: Useful information about a chosen road of the route

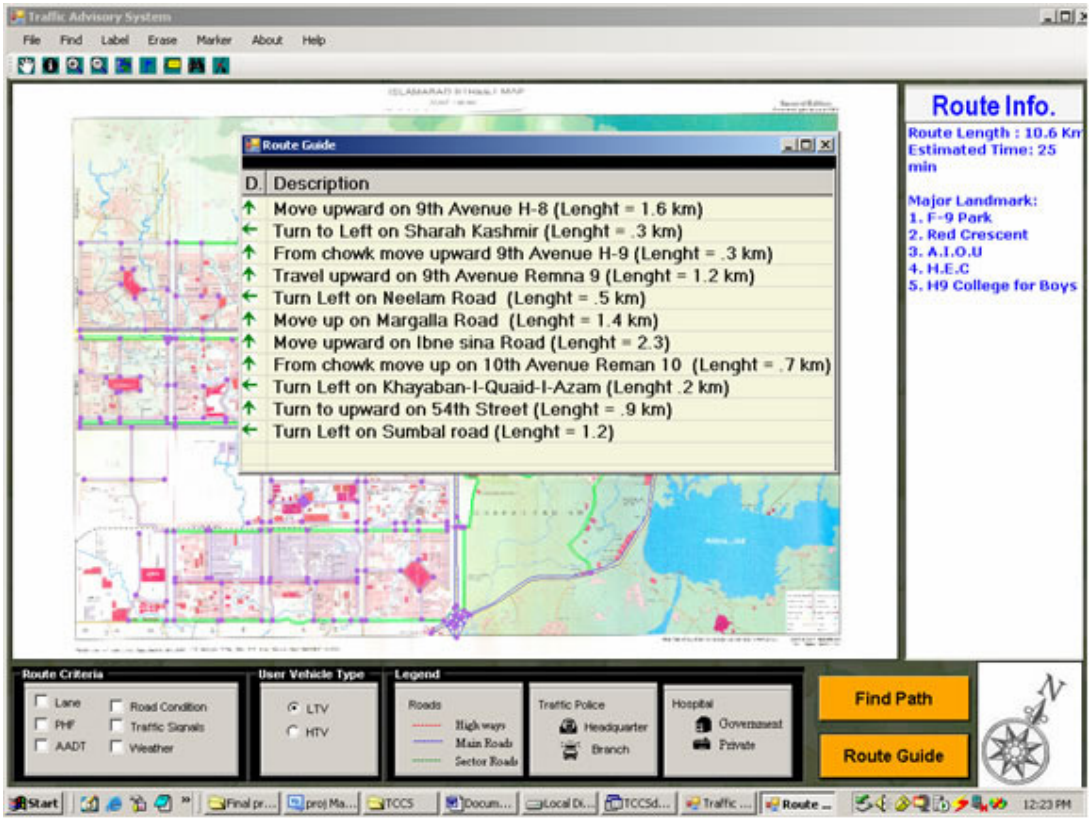

Figure 4: Detailed information of how to navigate to the desired destination.

The proposed system can provide accurate and relevant information to both the general commuter as well as transport authorities of how to navigate diligently to the desired destination, avoiding any bottlenecks and plan new routes and extensions to existing road system. It is pertinent to note that congestion is a widespread phenomenon in urban environments, and in US alone 2.9 billon gallons of fuel at a cost of $78 billion was consumed. Furthermore 220 million hours were wasted in traffic congestion. Hence this worldwide urban traffic congestion problem, which has many facets e.g. social, economic as well as health wise require solutions of numerous dimensions; involving employers, commuters, shoppers, travelers highway and road agencies. This paper is a first step in that direction where the focus is on Islamabad.

5.0 References

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