THE ROUTE OPTIMIZATION USING TRAFFIC EVENTS (ROUTE) SYSTEM

Danny Y.C. Ho **Macy Lui** **Gegi Thomas**

Department of Systems Design Engineering

Dr. Doug Dudycha **Dr. David A. Clausi** **Dr. Eric Kubica**

Department of Geography **Department of Systems Design Engineering**

Abstract: Traffic congestion is a relevant societal problem for all drivers who use urban road systems. One proposed technique of successfully reducing traffic congestion is through the effective rerouting of traffic [1]. The Route Optimization Using Traffic Events (ROUTE) System seeks to improve travel times by rerouting motorists using current Global Positioning System (GPS) data and traffic congestion data measured in real-time. A functional prototype was designed and implemented during the Fall/2001 and Winter/2002 terms, to meet the demands of urban motorists. With a distributed computing architecture, reliable connectivity layers and versatile user interface, the completed ROUTE System prototype fully addresses all objectives defined at its conception. The ROUTE System can serve as an end-to-end template of a functional Telematics solution for the Canadian motorist.

1. INTRODUCTION

The motivation for this design project arises from the absence of connectivity in current automobiles to effectively warn motorists of impending traffic situations. Road conditions have traditionally been reported to motorists via radio stations during pre-set time intervals, and recently large cities such as Toronto have employed LED-type changeable message signs [2] to inform motorists with traffic flow. Current methods of communicating this information, despite its availability, often result in warning motorists only after navigational decisions have been made or have assumed that motorists know what alternate route to take. Despite the existing, if not advanced, traffic sensing infrastructures in North American cities, motorists lack the appropriate information at the proper time to make more efficient travelling decisions. This contributes to the congestion of urban roads.

To aid with directional navigation, many available products and services currently provide motorists with driving directions from an origin point to a destination point. Although the directions are provided with respect to travel efficiency based on distance and/or time, path calculations are determined based on static traffic flow patterns that rely solely on speed limits. Hence, the optimization may not provide the best path based on actual travel time, as the calculated path will not reflect dynamically changing qualities of the road network. By utilising location-tracking technology and the emerging field of Telematics, a more robust system can be designed to better meet the needs of drivers.

2. PROBLEM STATEMENT

A system is desired with the capacity to effectively communicate traffic conditions to motorists, and to incorporating them into a user-cantered interface.

The purpose of this project is to develop a software solution implemented in vehicles, providing the drivers with efficient and accurate driving directions from current position to specified destination, optimized using physical street data and real-time coincident traffic information.

3. OBJECTIVES

The completed design consists of an end-to-end solution that consumes simulated traffic data, current geographic location, and desired destination locations to output an optimized path of travel. Listed below are objectives for implementing the ROUTE system:

(1) A simulated traffic data set will be populated in a database on the server machine. Updates to this database will be facilitated through a constructed interface, either web-based or a static application.

(2) A client prototype will employ a wireless TCP/IP connection to the server-side database, and a GPS unit to obtain client location coordinates.

(3) The route optimization process will be implemented on the server, while destination selection and route rendering will be client-based processes.

4. METHODOLOGY

Numerous design techniques were used to provide for more detailed guidelines in choosing the right solution for implementation. Initially a modular architecture approach that utilized the chunking technique was employed to decompose the overall problem. The Evolutionary Prototyping model was used for part of the client component design, while the *Rapid Prototyping* model was used for gathering of cyclic server-side development (design/ prototype/ evaluate /refine). These three methodologies aided in yielding desired results in the final prototype.

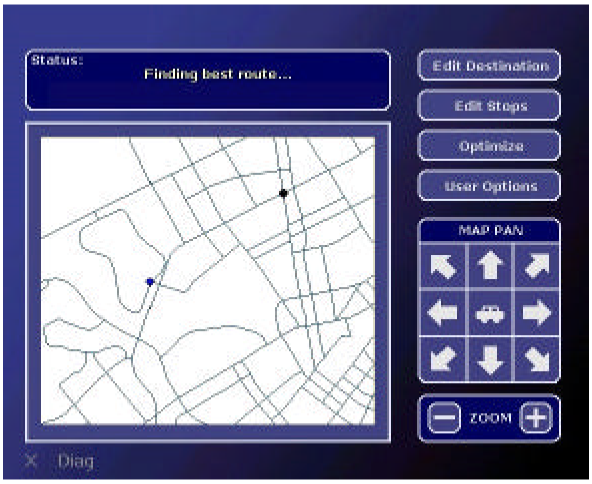

Figure 1: Client graphical-interface of final prototype

5. DESIGN ARCHITECTURE

5.1 Client-Side

The client system was developed in the Visual Basic environment, and grouped into several key components: GPS location tracking, client interface, and internet protocol for communication with the server.

The GPS device used was the E-Trex© Summit. Location coordinates were gathered from the device to the client interface as spherical coordinates. Converted UTM (Universal Transverse Mercator) coordinates were then used by the client interface to track the vehicle's movement at 1 second intervals.

On the client interface, a map display renders the city map using a single-line street network database of the Kitchener-Waterloo area. This map displays the location of the vehicle, the chosen destination point, and the optimized route. Panning and zooming features accommodated map manipulation. Command buttons allowed the user to select their destination, modify intermediate stops, re-optimize the route, and change user settings. Map rendering on the client interface was facilitated through the ESRI© MapObjects 2.1 ActiveX control.

When the driver deviates from the route or when street impedances update, the vehicle's current location, its forward node on the street network, and destination node are sent to the server for route optimization via an HTTP GET request.

5.2 Server-Side

The server-side design consists of an assemblage of sub-components in layered tiers. The back-end tier maintains an up-to-date record of impedance levels (in seconds) within a database of all the streets(arcs) and intersections (turns) in the coverage area. The middle tier, implemented using J2EE technology, facilitates route optimization and impedance update requests within an industrial-strength application server. Routes are based on a data snapshot acquired from the database (via a JDBC connection to bridge the tier boundary), and from the input parameters supplied by the client layer. The optimization algorithm performed is the Dijkstra shortest path-cost calculation, which can be calculated for the shortest path distance or the lowest real-time impedance values. The efficiently calculated path is both complete and optimal, and is returned to the client as a textual string in the response of the HTTP GET operation.

6. CONCLUSIONS AND RECOMMENDATIONS

The successful implementation of the core ROUTE System components has proven the possibility of developing a solution that would solve problems caused by traffic congestions. This robust, portable client-solution, when implemented on a large scale, can have many positive societal implications; such as reduced businesses' cost, improved emergency vehicle response time, reduced energy consumption and pollution, increased enjoyment of driving and get drivers and passengers to where they need to be more efficiently.

REFERENCES

[1] Institute for Operations Research and the Management Sciences. "New Model Would Shorten Delays Caused by Highway Incidents", *informs Online*, April 28, 1999.

[2] Ontario Ministry of Transportation. *Highway 401 COMPASS System*, March 5, 1999. http://www.mto.gov.on.ca/english/traveller/compass/hwy401/401main.htm