Cellphone as a Traffic Guidance System

Abdallah Alashqur
Mohammed Badwan
Ezzidin Rohi
Mahmoud Abo-Tahun

Faculty of Information Technology
Applied Science University
Shafa Badran, Amman, JORDAN

Abstract

The worldwide proliferation of cellphones has created numerous opportunities for new and powerful applications that contribute towards improving the quality of life. Traffic problems due to traffic congestions, especially in cities with high population density, is one of the areas that need attention. GPS-enabled cellphones can contribute towards alleviating some of these traffic problems. A GPS-enabled cellphone can be a source of useful information pertaining to traffic congestions. The velocity and location information that are transmitted by GPSs on the road can be gathered and analyzed at run-time to determine traffic status. In addition, a cellphone can receive area maps with overplayed traffic information to help drivers select optimal routes for their trips. In this paper we describe a prototype system that enables passengers who are carrying cellphones to know, *in advance*, the best route that a taxi needs to take by providing them with distance information, taxi fare estimate, and traffic congestion status. The system can be of benefit to other types of users in addition to passengers wanting to ride a taxi.

***Keywords**: Smartphone, Global Positioning System (GPS), Geographic Information System (GIS), Traffic Monitoring.*

1. Introduction

Traffic congestion is a significant problem that affects almost everyone in the world. In 2010, traffic congestions in the USA alone caused drivers to travel additional 4.8 billion hours and to purchase an extra 1.9 billion gallons of fuel for a cost of more than $100 billion [1]. This is in addition to the stress and frustration caused by these traffic congestions to drivers and passengers.

Having a powerful system and infrastructure for monitoring and predicting traffic patterns enables us to provide real-time guidance to drivers. This helps to reduce traffic congestions and enables drivers to avoid or minimize their exposure to such congestions.

Nowadays almost all sold cellphones are equipped with a Global Positioning System (GPS). The on-going information revolution and advances in computing and communication technologies along with the proliferation of GPS-enabled cellphones makes it possible to revolutionize traffic monitoring. GPS-enabled smartphones can be used, while on the road, as powerful and widespread sensors. These GPSs transmit huge amounts of data pertaining to their locations and velocities. This data can be used, in real time, to calculate, with a high degree of accuracy, traffic speed and road congestion status.

Several research papers and experiments have been reported in the literature pertaining to the use of cellphones with GPSs as traffic monitoring devices [2-5]. Some of them have used GPS technology in combination with other conventional traffic monitoring technologies such as inductive loop detectors as in the case of the Mobile Millennium project at the University of California Berkeley [6, 7].

The general framework for using GPS-enabled cellphones as traffic monitoring and guidance systems is as follows. GPS-enabled cellphones transmit location and velocity data to a data center. This data is then analyzed at run-time to produce useful traffic information such as traffic congestion points, estimated travel time, and areas of blocked traffic. This information is then fed to a Geographical Information System (GIS), where it is overplayed on the area’s map. The map with traffic information is transmitted back to cellphones. Based on such map, drivers and passengers can make enlightened choices about the best routes to take in order to reach their destinations.

In this paper we describe a prototype application, called Taxi Guide, that we have developed at the Applied Science University. The focus of the application is to serve individuals who need to take a taxi from a certain location to a certain destination by giving them distance and estimated taxi fare information on their cellphones. The application has other features and can be useful to other types of users.

The remainder of this paper is organized as follows. Section 2 of this paper gives a general overview of this application. A relatively detailed description of the application is given in Section 3. In section 4 we provide some conclusions.

2. System Overview

We have implemented the prototype system introduced in this paper using Visual Studio 2010 and Windows phone SDK 7.1 Software Development Kit. We used the C# programming language. Bing maps have been used. The application can be used on cellphones running Windows 7 Phone. The primary users of the system are passengers who want to ride a taxi from one location to another. The system helps the passenger know the best route that the taxi should take and provides him/her with an estimated distance, traffic jam information, and taxi fare for the trip. Other potential users of the system are taxi drivers themselves, drivers of ambulances who want to know the fastest possible route, and drivers of personal cars. The main features supported by the system are as follows.

- The user can select a country in which he/she will be riding a taxi. The selection of the country is an important step since the taxi rate depends on the country selected.
- The user specifies the starting location and the destination location of a trip. If the user does not specify a starting location, the default is the current location of the cellphone as identified by the GPS system.
- The user may choose to let the system select the shortest route between source and destination or may provide some additional information to the system regarding a certain route that the user has in mind. This is done by means of filling a "VIA" field. If the VIA field is filled, the system finds a route between source and destination that goes through the location specified in the VIA field.
- The system displays a map on the cellphone screen that shows the requested information.
- The route identified by the system is colored green, yellow, or red depending on the level of traffic congestion in that route. A green-colored route means that it is clear, a yellow-colored route means that the traffic congestion is medium, and a red-colored route means that the route is very slow due to high traffic congestion. The identification of the level of congestion of a road is supposed to be based on fixed sensors placed in the road and/or based on the velocity and density information of GPSs that are on the road. In this initial prototype implementation, we have used a random number generator to simulate the feedback from these sensors and GPSs until such data becomes available.
- The system calculates and displays the distance of the trip in Kilometers.
- The system displays the taxi fare in the local currency of the country in which the trip is to take place.

In section 3, we provide a brief description of the system with several screen shots to demonstrate the various capabilities of the system.

3. System description

Figure 1 shows the main application's page. The key buttons or text boxes shown on this screen are briefly described below.

TRACK ME. When the user clicks on this button, the system places a mark on the map to identify the current geographical location of the cellphone.

PLEASE SELECT A COUNTRY. When the user clicks on this button, he/she is presented with the screen shown in Figure 2 in order to select one of the countries provided in the list.

SOURCE. This is a textbox in which the user specifies the source location from which the trip should start. The default is the location returned by clicking the TRACK ME button, but the user is free to enter another location.

DESTINATION. In this textbox, the user specifies the location that represents the end point of the trip.

VIA. Here the user can provide additional information regarding the route by specifying a location that the route from Source to Destination should go through. If a VIA location is not specified, the system selects a route based on shortest distance.

TIME. When the user clicks on this button, he/she is provided with a screen from which to select the time of the trip. This is useful since in some countries like Jordan, the taxi rate depends on the time of day. Nighttime taxi rate is higher than daytime. If the user does not provide the time of the trip, the system defaults to current time. In the current prototype implementation, real taxi rates for Jordan are used. For few other countries, fake taxi rates have been used by the system for the sake of demoing the application's capabilities.

The caption strip for the four buttons shown at the bottom of the screen in Figure 1 is hidden until the user points on top of these buttons where the caption strip becomes visible as shown in Figure 3. These four buttons, from left to right, are described below.

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Figure 1: Main page

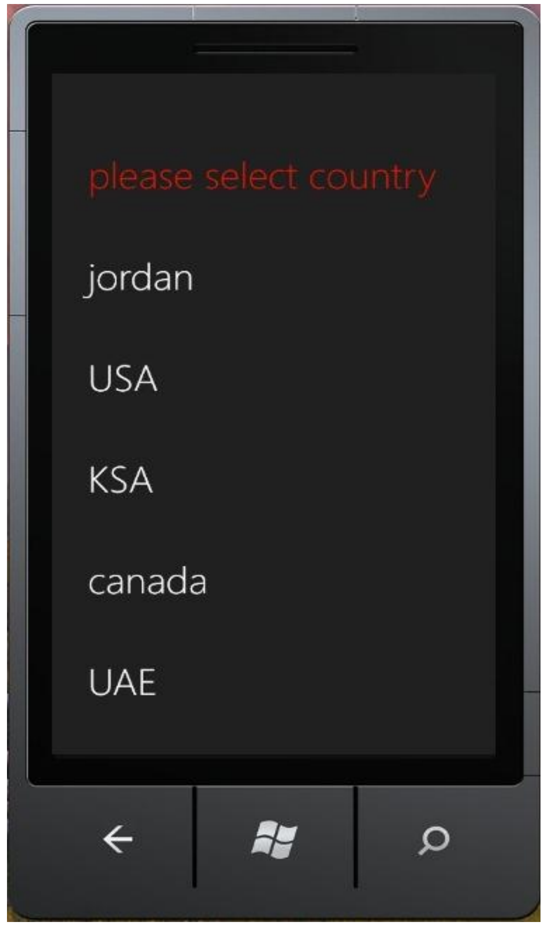

Figure 2: Country Selection

MAP VIW. This button is used to switch the map between "road mode" and "aerial mode."

CALCULATE. This is used by the user after entering all needed information to prompt the system to perform all calculations.

DIRECTION. The user clicks on this button if he/she needs step by step directions of when and where to turn right or left in order to reach the destination.

CLEAR MAP. Used to clear the map.

Figure 4 shows an example where the user has specified Amman as the source, Irbid as the destination. The user has left the VIA field unspecified. In this case, when the user clicks on the CALCULATE button, the system defaults the VIA field to the same value specified in the destination field and performs all calculations. These calculations include the distance in Kilometers, the taxi fees in the currency of the selected country, and the traffic congestion status. The results of these calculations are overlaid on the map as shown on the figure. The selected route is clearly marked and colored on the map. The color of the route reflects the level of traffic jam that is currently monitored on the road. We have used "red', "yellow, and "green" to denote high traffic congestion, medium traffic congestion, and low traffic congestion (i.e., clear road), respectively.

In the current prototype system, we were unable to obtain from the Traffic Department authorities any live information regarding traffic congestions. In addition, we were unable to obtain live GPS velocity and location information for GPSs that are on the road (from which we can compute congestion status) from major cellphone companies.

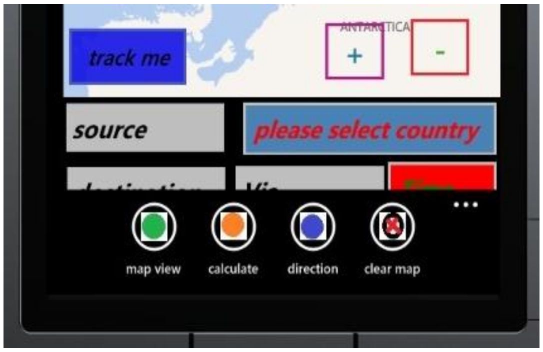

Figure 3: Button Captions

Therefore, we resorted to using a random number generator to simulate the traffic congestion percentage.

After seeing the results displayed on the screen of Figure 4, the user may choose to compare these results with another route. In this case, the user can provide a specific location in the VIA field. This instructs the system to compute the results for the shortest route that starts at the source, goes through the location specified in the VIA field and ends at the destination. In Figure 5, the user has entered “Suwaylih” in the VIA field and clicked CALCULATE. In response, the system displays the new route, but keeps the previous route that was shown in Figure 4.

As shown in Figure 5, the two routes happened to converge for most of the trip. They divert only in the area near the source location (Amman). The distance, taxi fare, and traffic jam information displayed on the screen are for the new rout that goes via Suwaylih.

4. Conclusions

In this paper we have described a prototype system that aids passengers wanting to ride a taxi to find out, before starting their trip, possible alternative routes, taxi fares for these routes, and traffic congestion situation on the road. Our objective is to demonstrate the feasibility of such application on a Windows 7 Phone platform. Due to lack of live information in Jordan, the traffic congestion

Figure 4: Selected Route

Figure 5: An Alternative Route via Suwaylih

percentage used in this prototype has been simulated using a random number generator.

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Abdallah Alashqur obtained his Masters and Ph.D. degrees from the University of Florida in 1985 and 1989 respectively. After obtaining his Ph.D. degree, Dr. Alashqur worked in the Industry for seventeen years before returning to academia. Currently he is an associate professor in the Faculty of Information Technology at the Applied Science University in Amman Jordan. His research interests include Data Mining, Artificial Intelligence, and Geographical Information Systems.

Mohammed Badwan is currently a student in the Faculty of Information Technology at the Applied Science University. His research interests include Computer Networking and Network Security. Mr. Badwan is also interested in programming using the C# programming language and other languages.

Ezzidin Rohi is currently a student in the Faculty of Information Technology at the Applied Science University. His research interests include Computer Networking and telecommunications.

Mahmoud Abu-Tahum is currently a student in the Faculty of Information Technology at the Applied Science University. His research interests include Computer Networks Systems.