An Intelligent Location-Based Service System (ILBSS) using mobile and spatial technology: A proposal for Abu Dhabi petrol stations

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Many services in Abu Dhabi such as petrol stations are witnessing increasing demand and high congestion levels which adversely affect both service quality and efficiency. To help combat such a situation, this article develops a mobile-based spatial system to solve petrol station problems and to reduce the delays in service. The nearest petrol station is selected based on a match with its current congestion status (empty, full, or partially full) that will be extracted from a real-time satellite imagery analysis and Global Positioning System (GPS) earth coordinates. Secondly, the developed system automates the payment process at petrol stations using mobile devices via three payment options: website payment by credit card, use of a mobile payment registered account, or payment from a mobile credit. A reservation algorithm is also provided by which the customer can reserve a service number at a certain designated petrol pump with an authentication code that will be scanned and verified upon arrival.

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1. Introduction

1.1. Background

Long queues can be seen waiting at petrol stations in Abu Dhabi. Overall service is slow, on account of long waiting times for service and time-consuming processes required for service delivery and payment. Location based system (LBS) management, represented by petrol stations in our case study, using modern technology such as smartphones and spatial technology could enable customers at petrol and gas stations to pay for their fuel using smartphones, reducing waiting times, improving the safety of child passengers, helping people with physical disabilities, and through providing other facilities with the potential to enhance customers’ lifestyles and facilitate petrol station services.

The proposed system will also generate statistical information for the provider regarding patterns of purchasing, and could potentially provide a valuable tool for business decision making and future strategic planning.

1.2. Research objectives

In this paper, a new proposed mobile application for petrol station finding and payment is described that has the following objectives:

a) To develop an ILBSS mobile application for petrol station search and selection, with a payment application.

b) To use Dijkstra’s algorithm as an efficient method for finding the shortest path to the nearest petrol station.

C) To propose a system architecture for the proposed solution.

d) To outline the benefits of the proposed system and future opportunities for enhancement.

1.3. Problem statement

Due to the massive daily traffic volumes witnessed on the roads in the United Arab Emirates (UAE), particularly in Abu Dhabi as the capital city, an increasing demand is apparent on local services. Fig. 1 shows the long queues that can be seen waiting at each petrol station. Overall service is slow, on account of long waiting times for service and time-consuming processes required for service delivery and payment. Mobile applications are strongly influencing our lives. Besides the desirability of saving people’s time through
streamlining transaction processes, a mobile application for fuel payment transactions at petrol stations is a potentially innovative idea for UAE society in particular and for the world as a whole. The UAE government’s decision to switch to a “smart government” approach and now is beyond the e-government era provided another motivation to devise an application that uses smartphones to provide a better service at petrol stations in the UAE.

What motivated us to conceive of such an idea is the long queue of vehicles that we frequently observe waiting at petrol stations each time we visit one, especially during the peak hours.

With ILBSS, drivers could pay for petrol by accessing ILBSS on their smartphones. From inside their vehicles after identifying the nearest petrol station according to the occupancy status and its shortest path, customers would just indicate which petrol station they wish to go to. Once the fuel nozzle is replaced, payment would be taken through the customer’s mobile credit account (other payment options are available) and an electronic receipt for the transaction would be delivered instantly via SMS or an alternative such as email or print (e.g. SMS + email + print at pump, SMS + print at pump, email + print at pump) thus allowing drivers to continue rapidly on their way.

The application would be easy to use: the user would need to download it from the Apple App Store (iOS) or one of the Android stores for free and then set up the application by registering an account with the appropriate contact information (first name, surname, email address) and password. The user would be able to select the payment method: either fuel company account, mobile credit balance, or own credit/debit card registered within the application.

2. Literature review

Motorola Solutions (2013) examined the critical role of mobile devices in service delivery and business operations. They stated that any company, organisation, or enterprise that is currently using or planning to incorporate mobile device applications into their critical business processes needs to evaluate the ability of the device to maintain operational readiness. They also emphasized the criticality of the need to identify and anticipate potential issues that might affect the device or its application performance. Alliance (2011) concluded that mobile commerce is growing dramatically and affects all parts of industry. The authors claimed that mobile payments are also as secure as or even more secure than card payments. Kumar et al. (2005) discussed an implementation of an “Advanced Traveller Information System” (ATIS). It is an intelligent application that provides a variety of information services to users. The system is a Geographic Information System (GIS)-based application that provides user-friendly, comprehensive information about the city of Hyderabad in India. Chen et al. (2009) described an ILBSS to provide local news with summaries to users through PDAs based on the user’s location. They found that using GPS to determine the user’s location is up to 90 percent accurate. Huang et al. (2011) claim that with the development of GIS technology and high-precision, fast, and accurate GPS, vehicle location identification is essential for developing intelligent transportation systems. Their results showed that the use of these technologies had improved the accuracy of spatial location of moving vehicles and enabled their locations to be visualised.

Another proposed system was developed by Mathkour using a GPS-based mobile service locator system that helped users in different locations to find addresses and to request services they wish using a mobile device. This article describes a complete end-to-end mobile GIS service solution to be used by organisations for offering services to consumers and businesses, based not only on the usual Internet channels but also by using the 3G or 4G data networks (Mathkour 2011).

Gao and Zhong (2010) presented a type of a location-based system (LBS) architecture by using Time Difference on Arrival (TDOA) positioning modules that are appended to the mobile base stations to implement the LBS. The authors confirmed that real-time testing in the mobile communication system showed that the proposed LBS could provide exact location services for mobile users by offering higher positioning precision, more convenient operation, and complete location information.

Another study by Ahas and Mark (2005) introduced a Social Positioning Method (SPM) that can be used both in organisations and individuals. In their work, they discussed the idea of data organisation and attempted to construct a highly efficient method through enhancing the multiple index mechanism of spatial data based on an object-oriented design.

Chen et al. (2005) proposed a mobile GIS based on LBS. They also proposed system architecture, method of spatial data management, spatial data compression, spatial data index, and visualization of digital maps.

3. The proposed ILBSS

The developed system will help in locating the nearest petrol station according to occupancy status showing the shortest path to the one chosen and presenting a reservation option for the designated pump. It will also provide management information to a supplier: activity statistics and peak usage times for individual petrol stations, times taken to serve customers, volumes sold of different types of fuel, and other transaction data of potential value.
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