Crowdsourced Traffic Accident Reporting for Hot Spot Analysis and Emergency Response

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ABSTRACT: Traffic accidents are a major cause of death worldwide. Rapid response by emergency medical personnel is essential to reduce fatalities. However, preventing accidents is equally important.

Although many accidents are caused by human error, infrastructure design and conditions also play a role. Thus, government agencies concerned with both public health and transportation planning want to identify locations where accidents frequently occur. This activity, often called "hot spot analysis", requires detailed spatio-temporal information about accident events. Such information can be difficult to obtain. Relevant data are often locked in paper reports or text documents rather than stored in geospatially-enabled data bases. Even when resources are available to convert data to a digital form that can be analyzed and mapped, there will be a significant time lag between accident occurrence and analysis.

In this paper, we report on a system that addresses these issues. Our EMTAlert system provides emergency medical personnel with near-real-time notification about accident events while also gathering and storing geo-tagged accident data for analysis and modeling. EMTAlert consists of a free mobile application that anyone can use to report traffic accidents, a geospatial data base to retain accident data, and a web application for querying and displaying accident data on a map. Accident reports created by EMTAlert can be immediately viewed by monitoring personnel and used to dispatch an ambulance if necessary. Meanwhile, accident details are retained to serve as the basis for reporting, time series displays, hot spot analysis, and simulation.

INTRODUCTION

Traffic accidents present a serious challenge to transportation infrastructure managers. When an accident occurs, rapid response is essential in order to save lives. Emergency personnel do not have the time to create detailed reports. However, it is highly desirable to gather as much information as possible about the event, to support future causal analysis and decisions about road safety improvement. In general, the collection, entry and aggregation of detailed accident information must be performed post hoc, via processes that are both labor intensive and error prone. In particular, it may be difficult to determine, after the fact, the exact geographic location where the accident occurred, even though this is critical to identifying so called “hot spots” where the poor road design or suboptimal driving conditions increase accident risk.

Recent developments in mobile computing offer a possible solution to this problem. Most modern mobile devices provide location sensing capabilities as well as Internet connectivity. Using these devices, it is straightforward for anyone to create and send geo-tagged data reports about a variety of phenomena.

Applications abound for such volunteered geographic information (VGI) (Goodchild, 2007). In particular, VGI (sometimes called “crowdsourced” geographic
information) has been used for reporting the need to repair transportation infrastructure (e.g., http://www.fixmystreet.com, http://en.seeclickfix.com), for modeling road traffic volumes (Ježek et al., 2015) and for reporting traffic congestion and existing accidents while driving. However, few if any projects have deployed a system that uses mobile devices to gather crowdsourced traffic accident reports for emergency response as well as hot spot identification.

This paper describes such a project. The EMTAlert system includes a free mobile app for generating accident reports, a map-based web application for locating and browsing reports, and a geospatial data base for accumulating this data in a form suitable for reporting, analysis and simulation.

PROJECT BACKGROUND

The Emergency Medical Institute of Thailand (EMIT) was established in 2008 to harmonize and manage the delivery of emergency medical services around the country. An individual in need of medical services anywhere in Thailand can dial the special phone number 1669, and a local EMT team will be dispatched to the site of the problem. The actual provision of emergency services is handled by a variety of organizations nationwide, many of them staffed by volunteers.

The Ministries of Public Health and of Transportation both require these organizations to submit paper reports to support analysis and planning. This process is quite onerous since it requires extensive manual data entry. To address this issue, in June 2014, the Sawang Benjatham Ambulance Foundation in Samut Songkram province (about 100 km southwest of Bangkok) received funding from the Thailand Research Fund for a pilot project using mobile devices for accident reporting. The project had two main objectives: 1) to improve the speed and quality of emergency response by providing the public with a fast, accurate way to report accident events; and 2) to accumulate accident data in a form that would facilitate later reporting and analysis. Our geospatial research and development center, KGEO (http://www.kgeo.org), received the contract to create this pilot system.

EMTALERT SYSTEM COMPONENTS

FIG. 1 illustrates the software architecture for the EMTAlert system. The mobile application (left) creates accident reports and sends them via the Internet to our server. Each report includes an optional photograph, plus data gathered from a simple form, including the name of the reporting person, the street or intersection, the number of people injured or killed, and the number and type of vehicles involved. The mobile app adds the location in latitude and longitude, acquired from the device GPS receiver; the IMEI, a unique identifier for the device; and a time stamp. Software on the server stores the report information in a geo-enabled relational data base.
Figure 1. EMTAlert system architecture.

A publicly available web application running on the server allows any user with a browser to query accident reports by date range and/or time range. The web application uses the GoogleMaps API to display a background map and shows the locations of all accidents that satisfy the query. The application can also locate accidents based on a spatial query, finding all reports within the specified date/time range that are within a specified radial distance of a point selected on the map.

Accidents are displayed as pin icons familiar to most Internet users. The user can click on a pin to view the details of the accident report, including the photograph.

In addition to the public web page, a private web page is available through a login for system administrators. Using this page, administrative personnel can search, view, modify, combine and delete reports. They can also request a variety of summary reports.

DETAILED RESULTS

FIG. 2 shows some screen shots from the EMTAlert mobile app. The app, which currently runs only on Android devices, is designed to be as simple as possible. The user interface is available in both English and Thai. FIG. 2(a) shows the opening screen. There are only three options: create a report, manage reports or get help.
FIG. 2(b) shows the screen that appears when the user selects the New Report option. The user can click the camera icon to photograph the accident. He or she can also fill in the data fields describing the accident, as shown in FIG. 2(c). Only the most critical data fields are required.

FIG. 2(d) shows the Manage Reports screen. If mobile Internet is not available, the app will save the report information on the mobile device. The user can then upload the report later. This screen also allows a user to modify or add to the data for a report that has not yet been uploaded, and to delete reports.

FIG. 3 shows the web application for mapping accident reports. In this screen shot, the user has requested the retrieval of all reports later than June 10, 2015. Some of the pins that indicate accident locations are visible in the lower left of the map. The user has clicked on one pin to view the report details, and scrolled the report window down to see the photograph.

FIG. 4 shows the administrator screen, used to view, edit, delete and combine reports. The “combine” operation is necessary because sometimes more than one individual may report the same accident. Thus, the information schema for EMTAlert includes both the concept of “accident” and the separate concept of “report”. One accident may be associated with multiple reports.

The current administrator functionality is quite basic. The administrator cannot filter the data by any criterion other than date. Although reports can be retrieved geographically via the map interface, the administrator console does not yet provide a way to search for reports based on their locations (for instance, within a specific region, or located near a specific intersection). This would clearly be useful for hot spot analysis.
The initial version of EMTAlert was released in June 2015. We held a training session for the Sawang Benjatham volunteers and employees in September 2015. Between those dates, 73 accident reports were uploaded. This first version was intended as a prototype. The funding agency indicated a willingness to support the next round of development, which would include migrating the database to a server under their control, additional reporting capabilities, and possibly a port of the mobile component to the Apple iOS operating system.

However, funding priorities changed. At the moment, development has been frozen. Meanwhile, the mobile application is available in the Google PlayStore at https://play.google.com/store/apps/details?id=org.kgeo.emtalertapp. Anyone can use the app. However, currently the server is configured to ignore any reports uploaded from locations outside of Thailand.

The web application can be accessed at http://call1669.cpe.kmutt.ac.th/emtalert

IMPLEMENTATION STATUS

Figure 3. EMTAlert map-based web application.

Figure 4. Administrator screen.
DISCUSSION

The EMTAlert system has the potential to provide near-real-time information about traffic accidents to emergency medical service personnel, while at the same time accumulating this information in a geospatially-enabled database where it can be accessed by researchers and policy makers. The system uses PostGIS (http://www.postgis.org), an open source package that adds a wide range of spatial analysis capabilities to the PostgreSQL relational database management system. EMTAlert currently uses PostGIS spatial functions to efficiently identify all the accident reports within a specified radius of some location, but the possible applications of PostGIS go much further. For instance, PostGIS can compute and display information about spatio-temporal clusters of reports, to provide the foundation for hot spot analysis.

One problem faced by any VGI-based application is recruiting the users who will provide the spatial information. Most if not all of the reports currently in the EMTAlert database were created by the workers at the Sawang Benjatham Foundation. The long term goal for the project, however, was to have members of the general public download and use the mobile app. Making this happen would require a significant publicity campaign, to make people aware of the app and encourage them to use it. Indeed, we might have to implement some sort of social rewards system as an incentive. Research has shown that crowdsourcing will be successful only when there is a good-sized community of users who want to participate. Hence, it is important to help users see the benefits of doing so, both to the users personally and to society.

Obviously we are disappointed that the EMTAlert project was not extended. However, we plan to apply the same basic architecture and technology to a new project, funded by the Thailand Department of Rural Roads (DRR). DRR, a division of the Ministry of Transport, is responsible for maintaining more than 48,000 km of road infrastructure outside the urban centers. DRR would like a mobile app plus map-based web site to allow residents to report road problems. Because the system will accumulate reports in a geospatial database, DRR will have the capability to do geographic and historical analysis, to assist in optimizing maintenance schedules and budgets.

We are also seeking funding from other sources, to re-activate the accident reporting functionality of EMTAlert. Individuals at various organizations including the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), have expressed interest in this effort.

CONCLUSION

In this paper, we report on a system which provides emergency medical personnel with near-real-time notification about accident events while also gathering and storing geo-tagged accident data for analysis and modeling. EMTAlert consists of a free mobile application that anyone can use to report traffic accidents, a geospatial data base to retain accident data, and a web application for querying and displaying accident data on a map. The mobile app requires the user to photograph the accident and enter basic information. The app adds GPS coordinates and device identification then uploads this information to the server, where it can be immediately viewed by monitoring personnel and used to dispatch an ambulance if necessary. Meanwhile,
accident details are permanently retained in a PostGIS data base, where they can serve as the basis for reporting, time series displays, analysis of hot spots, and simulation.

A first-generation implementation of EMTAlert has been deployed for use by emergency medical teams in Samut Songkram province, Thailand. Although simple in concept, the EMTAlert approach offers a robust mechanism for capturing critical information about accident events, while enhancing the immediate effectiveness of emergency response activities.

REFERENCES

