New England University Transportation Center

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Final Report

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Automated Congestion Prediction with Smart Phones

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Problem Description

Accurate collection of traffic data is essential for tactical efficient highway operations and strategic planning. Currently, the collection of such traffic data relies on physical sensors, which gather limited measurements of vehicle speeds and times as observed from fixed locations. These sensors cannot systematically acquire data on the mobility dynamics of individual vehicles and collective interactions among them, preventing the formulation of detailed models of vehicle flow within a transportation network. Finally, deployment and maintenance of physical sensors is expensive and time consuming.

Approach

To overcome these issues, this project demonstrated the feasibility of using location-aware smartphone technology as a simple, inexpensive alternative to facilitate the collection of dynamic vehicle behaviors. A privacy-preserving smartphone application was developed, deployed, and tested on the transportation network surrounding the University of Connecticut (UConn) in Storrs. It securely transmits data on individual trips over the public Internet to the servers hosted at UConn.

Methodology

Figure 1 shows the three major components of the smart phone system, which include: (i) the smart phone application; (ii) a database management system (DBMS); and (iii) a PHP page that serves as a channel to transfer data from the application to the DBMS.
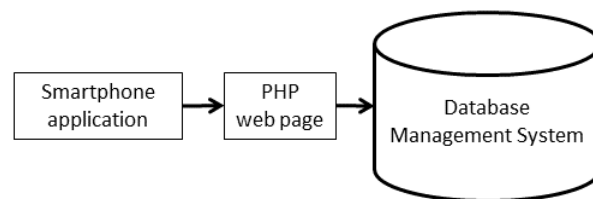

Figure 1: Organization of Major Components

Once the application is started, the traveler's location is sampled periodically and recorded. After collecting a certain number of data points, the application transmits this sequence to the database server via the PHP enabled web page, which processes the data by building a sequence of SQL queries that insert the location and time data. The database supports data queries for analysis and modeling.

Findings

Figure 2 shows an experimental set of data collected with the smart phone system during a ride on the Orange Line bus route around the University of Connecticut campus. This data consisted of geo-location data and times (with precision to the nearest second) at which the data points were collected. We analyzed the time series data of vehicle speeds throughout the trip and correlated the location of the bus stops to times when the vehicle slowed down. Most data points are shown in green. Red data points indicate delays associated with bus stops or congestion where the bus stopped for pedestrians at crosswalks. The results suggest that dynamic data collection with smart phones can be used to predict congestion. Our preliminary findings also suggest that future work should include: (1) enhancements to the application to minimize the involvement of users in data collection and (2) application of machine learning algorithms to data collected to serve as a foundation for automated congestion prediction techniques.
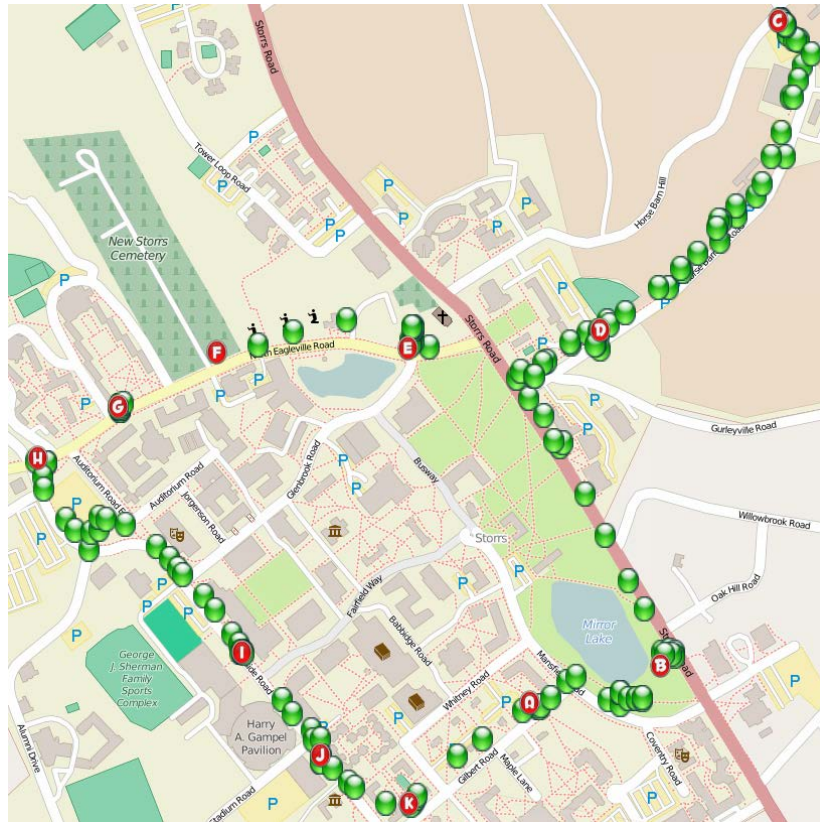
Figure 2: Data collection points along bus route

The following paper summarizing the results of the research has been published:

L. Fiondella, S. Gokhale, and N. Lownes, Crowdsourcing of Automated Congestion Prediction: An analysis of architectural alternatives, In *Proc. of International Conference on Software Engineering and Knowledge Engineering (SEKE 2015)*, Pittsburgh, PA, July 2015.

The proceedings of this conference are published online at (http://www.ksi.edu/seke/sekeproc.html) and will be accessible free of charge.

Conclusions

This project demonstrated the feasibility of the crowdsourcing of transportation data collection, which can serve as input to algorithms to automatically detect congestion within transportation networks. The demonstration was performed in the context of public transportation, namely a bus service operating around the University of Connecticut. The benefits of crowdsourcing data collection for automated transportation network congestion prediction are: (1) mobile application users bear a significant portion of the cost of collecting data, which is limited primarily to charging their cell phones and (2) smart phones can provide continuous streams of mobility data for individual vehicles, which will support the construction of time-varying models for automated congestion prediction.

Recommendations

This preliminary study suggests that crowdsourcing the collection of traffic data with smartphones is feasible, potentially cost effective and can lead to richer data sets, which in turn can support a wide range of new models for transportation planning to enhance road safety and reduce congestion.