Real Time Road Traffic Characterization Using Mobile Crowd Sourcing

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Traffic optimization is a subject that became vital for the world we live in. People need to get from a starting point to a destination point as fast and safe as possible. Traffic congestion play a very important role in the frustration of people resulting in time loss, reduced productivity and wasted resources. With our research we aim to address these issues by proposing a real time road traffic planning system based on mobile context and crowd sourcing efforts. The first step toward this goal is real-time traffic characterization using data collected from mobile sensors of the traffic participants: drivers, pedestrians, cyclists, passengers. We started developing a data collection and analysis system composed of a mobile application to collect user context data and a web application to view and analyze the data.

The architecture presented in Fig. 1 is composed of modules representing the main characteristics and functionality of the system. The data collection module can be further divided into two categories: the mobile sensors and the mobile local database. It collects environmental context information from sensors of the smart phones. It uses the accelerometer as the starting point of the system. Because of its low power consumption, the accelerometer could be always on. When it detects acceleration greater than a threshold it activates other sensors in the mobile probe depending on the momentary context. The location is gathered via Mobile Station Sensors, GPS and GSM. When the mobile device, for some reason, can't connect to the main server, then proposed system uses a database in the mobile device as a temporary cache database. Here the information about the environmental context is stored and transmitted to the server when the connection is available.

Figure 1: Overall architecture

The data transmission module uses the standard mobile connections available 3G/4G or Wi-Fi. When the connection is severed intentionally (user turns off data connection) or not (areas with bad data connection) then the environmental context data will be stored in the mobile database. When the connection is available, then the transmission of data resumes. Not all data is relevant or necessary or it is private. Initial data filtering could be done in the mobile phones to reduce the amount of data transmitted to the server. Than the server takes the data, analysis it, processes it and in this process filters it. Anonymization is a very important part of the whole process. The user's private information should not be published or transmitted in any way.

Another way of collecting the data is by using Social Media Crowd Sourcing. Social media like Facebook or Twitter are also used to collect traffic information. These techniques are not yet integrated into any ITS, because, like the radio station collection, the opinion regarding the status of the roads, congestion, incidents are subjective to the crowd. Popular route planning systems, like Google Maps, Bing Maps, Yahoo Map, generate driving directions using a static database of historical data [1]. They are built in the assumption of constancy and universality, the notion that an optimal route is independent of the weekday and the time of day [1]. In a number of countries Google Maps has a system called Google Traffic integrated into the Maps application that uses crowd sourcing as the main source of data collection [2]. Another route planning system is Waze which uses the subjective information given by the users regarding the status of the roads, congestion, incidents. Waze is using human users in the loop for large-scale sensing and computing, including human-powered sensing, human-centered computing, transient networking, and crowd data processing and intelligence extraction [3]. Most of the web maps mentioned before give real time traffic information for a few road segments. However, the real time traffic conditions are just for the user information and it is not integrated into the driving route that the user queried. The suggested routes are still static, they do not change according to the weekday or the time of day or the congestion that could form, calculated by knowing the distance of two points in a graph and the legal speed a vehicle [4].

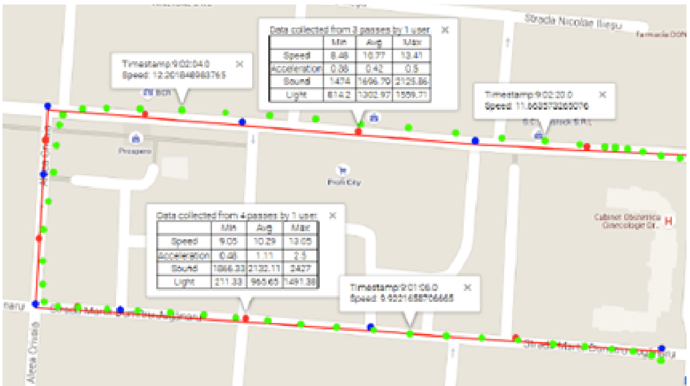

Figure 2: Tool overview

Having data collected from the mobile device sensors helped to analyze and characterize different routes based the start point, the end point and data corresponding to different location points between them. Using the Google Directions API all the API segments that are part of a certain road were queried in order to estimate the minimum, medium and maximum speed, acceleration, light intensity and sound intensity on each static segment based on the data previously acquired from the sensors. Each route recorded was parsed: for each segment provided by the API, a local query was used to determine if there are points which could be mapped to the API segment and then based on their timestamp the API segment end-points timestamps are estimated (Fig. 2). Then, based on the timestamps, the acceleration, speed, light intensity and sound intensity for the current API segment are estimated based on the sensor data collected. If a segment has no points that can be mapped inside of it, that the segment is not estimated for that particular route and may be estimated when analyzing a different route that may have locations that can be mapped inside the segment. We started the collection of context data in January 2016 in Timisoara, Romania. We now have 2.9 GB of data in the database. That includes over 17 million entries from accelerometer, over 58.000 entries from battery level, over 1600 entries from contexts, over 50.000 entries from foreground application, over 9 million entries from gyroscope, over 2.5 million entries from light level data, over 5.5 million entries from linear acceleration data, over 400.000 entries from GPS, over 9 million entries from magnetic field data, over 1.3 million entries from pressure data, over 220.000 entries from sound data, 321 processed routes, over 15.000 map segments.

References

[1] J. Letchner, J. Krumm, E. Horvitz, "Trip Router with Individualized Preferences (TRIP): Incorporating Personalization into Route Planning", 2006.

[2] F. Lardinois, "Google Maps Gets Smarter: Crowd sources Live Traffic Data", 2009.

[3] B. Guo, Z. Wang, Z. Yu, Y. Wang, N.Y. Yen, R. Huang, X. Zhou, "Mobile Crowd Sensing and Computing: The Review of an Emerging Human-Powered Sensing Paradigm", ACM Computing Surveys, Vol. 48(1), 2015

[4] Ji Yuan, Yi Zheng, Xi Xie, G. Sun, "T-Drive: Enhancing Driving Directions with Taxi Drivers' Intelligence", IEEE Transactions on Knowledge and Data Engineering, Vol. 25(1), 2013.