Using Collective Intelligence to Improve Urban Mobility in Smart Cities

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Abstract

The cities are becoming smarter cities in order to improve their citizens' quality of life. Our research focuses on developing technological solutions based on collective intelligence to improve urban mobility in Brazil. Our current studies focus on providing transportation information in real time and on the support of visually impaired people. We aim to extend these studies considering other Smart City characteristics and apply them to the city of São Paulo.

Author Keywords

Smart city; smart mobility; collective intelligence

ACM Classification Keywords

See: http://www.acm.org/about/class/1998/

Introduction

The disproportionate growth of cities resulted in problems related to resources scarcity and sustainability [13]. To mitigate these problems, cities are becoming "smart cities." According to Hancke et al. [7], a smart city is a city able to manage its resources in an intelligent way, integrating its infrastructures and services into a cohesive whole and using intelligent devices for monitoring and control, in order to ensure sustainability and efficiency.

Giffinger et al. [6] have split the relevant key fields of urban development: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. A smart city supports these characteristics providing Information and Communication Technology (ICT) infrastructures and an increasingly smart, interconnected, and sustainable urban system [4].

Smart people are also an integral part of the smart city [7]. Social networks may be leveraged as a means to exercise the citizenship [9]. Collective intelligence involves combining knowledge provided by a group of people to produce novel information or insights [11].

Collective intelligence led to the rise of a new business model known as crowdsourcing. The term, coined by Jeff Howe [8], describes a model that takes advantage of several creative solutions that people can propose. The idea of crowdsourcing is to send a task to the crowd instead of running it using proprietary resources.

Another way to take advantage of collective intelligence is by using personal devices (like smartphones, GPSs, and so on) as sensors. In contrast to physical sensors, sensors based on humans can shed light into *why* and *how* events and patterns that are exposed by physical sensors emerge [5]. The process to take advantage of people willing to work towards continuous data collection is known as crowdsensing [2].

In this context, we are investigating how collaborative systems, especially the ones based on collective intelligence, can contribute to transform existing cities into smarter cities. Our research has started in the context of the Ubibus project [12], which objective is to propose, specify, and implement technological solutions to facilitate Brazilian users to access to public transportation information in real time. Our future work includes integrating previous results to an infrastructure able to support other Smart Cities characteristics.

In the following sections, we present our previous work and our insights for the future.

Previous work

The urban mobility is a problem in most cities in Brazil. The number of vehicles has increased disproportionately to infrastructure's investment. Traffic congestion, accidents, and pollution caused by vehicles became part of the daily life of citizens. For this reason, our previous research focused on public transportation. We have investigated how crowdsourced data could help people to get information about public transportation services.

We have conducted a survey with public transportation users to investigate how collaborative systems based on social networks and collective intelligence could support sharing information among the passengers. The results have showed that there is a scarcity of ways to obtain real-time information related to public transportation and that the use of social network applications and collective intelligence is an interesting way to share and obtain this kind of information [3].

Then, we proposed a set of tools based on social network and crowdsourcing. Our main focus was to provide traffic and occurrences information. For this context, occurrences are any fact that happens along the way that can influence the efficiency of the

transportation service, such as: traffic jams, flooding, accidents, overcrowding, and so on. We also proposed a route recommendation system to support visually impaired people to plan their route. These tools are briefly described below.

CollabRoute
Collaborative Routes Editing (Collab Route) [12] is a tool integrated with Facebook to enable users to collaboratively create routes that can be visualized and edited by the user's contacts. This service is especially useful for tourists who have little knowledge of the public transportation system in a given location, as well as their routes and lines. People can use the features of Facebook's social network to share, comment, and "like" the collaborative route.

Ubibus-Occurrence
The Ubibus-Occurrences application [12] aims to support users to register and view information on occurrences. Thus, passengers can be constantly aware of the problems that occur in bus lines they use. The application is available through Web and mobile interfaces. The Web interface aims to enable users to report occurrences using a collaborative map. The application informs the bus lines affected by occurrences. In addition, occurrence information is used to indicate the possibility of problems in a given location. It uses different colors in each section of a bus route (heat map), based on the amount, the intensity, and the type of messages reported. The mobile interface provides and gets real time information about the public transportation that people are using; users can report facts that occur in their route and retrieve facts that affect a given bus line; messages can be visualized textually or in a map showing the most recent occurrences.

Route recommendation system
The Route Recommendation System [1] is a tool that implements an adapted collaborative filtering algorithm. It gathers information to recommend bus routes to visually impaired people based on accessibility level of places near the bus stops. Collaborative Filtering algorithms use profile, preferences, and previous ratings to provide recommendation to a specific user. In this context, the preferences and ratings are represented by information about the accessibility level of bus stops and nearby locations, according to the individual characteristics of each kind of disability.

Smart Audio City Guide
Smart Audio City Guide [10] is a collaborative environment that relies on the use of smartphones and georeferenced voice messages to aid urban mobility of visually disabled people. The system is composed of a website and a smartphone application. The website provides a map where is possible to search for an address and associate it to a message about impressions, suggestions, and tips for other people. The smartphone application is used while the users are moving around the city. It allows creating a message, and playing the messages associated with a specific place while the user is going through it.

Future work and insights

The next steps of our research comprise addressing challenges related to the evolution of our previous work. We intend to apply the crowdsourcing model to generate information to support users of other kinds of vehicle (individual or collective). Besides, we want to

help managing the transportation network to identify violations of traffic laws or problems related to service provision. Crowdsensing can be used to define behavioral models to estimate bus capacity by time, bus stop or line, and to recommend alternative routes. In addition, algorithms based on collective intelligence will be developed to support visually impaired people to use the public transportation (e.g. informing when the correct bus is approaching, if the destination stop is near, etc.).

We also intend to generalize our results by applying them to other Smart City characteristics. Crowdsensing based behavior models will be extended to improve the user experience regarding other public services, such as health, educations and social participation. Crowdsourcing based applications will be used to support people on issues such as security and surveillance of sustainable resource consumption. To integrate all those characteristics, we intend to develop a middleware infrastructure able to gather data from crowds, compare them with official data, and aggregate the results to provide useful services and information to citizens.

This research counts on an important strategic partner in Brazil, the São Paulo Municipal Secretary of Transportation and a partnership with the Cittati company, in the area of urban mobility in Smart Cities.

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