Enabling Participatory Routing Using A Smart Routing Platform

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***Abstract*—Participatory sensing has been advocated as a decentralized mechanism for getting up-to-date data about a city. However, this leads to data flowing only in one direction, from the citizen to the data collector. We advocate closing the loop, by creating a platform that aggregates participatory data, visualizes it, and provides utility from the data. We argue that this will lead to greater participation, as well as greater interest in various aspects of a city that can be collaboratively mapped.**

***Index Terms*—smart transport, participatory routing, sensors, dynamic routing**

I. Collaborative Citizen Environment

Smart Cities represent a conceptual urban development model based on the utilization of human, collective, and technological capital for the enhancement of development and prosperity in urban agglomerations [1]. Smart cities, as defined by the European Union, consist of three main factors that need to be developed in unison: (1) use of resources (*e.g.,* water, electricity), (2) impact on the environment (*e.g.,* waste, pollution), and (3) citizen well-being. The advent of Information Technolgy (IT), and pervasiveness of smart devices are key to empower citizens in their every day activities. IT can be used to offer better public services (*e.g.,* waste disposal management), or by assembling relevant information to be handled by the authorities and other smart city systems (*e.g.,* electricity consumption patterns to improve its use and electric grid load).

Our research spawns from the observation, that these two types of interactions are presented to citizens through detached interfaces (*e.g.,* smartphones, professional instrumentation). The hypothesis of our work is that, in order to truly have *collaborative living* environments amongst citizens, the gap between data collection and services presentation needs to be closed. Citizens' experience can be enhanced taking advantage of information available in the environment by empowering the collection of the data most relevant to them. Collaborative data collection by citizens is granular and large scale, which has been proved to be of good quality, and sufficient utility [2]. Such information can be actively used by citizens through interfaces that help them take more informed decisions about how to better interact with their surroundings, or accommodate their preferences, thus implicitly improving citizens' well-being.

This paper presents a model for data collection and interaction via a collaborative smart routing platform, enabling citizens to submit gathered data from their mobile devices and directly interact with aggregated data, closing the loop between data collection and presentation. Collected data is displayed to citizens in a map that provides different routing possibilities, and multiple transport modes taking into account real-time data, incentivizing users' participation in the data collection.

II. SmartHopper

Finding ways to navigate from one point to another, is an activity that many citizens instinctively undertake, during their daily lives. Current available technology offers the possibility to navigate a city following, the best possible route between two points —that is, the fastest, shortest, or the one with most touristic attractions. The qualification of the best route to go from point A to point B is subject to the user's preferences. While the shortest route may be the best for some users, alternative routes may be more suited for others [3].

We introduce a smart routing collaborative platform, creating smarter routes for citizens and their communities. SmartHopper[1] is a decentralized routing application that integrates data collected by citizens, using different sensor sources, and takes advantage of gathered sensor information to display data dispersion and scale in a map. The gathered data is used by citizens to find the best routes between two points in a smart city, according to their preferences. The first instantiation of SmartHopper exploits noise and air quality data combined with routing data from OpenStreetMaps, to allow users to calculate the *least noisy* or *least air polluted* routes, using Dublin, Ireland as a case study [4]. Noise data is contributed via smartphones' microphones through the NoiseTube [2] application, while air quality data is collected from environmental stations located at fixed points around the city. Notwithstanding initial enthusiasm of mapping one's own city, contributed data is of little use to citizens, evidencing a disconnect between data collection and usage.

To solve these problems, SmartHopper is to fully automate data collection and usage and integrate different

[1]https://github.com/DIVERSIFY-project/SMART-GH

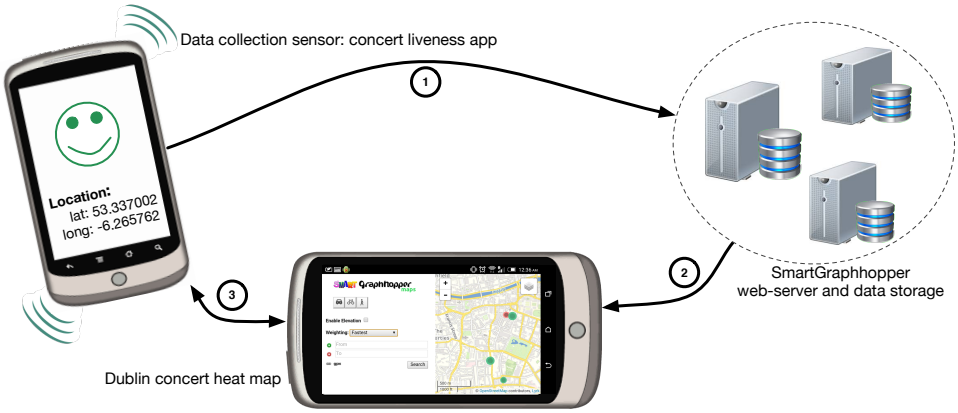

Fig. 1. SmartHopper data collection and presentation closed loop model.

sensors to support more citizens' preferences. SmartHopper is a stepping-stone in fostering citizens' well-being by offering a city-wide smart routing service that accommodates citizens' preferences. We envision SmartHopper as a flagship platform for collaborative living in smart cities, incentivizing data collection from citizens, and increasing their well-being. Such platform must include: (1) fully automated data collection, (2) real-time data visualization, and (3) services adaptation with respect to available information.

Fig. 1 depicts the SmartHopper model for automated data collection and utilization according to defined sensors. Fig. 1 shows an application that uses phones' accelerometer information to assess concerts' liveness, as an example. Other data collected from sensors and its usage would work similarly. First (1), accelerometer data is collected using a mobile application that submits (normalized) accelerometer readings to the SmartHopper database. Second (2), this information can be used in real time to visualize the location and quality of the information. In SmartHopper information is displayed using a heat map, in the example the color of the data source represents the phone's movement (*e.g.*, green: high accelerometer readings) and the diameter of each point represents the amount of data collected (*i.e.*, bigger points represent more submissions, and hence more lively concerts). Third (3), to close the loop between data collection and usage, collected data is used to route citizens to areas with lively music, or more quiet areas according to their preferences.

Other sources of collaborative data gathered by citizens can be used to adapt and improve services offered to citizens. SmartHopper uses cars, public transport, and bike sharing as transport modes to route citizens. These services could be adapted, for example, by taking into account social media data. Citizens can contribute data about bikes and parking space availability in bike-sharing stations. Such information can then be used to route citizens to stations with available parking spaces, or not to offer a biking route whenever there are no bikes available in citizens' vicinity. This mechanism can also be used to alert road conditions, generating alternative routes for congested roads or roads in a bad state. Other types of information can also be integrated with SmartHopper to identify blocked sewer systems, refuse to be collected [5], or even to identify security or emergency situations.

III. Closing Remarks

Information collected by mobile sensors in a city can be used to enhance citizens well-being in a smart city. By closing the loop between data collection and usage, citizens can take advantage of collected information to personalize different services according to their interests, enhancing their well-being. This paper presents SmartHopper, a smart city platform exploiting environmental sensed information to generate smart routes. In SmartHopper citizens can submit data about the city using their mobile sensors, visualize collected data from multiple users, and use such data to select routes that better match their preferences.

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