tripzoom: An App to Improve your Mobility Behavior

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ABSTRACT
Mobile devices can help to solve urban traffic problems by improving personal mobility and making transport, traveling, and commuting for individual users more flexible, sustainable, and rewarding. For that purpose, the tripzoom application combines mobility data and patterns from mobile sensing, a dynamic incentive system, and community feedback from social networks. This paper gives an overview of tripzoom, its features, and technical realization, and explains how users can take advantage of it to monitor, manage, and improve their mobility behavior.

Categories and Subject Descriptors
H.5.m [**Information Interfaces and Presentation (e.g., HCI)]**: Miscellaneous

General Terms
Design, Human Factors

Keywords
Mobility patterns, mobile mobility, sustainable traffic, mobile sensing, incentives, social networks

1. INTRODUCTION
Urban traffic challenges transport authorities and users with different issues regarding traffic volume, infrastructure extensions, capacity limits, congestions, pollution, sustainability, or economic efficiency [10]. Different applications and services try to improve these issues on the level of personal mobility by providing real-time traffic information (e.g., Google Now [8]), mobility monitoring (e.g., IYOUIT [2]), navigation (e.g., Google Maps [7]), car and bike rental (e.g., GreenWheels [9], Velib [14]) or trip sharing (e.g., Avego [1]). These and other solutions often take advantage of mobile devices to make transport, traveling and commuting smarter and more flexible for individual users. Mobile devices allow users to retrieve traffic-related information, e.g., about traffic jams, anywhere and at any time. They can provide location data via cell positioning or GPS that mobile applications (apps) can use for showing users on maps, navigation or location-based services. Apps can also use data from mobile device sensors (e.g., accelerometers) or specialized, external sensors (e.g., FitBit [4]) to track, record and quantify user actions, especially motion, for sports, healthy living, or games. Mobile devices are also persuasive technologies [5] that can influence the behavior of users by stimulating them in a personalized way in the right place and at the right time, e.g., to walk instead of taking the car.

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tripzoom [13] is another approach to mobile mobility that uses mobile devices and applications to improve personal mobility. It is developed in the European FP7 project *"Sustainable Social Network Services for Transport"* (SUNSET) [11] to investigate how mobility monitoring, incentives, and social networking can be combined to motivate users to change their daily mobility behavior and to make it more sustainable. tripzoom uses the sensing capabilities of mobile devices to create individual mobility profiles with details about trips, places, mobility patterns, and transport modalities (Figure 1c), similar to TravelWatcher [12]. Based on this data, tripzoom motivates users to change their usual mobility behavior by offering incentives that match their interests and preferences. For example, users can earn a reduced ticket for public transport if they do not use their cars for a week. tripzoom also uses social networks like Facebook or Twitter to encourage further improvements of mobility behavior by letting users share and compare their mobility data with the tripzoom community. For example, the tripzoom app visualizes individual performances regarding costs or CO_2 footprint to show users how well they perform compared to the community (Figure 1a).

The following section describes the tripzoom system in greater detail and shows how users can take advantage of its features. Section 3 outlines the technical realization of tripzoom and explains its main components. The paper closes with an outlook of the evaluation of tripzoom in the living lab cities of Enschede (the Netherlands), Gothenburg (Sweden), and Leeds (UK).

2. THE TRIPZOOM SYSTEM
The tripzoom system consists of a Web portal to attract new users, a mobile app to improve personal mobility behavior and a city dashboard for providers to manage the provision of incentives and the communication between users in tripzoom.

2.1 Web Portal
The tripzoom Web portal [13] consists of two parts: The landing page advertises tripzoom to interested users, explains its features, presents background information, and provides links to download the tripzoom app for iPhones and Android devices. It is also a first step into the tripzoom community by linking to tripzoom pages on social networks and showing updates from Facebook and Twitter feeds. A community feature presents anonymous and aggregated real-time statistics about the performance of users in the three

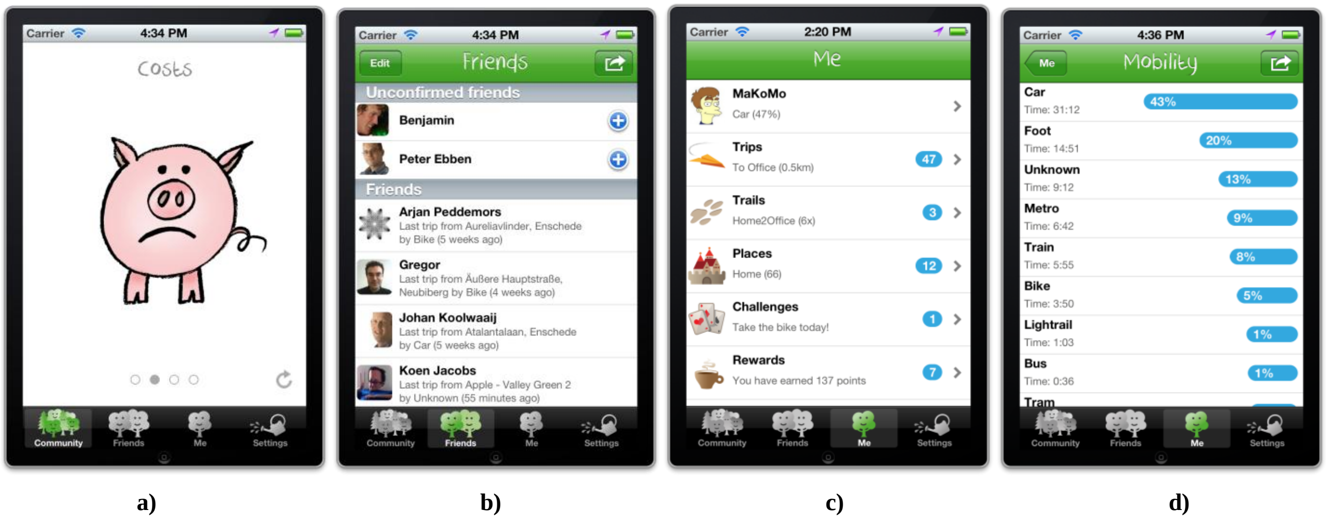

Figure 1. Mobile tripzoom app

living lab cities regarding the number of trips or the amount of CO_2 that is saved through improved mobility behavior.

The other part of the portal is only accessible for registered users. It is based on the open source social network platform ELGG [3] and provides features to let users maintain their accounts, edit their profiles, or manage general settings. As the portal focuses on social features, users can create blogs, send messages, invite friends, and categorize them as "family members", "close friends" or "colleagues" to allow different privacy settings for different circles of friend. An activity stream gives a live overview of all actions by users and their friends.

2.2 Mobile App

The tripzoom app for iPhones and Android devices can be downloaded from the App Store and Google Play. It is the center of the tripzoom system and makes its main features available to users. The app is designed to run as a constant background service that uses the sensing capabilities of mobile devices (e.g., GPS, accelerometer) to detect, record, and quantify the movements of their users. This raw sensor data is filtered, refined, and turned into useful mobility data about transport modalities, places, or trips. This data can later be used to derive the travel behavior of users and give recommendations for improvements. The app has various features to visualize this mobility data and to let users interact with it. These features are represented by the three tabs "Community", "Friends" and "Me" (Figure 1).

- **Community:** This tab shows how the user of the app performs compared to the tripzoom community (Figure 1a). Four different visualizations illustrate this performance with regard to saved money and CO_2, health, and collected points (Figure 2). If users perform better than the community average, the state of the respective illustration is more positive, if they perform worse, it is more negative. In contrast to similar visualizations of sustainable behavior, like UbiGreen [6], this one is more dynamic, better connected to mobility data and related to other users.

- **Friends:** This tab shows a list of the user's friends within the tripzoom community (Figure 1b). This list can be managed on both the mobile app and the Web portal. Every list entry provides additional information about a friend and his trips.

- **Me:** This tab contains all information related to the individual user of the tripzoom app (Figure 1c). It provides detailed information about his mobility profile, including visited places, individual and frequent trips ("trails"), or statistics on travel modalities (Figure 1d). It also manages challenges that users try to achieve and gives an overview of rewards they have earned. Challenges are based on the regular travel behavior of users and dare them to improve this behavior by offering rewards for healthier or more sustainable actions. For example, tripzoom can challenge a user to take the bike to work instead of the bus and reward him with a free coffee if he masters this challenge.

- **Settings:** This tab comprises different auxiliary options for the management of the tripzoom app including settings for privacy, profile information and sharing data.

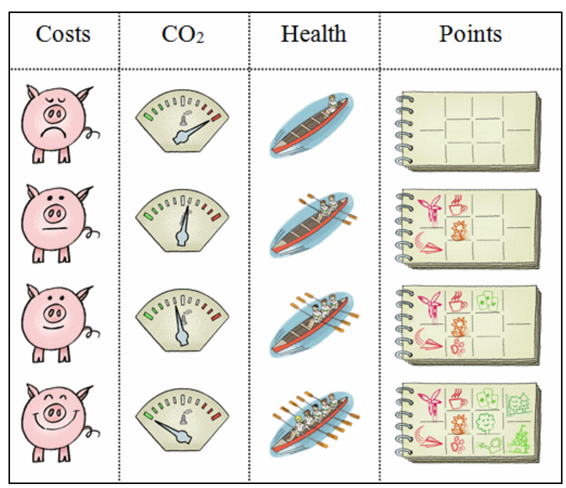

Figure 2. Visualizations of user performance

2.3 City Dashboard

Next to the Web portal and the mobile app, tripzoom offers a service called city dashboard that allows city authorities, who provide tripzoom to a municipality, to monitor and manage the incentives and reward system. They can add new incentives and

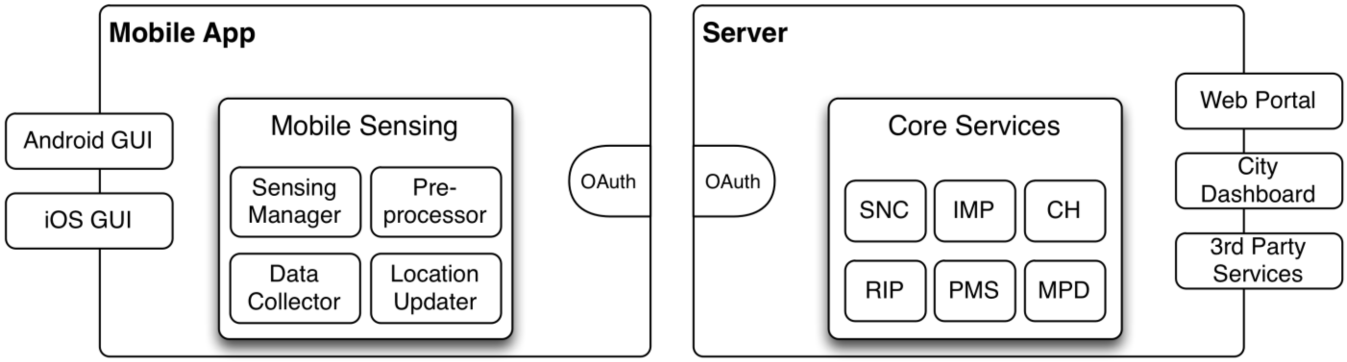

Figure 3. Architecture of the tripzoom system

specify for which target group and in which situations these will be triggered. Furthermore, they can get an overview of the current and past mobility situation in the city, to design suitable and effective incentives. The city dashboard offers a live view on various aggregated statistics and anonymized data of the users within a city with which operators can check and evaluate the current state and impact of incentive measures. This approach can be used to influence overall mobility behavior (e.g., fewer cars in the city) or to target specific goals, e.g., optimize the use of alternative travel modalities before and after large events.

3. TECHNICAL REALIZATION

Figure 3 shows an overview of the general architecture of the tripzoom system with its main components including details about central functionalities as well as the collection and interpretation of the users' movement data to build mobility profiles. tripzoom follows a client-server architecture offering a service infrastructure that provides a set of core mobility and social networking services guarded by a security layer. As described above, users can interact with the tripzoom app for iPhone or Android or with the Web portal. City controllers can make use of a city dashboard view which provides access to city wide mobility information and incentive control. Finally, third party services like social networks expand the reach of tripzoom information and allow for personalized sharing of mobility information.

The mobile devices of tripzoom users provide mobility data and present transport information and incentives to guide the travel behavior of their owners. Correspondingly, the mobile client is composed of components for graphical user interfaces, mobile sensing, and secure communication with the server (Figure 3). The sensing component is responsible for gathering mobility data from sensors, to preprocess the data, and then to upload them to the tripzoom server. Sensing data elements such as location and battery level can be obtained from onboard mobile device sensors. Other data can be incorporated from external sensors, such as step counters or bike sensors. Currently, the tripzoom app supports a range of sensors based on the ANT+ protocol, such as the Wahoo Cycling Speed/Cadence Sensor [15]. There are four sub-components in the mobile sensing pipeline.

- **Data Collector:** Gathers raw measurements from built-in mobile device sensors and externally connected sensors.
- **Preprocessor:** Applies algorithms to reduce the noise and size of the gathered data, to recognize stationary and travelling situations, and computes initial trip modalities based on the gathered data and the type of the corresponding sensor source.
- **Location Updater:** Decides when to upload the sensed data to tripzoom servers and uploads them when appropriate.
- **Sensing Manager:** Activates, deactivates, and adjusts the available sensors and sampling rates to optimize energy consumption as well as data quality.

The social and UI components provide the user interfaces to show the users' mobility profile or the live status of their friends and to receive incentives for a better mobility behavior. A security and communication component is responsible for authenticating mobile users to access their sensitive personal mobility data and to synchronize the mobility, incentive, and social network data between tripzoom mobile clients and the tripzoom server. Upload and download links to push data to and query data from the tripzoom server are implemented by a communication manager module. Another important component to keep the users up-to-date and to be able to request their feedback on the spot is integrated in the mobile notifications component. This is used to published new incentives, inform about earned rewards, and to send experience sampling questions. Since it is based on the respective mobile operating system's notification mechanism, it can deliver messages even when the phone is in sleep mode.

The tripzoom server consists of a set of core services, Web user interfaces, and programming interfaces to third party services, data, and applications. It offers core services like incentives, mobility monitoring, and basic social network services (Figure 3).

- **Personal Mobility Store (PMS):** Collects raw sensor data from mobile clients and preprocesses them to be input to algorithms for mobile pattern detection.
- **Mobility Pattern Detector (MPD):** Receives data from the PMS and employs sophisticated algorithms to detect patterns for individuals, groups, places, regions, routes, or vehicles such as bus lines or a taxi.
- **Relation, Identity, and Privacy Manager (RIP):** Provides a homebuilt social network implementation and organizes the privacy policies of users based on their social relations.
- **Social Network Connector (SNC):** Connects the internal social network (RIP) with existing social networks such as Facebook or Twitter, to facilitate user registration, information sharing (e.g., a notification on the successful

completion of an incentive), importing contacts, or showing visualizations from the MPV.

- **Incentives Market Place (IMP):** Provides a platform to offer incentives in the form of rewards, recognition or real-time feedback to encourage travelers to improve their travel behavior with respect to the system's and an individual's objectives. The IMP matches available challenges with mobility patterns from the MPD, individual user profile and preferences from the RIP, general transport information, and can publish performance and events using the SNC.
- **Context Harvester (CH):** Harvests all information required to populate the user's buddy list from all server-side components, such as the IM for the user profile, the PMS for the last location and trips, the MPD for mobility patterns and the IMP for rewards gained with incentives.

Third party applications can request access to services provided by these core service provider components after obtaining user's consent. The implementation of this distributed system is based on Representational State Transfer (REST) and JavaScript Object Notation (JSON). This supports loose-coupling between components, clear APIs, and independence of platforms and programming languages. The security layer uses OAuth to publish and interact with data that needs access control. The social network features of tripzoom build on the open source social networking platform ELGG [3] that simplifies the integration with functionalities offered by the Web portal or the mobile app.

4. CONCLUSION

In this paper, we have presented the components and features of the tripzoom system and showed how users can take advantage of them to monitor and improve their mobility behavior through a combination of mobility sensing, incentives, and social networking. Ongoing work on tripzoom within the SUNSET consortium focuses on enhancements for mobility and pattern detection, energy efficient sensing, the adoption and effectiveness of incentives, benefits of social networking, as well as usability and user experience. The latter will be the focus of the evaluation of tripzoom with living labs in Enschede in the Netherlands, Gothenburg in Sweden, and Leeds in the UK during the first half of 2013. In cooperation with city councils and transport authorities, each living lab will focus on different target groups to evaluate the tripzoom system in a real world setting. We provide a hands-on demonstration of tripzoom during the conference, based on real-world mobility data of several test users.

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