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Crowdsourcing Real-Time Traveler Information Services: Issues, Challenges and Recommendations

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INTRODUCTION

Traditional solutions to traveler information services rely on fixed sensor networks (in the form of loop detectors, and traffic detection cameras), augmented with reports about planned and unplanned network perturbations to provide real-time traveler information services (RTIS). The information provided by RTIS is often limited in its coverage because of high cost of installing sensors across entire networks. Further, data is often delayed owing to limitations of communication and transmission technologies, and sensor network unreliability leads to a lack of information provision. Additionally, physical sensor networks are prohibitively expensive to maintain and operate.

Recent advances, however, in information and communication technologies – in the form of smartphones and portable handheld devices – combined with participatory paradigms of information sharing, such as crowdsourcing, offer the ability to overcome challenges associated with traditional information provision solutions that rely on physical sensor networks. In this new wave of traveler information services, consumers with location-aware and data-enabled devices serve as a network of mobile sensors providing information about prevailing network conditions. This approach of traveler information has potentially wider coverage, almost real-time currency, and redundancy in data collection due to the participatory paradigm of information sharing. Additionally, since the end users serve as sensors, there is little investment involved in deploying the sensor network and minimal cost is incurred in maintaining and operating the information services.

Despite the potential of crowdsourced based RTIS solutions, a number of issues abound about its feasibility and applicability to provide complete traveler information about entire transportation networks across all modal alternatives. To this end, researchers have developed a prototype of a RTIS solution called RETTINA to assess and evaluate the feasibility of providing real-time traveler information based on crowdsourced data. In the next section, an overview of the RETTINA prototype is presented. In the last section, some ongoing and future work is described.

RETTINA: REAL-TIME TRANSIT TRAVELER INFORMATION

RETTINA stands for Real-time Transit Traveler Information. It is a prototype of a crowdsourced real-time traveler information prediction system which utilizes mobility traces shared by users to provide real-time traveler information. Figure 1 provides an overview of the system. The system includes two components, namely, a user-end (also referred to as a front-end) and a back-end. The bottom portion of the figure (below the thick black line) shows the user-end of the system. The user-end includes an Android based smartphone application that is used by crowdsourcers (users of the system). The smartphone application allows users to interact in two ways. First, users will be able to access information about both expected traveler information (based on historical information) and real-time traveler information (based on prevailing conditions). Second, users will be able to share real-time traveler information both passively (about their current location as they pursue a trip) and actively (about prevailing network conditions such as disruptions, accidents, weather conditions, and ride experience). In the bottom half of the figure, the data that is accessed by the users is shown with incoming arrows and data that is shared by the users is shown with outgoing arrows.

Information shared by the users is sent to the back-end shown in the top portion of the figure (above the thick black line). The data shared by the users is consumed in real-time to provide traveler information about prevailing conditions. Back-end features hardware and software to process, predict, and disseminate real-time traveler information. The connections and workflow between different components of the backend infrastructure are shown in solid arrows. In RETTINA, currently only the passively shared mobility traces are utilized to predict real-time traveler information. While the other unstructured information about traveler observations and ride experience can be shared by users, they are currently not utilized. The critical back-end components include a Hidden Markov Model based map-matching algorithm that predicts the potential path of the crowdsourced mobility trace and maps the mobility trace to the underlying road network. The map-matched information is then utilized to not only to predict the real-time traveler information but also to populate/update historical information about travel conditions on the transportation network. A critical challenge with crowdsourced mobility traces is that it is often incomplete and provides information about only a subset of links from the entire network. This is primarily because at any given moment, users in a region are not traversing all links. Further, even if users traverse all links, only a small portion of those users participate in crowdsourcing solutions. In RETTINA, a trajectory based regression technique that combines incomplete data about prevailing travel conditions (on a subset of links) afforded by crowdsourced mobility traces is utilized to predict traveler information for the entire transportation network.

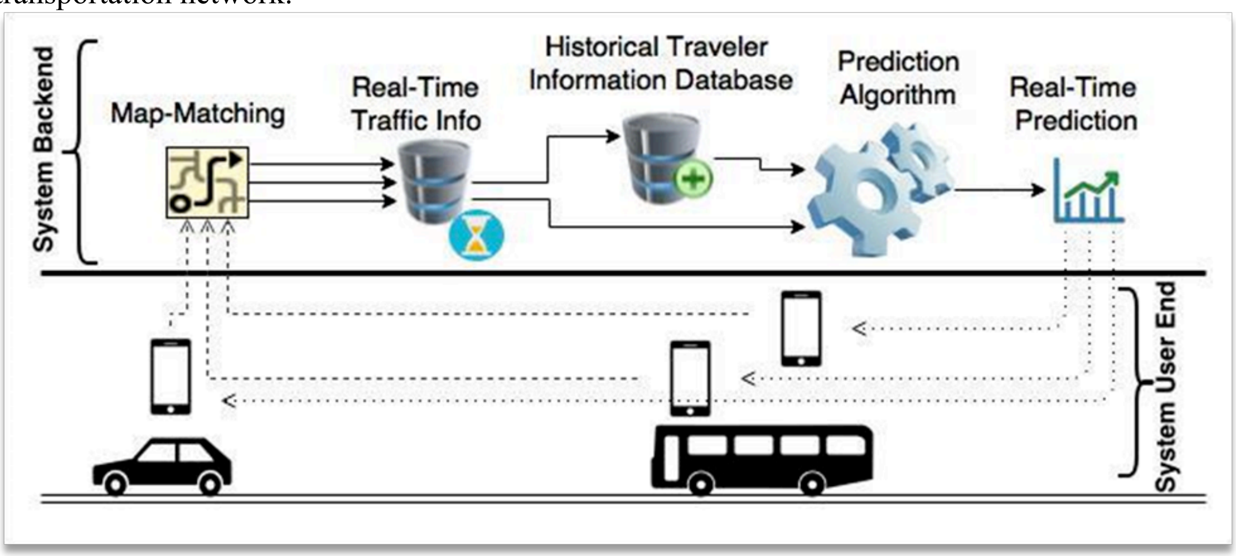

Figure 1: Overview of the RETTINA: Real-time Transit Traveler Information

ONGOING AND FUTURE WORK

While RETTINA prototype has been fully developed, it hasn't been field tested. The front-end smartphone application, is currently under Beta testing. The back-end was tested and validated by utilizing location traces of shuttles serving the University of Connecticut to predict estimated arrival time for any given origin-destination pair. The prediction results show that the back-end is accurate and robust even under varying levels of coverage and sampling frequency of the location traces. The study researchers wish to build on this effort to field test the RETTINA solution. Additionally, RETTINA will be distributed under open-source licensing agreements allowing other researchers to systematically address issues of quality and validity of crowdsourced data; algorithms and approaches for synthesizing structured and unstructured crowdsourced data; and understanding participant behaviors as they relate to motivations for participation, and incentives for continued involvement.