

Chapter 70

Privacy in Participatory Sensing Systems

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ABSTRACT

Participatory sensing is a revolutionary new paradigm where ordinary citizens voluntarily sense their environment using readily available sensor devices such as mobile phones and systematically study, and then reflect on and share this information using existing wireless networks. It provides data collection, processing, and dissemination opportunities for socially-responsible applications spanning environmental monitoring, intelligent transportation, and public health, which are often not cost-viable using dedicated sensing infrastructure. The uniqueness of the participatory sensing system lies in its data communication infrastructure which is constituted by the deliberate participation of community people. However, the potential lack of privacy of the participants in such system makes it harder to ensure their voluntary contribution. Thus preserving privacy of the individuals contributing data has introduced a key challenge in this area. On the other hand, data integrity is desired imperatively to make the service trustworthy and user-friendly. Different interesting approaches have been proposed so far to protect privacy that will encourage participation of the owners of data sources in turn.

INTRODUCTION

The participatory sensing system is a system providing cost-effective, reliable, and impartial data collection, processing and dissemination. Here the data communication is initiated by the ordinary citizens using their sensor-equipped mobile devices to collectively measure, contribute and thus develop database for the desired service

by sharing information of mutual interest. The concept has become very popular lately with the massive boost in the usage of mobile devices capable of capturing, classifying and transmitting image, sound, location and other data, interactively or autonomously (Burke *et al.*, 2006). However, thinking practically none would be tolerant enough to contribute voluntarily if her privacy is not protected. The right against unsanctioned invasion

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of privacy by the government, corporations or individuals is part of many countries' privacy laws, and in some cases, constitutions. To work within the scope of privacy laws and meet the specific privacy requirements of the contributors is a must to run the system effectively. At the same time, the data of interest should maintain its credibility and the quality of service should meet the users' need in order to keep the service dependable and attractive to the users.

This chapter will introduce and explicate the system of participatory sensing as an emerging system with the intrinsic challenges of meeting privacy requirements and maintaining data integrity and the comparative study of various solutions approached so far. It will enlighten various sectors of privacy issues in participatory sensing system and possible approaches to face the privacy attack while maintaining the data integrity at the same time. It will discuss the pros and cons of various existing privacy preserving approaches. Among which some are computationally less expensive and real-time in operation while some may be more applicable in practical scenarios. Some concentrate on preserving privacy regardless the cost it has to pay by compromising the data integrity, while some overcome the dependency on a centrally trusted node to be more realistic.

BACKGROUND

The concept of participatory sensing system was proposed a few years back as a system that facilitates community people share data for mutual benefit. It is initiated by ordinary citizens using their privately-owned sensors to collectively measure and contribute by sharing information of mutual interest from the environment. Unlike web applications, here data is likely to be sensed from different places people visit in course of their daily life using ad hoc sensing devices mounted on cell phones, vehicles, etc. Then the data are sent to servers via some inexpensive wireless communi-

cation architecture. The server is able to generate aggregate results using the data received from all participating users. Accordingly it replies to the queries made by the users at any time. In short, it is a system by the people and for the people.

The interactive participatory sensing network is formed by mobile devices deployed to enable public and professional users gathering, analyzing and sharing specific information. Moreover, participatory sensing can easily scale up by attracting more volunteers among the ever-increasing mobile phone users. Devices connected to the Internet of Things will engage in many participatory sensing systems, most through automatic risk assessment without directly asking for user consent. As for example microphones and image-capturers attached with the mobile devices can record environmental data. Cell tower localization, GPS and other technologies can provide location and time-synchronization data. Wireless radios and on-board processing equipments enable interaction with both local data processing and remote servers. Examples of participatory sensing system include documenting invasive plants and insects in national parks, monitoring heavy duty trucks idling or stopped in the neighborhood, reporting noise level, roughness, variation in elevation along bike routes, reporting garbage in the beaches, monitoring gasoline or grocery prices, monitoring the effectiveness of diet programs, reporting accidents or hazards etc. Unlike sensors of wireless sensor network, these sensors are always under their owners' control which implies battery back-up is not a major concern as that in a wireless sensor network. The mobility of users carrying the sensor nodes makes it distinctive from the static feature of wireless sensor networks and incorporates dynamicity in it. With all these capabilities, participatory sensing is now considered as one of the most emerging research areas.

Different application areas have motivated the revolutionary concept of participatory sensing system among which some are public health, urban planning, natural resource management,

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