

Chapter 40

Crowdsensing in Smart Cities: Technical Challenges, Open Issues, and Emerging Solution Guidelines

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ABSTRACT

The widespread availability of smartphones with on-board sensors has recently enabled the possibility of harvesting large quantities of monitoring data in urban areas, thus enabling so-called crowdsensing solutions, which make it possible to achieve very large-scale and fine-grained sensing by exploiting all personal resources and mobile activities in Smart Cities. In fact, the information gathered from people, systems, and things, including both social and technical data, is one of the most valuable resources available to a city's stakeholders, but its huge volume makes its integration and processing, especially in a real-time and scalable manner, very difficult. This chapter presents and discusses currently available crowdsensing and participatory solutions. After presenting the current state-of-the-art crowdsensing management infrastructures, by carefully considering the related and primary design guidelines/choices and implementation issues/opportunities, it provides an in-depth presentation of the related work in the field. Moreover, it presents some novel experimental results collected in the ParticipAct Crowdsensing Living Lab testbed, an ongoing experiment at the University of Bologna that involves 150 students for one year in a very large-scale crowdsensing campaign.

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INTRODUCTION

Thanks to the recent advances in Information Communication Technologies (ICTs), for the first time more smartphones than feature phones were shipped in 2013, thus marking a trend whereby the former will permanently outnumber the latter. The explosive and widespread diffusion of smartphones enables data availability and gathering, provided by sensors, such as accelerometers, barometers, cameras and microphones. This information can be densely available and harvested in urban areas, preparing a large ground for crowdsensing, in the sense of allowing large-scale and fine-grained sensing by exploiting all personal resources and people's mobile activities/collaborations.

At the same time, Smarter Cities themselves can also make several resources and data available to be managed and harnessed safely, sustainably, cost-effectively and efficiently to achieve positive and measurable economic and societal advantages. Information gathered from people, systems and things, including both social and technical data, is one of the most valuable resources available to the city's stakeholders, but its potentially enormous volume makes its integration and processing difficult, especially in a real-time and scalable manner.

The ability to harness the power of the above collective intelligence (even if inaccurate) to self-organize the spontaneous collaboration of citizen groups with other people to achieve, through their collective action, a common goal with a tangible effect also on the physical material world, namely, e-Participation and e-Inclusion, is still largely unexplored (Fogg, 2009). We consider it essential to fill this gap by proposing a new class of pervasive services, called participatory services, to emphasize their fundamental feature of providing people with the innovative opportunity to participate and act collectively. In short, the main objective of participatory services is to close the loop between immaterial and material world scenarios in the pervasive cyber-physical system of a Smarter City, going in the direction of facilitating positive behaviors by preventing dangerous situations and of enabling smarter e-Governance with a high participation of interested citizens, thus fostering an increased sense of belonging. The final goal is to enable new models for the development of the consciousness/environmental awareness on the part of the citizen as a consumer and user of the quality and environmental impact of goods and services that they expect and use in their Smarter Cities.

To become really effective technologies, crowdsensing and participatory services still have to face a number of challenges that can be considered from either a main social perspective or a more technically-oriented one. From a more social point of view, there are many duties involved in people participation: the identification of people willing to participate in crowdsensing campaigns, how to keep them involved (e.g. by providing attractive crowdsensing and participatory services, entertainment and rewards), and how to foster their participation with active collaboration actions in some data collection campaigns, for instance that require people to operate at a specific location (e.g. taking a picture of a monument, tagging a place etc.). From a technical point of view, it is important to balance sensing accuracy and user resource utilization to avoid making the crowdsensing process cumbersome to users, to process incoming data, to clean up corrupted entries, and to store information in a format that allows fast space-time queries. The boundary between social and technical challenges is not clear cut: for example, the technical problem of minimizing the global resource overhead by entrusting a minimal subset of users in a crowdsensing campaign requires the analysis of large datasets to extract a proper geo-social/preferences profile, in order for example to identify and infer which users are most likely to successfully harvest the required data.

Because crowdsensing and all above topics are not only articulated but also deeply interconnected, there are as yet no clean and easy to follow strategies in this area; most contributions seem to search

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