

# Urban Sensing: Opportunistic or Participatory?

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**Abstract**—Sensing systems for urban deployments are still in their infancy. An interesting unresolved issue is the precise role assumed by people within such systems. This issue has significant implications on where the complexity and main challenges in building urban sensing system reside. We discuss the two end-points of the spectrum of conscious human involvement, namely participatory sensing and opportunistic sensing.

## I. INTRODUCTION

An expanding research community is developing techniques to bring about very large scale urban sensing by leveraging the increasing sensing capabilities found in consumer devices such as cell phones (i.e., [5] [2] [3]). Data collected from these mobile sensors provide the bases for exciting people-centric applications. Architectural design considerations include: the methods of sensed data collection, analysis, verification, and sharing; and respecting the privacy and anonymity concerns of the people involved. Including consumer devices implies the human owners of these devices play an important role in the resulting system architecture. In the following, we consider the question of what roles people are willing to play in large scale urban sensing systems, particularly to what extent they should be conscious active participants in meeting application requests. See [4] for an extended treatment of this topic.

## II. THE ROLE OF SENSOR CUSTODIANS

We consider the two end points on the spectrum of custodian awareness and involvement in the architecture, referring to one as *participatory* [3] and the other *opportunistic* [2]. With participatory sensing the custodian consciously opts to meet an application request out of personal or financial interest. A participatory approach incorporates people into significant decision stages of the sensing system, such as deciding what data is shared and to what extent privacy mechanisms should be allowed to impact data fidelity. Consequently, a participatory system design focuses on tools that assist people to share, publish, search, interpret and verify information collected using a custodian's device.

With opportunistic sensing the custodian may not be aware of active applications. Instead a custodian's device (e.g., cell phone) is utilized whenever its state (e.g., geographic location, body location) matches the requirements of an application. This state is automatically detected; the custodian does not knowingly change the device state for the purpose of meeting the application request. To support symbiosis between the custodian and the system, sensor sampling occurs only if the privacy and transparency needs of the custodian are met. The main privacy concern is the potential leak of personally sensitive information indirectly when providing sensor data (i.e., the

custodian's location). To maintain transparency, opportunistic use of a device should not noticeably impact the normal user experience of the custodian. Thus, the primary challenges in opportunistic sensing are determining when the state of the sensing device matches the requirements of applications, and sampling when application (device state) and custodian (privacy and transparency) requirements are met.

The characteristics of opportunistic and participatory sensing impact the applications that can be practically supported. Participatory sensing places demands on involved device custodians (e.g., manually support data collection) that restrict the pool of willing participants. The capacity of people to remember applications and their requirements limits the number of concurrent applications that can likely be supported. Further, under the participatory approach, an application needs to have a critical mass of community appeal. These factors combine, we conjecture, to limit both the scale and the scope of application diversity that is likely to be realized. Applications are best suited to the participatory model when they have a collection of interested custodians whose size is at least as large as number of sensors required to carry out the application. Thus, a strong motivation for opportunistic sensing is to increase the scale and scope/diversity of applications that may otherwise not be supported. Opportunistic sensing shifts the burden of supporting an application from the custodian to the sensing system, automatically determining when devices can be used to meet application requests. In this way, applications can leverage the sensing capabilities of all system users, without requiring human intervention to actively and consciously participate in the application.

## III. CONCLUSION

While we consider participatory and opportunistic solutions to be complementary, we believe that leveraging opportunistic sensing yields a system that more easily supports large scale deployments and application diversity. In the MetroSense project [1], we are developing techniques in support of opportunistic sensing systems.

## REFERENCES

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