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Incentive Models for Participatory Phone Sensing

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Abstract In this paper we describe incentive models for participatory phone sensing. Our previous work includes a model in which value of sensing changes depending on the frequency of sensing and the number of visitors at points of interests. This paper discusses the metrics for participatory sensing and explores its applicability.

Keyword Networked Sensing, Mobile Sensing, Incentive

1. Introduction

Participatory sensing using mobile phones is becoming a new source of information about the real world. After several preliminary trials were conducted, the importance of incentives emerged to promote participatory sensing. Without an incentive to join sensing activities, acquiring sufficient amount of data is impossible; many smartphone users are not likely to participate in sensing activities because it requires time, energy and monetary cost for data communication. Therefore, incentive mechanism is indispensable to realize active participatory sensing by encouraging people to report sensed data [5].

In this paper we describe metrics to consider participatory sensing and suggest a model to enhance sensing activities.

2. Previous Work

Participatory sensing using mobile phones is an active and growing research area with a number of open issues and challenges [1,3]. Reddy et al. [4] pay attention on user selection by developing a recruitment framework to enable organizers to identify well-suited participants for data collections based on geographic and temporal availability as well as participation habits. Askus [2] is a mobile social platform which allows users to send a request to a group of potential people in a remote area to do a task, e.g., checking the availability or condition of a room, turn on/off an electric appliance and so on. The platform is able to select a potential agent based on the distance from POI, success rate of the agent, average time taken by the agent to finish the task, and reputation score. Similar to Askus, other existing sensing platforms are voluntary systems, i.e., sensing data are contribution from cooperative users.

3. Metrics

In this section we consider metrics to evaluate the value of data for participatory sensing.

V1: Value of pre-sensed data with sensed time
V2: Value of post-sensed data with elapsed time
V3: Value of pre-sensed data in spatial correlation
V4: Value of post-sensed data in spatial correlation
V5: Value of pre-sensed data from demand
V6: Value of post-sensed data from demand

V1 defines the importance of data in the time domain. If datum were not sensed at a Point of Interest (POI) for a long time, the value related to the POI would increase. V2 determines the value of datum after it has been collected. Some kind of data do not have meaning after a long time. V3 deals with the value related to nearby POIs. If a datum at some POI is obtained, the value of a datum at its nearby POI may decrease. V4 is similar to V3, but it is decided for post-sensed data. V5 and V6 are consumer-side metrics; a datum with more references has higher value.

These values are concretely calculated in each participatory sensing and do not restrict themselves to some pre-determined model. The incentive model needs to take these values into account.

4. SenseUtil: Our System

SenseUtil consists of three main players: consumers, producers and a server. A consumer would like to have

data being sensed at a remote area, while a producer is willing to carry out such sensing tasks. A person can serve as both the consumer and producer. A central server is responsible to manage interactions between consumers and producers. Interactions of three players are summarized.

4.1 Consumers

A Consumer defines a Point of Interest (POI) where data should be sensed. In addition to location information, POI also includes starting time, expiry time and data type (i.e., which kind of data need to be sensed). The consumer sends POI information to the server on demand. When receiving corresponding data, the consumer pays reward determined by the utility functions.

4.2 Server

A server is a middleman between consumers and producers. It maintains POIs' information or the sensing tasks re- quested by consumers and updates corresponding reward of each POI periodically or on demand. The producers acquire detailed information of sensing tasks by exploiting pull and/or push services. By adopting the pull or on-demand services, the server dispatches POI information upon receiving a request from a consumer. The producers may use the pull service to avoid being overwhelmed by too frequent update of POI information. In addition, the producers can use the pull service to update current reward of POI. On the other hand, the push service provides two methods for dispatching the information to producers, i.e., instant and periodic push. The instant push allows the server to dispatch the POI information immediately upon receiving new POI information from a consumer. The service is beneficial for producers who would like to have the information of new POI in real-time manner; thus they can act fast to receive rewards. The producers subscribe to periodic push will receive the POI information periodically. The server is also responsible to collect sensing data from producers and forward the data to consumers. In addition, the process of collecting payment and rewarding are handled by the server.

4.3 Producers

As described above, a producer receives the information of sensing tasks including current reward from the server through pull and/or push services. The producer can also determines her preferences including area of interest (e.g., a limited area based on current position or any specific area), maximum number of tasks, minimum reward, frequency of push-based notification, and so on. The behavior of a producer depends on current position and reward of sensing task. A producer k will carry out a sensing task if all the following conditions satisfy: (1) her position is not far from a POI, i.e., the distance between the producer and the POI is shorter than or equal to Dk th, (2) the reward is higher than or equal to a threshold Uk th, and (3) the time elapsed from previous sensing at the same POI is longer than Tk th. The underlying reason of the third condition is to avoid too frequent sensing at the same POI. If the above conditions satisfy, the producer changes the route by moving towards the POI, carries out the sensing task and moves towards the original destination. By default, the producer uses the maximum speed in order to minimize moving time. However, the producer may move with the current speed if she is not in a hurry. After the task has been done, the producer receives reward via the server. However, the producers may have incorrect value of utility because they do not know when other producers carry out the sensing tasks. The producers need to use the pull service to ask for current utility maintained by the server.

5. Summary

In this position paper we have described several metrics for participatory sensing. Future works include simulation study on the relationship between the definition of utility and producer's behavior.

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