An overview of Citizense – A generic user-oriented participatory sensing framework

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Abstract

One of the effective methods to collect and share information on the surrounding environment is through participatory sensing. It allows to gather both physical data produced by embedded sensors in the participants' device and their observation and reasoning. However, almost all existing participatory sensing applications lack multi-functional capabilities; they are designed to collect one single or limited types of information. In this work, we propose a generic participatory sensing framework - Citizense - that focuses on ease of use, and allows the creation, execution of context-aware, multi-purpose participatory sensing campaigns.

*Keywords*: Participatory sensing, human-centric sensing, context-aware sensing, smart city.

1   Introduction

There have been many participatory sensing applications in different fields such as measuring outdoor noise level [1, 2] and reporting traffic-related issues [3]. However, several drawbacks of the existing participatory sensing projects have hindered their widespread deployment in the society. We propose a generic user-oriented participatory sensing framework that allows to create arbitrary participatory sensing campaigns using the mobile device's built-in physical sensors and human as a sensor, and overcomes existing drawbacks (i.e., single-purpose apps, lack of incentives for participants, lack of spatial and temporal context-awareness). The framework serves as a single platform that can be deployed fast on a city scale, enabling city authority and/or any interested party to effortlessly start a data collecting process on demand: the campaign authors start the process by creating dynamic context-sensitive sensing campaigns using the tools of the platform; the participants, having installed only a single mobile app, interact freely with the framework and carry out the tasks specified in the campaigns and receive acknowledgements and rewards from the system. In this way, a two-way communication channel between the data consumer (typically city authority and/or researchers) and the data producer (citizens) can be formed quickly and efficiently, which is beneficial for the various stakeholders.

2   The architecture of the framework

The main components of this framework are the campaign object, the campaign manager, the campaign server (including context engine and incentive engine) and the mobile client application.

Figure 1: The architecture of the framework.
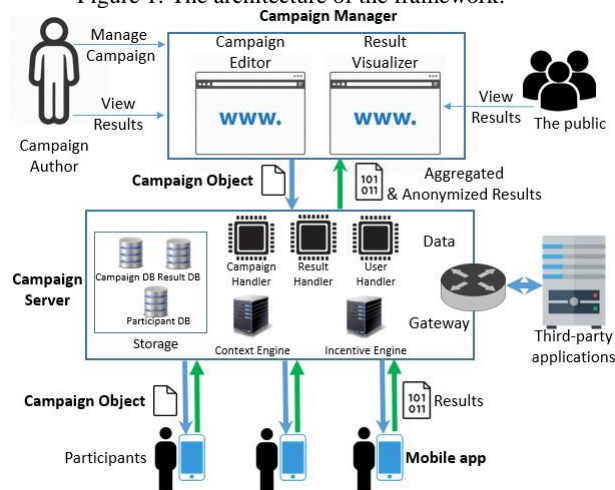
2.1   The campaign object

This object is central entity of the framework. It has the following life cycle: created by the campaign editor, stored in the campaign database, processed by the campaign server, sent to the mobile app and rendered on the mobile device. This object contains the specification of a sensing campaign (campaign ID, list of elementary sensing tasks, dynamic transition between the tasks, context restrictions).

2.2   The campaign manager

A web-based tool that enables campaign authors to manage (Create, View, Edit and Delete) their sensing campaigns in an intuitive way. The graphical user interface of the editor helps the authorized campaign creator (even users with limited computer skills) to intuitively specify the necessary

components of a sensing campaign. The campaign manager allows campaign authors (and the public, if enabled) to view in real time the results of the campaigns.

2.3   The campaign server

This component handles the interactions between participants and the framework. It serves campaigns to participants by matching their context (location, time and/or other context information) to the campaigns' context specified by campaign authors. It processes the submissions from participants and computes their incentive gained in the completed campaign. Finally, it provides a connection to which other systems connect and can further analyze the collected data.

2.4   The mobile client application

It is in charge of reporting the context of the participant, downloading campaigns from the campaign server, and rendering the campaigns on the device's screen. For every elementary sensing task of the campaign, the app evaluates the input of the participants and renders the next task as specified in the dynamic task transitions. This app also maintains the unique ID of the participant and encrypts the results before sending over the (public) communication network. The app can also function as an offline data collecting tool when the network connection is not available.

3   The Citizense prototype

The prototype, based on the aforementioned architecture, allows different types of data to be collected, ranging from humans' observations and reflections to physical data from the surrounding environment. The data collecting process starts with campaign authors, who use the Citizense campaign editor (see Figure 2) to create a campaign by specifying elementary sensing tasks and task transitions. Advanced authors can set the execution mode of the campaign, the location and/or time period in which the campaign is executed. The resulting generated campaign object (in JSON format) is then stored in the storage facilities, matched with participants' context by the context engine upon requests and sent to the participants' devices depending on their context.

The mobile application shows the necessary guidance (in the form of text and pictures), as specified by the campaign author, for the participants to collect the required data and compiles the result of the campaign (see figure 3). When the campaign server receives the submission, the incentive engine processes it and updates the participant's incentive account.

4   Current use cases

We have deployed this framework in a sport event in Castellón, Spain where a large and complex campaign was launched targeting hundreds of runners of the city marathon. This deployment demonstrated the full capabilities of the framework; other deployments were also planned.

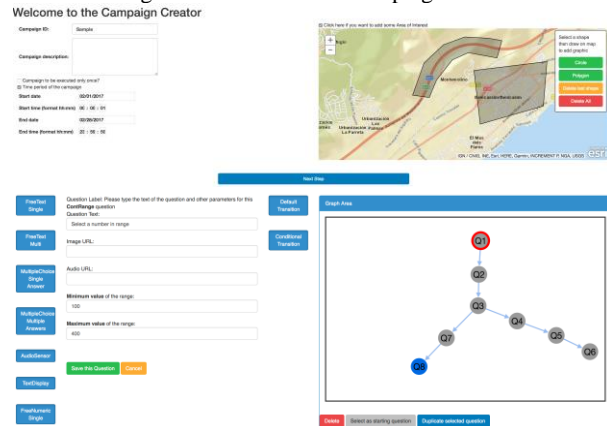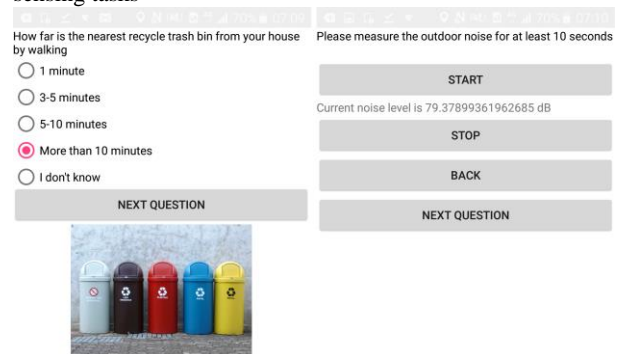Figure 2: The Citizense campaign editor

Figure 3: The Citizense mobile app, with different types of sensing tasks

5   Conclusion

In this paper, we present a generic participatory sensing framework that allows stakeholders to easily create a variety of dynamic, context-sensitive participatory sensing campaigns, and participants to execute these campaigns through a single mobile application.

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