

# [Participatory sensing services for smart phones](https://assignbuster.com/participatory-sensing-services-for-smart-phones/)

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1. Motivation

In modern society, environmentalpollutionis usually a headache for citizens, especially those who live in the urban areas. Many researches have shown that there is a direct link between environmental pollution andhealtheffects. In the last two decades, the overallenvironmentquality has improved. However, there is still a concern about environmental pollution in the urban areas. Citizens, especially the elderly and children, are vulnerable to the effects of environmental pollution.

Nowadays, the latest technologies in the wireless field provide an innovative approach for the citizens to access the information about environmental pollution. With over 3 billion subscriber lines active today, nearly half the world’s population uses mobile phones [1]. Given the right structure, the ubiquitous mobile devices could act as sensor nodes, capable of capturing, classifying, and transmitting environmental data, such as image, acoustic, and temperature. In the foreseeable future, other sensors may be embedded in or connect wirelessly to the mobile phones to gather information about air pollutants, like CO2, NO2 and SO2. Participatory sending can employ a variety of devices to collect data; however, some special characteristics of mobile phones enable them to be an unprecedented tool for engaging participants in sensing their local environment. The sheer ubiquity across the geographic and demographic spectrum and the broad proliferation of cellular infrastructure and mobile phone usage make it possible to collect data over large areas for little incremental cost. Participatory sensing will utilize current wireless network, which consists numerous mobile phones, to form a vast interactive participatory sensor network that enables professional users and lay public to gather, analyze and share environment information [2]. Citizens, especially the elderly, children, urban commuters, urban office workers and students, will benefit from such a revolutionarytechnology.

2. Background

In virtue of the rosy prospect and importance of participatory sensing, there are more and more research institutes engaging in this field. The concept of PES has been proposed in recent years (Karatzas, 2005; Burke et al., 2006; Goldman et al., 2009), and related projects have been in development around the world, especially in the USA and Europe [3].

PEIR, one of the most successful participatory sensing projects, is research collaboration between CENS, UCLA and Nokia. It makes use of Internet to allow citizens to use their mobile phones to interact with PEIR, and explore and share the impact between environment and the citizens. PEIR senses pollution by using existing infrastructure without user intervention and emphasizes how individual transportation choices simultaneously influence both environmental impact and exposure, which makes it different from other existing carbon footprint calculators [4].

Eye on Earth project of the European Environment Agency is a two-waycommunicationplatform on the environment. It has introduced the participation of millions of ordinary people to create the first environmental portal that includes citizens’ observations on air and bathing water quality at present. Eye on Earth aims to gradually include information on many other environmental topics and grow to a global observatory for environmental change [5].

MESSAGE is to provide data collecting through three sensor platforms for the planning, management and control of the environmental impacts of transport activity at urban, regional and national level. Mobile phones are investigated to support a sensing system, in which people play an important role [6].

In addition to the projects introduced above, other participatory sensing projects have also appeared, such as Living Environments, Citysense, Common Sense, Envitori and MIMAQ [3].

A lot of evidences have shown that new intuitive ways of interactions and user friendly context aware service can be introduced by various sensors in mobile phones. Therefore, mostly specialized sensors were applied in participatory sensing. Some projects also suggest that standard sensors already embedded in the mobile phones can be used for this.

Overall, there are a variety of participatory sensing projects, and they can be divided into three categories according to the participation patterns [1]:

Collective Design and Investigation. A group of individuals work together to decide where, what and why to sense. Then a data collection system is collectively designed, and an investigation is conducted. The group interprets the data and acts on the results. An evident feature of this participatory pattern is that the community of participants owns the entire process. Instead of serving merely research subjects, individuals play an active role in the investigative process.   
Public contribution. Individuals or organizations define inquiries and then other individuals collect data in respond to such inquiries. In this case, participants actively engage in the data collection and make contributions to an effort they find meaningful. For organizers, they can gather as many data as possible at a scale unachievable by professionals acting alone.   
Personal Use and Reflection. Individuals log information about themselves, like images, sounds and so on. Such recorded information may reveal hidden habits and patterns in one’s life after analyzed and visualized. Participants use the results for personal discovery to reflect on, evaluate, and perhaps change patterns that were previously overlooked.

3. Methods

Data collection and interpretation are the heart of participatory sensing which places the emphasis on the involvement of citizens and community groups. In spite of participation patterns, the basic process for every participatory sensing project is similar, and it can be broken down into the following eight steps: coordination, capture, transfer, storage, access, analysis, feedback and visualization [1].

Coordination explains the sensing effort to the participants and provides necessary guidance to them.   
Capture is the collection of data on a mobile phone, which is the core step of participatory sensing. Data can be captured by the existing sensors already embedded in the mobile phones or by those specialized sensors connecting wirelessly to the mobile phones. In the course of data collection, the credibility of data must be guaranteed. More significantly, data about geographical position and time must be captured every time.   
Transfer is processed automatically by mobile phones via wireless network. Mobile phone software takes theresponsibilityof uploading data and makes it transparent to the participants. Furthermore, mobile phone software should be tolerant of inevitable network interruptions.   
Storage takes place on servers which are distributed remotely in the Internet.   
Access is under the control of project organizers and participants according to the privacy policy. Due to the possible disclosure of private information about the participants, it is of vital importance for the participants to determine what information to share and with whom.   
Analysis includes various data-processing methods, the calculation of group statistics and the integration of contributed data into statistical and spatial models that can be used to determine patterns in space and time.   
Feedback may be required in the event of a project triggering manual or automatic events.   
Visualization is closely related to the analysis. It is the step to present the contributed data after analysis. In some sense, well-designed visualization increases the applicability of a participatory sensing project.

The project of Participatory sensing services for smart phones can be divided into two collaborative subprojects based on the Android platform, one focusing on data gathering and the other one dealing with the data processing and visualization. We take the responsibility for presenting data in some friendly and easy-understandable way. Thus the data analysis and visualization are the center of our work.

For the subproject of data processing and visualization, we have to deal with data and services. In the assumption that the contributed data are already available and their credibility has been verified, we get data via a server-based application which acts as a data storage. This server-based application will provide web service interfaces for data access. Thus WSDL language for web services will be utilized to develop an Android-based application with the aid of development environments like Eclipse. There are a wide variety of available solutions to make use of web services via Android, and the solution to use ksoap2 will be suitable for our project.

The data accessed via web services can be classified into two kinds: subjective data and objective data.

Subjective data: a categorization of the quality of the environment. They are feedback commented and reported by the citizens on the air quality. We intend to make use of the EEA categorization forair pollution, which is applicable on http://www. eyeonearth. eu/.   
Objective data: in the form of numeric values. They are automatically captured by the sensors or reported manually by the users. Images, sound, location and time are objective data.

All data processed in the frame of participatory sensing project will include the following three categories of information:

Georeference. Geographical position and time is extremely important for participatory sensing, and forms the cornerstone of the follow-up work.   
User categories. At the initial stage, our project will serve the urban commuters, office workers, students and the elderly. Other categories of users are possibly added if necessary at the later stage. We allocate every user group a unique ID, which will be used to identify the category which the users belong to. Furthermore, category ID will be used to send a request to the server which involves user category.   
Thematic profiling. Our project is to process information about environment and we aim to deal with air pollution, odors, noise, traffic congestion and waste.

In order to present the result of the contributed data to the participants in a user-friendly and easy-understandable way, GMap API may be utilized to map the georeference and thematic profiling, which will provide an interactive feature between our project and participants. Due to the distinct flexibility, Modest Maps API is an alternative to achieve the same goal.

4. Metrics for evaluation

To encourage the handset owners to participate in our project, privacy protection policy has to be taken into account to prevent privacy disclosure. One of the basic rules is that participants cannot access other people’s private information, and such an attempt should be denied.

Furthermore, the data visualization should be easily and readily comprehended or understood not only by the professional users but also by the general public. In some sense, the degree of understandability of data presentation determines the scope of applicability of participatory sensing. Another metric related to the visualization is that the users are able to customize the configuration to present what they want.

With regard to air quality, if the concentration of air pollutants detected does not fall into the scope which is safe and suitable for humankind, the participants should receive a warning, so that they can take actions to avoid being harmed. Due to regional differences, different air pollution standards are applied in different areas.

5. Outputs

The output of our project is an application running on the Android platform. Interested people can download it from the Internet and install it in their Android phones to access the information about environment surrounding them.

6. Workplan

The rough time schedule of our project is listed below, including the milestones and corresponding estimated completion dates. In table 1, some stages may overlap with others. In the course of project development, the time schedule may be changed according to specific situation.

Milestone

Anticipated completion date

Analyze the project and do literary reviewFebruary 28, 2011   
Define the project scopeFebruary 28, 2011   
Write the research proposalMarch 23, 2011   
Study mobile phone programming techniquesMay 27, 2011   
Make a plan for the projectMay 28, 2011   
Implement the projectJuly 28, 2011   
Test the projectAugust 3, 2011   
Take field trialsAugust 5, 2011   
Deliver the projectAugust 8, 2011   
Complete the dissertationAugust 19, 2011

7. References

[1] J. Goldman, K. Shilton, J. Burke, D. Estrin, M. Hansen, N. Ramanathan, S. Reddy, V. Samanta, M. Srivastava, R. West, “ Participatory Sensing: A citizen-powered approach to illuminating the patterns that shape our world”

[2] J. Burke, D. Estrin, M. Hansen, A. Parker, N. Ramanathan, S. Reddy, M. B. Srivastava, “ Participatory Sensing”

[3] https://projects. inf. ed. ac. uk/msc/project? number= P165

[4] http://urban. cens. ucla. edu/projects/peir

[5] http://www. eyeonearth. eu/About. aspx? culture= en-GB

[6] http://bioinf. ncl. ac. uk/message/? q= node/5