Interoperable Framework for Mobile Dynamic Surveying based on open source components

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Keywords: Crowd-sourcing, adaptive driven architecture, data validation, participatory GIS, Location Based Services, OGC web services; Smartphone

Abstract

The exponential growth and popularity of mobile devices in the last few years, their location-based services capabilities, broadband connectivity and ease of use, enable general public participation in all kinds of crowd sourcing applications. One of the most interesting possible uses of crowd sourcing are improved surveys, based on ordinary people's perceptions and feelings. The spatio-temporal characteristics associated to the surveyed data bring usually an important focus of the survey. Nonetheless, to be widely used and to derive useful information, two major hurdles have to be overcome: (i) the technical complexities presented by the range of operating systems in mobile phones and network availability, (ii) the risks associated with the quality of the data collected. This paper describes a solution to these problems developed on top of an open source stack. A dynamic surveying knowledge server, with a spatial database, holds remotely layers of information related to a particular survey, guiding and supporting in-field surveyors with up to date or even live data. The server side of the dynamic surveying knowledge system contains plugged-in processing algorithms allowing the support to be survey specific.

The implementation is designed as a generic framework, so both the client and the server can support many types of surveys with minimal effort.

1 Introduction

Precise location-aware surveys are common-place, e.g. in geodesy, but device cost and complexity means they are unsuitable for mass Public Participation (PP). The recent unprecedented growth and popularity of mobile devices,, their location-based capabilities, broadband connectivity and ease of use enable public participation in all kinds of crowd sourcing. Annual tablet and smart device shipments have been predicted to reach 150 million units by 2015 (Renowden, 2010). Such devices, permanently connected to the internet, open a new dimension in undertaking surveys, augmenting automatic monitoring and modelling with a human-driven holistic view of the environment.

There are risks associated with crowd sourced surveys, related to quality of data, e.g. innocent mistakes or intentional falsehoods that can reduce not only the quality of the information, but also public's confidence in volunteer gathered information as a legitimate source of data (Mummidi and Krumm, 2008). Different institutions collect spatial data for different purposes, which lead to multiple representations of the same objects of the world. Multiple representations mean that redundant information is available and can be used for the evaluation and improvement of the quality of the data (Chen and Walter 2009). Advantages are huge: data can be produced by "ordinary people" without barriers of the rigorous traditional survey construction, with a quick path from start to results interpretation. There is also a spatio-temporal dimension available, which makes a precise graphical interpretation possible.

A dynamic surveying knowledge base, which remotely holds many layers of information related to surveys, can guide and support in-field surveyors with up to date and even live data, e.g. RSS feeds or Twitter.

2 Platform free interface

Existing geospatial-enabled surveying platforms work mostly as applications, which require users to choose a system platform and stick to it. On the other side there are powerful browser-based surveying systems, but they usually lack the location dimension. HTML5 extensions, e.g. geolocation and local storage features, enable platform-independent survey deployment in a wide range of domains. In connection with increasingly available mobile broadband, web browsers give also a unified, very popular user interface, making navigation clearer even for a user unfamiliar with new ubiquitous devices. HTML5 makes surveying possible on ubiquitous devices.

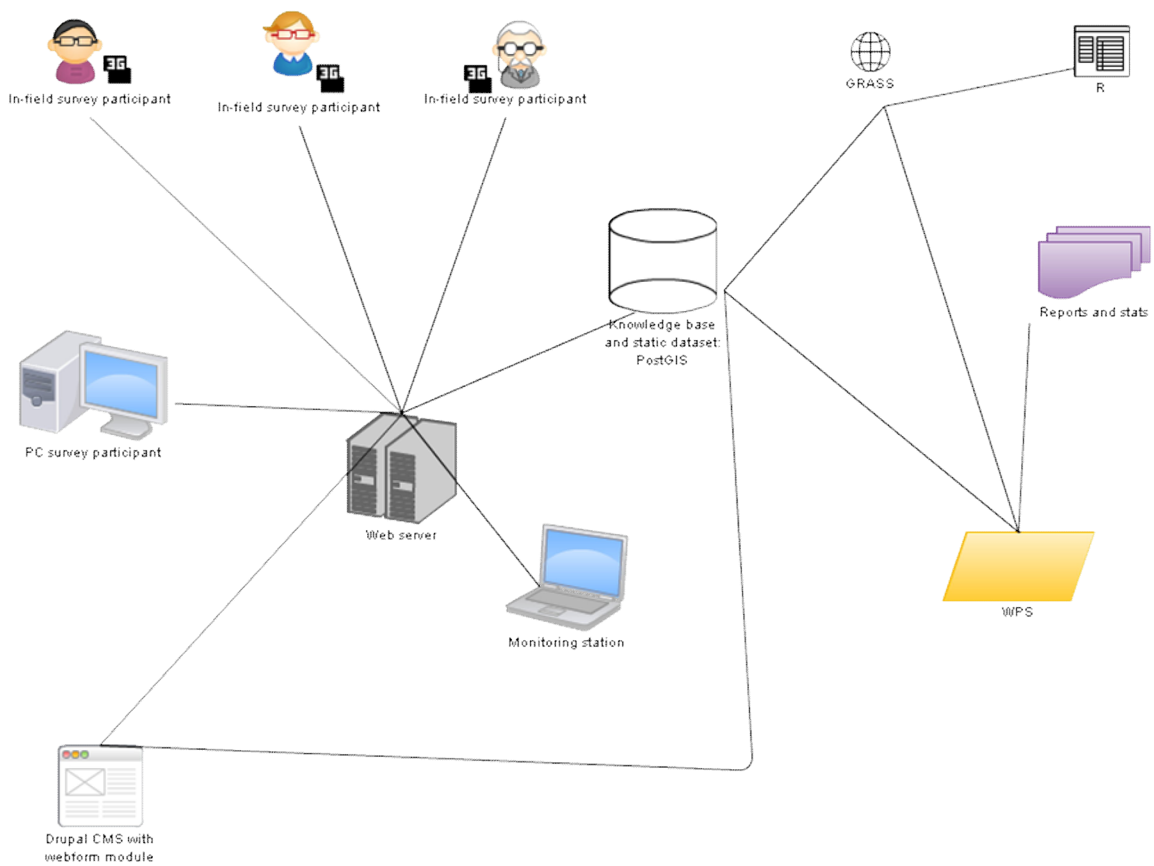

Figure 1 - Interoperable Framework for Mobile Dynamic Surveying

The surveying system (Figure 1) consists of the following software, hardware and data components:

- **Geoserver** - a Java-based software server that allows users to view and feed geospatial data. Using open standards set forth by the Open Geospatial Consortium (OGC 06:56), GeoServer brings great flexibility in terms of map creation and data sharing, and is the heart of the GIS survey system.
- **Map base layer** – geographical context and administration boundaries are based on Openstreetmap (OSM) and Ordnance Survey (OS) raster layers.
- **PostGIS RDBMS**, adding support for geographic objects to the object-relational database, "spatially enables" the PostgreSQL server, allowing it to be used as a backend spatial database for the GIS, thereby allowing the survey results to be stored and processed for post-survey analysis.
- **WPS**, Open Geospatial Consortium Web Processing Service, can be configured to offer any sort of GIS functionality to clients across a network, including access to computational models that operate on spatially referenced data. This system is using helpers from GIS-enabled “GRASS” software and connected “R” processing software, a language and environment for statistical computing and graphics.
- **Smart-phone**, a modern Android-based device, with 1- and 3-G Internet connectivity, a GPS on-board, a touch-screen and a web browser with HTML5 location capability, which enables a direct device-browser interface.
- **Drupal -** powerful content management platform for building nearly any kind of website: from blogs and micro-sites to collaborative social communities.
- **OpenLayers,** is a pure JavaScript library for displaying map data from any source in most modern web browsers, with no server-side dependencies. It is effectively an open source equivalent to Google Maps or Microsoft Bing Maps API.

As shown on Figure 1, submissions from a Drupal webform are saved in a database table and can optionally be mailed to a nominated e-mail address upon submission. Past submissions are viewable for users with the correct permissions. Webform can contain some simple statistical tools to help in form design and evaluation and also allows the whole table to be downloaded as a Comma-separated values (CSV) file for detailed statistical analysis. Geoserver stores and serves geospatial enabled data together with static map layers. The presentation layer is built using OpenLayers.

3 Adaptive driven architecture

The Web-browser base rapidly reduces the effort required in application distribution: it allows active support from a central knowledge base, that can consist of virtually unlimited layers of information, not only static, but also actively fed by remote sensors. These sensors include not only technical devices e.g. temperature or weather conditions, but also human generated content, as RSS or Twitter feeds, with pre-programmed search ontology. The in-field surveyor can have survey questions, which are dynamically, adapted by the surveying system, using artificial intelligence rules based on surveyor location, changes in the knowledge base or answers given by near-by surveyors. The approach has application over a huge range of disciplines.

4 Progress and next steps

We have tested the concept in two use cases. Firstly in tranquillity mapping (Jackson, Fuller, and Dunsford, 2008), where traditional modelling and paper methods are not flexible enough to add another dimensions, e.g. location mixed with a user feedback, neither to orientate the users to improve sampling data in a specific area or specific range of questions.

The second is related to health science, based on data related to gastrointestinal disease in Nottinghamshire. A location-based survey in this context helps to identify a source of the disease and to monitor any outbreak of an epidemic. The aim of the use case is to assess the relevance of participatory health surveys in a form of a symptom checker in order to develop public understanding and health support, which can also alleviate some pressures on the healthcare system.

The next phase is to extend the initial deployment to make off-line surveys available, when the internet connection of ubiquitous devices is slow or sometimes inaccessible. Maintaining the use of OGC standards for data exchange will allow the system to be improved on the client side with mapping services such as the open source gvSIG.

Another aspect of future research is feeding the knowledge base from other sources of crowed-source data seemingly independent of the survey, such as live data coming from Twitter. However, in-field devices should have a built-in software sensor, continuously measuring internet connectivity, and contacting the server to exchange gathered data for new questionnaires as frequently as it is possible.

5 Acknowledgements

This work is sponsored by a grant that is co funded by EPSRC and SciSys UK Ltd.

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