A Reconfigurable Citizen Observatory Platform for the Brussels Capital Region

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Key messages

Today’s citizen observatories are beyond the reach of most societal stakeholder groups.

A generic approach towards reusable and reconfigurable citizen observatories is required.

This project’s prototype platform shows great potential and draws a lot of stakeholder interest.

The Brussels Capital Region should provide a professional configurable citizen observatory platform.

Participatory sensing techniques should be included in environmental studies performed in the Brussels Capital Region.

Introduction

The evolution of the smartphone as a general computing platform combined with the rich sensing functionalities that it has acquired in recent years, have led to a new collective data gathering paradigm called participatory sensing. Participatory sensing is the driving technology behind so-called citizen observatories; i.e. a set of cloud-based software tools that are used to gather, analyse and visualise data by a group of citizens that share some collective concern. Participatory sensing is often used in so-called campaigns. A campaign is a collective data gathering effort that is delimited in both space and/or time.

Today citizen observatories have to be developed from scratch for each application domain, meaning that deploying a new citizen observatory is nothing less than a complex cloud-driven software engineering project that is extremely labour-intensive precisely because of its technical complexity. Despite an overwhelming demand for such platforms, they are thus beyond the reach of most societal stakeholder groups.

What is needed is a generic approach towards reusable and (re-)configurable citizen observatories, i.e. a platform that can be used by stakeholders to create new and adapt existing citizen observatories. Thus, apart from the technical design challenges, a key requirement of such a platform is that it is easily accessible by societal stakeholders and communities. Deploying a new citizen observatory and setting up campaigns through the meta-platform should therefore be possible without or with only very limited programming skills.

Methods, approaches and results

Starting from an initial literature study and previous experiences with participatory sensing, we created a formal modal of participatory campaigning and identified similarities between various existing citizen observatories. From this, a generic citizen observatory architecture was defined on which we performed a requirement analysis and identified the key challenges of a reconfigurable citizen observatory platform. To facilitate the implementation of a reconfigurable citizen observatory platform, we implemented a novel visual flow-based domain-specific language (VFBDSL), named DISCOPAR, that can handle the distributed nature of a citizen observatory's architecture. DISCOPAR is created specifically to hide the unwanted complexity of citizen observatories and their distributed nature from the ICT-agnostic end-user, and to present only concepts that are relevant to their domain.

DISCOPAR features a web-based visual programming environment (VPE) that provides end-users with the means to visually compose components into a graph through drag-and-drop interactions. This VPE is used throughout the reconfigurable citizen observatory platform to construct the various parts of a citizen observatory, i.e. mobile app, server-side data processing, and web-based visualisations. For example, Figure 1 depicts the use of DISCOPAR's VPE to design a citizen observatory's mobile app.

The reconfigurable citizen observatory platform developed during this project is available online at https://discopar.net/. To test is expressiveness and correctness, we created two radically different citizen observatories: an observatory on noise pollution, and another focussing on mapping pedestrian's experience of slow roads in Brussels. These observatories were validated during real-world campaigns.

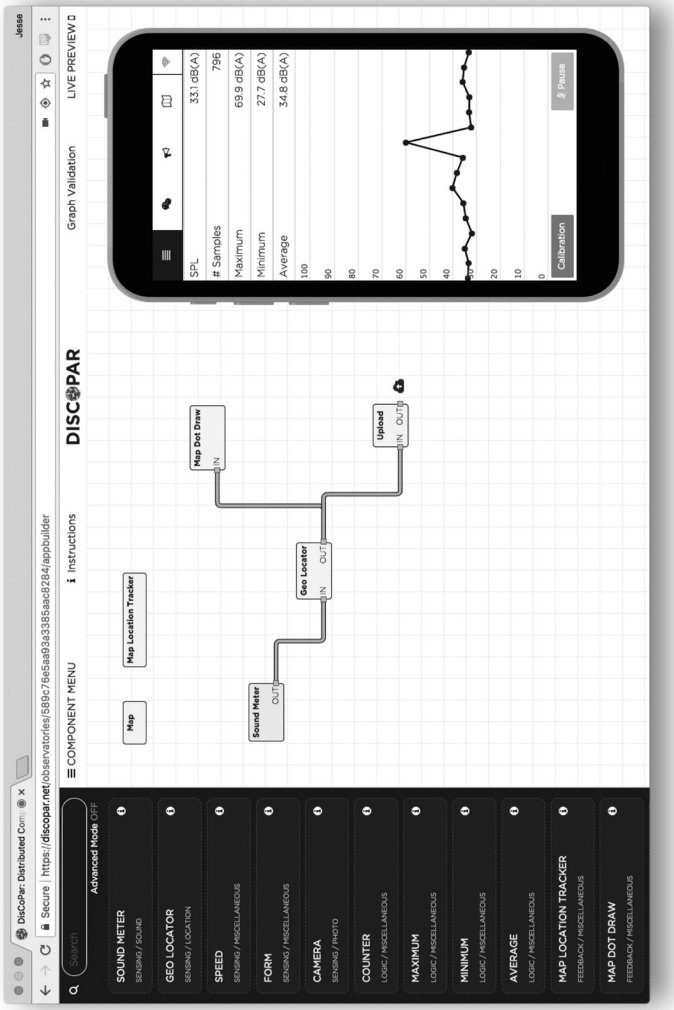

Figure 1 Creating a Mobile App using DISCOPAR's visual programming environment.

Conclusions

Despite the high societal demand, citizen observatory development remains labour-intensive, lengthy, and requires technical expertise. This led us to the idea of a generic approach towards reusable and (re-)configurable citizen observatories. During the various validation experiments and real-world deployments of our reconfigurable citizen observatory platform, we noticed its great potential and large amount of stakeholder interest. We therefore suggest that the BCR expands on this idea and provides the community with a professional configurable citizen observatory platform where anyone is allowed to create a citizen observatory and contribute measurements. We also suggest that a participatory data collecting approach is included in official environmental studies from now on, possibly by including employees of the BCR in the data collection process. Furthermore, we propose that all the data contributed to the citizen observatories is added to the Open Data platform of the BCR to increase its value.

Policy recommendations

1. Create a Professional Configurable Citizen Observatory Platform for the Brussels Capital Region

The two citizen observatories used in the validation of this research project are but the tip of the iceberg of the possibilities that a reconfigurable citizen observatory platform can offer. The reusability and configurability of such a platform makes it capable of implementing a wide variety of citizen observatories. Example applications that can be considered are itinerary planning, modal choice investigations, better management of loading/unloading areas for truck logistics, and assessment of urban traffic fluxes. With respect to urban traffic fluxes, an important connection can also be made with noise pollution, air pollution and, by extension, the effects of transport on health. As an example, one can envision coupling noise measurements with traffic information, using tags to obtain specific information on health-related issues (e.g. when does a person wake up, when is the traffic causing exhaust smells...). As another example, the highly localised nature of noise measurements could be connected to distribution of respiratory medication use to study correlations between traffic pollution and asthma. These are just instances of the type of applications one could implement by reconfiguring the observatory in the desired way.

The reconfigurable citizen observatory platform developed during this research project is only a research prototype. We therefore suggest the development of a professional consumer-ready configurable citizen observatory platform that is open to the community of the Brussels Capital Region (or even the entire country of Belgium). Such a platform would be the central hub for various environmental and personal studies performed in the Brussels Capital Region. While the Open Data Portal[I] is already a great first step in making data accessible to the community, the next logical step is actively involving the community in enhancing and extending the data included in the Open Data Portal. As such, the citizen observatory platform can be developed to automatically include its data into the Open Data Portal.

If a configurable CO platform is provided by the BCR, it would also increase the efficiency of various other research projects performed by reducing the workload involved in collecting data. During the many dissemination activities performed during this project and networking with other researchers, we noticed a great demand for our work and the platform we created. Many researchers stated something along the lines of "If only we had a mobile app to collect this information and a server to automatically process it, it would make our pen-and-paper approach obsolete". However, these were often researchers from a completely different domain than ICT, and thus did not have the knowledge on how to program such a system themselves, nor did they have the money to finance a developer to do it for them.

A configurable CO platform also eliminates the need for several already existing stand-alone platforms and the cost involved in hosting these platforms. For example, consider the FixMyStreet platform[II]. While this platform functions great and is still actively used, all of its features can be easily implemented by the platform developed in this research project. The configurable CO platform already provides support for the creation of a mobile app capable of taking photographs and adding a comment to them. As such, it is perfectly possible to build a CO focussing on reports incidents in the Brussels public space.

2. Include Participatory Approach in Existing Environmental Studies

Conventional data gathering methods used by governments and authorities in environmental studies, i.e., using a limited number of expensive sensors placed in strategic locations, have important limitations:

- → The number of sensors deployed in a city is usually limited. Data collection at sparse locations does not scale to meet a high spatial and temporal granularity.
- → Deploying a large number of sensors to cover the city is expensive, discouraging cities from applying this method due to budget limitations.
- → Sensors are usually placed in fixed locations, which means they are inherently measuring the environmental conditions at given places and not those surrounding actual people.

I Link
https://opendata.brussels.be/page/home/

II Link
https://fixmystreet.irisnet.be/

As smartphones matured as computing devices, they were gradually equipped with an increasing number of sensors. All these sensors have additional potential: they enhance our ability to measure the real world around us while we carry out our normal daily activities. For example, they can provide real-time information about the current temperature, or we can use them to determine whether noise levels fall within the desirable limits.

The use of smartphones as sensor nodes and location-aware data collection instruments led to the establishment of a new data gathering methodology, referred to as participatory sensing. This approach to data collection and interpretation relies on individuals, acting alone or in groups, along with their personal smartphones to systematically monitor personal information (e.g. health) and/or environmental information (e.g. noise levels, traffic conditions). Participatory sensing has the potential to collect enormous volumes of highly localised, person-centric data, which can support policy makers to assess urban processes in a way that was previously unthinkable. Previous experience with participatory sensing illustrated that there are occasions where the data from official studies are not correctly representing the reality. For example, noise pollution maps are often based on simulations and data interpolation. What may appear as a silent area on an official map, may in reality be a very loud area due to unforeseen and unmeasured causes.

We strongly advise the use of participatory sensing for any compatible environmental study performed in the Brussels Capital Region. Two main benefits of adopting this approach are (i) more fine-grained data can be collected, and (ii) the concept of a CO itself can be validated and perfected through experience. As such, PS becomes an even more reliable and accurate data gathering method. Obviously, PS can only be used in studies where the data in question can either be provided by the smartphone's sensors or manually filled in by users through a dedicated app.

In order to ensure a high data density throughout the Brussels Capital Region, we suggest to actively use employees of the BCR in the data collection process. For example, employees belonging to the "Gemeenschapswacht" are ideal candidates to carry around smartphones (potentially augmented with external sensors) to gather information about air quality, noise pollution, etc. during their daily activities. We therefore suggest exploring the possibilities and cost involved in equipping these employees with wearable sensors and/or using their personal smartphones as data gathering "station". Other people, such as waste collectors, federal police, etc. could also be used as data gatherers.

3. Promote and Enhance the Existing Open Data Portal

The Open Data Portal[III] provided by the City of Brussels is a great idea, but it should be further promoted. We propose that every researcher funded by the Brussels Capital Region that has any data worth contributing should be informed of the platform and encouraged to do so. For example, the Innoviris Anticipate project guidelines could instruct its researchers to add their data to the Open Data Portal.

In the current state, the Open Data portal provides relatively static data. This is mainly caused by the fact that the used visualisations and underlying server-technology is not aimed at providing real-time dynamic data visualisations and analytics. However, it may be interesting to provide more dynamic data visualisations. For example, a real-time map tracking every public transport vehicle in the Brussels Capital Region, where the number of passengers are indicated and updated in real-time for each vehicle. Such a real-time stream of information could then be used by researchers such as ourselves to feed into data processing and learning algorithms to analyse and predict all sorts of behaviour.

III Link
https://opendata.brussels.be/page/home/

List of publications

Zaman J. & De Meuter W.
2016
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In 2016 IEEE International Conference on Mobile Services (MS) (pp. 79-86). IEEE.

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A flow-based programming framework for mobile App development.
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2014
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2014
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In 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing (pp. 727-738).

The author & project

Jesse Zaman is a PhD researcher at the Software Languages Lab of the Vrije Universiteit Brussel. His research is primarily focussed on developing a new generation of citizen observatory platforms through the use of state of the art technologies in reactive programming and web-based technologies. During his Innoviris project "A Cloud-Based Reactive Infrastructure for Modelling Participatory Sensing Campaigns --- Towards Mapping Mobility Parameters in Brussels", a first prototype of a reconfigurable citizen observatory platform, named DISCOPAR, was developed where ICT-agnostic end-users can create their own citizen observatory without any programming knowledge.

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