Using behavior data for creating awareness in motorists about emission consequences

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Abstract
Personal data is increasingly used by cities to track the behavior of their inhabitants. While the data is often used to mainly provide information to the authorities, it can also be harnessed for providing information to the citizens in real-time. In an on-going research project on increasing the awareness of motorists w.r.t. the environmental consequences of their driving behavior, we make use of sensors, artificial intelligence, and real-time feedback to design an intervention. A key component for successful deployment of the system is data related to the personal driving behavior of individual motorists. Through this outset, we identify challenges and research questions that relate to the use of personal data in systems, which are designed to increase the quality of life of the inhabitants of the built environment.

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Artificial intelligence; environmental awareness; societal awareness; privacy; community-based computing

ACM Classification Keywords
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Introduction

The current state of ubiquitous computing and sensing technologies has created opportunities for repurposing parts of the built environment to track the actions and behavior of people situated in the environment [1]. Many cities already track the behavior of inhabitants in various contexts, such as movement of vehicles in the transportation network and public engagement with the services of the city [2]. The purpose is often to provide information to the authorities, but some authorities also communicate aggregated data to the inhabitants.

The Urban Experiences and Smart Citizens (UrbanUX[1]) research group at The Hague University of Applied Sciences is currently investigating how sensing technologies and artificial intelligence (AI) could be used in public spaces to motivate and engage citizens to act for the benefit of their community. The variety of potential contexts ranges from playful interactive installations designed to inform people about recycling to making people aware of the health-related consequences of their behavior, which may be positive or negative. Obviously, this kind of research is not without challenges related to the use of personal data.

In this position paper, we highlight some of the opportunities and challenges of using personal data in the built environment through a case from our on-going research: tracking the behavior of motorists to create a real-time intervention aiming at making the motorists more aware of the impact of their driving on air pollution and, consequently, the health of the surrounding communities.

[1] http://www.urbanux.nl

The Case of Increasing Environmental Awareness of Drivers

Many large cities suffer from poor air quality due to air pollution. Transportation networks, such as roads, are an integral part of the built environment and traffic on the roads contributes to air pollution. Exhaust gases from cars contribute not only to well-known greenhouse gas emissions such as carbon dioxide (CO_2) and nitrogen oxides (NO_x) but also to substances such as ultra-fine particles that are directly harmful to human health and can cause cardiorespiratory morbidity and cancer [5]. Our main assumption is that drivers of private cars are not fully aware of the impact their behavior has on personal health of others in the polluted areas. This lack of awareness likely extends also to the inhabitants of these polluted areas.

The city of The Hague has been identified to have several areas, which belong to the top-20 list of most air polluted areas in the Netherlands [3]. Therefore, we are designing an intervention for one of these areas in the city to increase the awareness of car drivers of their contribution to air pollution and its adverse health effects. In our perspective, creating this awareness is the first step towards changing the behavior of the drivers.

As a source of inspiration, we consider speed displays that are commonly found on the side of many roads. These displays are effective, because they give immediate feedback to the drivers while they are engaged in a potentially harmful or illegal activity (speeding). The speed of the car can be considered as personal data, which is visible to the driver of the car and those near the car. In a similar fashion, we aim at

informing the drivers about their pollution contribution while they are driving their car.

In terms of technology, we are investigating the use of sensors, integrated in the built environment, to track particularly harmful behavior such as idling or unnecessary acceleration, which often occur especially during traffic congestion. The speed of the car, its make and model, and the driving style of the driver have influence on how much pollutants the car is emitting. This kind of data is inherently personal. However, we wish to pursue a community-based approach, in which not only the driver but also the broader surrounding community is made aware of the data. This is a design challenge that we are going to tackle through user-centered activities involving all the primary stakeholders: the drivers, the inhabitants and users of the built environment, and the local authorities.

In an example scenario, the driver accelerates too fast or idles for too long at a pollution-prone area. The sensors in the built environment near the road capture the actions and artificial intelligence translates these actions to provide meaningful feedback to the driver in real-time to increase the driver's awareness of the emissions and their consequences.

Challenges and Open Research Questions

In early stages of the research, we have identified four interrelated challenges w.r.t the use of personal data in the described case:

1. From personal data to shared data.
2. Avoiding the "surveillance city" [4] dilemma.
3. Volunteering to share the data.
4. Motivating behavior change.

From personal data to shared data

A possible solution to displaying the feedback to the driver is a side-of-the-road display akin to the current speed displays. The benefit would be that also the surrounding community becomes aware of the air pollution phenomenon. In this case, a significant challenge is to design the feedback in a way that is informative to the driver and the community, but does not lead to stigmatizing the driver. If the community would see detailed data related to the emissions of individual vehicles, it could soon lead to adverse social reactions. This leads to the following research question:

- What data should be displayed in public and in real time, to make both the driver and the community aware of the emissions and their consequences, while respecting the privacy of the driver?

An alternative to the public display would be to utilize a personal display. For example, it would technically be straightforward to develop a mobile application for drivers that would give a more detailed and personal view to their pollutant emissions. The significant challenge in this approach would be that the drivers would have to "opt-in" to access the data, i.e., willingly use the mobile application on their personal device. This yields the question:

- How to motivate drivers to access the data related to the emissions of their vehicle?

Avoiding the "surveillance city" dilemma

While the air pollution problem is shared by all the inhabitants of the city, drivers might be reluctant to make use of the feedback if it comes from a system

that they consider as policing or correctional. Thus, an important research question for user-centered design activities is:

- How to present the intervention in a way that is not perceived as policing by the drivers?

Volunteering to share the data
Closely related to the previous challenges is a traditional privacy conundrum. For the system to be effective, it would need access to data such as instantaneous speed of the car, which can be considered as personal data that drivers might not be interested in sharing with the system. The sensors could of course capture this data anyway, but without an "informed consent" of the driver there is a risk to introduce the perception of a surveillance city, which would likely have a negative impact on the effectiveness of the system. Thus, in the research we need to find out:

- How can we motivate drivers to share their data with the system?

Motivating behavior change
Our eventual aim is to increase awareness and stimulate behavior change. Awareness of consequences of current behavior, in these scenarios, will require extrapolation and aggregation of data: "if everyone would behave like this all the time, then…" It also requires presenting convincing possibilities to change and achieve significant improvements. This leads to the question:

- How to convincingly show that alternative behavior in driving can significantly reduce negative consequences?

Conclusion

As the research is currently in early stages, we do not yet have answers to our research questions. However, the themes that they address will be an integral part of the user-centered activities we will undertake with the stakeholders. These activities will include co-design sessions, in which we aim at utilizing the research through design approach to find answers to the open questions and guide the design of a successful intervention. With these co-design activities, we are also empowering the primary target group, the motorists, to have a genuine impact on the design of the intervention and the use of their personal data.

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