Patterns in Movement

Tom Gross
Faculty of Media, Bauhaus-University Weimar, Germany
(tom.gross(at)medien.uni-weimar.de)

Abstract. Knowledge workers frequently work at various places and on a flexible schedule. In order to support this flexibility of the individual and at the same time provide teams with a common frame of reference that is needed for the coordination in the team, knowledge workers need tools that provide adequate support depending on the respective location and activity. In this position paper we introduce the sensor-based platform Sens-ation and describe how it can be used to identify patterns in users' movements.

1 Introduction

Knowledge workers according to Peter Drucker do not have a permanent working place and strict schedule [Drucker 2000]. Rather knowledge workers frequently work at various places such as in their personal office, in meetings, at home and on a flexible schedule depending on the requirements of their working partners and their own commitments. In order to support this flexibility of the individual and at the same time provide teams with a common frame of reference that is needed for the coordination in the team, knowledge workers need tools that provide adequate support depending on the respective location and activity [Dourish 2006]. Such tools need to capture information on the users, their positions and movements in space, their activities, and their surrounding. Next these tools aim to detect the users' context by inferring on the captured data. Finally, they provide information and functionality that is adequate for the users and the situation. Despite the considerable time and effort that has been put into context detection still automatic adaptations have their limitations [Erickson 2002]. Nevertheless, in this position paper we want to briefly introduce Sens-ation, a platform that supports developers of sensor-based platforms with basic concepts and technology for capturing and inferring on data as well as on adapting environments. We particularly want to focus on recent work on mining on users' position data and the finding with relation to patterns of user's movements.

2 Sens-ation

Sens-ation provides an interoperable service-oriented sensor platform, which supports access, discovery, and use of real-time data obtained directly from sensors over the wired or wireless networks [Gross *et al*. 2006; Gross *et al*. (accepted)]. The service-oriented paradigm [Singh & Huhns 2005] of Sens-ation based on service providers, service consumers, and brokers enables standardised communication within the platform, and between the platform and the sensors. Each Sens-ation server can act as a Web service provider. These service providers allow encapsulating and hiding of all specific hardware implementation details of their attached sensors. They provide a simple common interface for other application to obtain real-time sensor data, or persistently stored past sensor data. The service consumers are independent of the Sens-ation service provider so that a service consumer does not depend on the implementation of the service and communicates with it according to a well-defined interface. A Sens-ation broker contains information about Sens-ation service providers such as their registered sensors and their location. A service consumer can discover available sensors and their contact information via a broker. The service consumer can then directly request required sensor data from that service.

3 From Positions to Significant Places

So far, Sens-ation has been used in several static scenarios, where specific rooms (e.g., personal offices, student laboratories) have been equipped with sensors, inferences were made (e.g., detecting a room state), and adaptations were done (e.g., changing the information displayed on smart doorplates).

Only recently we started collecting location data and inferring on them. Over the last six months we collected position data of users with the GPSCoordsLogger—a J2ME tool [Sun Microsystems 2007] that runs on the users' mobile phones, collects GPS data from GPS mice via bluetooth, and stores these data on the mobile phone. The users can then synchronise these data with their computers and send these data to Sens-ation. In Sens-ation an inference engine uses Hidden Markov Models [Rabiner & Juang 1986] to detect significant places (i.e., distinguish locations where users either spend considerable time or go frequently from movements between these locations). Based on a given current location the inference engine can also provide estimations of potential next locations (i.e., typical movement patters such as from office to the apartment).

Figure 1. GPSCoodsLogger, Location-Time Rhythm, Location Prediction.

Figure 1 shows a screenshot of the GPSCoordsLogger (this screenshot is taken from a Sony-Ericsson mobile phone) on the left; the Location-Time Rhythm (i.e., the neighbourhood of the current user and two locations the user typically visits, and the time of the typical visits in a 24-hour pie chart) in the centre; and the Location prediction (i.e., a white bar showing the user's current position, and two green bars showing possible next locations including the probability as height of the light green part) on the right.

4 Conclusions

In this workshop I would like to contribute some ideas and preliminary results of automatic detection of patterns of movement. Studying and understanding movement is a complex issue. I would be particularly interesting in exchanging ideas and experience from movement studies—both qualitative and quantitative—and from the design and implementation of systems providing adequate support for social interaction of mobile knowledge workers.

Tom Gross is associate professor for Computer-Supported Cooperative Work and head of the Cooperative Media Lab at the Faculty of Media of the Bauhaus-University Weimar, Germany. His research interests include Computer-Supported Cooperative Work, Human-Computer Interaction, and Ubiquitous Computing.

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