

Chapter 42

Nikko: A Sensor Management System for Ambient Intelligence and Urban Computing Environments

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ABSTRACT

Nowadays smartphones are equipped with a large amount of sensors, including GPS, accelerometers, cameras, microphones, and light sensors. These sensors are the perfect way for sensing the context in which a user is located. This chapter describes a simple framework able to recognize different kind of events triggered by sensors, distributing them among interactive objects. This framework has been tested in an application able to recognize the movement of a user in indoor and outer locations, and in another one able to detect a user's falls and car accidents analyzing the information provided by the accelerometers of a smartphone. The proposed application is an example of the framework utilization based on the combination of the existing sensors in a common smartphones. This method tries to minimize the typical error localization inaccuracy of current systems. One of the main motivations of this chapter is to demonstrate the possibility to successfully manage and add different kind of sensors to an application.

INTRODUCTION

The need for location awareness is a key functionality in many of today's applications in Ambient Intelligence, Urban Computing and Augmented Accessibility environments. Global Positioning System (GPS) has become an everyday use item

and users demand to still be able to use wireless localization in an indoor environment even when the GPS signal is not accessible. Some indoor localization systems utilize WiFi/GSM based fingerprinting and triangulation to localize smartphones. The error ranging from these systems go from 50m to 500m, so such error margins on

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some applications cannot be acceptable. Even though if these systems reduce errors bounds to a couple of meters it will still not be enough for some applications.

Our motivation is to create an open framework for the development of applications in Ambient Intelligence and Urban Computing and Augmented Accessibility environments, able to collect, manage and distribute mobile-based sensor-related events in an easy way. This framework, called Nikko, facilitates the interaction between sensors (like accelerometers, GPS, video cameras, and so on) and business objects containing the logic layer of the application. These objects can be located in the mobile device for local processing (e.g. displaying the sensor's data in a smartphone's screen) or in remote locations in cloud computing environments (e.g. to recording users' actions in remote servers for late massive data mining processing).

In this document we will focus our analysis on how such framework may be used to increase the accuracy of location awareness in Ambient Intelligence Urban Computing and Augmented Accessibility environments combining the data provided by several sensors. The estimation of the position and the orientation of the user are made by combining all the recollected data ensuring the user location coherence. The goal is to receive as much information as possible from all the sensors connected to the framework to make a much more efficient estimation.

Almost any kind of sensor included in a state of the art Android smartphone can be added to this framework, including cameras, internal and external GPS, sound sensors, light sensors and even Augmented Reality Systems, which can be used to detect distances (Malbezin et al) and/or special objects like beacons and specific colors present in the user's context.

The developed framework can also work in collaboration with external sensors in other smartphones, like the ones installed on buildings for indoor localization systems like infrared transmit-

ters (Hiyama et al 2005), RFID tags (Ghiani et al 2009), VHF radio (Iketa et al 2008), or Bluetooth beacons (Bruns et al 2007).

RELATED WORK

Many kinds of sensors are used for positioning technologies, including radio signal time (Cheng et al, 2004) or signal strength (Niculescu and Nath, 2003), (Nagpal, 1999), infra-red (Stoleru et al) or ultrasound (Nissanka et al, 2000) sensors. But as described by I.M. Zendjebil (Zendjebil et al 2008), the idea of joining several sensors together is not recent. Vieville et al. (1993) propose to use inertial sensor with vision for autonomous robotics. The first outdoor AR systems such as MARS (Hollerer, 1999) (Mobile Augmented Reality System) and BARS (Julier et al, 2000) (Battlefield Augmented Reality System) used a GPS to estimate the absolute position of the user, and an inertial sensor coupled with an electronic compass to estimate the orientation.

There are two strategies of combination described by Zendjebil et al (2008):

- The first strategy consists in merging data from various sensors to make estimations of a user location. You et al (1999) combine a vision system with three gyroscopes to estimate the orientation. The 3D orientations provided by the gyroscopes are fused with the 2D motion of the camera using a Predictive/Correction model. Riho et al. (2002) propose to combine point-based tracking method with data provided by an inertial sensor to recover the position and orientation using an Extended Kalman Filter.
- The second strategy consists in using an alternative sensor when there is a sensor failure in the main source of data. Thus, Aron et al. (2007) suggest using the inertial sensor only when visual tracking fails.

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