Chapter XI

Kindergarten: A Novel Communication Mechanism for Mobile Context-Aware Applications

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ABSTRACT

Mobile context-aware applications have specific needs regarding data communications and position sensing, that current standard hardware is still not able to fulfill. Current mechanisms are inadequate for applications that need constant communications because of their high power needs and low precision when used to measure the physical indoor position of a mobile device. For this reason the authors have created a new, flexible and inexpensive technology that aims to solve both the needs of communication and position estimation on mobile platforms. This new network type uses recently developed technology to minimize power consumption, leading to a longer battery life and maximizing the precision of the position sensing of the device. Finally, on top of their hardware platform they have devised a software layer, named Kindergarten, which allows high-level languages to interact with the underlying hardware.
INTRODUCTION

During the last decade, mobile context-aware (CA) applications have been gaining importance and are slowly weaving into everyday life. In a conscious and seamless fashion, we start to get used to incorporate new technologies, appliances and applications that where almost unthinkable ten years ago. The penetration of this kind of applications in the society is mainly due to improvements in hardware and communication areas.

However we are still far from having solved all these issues in these areas. Even tough there are different hardware devices and protocols for wireless communication and position estimation, we still need one that is small enough to be integrated into a wide range of appliances, not only PDAs and Smartphones, but also in active badges or key rings. This device must also have very low power consumption, so that the mobile appliance’s battery life is not significantly shortened. Most current wireless communication standards have successfully accomplished the size constraint, being effectively embedded in mobile devices. However, low power consumption is still an unresolved issue which leads us to the necessity of conceiving a new kind of hardware.

During our research we tested existing technologies for suitability in our project, including Wi-Fi (O’Hara & Petrick, 1999) and Bluetooth (Morrow, 2002) which, despite their presence in nearly all current PDAs and Smartphones, we found to be too power-hungry. We also tested GPS (Hofmann-Wellenhof, Lichtenegger & Collins, 2004), whose location sensing capabilities only work outdoors making it unusable inside buildings. Unfortunately we arrived to the conclusion that there is no standard hardware device that can be added to any mobile system and that can be used for both communication and position sensing in a practical manner. For this reason we decided to build our own hardware and software platform to communicate and position mobile devices in an efficient way. In this chapter we will describe the design and implementation of our software/hardware combination, which is designed to provide a balance between network bandwidth, power consumption and roaming capabilities. To complement this work, at the end of the chapter we present an example showing how the hardware is combined with our sensing layer to develop context-aware applications. In particular we will show how to use Kindergarten to provide location-based services (Rao, Minakakis, 2003).

PREVIOUS WORK

In order to understand our needs for new hardware and sensing architectures, we have to consider previous approaches and analyze their weaknesses and strengths. In the next subsections we will discuss some of the most pervasive communication and location mechanisms available today. In particular we will describe Infrared, Bluetooth, Wi-Fi and GPS technologies and examine their characteristics from the point of view of a CA application.

Infrared Port

Maybe the most basic device at the hardware level is the infrared (IR) port, which is primarily considered as a communications interface for small devices such as PDAs or cell phones (Knutson & Brown, 2004). In its most pure form, as defined by the IrDA association (IrDA, n.d.), an infrared port sends and receives data between two devices coding it as a stream of infrared pulses. Each device has a small infrared emitter (an infrared LED) to send the light pulses to the other device and an infrared detector to receive the ones sent to it.

This mechanism leaves to software stacks the responsibility of assembling and disassembling the higher-level data structures to allow applications in both sides of the infrared link to exchange data in a reliable and structured way.
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