Chapter 8.9
Virtual Cities for Simulating Smart Urban Public Spaces

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ABSTRACT

Many research projects have studied various aspects of smart environments including smart rooms, home, and offices. Few projects, however, have studied smart urban public spaces such as smart railway stations and airports due to the lack of an experimental environment. We propose virtual cities as a testbed for examining the design of smart urban public spaces. We developed an intelligent emergency guidance system for subway stations and used the virtual subway station platform to analyze the effects of the system. This experience allows us to argue that simulations in virtual cities are useful to pre-test the design of smart urban public spaces and estimate the possible outcome of real-life scenarios.

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INTRODUCTION

Virtual cities are three-dimensional graphical representations of digital cities (Ishida, 2002a). This chapter describes virtual cities for testing smart environments installed in large-scale crowded urban public spaces such as airports and railway stations. Smart environments are living spaces with embedded abilities to perceive what their inhabitants are doing and support their lives. Since living spaces vary with respect to scale, smart environments of various sizes have been developed: smart rooms (Bobick et al., 1999), smart classrooms (Brotherton & Abowd, 2004), smart homes (Kidd et al., 1999), smart offices (Addlesee et al., 2001), and smart conference sites (Sumi & Mase, 2001). There have been few attempts, however, to develop smart environments in urban public spaces such as airports and railway stations, even though they are an essential part of our everyday life. A manifest reason for this is the sheer vastness of such spaces. Many researchers have built their own room (Bobick et al., 1999) and home (Kidd et al., 1999) in which to conduct their projects, but it is almost impossible to build urban public spaces in research laboratories. Conference sites are too large to be purpose-built as laboratories, too. However, there is no need to do so, since researchers prefer to take advantage of actual conference events as testbeds for evaluating their systems (Sumi & Mase, 2001). Such deployment is preferred also for testing smart classrooms (Brotherton & Abowd, 2004) and smart offices (Addlesee et al., 2001). Deployment of smart urban public spaces is challenging, because it is difficult not only to attach sensors to the spaces but also to involve the visitors in situ; it can be awkward or prohibited to ask them to participate in experiments. Furthermore, it is usually impossible to shut visitors out of the space and occupy it in order to conduct experiments with study participants. We propose virtual cities as a solution. We present a user testing method that utilizes virtual cities populated with scenario-controlled software agents developed by us (Ishida, 2002b).

More than 300,000 passengers pass through Kyoto station, the main railway station in Kyoto City, every day. In this station we installed a guidance system that tracks passengers to help their navigation based on their current positions (Nakanishi et al., 2004). Beyond conventional navigation systems, which passively present route information, our system proactively sends instructions to the individuals' mobile phones to control their routes and avoid congestion. The system's primary application is crowd control in emergency situations. Fortunately, we were permitted to attach positioning sensors to the station's subway platform and install the system, though we were not allowed to conduct experiments that would employ many subjects playing the role of an escaping crowd. To conduct experiments without occupying urban public spaces, we developed a virtual city simulator integrating a large number of software agents and humans into the same crowd. This simulator can produce complex group behaviors such as escaping crowds. This simulator enables the agent-based user testing described in this chapter.

The next section explains how agents, humans, and avatars are integrated in the agent-based user testing. The third section presents an experiment, which was conducted to see how the user testing method can work on our guidance system. In the fourth section we discuss implications obtained from the experiment. The fifth section summarizes related work. The sixth section concludes this chapter.

AGENT-BASED USER TESTING

Augmented Experiments by Agents and Humans

We developed an AR (Augmented Reality) based user interface for the virtual city simulator. Even in a crowded urban public space, it is not difficult to test smart environments that support individuals (e.g. normal pedestrian navigation systems (Abowd et al, 1997), since an experiment in which just one person or a group is taking part does not disturb the space. In contrast, it is extremely intrusive to test smart environments that support crowds (e.g. crowd navigation systems such as our emergency guidance system). To solve this problem, we contrived multi-agent crowd simulations that can be overlaid onto physical spaces. A large number of agents in the simulation augment an on-site small-scale experiment. We call this kind of experiment an "augmented experiment"