Using Quake III Arena to Simulate Sensors and Actuators when Evaluating and Testing Mobile Services

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ABSTRACT
We describe QuakeSim, a system that uses Quake III Arena to evaluate, test, and demonstrate context aware services. Context, such as users position or activity, is simulated in Quake and provided to real-world services as real data. The simulation is made more realistic by modeling real physical environments and calibrating the models to correspond to reality. QuakeSim allows simulated and actual context information to be used interchangeably in real services.

Keywords
Ubiquitous computing, mobile services, context aware computing, positioning technologies, quake simulator

CONTEXT AWARE SERVICES
Ubiquitous and mobile computing [3] deals with the possibilities and problems of using computing technology for fun or work in everyday situations. The computer of the desktop is replaced by mobile devices or specialized computers built into the fabric of everyday life. Users perform tasks using services in the network instead of applications on a PC.

The set of services that may be useful in this scenario is as great as the set of applications that is used traditionally. In the context of the present work, however, we have focused on services which are based on context information.

In our work in the area of ubiquitous and mobile computing we have built a number of services that make use of context information: in the *GeoNotes*[1] system we allow users to annotate their present location with virtual Post-It™-like notes; in another project we give family members a sense of awareness of each other using location, activity, time, and other context information.

QUAKESIM
One of the most interesting pieces of context information, and also one of the most readily available using current technologies, is the user's location. A person's location may be deduced by a number of means: a personal Global Positioning System (GPS) device, network based Global System for Mobile Communications (GSM) positioning, infrared beacons, radio receivers, etc. [1]

For example, to post a note in GeoNotes, a user performs the post operation. The service places the virtual note in a location defined by the user's present location in physical space. As another user passes this physical location, the note is presented to the other user.

However, a person's location, as well as many other pieces of context information, is directly tied to the real physical world. This makes it difficult to evaluate, test, and demonstrate context aware systems.

For example, to test GeoNotes, users are required to walk around in a real environment using not only the real GeoNotes system but also real positioning technology that provides accurate and actual positioning data.

For usability or scalability testing, it is obviously necessary to do real systems deployment in real environments. However, for demonstration purposes, development testing, and feasibility evaluation it would be preferable to *isolate* and *simulate* the physical-world context aspects of a system. This would enable systems to be developed with less regard for constraints that stem from using real sensor technology while still keeping the core functionality of the services separate and ready for real-world deployment.

For these reasons we have developed QuakeSim—a simulator for context information in physical space—which is useful for testing, demonstrating, and evaluating context aware services.

IMPLEMENTATION
In our current implementation of QuakeSim, we use a modified version of the 3D game Quake III Arena[1] for simulating positioning sensors in the real world and Georgia Tech's Context Toolkit [2] for gathering and publishing sensor information. We use GeoNotes as our

[1] See http://www.sics.se/humle/projects/GeoNotes/

[2] See http://www.idsoftware.com/

first example of a context aware and mobile service that we are able to test and demonstrate using QuakeSim.

Quake III Arena

Quake III Arena is a multi-user action game in which players experience the game from a first-person 3D view with other players represented by avatars.

We chose Quake as foundation for the simulator for several reasons. The Quake graphics engine is fast compared to e.g. VRML[2] engines and it can easily be deployed on a number of platforms. Quake allows sessions with several players in the same 3D model at the same time. Tools for creating 3D models of real world places, as well as avatars, sensors, and actuators, are freely available. Finally, the physics model that controls movement and behavior of objects is freely available with source code. This makes is easy to add simulated sensors (e.g. position and altitude registration and IR detection), as well as controlling actuators (e.g. door locks, light switches, and elevators), to Quake 3D models.

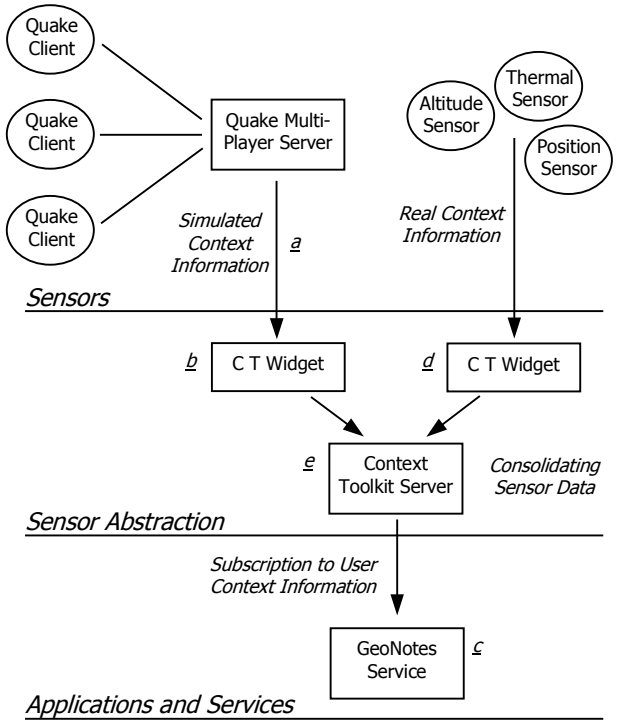

Figure 1. Schematic view of QuakeSim

In the present implementation of QuakeSim, we have provided each player in Quake with a positioning sensor and an altitude sensor. The position of a player, originally expressed in a local coordinate system of Quake, is converted into real world latitude-longitude coordinates. The altitude is converted into meters above sea level. If the 3D model is a copy of a real world place, the system adapts position and altitude to match the real world. The system may thus simultaneously use both the simulator and real sensors as input to context aware services.

[2] See http://www.vrml.org/

The Context Toolkit

The modified version of Quake provides simulated position and altitude information (see *a* in Figure 1). We use the context toolkit to make this context information available to the appropriate services.

The toolkit models sensory information as "widgets". Widgets encapsulate sensor specific details of gathering sensor information and provide a common interface towards services that make use of the information. Widgets also provide functions for communication with clients, updating of sensory data, polling of data, subscription to state changes, etc.

In QuakeSim we have encapsulated the modified version of Quake as a sensor in a Context Toolkit widget (see *b* in Figure 1). Therefore it is possible for a client to connect to and make use of the data that Quake provides using the API made available by the widget.

GeoNotes – an Example

GeoNotes (see *c* in Figure 1) implements a generic interface for acquiring position information. This makes it easy to switch from one source of data to another.

To test QuakeSim, we consequently configured GeoNotes to receive its positioning data from the Quake widget. To receive data from a real position data source the Quake widget can be transparently replaced by a widget representing the real sensor (see *d* in Figure 1). For this purpose, we use a Context Toolkit Server (see *e* in Figure 1), which enables us to consolidate several sources of sensory information.

DISCUSSION

We currently use QuakeSim to demonstrate GeoNotes and we intend to use it for demonstrations of other services as well. Users can now log into a common Quake server and simulate their movement in the physical world. The next development step is to allow data to be input into Quake to allow feedback from actions in the real world.

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