A Component-Based Simulation Environment for Large-Scale Simulation of Home Network Systems

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Abstract. In this paper, we propose a simulation environment for home network systems. The simulation environment consists of real houses, large-scale simulation testbeds and many simulation components such as environment, home appliances, electric power and human activity. These home simulations can install simulation components with different complexities. It enables the simulation to scale up the number of home on testbeds with limited nodes. As one of the results of the physical environment simulation, we compare the temperature measured in a real environment against that of a simulated. By being executed on large-scale testbeds and cooperating with real houses, the simulation achieves large-scale, realistic and real-time simulation of home network services, such as evaluating effects of an energy consumption service for a city of ten thousands households.

Keywords: simulation, emulation, home network, ubiquitous network, real-time, modeling, CFD.

1 Introduction

In this paper, we propose an ongoing research about realistic simulation environment for home network system, ubiquitous network system and context awareness system. The simulation environment consists of real houses, testbeds and home simulator based on simulation components. Figure 1 describes an overview of the simulation environment. The concept of the simulation environment is an emulation, which enables various home network applications to be executed with a native binary in real-time. The components of the simulation environment can be replaced with other simulation components or real objects.

The experimental environment is assumed to be StarBED[1] which is a large-scale networked testbed and on Home Network testbed. These testbeds provides functionalities to set up experimental configurations with supporting software (SpringOS[2], QOMET[3], RUNE[4]).

T. Magedanz et al. (Eds.): TridentCom 2010, LNICST 46, pp. 626–628, 2011.

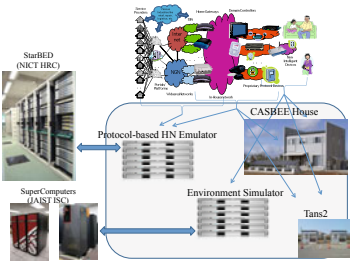

Fig. 1. Simulation Environment Overview

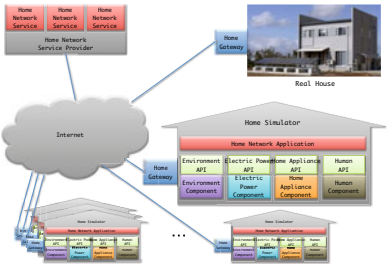

Fig. 2. Home Simulation

2 Home Simulator

The home simulator is a simulation of one house, which includes simulation components such as an environment, home appliances, electric power and human activity.The components are exchangeable for other simulation components. A combination of simulation components affects the complexity of the simulation, the speed of the simulation and the accuracy.

Figure 2 describes a simulation using a real house and home simulators. The home simulator provides common interfaces to access the home network. When an event occurs on the home, the home simulator changes the inner state of simulation components and sends appropriate control messages of home network if necessary.

3 Environment Simulation Component

The environment simulation component provides us for information related to physical space such as location, physical quantities (temperature, humidity, illumination), weather, disaster and so on. This information is measured as raw data by various sensors or is recognized as events by context awareness system.

One of the simulation components is the simulator of the physical environment properties, shown in figure 3. It calculates physical quantities using CFD (computational fluid dynamics). The calculated results can be accessed by the environment API to generate simulated sensor data in real-time.

As an evaluation of the simulation, we compared the simulation results of temperature with real experimental results. Figure 4 describes the comparison of the temperature of one room when air conditioner is cooling the room.

4 Future Works

In this paper, we proposed a simulation environment, which consists of real houses, testbeds and simulation components such as environment, home simulator, electric power and human activity. The simulation system executes in real-time to evaluate large-scale home network services.

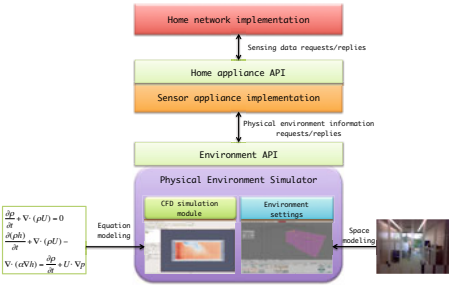

Fig. 3. Physical Environment Simulator

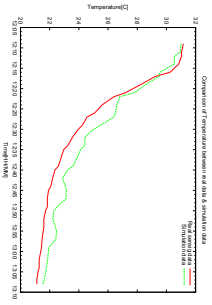

Fig. 4. Comparison of Temperature between real sensing data and simulation result

In future, we keep on developing more simulation components and enhancing the existing one. Currently, we are researching human simulation that models the behavior of residents using three statistical models. The first model is based on a statistical analysis of time schedules of human activities. These time schedules are generated by a profile and user preferences. The second model is a one-human activity model without contradicting behavior patterns. The third model is based on specific activities, which can be defined by the user. These three models can be used to simulate in order to human activity to evaluate home network services.

Finally we accumulate the simulation results to produce knowledge about various home network services.

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