Human behavior simulator in consideration of interaction with the elements in smart house simulation

Soichiro Okamura (1410012)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 10, 2016

Keywords: Human Behavior, Simulation, HEMS, Home Network.

In recent years, the popularization of the internet has led to many energy related equipment in the home to be connected to the network. Energy Management Systems (from now on referenced to as HEMS) that monitor and control their operation state are receiving a lot of attention.

The most basic service provided by hems is a visualization service that communicates power consumption information to the user in real time, in hopes that it will prompt the user to take action to reduce the overall power consumption. In general, in order to verify the effectiveness of a new service a proof-of-concept demonstration or simulation is used. When compared to a proof-of-concept demonstration, a verification method based on simulation turns out to be superior in terms of time, scale and thoroughness. However, in cases where the object of verification are services such as the visualization service where a lot of interaction happens between the user and the service, the results heavily depend on the reactions of the users that experience the service, thus the validity of the results comes into question. In previous research, heavy emphasis was placed on higher level concepts such as the user ' s needs and wants, used to generate users actions. The result was the implementation of a user behavior simulator framework which generated high quality user actions that can fulfill the needs of the next generation HEMS simulators. However, although the user ' s reaction is ultimately derived from high concepts such as the users ' will, in reality the user also takes advantage of other information that cannot be said to be directly related to higher concepts, such as information regarding physical properties like temperature, the operation of devices and equipment or any information provided by such equipment. This information is taken into consideration for the user ' s next action. It is necessary to recreate this process to achieve an accurate simulation. Based on these previous findings, in the current research a human behavior simulator that considers the interactions with the various entities of a smart house simulator is proposed and implemented. By interacting with various simulators such as a thermal environment simulator, an energy simulator and the real world (as represented by the experimental equipment present in the iHouse), the proposed Human Behavior Simulator exchanges information such as the operation status of devices, temperature, humidity and others, and through their mutual operation it is able to generate even higher quality user actions.

Furthermore, by having the results of the human behavior simulator be reflected in the real world, it is now possible to address the needs of systems that can automatically adjust the environment that the user actually wants by predicting the user ' s next action based on previous actions and the user ' s surrounding environment. In this research, although there is not a single item that can directly be attributed as the cause of user action, many elements that can prompt a change in the user ' s behavior were identified. The information regarding these elements comes from a thermal environment simulator, device simulator and the actual experimental equipment in the iHouse. To support these different kind of information sources, the information exchange format used for communication was defined. Furthermore, considering the output of the human behavior simulator and its reflection to the real world, simulators implemented in previous research would just output the higher level actions that a user would take and stop at that point. In reality, in order to operate a device, a user would go through a series of actions such as selecting an appropriate user interface such as a remote control or a switch, power up and then operate the device. By considering the above point, a functionality that translates higher level actions into such concrete commands was implemented in the proposed simulator. To test the effects of the human behavior simulator on the real world, the equipment present in the iHouse was used. Using as a base the command-level user actions that the human behavior simulator produces, we were able to operate household appliances of the iHouse by mapping these commands to commands of the ECHONET Lite protocol.

In this research, the basic infrastructure for communication with other simulators and the real world was put together. This infrastructure is necessary to generate human behavior that takes into consideration various elements of the home environment. As a result, the interaction with a thermal environment simulator, a device simulator and the interaction with the real world was demonstrated, and it is now possible to generate even more sophisticated human behavior by taking into consideration various elements.