User-Friendly Home Automation Based on 3D Virtual World

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***Abstract*— Home automation is a system to control things around the home such as a door, a light, surveillance systems and consumer electronics. A user can control a variety of home devices with the help of home automation. To provide mobility, a mobile-based home automation has been developed. Remote controlling and monitoring are possible with the mobile phone. As another home automation, an internet-based one has also been proposed and provides friendly graphic user interface. But the home automations mentioned above lack user-friendliness, neither intuitive nor realistic. To improve the user-friendly interface, 3D virtual world is adopted as the control interface for the home automation. With the help of 3D virtual world, a user can monitor the status of home devices and control them intuitively anywhere and anytime through the internet. The proposed home automation system can advance a 3D social network service by linking the virtual world to the real world.**

I. Introduction

The increasing number of consumer electronics and home appliances makes it necessary to connect them with one another for easy control. To achieve it, home automation emerges and enables the networked control. A user can easily control the home devices through the home automation system. And with the rapid development of cellular mobile technology, a mobile phone-based home automation has been developed by integrating mobile technology into home automation [1]. A hierarchical text menu helps a user select and control home devices. The mobile home automation provides remote control system for controlling and monitoring of home devices within the coverage of the mobile networks. With the proliferation of Internet, a variety of internet-based remote home automation systems have been proposed [2], [3]. The referred systems use the Internet as communication link and provide somewhat friendly graphic user interface such as a browser-style or a web-based menu. The internet-based system provides more user-friendly interface than the mobile home automation system. But the mobile and internet-based user interface has a limitation that it is not intuitive and less user-friendly. Therefore, more user-friendly user interface is required for a user to control home devices as if he does in his real house. The 3D virtual world technology is greatly needed to improve the user-friendliness [4], [5].

In this paper, we propose a home automation system based on 3D virtual world. With the proposed system, a user can have more user-friendly and intuitive control interface than a mobile and internet-based home automation system provides. He can easily control real home devices as if he is in the real world by controlling virtual home devices in the 3D virtual world

II. Proposed Home Automation Architecture Based on 3D Virtual World

The proposed home automation system is designed to be more user-friendly and intuitive. The system architecture is shown in Fig.1. It is composed of a metaverse client, a metaverse server and a home server. They have connections through the internet. The metaverse client communicates with the metaverse server through TCP/IP (Transmission control Protocol/Internet Protocol). The metaverse server communicates with the home server through the same protocol. The metaverse client plays a role of a graphic user interface to home automation. It has 3D rendering capability and a user can feel realistic graphic. The metaverse server consists of network daemons, zone daemons, database server and an authentication daemon. It configures a user's home with zone/map builder and contains various 3D objects. The home server is a kind of home automation controller. It is connected with various home devices such as a light, a window, an air-conditioner, a heating system, a gas valve, etc. It can control them and monitor the status of them.

A user can enter his house in the 3D virtual world through the metaverse client. He can find various virtual home devices similar to those in his real house. He can move around in the 3D virtual house and control home devices as if he controls them in the real world. Because the house's interior and home devices are modeled similar to the real objects, the virtual world is realistic and true to nature.

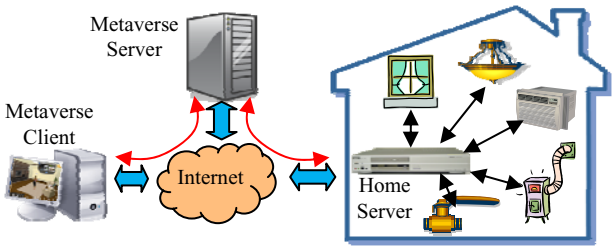

Fig.1. Architecture of the home automation based on 3D metaverse

The home automation control mechanism is illustrated in Fig.2. When a user logs in the 3D virtual world, the metaverse server requests the home server to send the status of home devices. Then the home server gathers and sends the status to the metaverse server. The metaverse server processes it and updates the metaverse client. Then the status of the home device is updated and displayed on the 3D virtual world. The home device status animates graphically according to each status. For example, when the air-conditioner is on, cold wind

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animates in the 3D virtual world. So a user can easily recognize the condition of his house intuitively. When a user wants to control a home device in the real world, he moves toward the home device in the virtual world, selects it by double clicking and configures the home device status on the pop-up menu which is designed similar to the real menu of the home device. Then the metaverse client sends the device control message to the metaverse server, which transfers it to the home server. The home server controls the home device according to the control message. The realistic menu provides intuitive control interface to a user. The 3D virtual world helps a user feel familiar and intuitive.

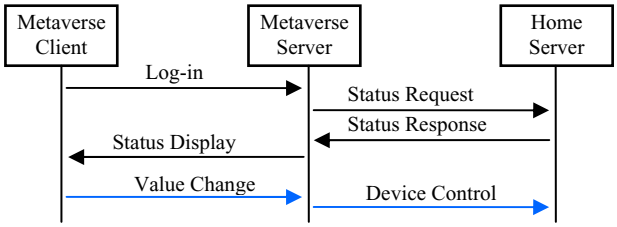

Fig.2. Home Automation Control Flow Chart

When a user tries to control a certain home device in the real world, the control message format is necessary to differentiate the specific device from others. Fig.3 shows the control message format. It has two bytes header and four bytes body. The Type field in the header notifies whether the transferred message is request or response or control message. The Length field means total byte size of the following body. The DevType field notifies the type of the target device such as a light, a window, a air-conditioner, etc. The DevID field shows the identification number among the same type of devices. If there are several lights, the DevID field has a different identification number. The CntType field shows what the control type is, for example, the intensity of the light or the temperature of the air-conditioner. The last byte, CntValue field, records the level of the CntType.

Header(2)		Body(4)			
Type(1)	Length(1)	DevType(1)	DevID(1)	CntType(1)	CntValue(1)

Fig.3. Control Message Frame Format

III. Implementation Results

To confirm the feasibility of our proposed home automation based on 3D virtual world, we implemented the metaverse client, the metaverse server and the home server. Fig.4 shows the captured figures of the metaverse client GUI(Graphic User Interface) and the miniaturized home in the real world. In the metaverse client GUI of Fig.4 (a), the avatar can move everywhere in the house. When a user wants to control a certain home device in the real world, he has only to make the avatar come near to the home device and double click it. When the pop-up control menu shows up, he can control the home device by changing the value. The control menu shows the current status of home devices. After a user changes the value, it is transferred to the home server and the home device is controlled according to the value instantly. And the changed status of the home device is updated in the metaverse client. Fig.4 (b) shows the real world. It has a light, a curtain, a heater and a fan. The home devices are connected to the home server through communication link such as RS-232 and RS-485. The home server can controls all the home devices according to the control value. Fig.4 (b) shows the current status that the heater is on the high level and so radiates heat. The implemented system enabled a user to control home devices in the remote area by intuitively controlling the virtual home devices in the 3D virtual world.

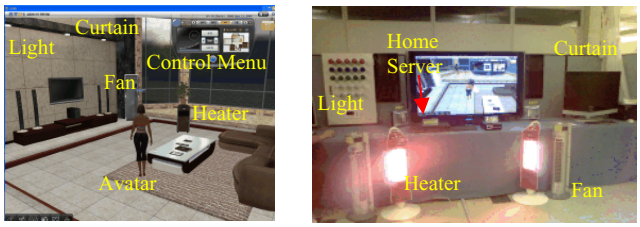

Fig.4. Implementation results: (a) Metaverse client GUI (b) Real world equipped with various home devices

IV. Conclusion

We proposed a home automation system based on 3D virtual world. The metaverse client, the metaverse server and the home server are implemented. The metaverse client and server provide the 3D virtual world similar to the real home. The home server controls home devices according to the avatar's action. With the help of 3D virtual world, a user can monitor the status of home devices and control them intuitively anywhere and anytime through the internet. The 3D virtual world interface is more user-friendly and intuitive than either a mobile-based or a web-based home automation. Furthermore, it can provide an advanced social network service by linking the virtual world to the real world.

Acknowledgement

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