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A Home Automation Prototype Based on the Project54 System

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ABSTRACT

This paper reviews the adaptation of the Project54 architecture to automate the use of electronic devices commonly located in houses. Project54 is a system that was designed to integrate electronic devices within police cruisers. This system provides police officers with the ability to interact with in-vehicle devices using speech commands or a graphical user interface. We took the voice-controlled device integration out of the police cruiser and brought it into the home. We discuss the development of handheld computer software enabled with location awareness and how the handheld computer controls common household electronic devices.

Keywords

Home Automation, Project54, Location Awareness, Speech User Interface, X-10 Devices

1. INTRODUCTION

Home automation is a growing area of interest for both engineers and consumers due to the proliferation of computers and handheld devices in the home. In its early stages, home automation consisted primarily of security systems and automatic garage door openers. In recent years, however, the consumer market has seen a rise in ubiquitous computing systems. This increase has translated into better home automation designs, possessing more flexibility and control. The state of the art in home automation systems provides consumers with the ability to control electronic devices throughout their house, both from their home PC and via remote access. However, many of the available systems involve complicated installations and are very expensive. On the other hand, our home automation prototype was inspired by the Project54 system which is designed with the integration of aftermarket devices in mind. The purpose of the Project54 architecture is to integrate the myriad components within police cruisers [3]. In the same fashion, the home automation prototype integrates preexisting household devices with minimal additional hardware. The system is comprised of a desktop computer, a personal digital assistant (PDA), a control area network (CAN), and an X-10 network, as shown in Figure 1. The desktop computer controls any device connected to the CAN or to the X-10 network throughout the house. Devices on the X-10 network are controlled using message packets transmitted via the CAN. The handheld computer executes remote device control using bidirectional message transmission with the desktop computer.

Mark Weiser imagined a world in which computers would cease to be a focal point for human interaction, due to the rise of ubiquitous computing [4]. Device integration, remote operability, and location awareness are some of the key features included in this design that strive to create an atmosphere within the home that is consistent with his vision.

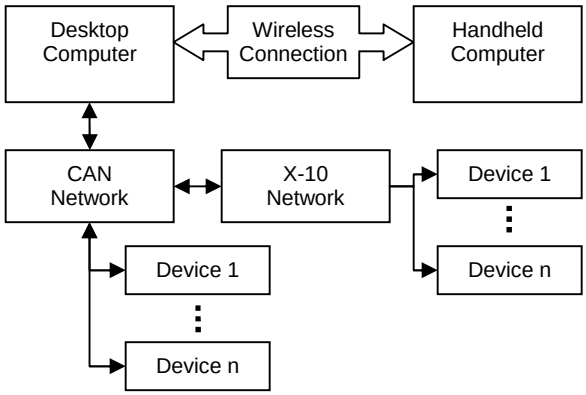

Figure 1. Project54 Home Automation Components and Connections

2. SYSTEM CONTROL

The Project54 architecture provides the necessary backbone for the home automation system communication and control. This includes support for a graphical user interface (GUI), a speech user interface (SUI), a wireless messaging system, and a CAN. The wireless connection facilitates message transmission from the handheld computer to a PC, which acts as the system control center.

The most basic X-10 modules are used in this design because of their relatively low cost and prevalence in many existing home automation implementations. However, X-10 devices are not the only possible solution available. Our home automation design utilizes the same CAN standard employed within Project54-equiped police cruisers in order to increase flexibility in the range of controllable devices. The network is capable of controlling devices that may not interface to X-10 technology. Furthermore, since many homes are now wired with Ethernet cables, which our implementation of the CAN uses for communication and power, there is no need to add X-10 repeater stations to the hardware network.

3. CONTROL THROUGH THE PDA

The home automation system uses distributed software running on a Windows CE-based handheld computer, enabled with the ability to execute speech commands [2]. The benefit to users is that with the handheld computer they would not have to constantly go to their PC to operate devices; the control would move around the house with them. This provides convenience and integrates the system in a pervasive manner.

An additional feature included in the handheld computer software is the ability to judge location, based on the remote device's proximity to the nearest wireless access point in the house. To accomplish this task the handheld device takes periodic 802.11 signal-strength measurements of all known wireless access points and compares the results to a calibration data set. The location of the remote device is determined based on which room calibration data most closely matches the current measurement results. The trouble with this method is that 802.11 signal strength measurements do not provide accurate results within a small area [1]. Preliminary results confirmed that distinguishing location between adjacent rooms was unreliable. Further testing still needs to be conducted to determine a method for improving location awareness accuracy.

4. APPLICATION

In order to test the design, the home automation prototype was installed in a laboratory room mock-up. Besides the previously-discussed system components, the setup included several wireless internet access points to judge location awareness capability, a climate control sensor, remote control of an AM/FM radio desktop application via software written for and added to the handheld device, and a relay box that enabled control of fixtures wired directly to power without using an electrical outlet. Figure 2 is a photograph of on of the room mock-ups used in the laboratory.

The climate control sensor sent periodic temperature and humidity information to the desktop computer via the CAN. This information was used to automatically operate climate-controlling devices, such as a fan, based on user-defined threshold settings. The radio control software created for the project demonstrated the ability of the system to move beyond merely acting as a device on/off switch. With the software on the handheld computer, a full assortment of the radio's built-in functions, such as tuning and pausing live radio, could be fully controlled from anywhere in the house using speech commands.

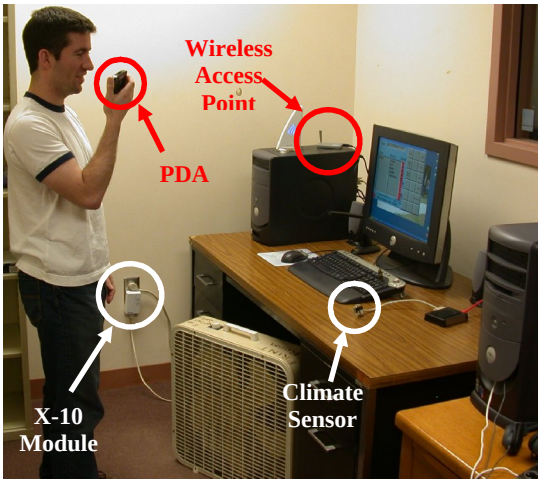

Figure 2. The Laboratory System Setup

5. CONCLUSION

A home automation prototype system was developed that enables the control and monitoring of electronic devices from both a PC and a handheld computer. The prototype tested in the laboratory was successful at controlling the various integrated devices and the speech command functionality available on both the PC and the handheld computer made the task even more effortless. With further development put into improving the location awareness estimation, operating household appliances and fixtures remotely could improve to the point where no attention to the actual devices is required.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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