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Smart Home System Operating Remotely Via 802.11b/g Wireless Technology

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Abstract

The purpose of this project was to integrate wireless networks into a smart home system, allows users to control and monitor their home in the most affordable way. Essentially, we are taking advantage of the growing Wi-Fi technology, due to a high demand in wireless networks. Nowadays almost every device such as laptop/desktop, mobile phone, etc has a built-in wireless networking capability. This system allows users to control/monitor their home appliances from a laptop/desktop or a mobile phone using wireless network 802.11b/g. It gives users the flexibility to control and monitor their properties in a convenient way and give them peace of mind when they are away from home, making them feel safer and improving their lifestyle.

Keywords: Wi-Fi technology, IEEE802.11b/g, smart home, remote home controller, appliances controller.

1 Introduction

Over a decade, technologies have been improved dramatically; in areas like telecommunication, control, monitoring (medical), and surveillance etc. It is certain that those technologies will be continued to grow, and affect clients' requirements. For this paper we are interested most in wireless technology. It has increased rapidly in last couple of years, almost all new devices like laptops, mobile phones and various electronic devices have a built-in wireless networking capability. Our intention in this research was to integrate wireless technology into home devices, using the industry standard IEEE 802.11b/g (Wi-Fi). As these types of devices have become easier to use and less expensive, it gives us the opportunity to deliver a new home automation system that has the ability to control and monitor a house in a convenient way being secure, affordable and efficient.

Two approaches were investigated for the proposed system:

- A. The system allows users to control/monitor home appliances from a laptop/desktop through a wireless embedded device using 802.11b/g technology.

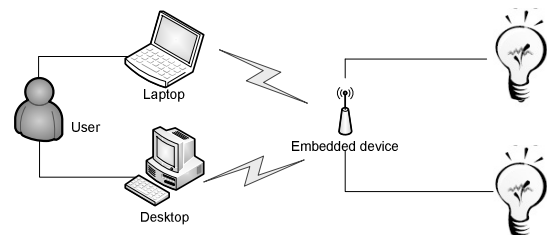


Figure 1: Approach 1 (control from a computer)

- B. Users could use a mobile phone to activate/deactivate home appliances and monitor the system through a wireless embedded device.

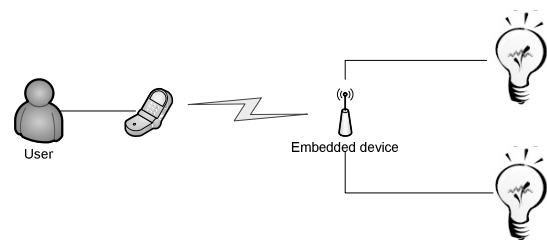


Figure 2: Approach 2 (control from a mobile phone)

2 Previous research work

Most of the smart home products in industry mainly use wireless technology in their systems; however there are various types of wireless communication, such as radio frequency (RF), microwave communication, infrared (IR), IrDA and Bluetooth. These are used in a short range communication, WLAN or IEEE802.11 is suitable for a long range

communication, it usually goes up to 100m range and operates in 2.4 to 2.5 GHz. WiMax and WiBro are recent developments in wireless communication; they could go up to 12km and are mainly used for mobile internet purposes, but yet this type of technology is still too expensive to be implemented for home automation system. And of course the cellular phone systems, 0G, 1G, 2G, 3G, and 4G, are in use worldwide.

Product likes Z-Wave from SmartHomeUSA[1] using a wireless RF-based method for instant remote control of lighting and appliance controls. This system would only work in a really short range, and need to operate from a remote control. Another invention from PLUTOHOME [2] uses a server to run all the applications, and sends a command to each individual controller box using Bluetooth or Infrared, depending on equipment.

There aren't many companies in the market using IEEE802.11 to implement home automation systems, especially from a mobile phone.

3 Design Approach

There are two approaches that are discussed here. One is using a computer to activate/deactivate the system through a wireless embedded device; another one is using a mobile phone to do the same task.

Lantronix Wiport Embedded Device [3] was used for the wireless networking server.

This device provides:

- 802.11b/g wireless networking
- Up to 100m range
- 11 in/output pins
- Protocols support: DHCP, UDP TCP HTTP, Telnet...etc
- PSK with AES-CCMP encryption security.
- Ad-hoc or infrastructure networks.



Figure 3: Wiport Embedded Device Server

3.1 Approach 1: control from a computer

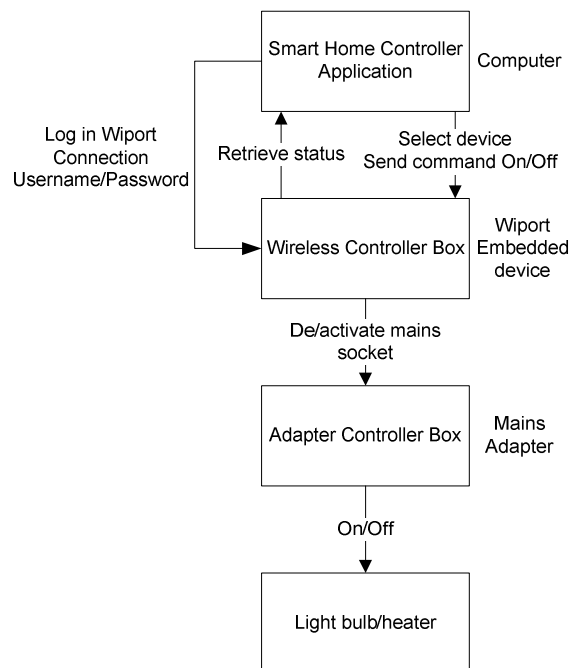


Figure 4: Computer controller design

Basically, this approach is using a computer as a main controller; the user selects which device to be turned on/off from the Smart Home Controller Application. The connection is made by providing an IP address of the Wiport Embedded Device. The user can either control the devices from the main control interface or floor plan interface.

The main control interface allows user to control and monitor the status of device(s). As on the floor plan interface user simply just click on the light bulb icons on the floor plan to turn the device ON/OFF, these icons will change to either ON or OFF depending on the status of the device. The red button is to shut the whole system down, preventing any emergencies from occurring.

Also implemented is a time controller to set when to turn the device(s) ON/OFF automatically. A warning voice system will be activated to alarm users before the device(s) turn ON/OFF.

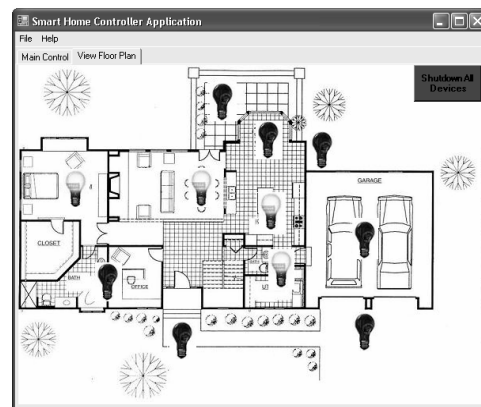


Figure 5: Floor Plan Controller Page

The command will be sent wirelessly from a computer to Wiport Controller Box to activate the GPIO pins to be ON/OFF.



Figure 6: Wiport Controller Box



Figure 7a: Front View



Figure 7b: Back View

We use the stereo sockets and cables for driving two low voltage signals from the Wiport Controller Box to activate the mains power supply on the Adapter Controller Box.

With this approach, it allows us to control two devices individually on each Adapter Controller Box. The box has been modified from a 4-way adapter, simply by cutting two of the sockets out; replaced them with a mains power controller circuit. A low voltage signal from Wiport turns on an optic triac, allowing the mains power supply to conduct.

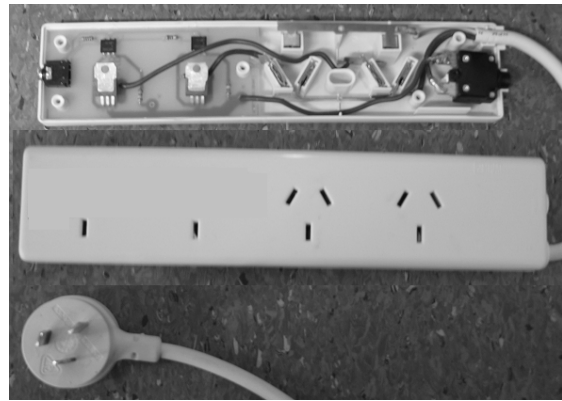


Figure 8: Adapter Controller Box

3.2 Approach 2: Control from a mobile phone

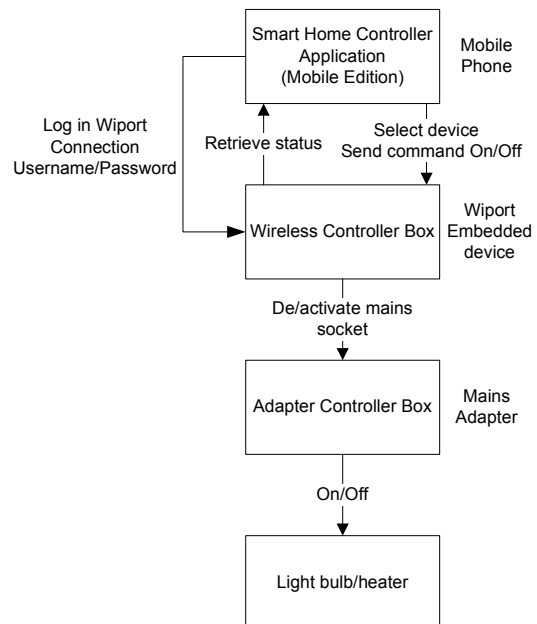


Figure 9: Mobile Controller Design

This approach is very similar to the first approach; however control home device(s) from a mobile phone gives user more flexibility and convenience.

The Smart Home Controller application was implemented on a Smartphone I-mate SP5 [4]. It has the ability to connect with the Wiport services.

- Microsoft Windows Mobile 5.0
- Built-in Wi-Fi 802.11b
- Smartphone Edition

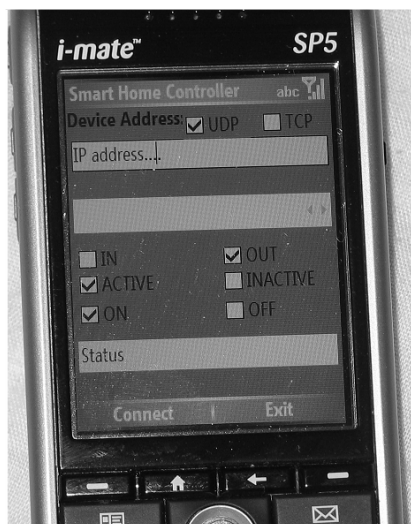


Figure 10: I-mate SP5 with Smart Home Application

It allows us to build a Smartphone application using Microsoft Visual Studio C#, simply by deploying [5] [6] an EXE file into the phone system. Users need to provide an appropriate Wiport IP address. Once it is connected, it will show the device's list, the device can then be selected individually to be turned ON/OFF.

4 Implementation & Results

The Wiport evaluation board needs to be re-designed to eliminate all of the unnecessary parts; to be able to reduce the cost of the final application.

Eliminated parts:

- Ethernet port
- Serial ports

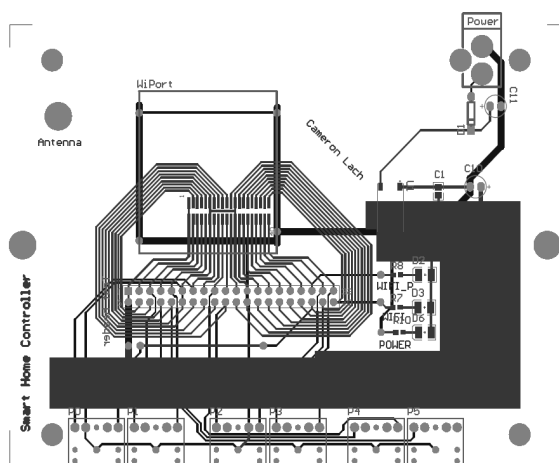


Figure 11: Wiport Evaluation Board PCB

The voltage feeding into the Wiport chip is 3.3V, which meet the requirements of Wiport specification. The chip needs to be configured using a serial port;

this could be done using an extension serial board with RS232 that plugs onto the test points on the Wiport Evaluation Board.

The factory settings for the Wiport chips are:

- Topology: Ad-Hoc and Infrastructure. If the configured infrastructure network is not found then an Ad-hoc network is allowed.
- Network Name (SSID): LTRX_IBSS
- Channel 11 (standard value for 802.11)
- Security: None (neither WEP or WPA)
- IP Address: Set to receive from DHCP or as a backup it will use Auto-IP to assign an address like "169.154.x.x".

Note: this setting could be found on Wiport User Guide [3].

When switching the Wiport controller Box on it works like a home wireless access point. The computer must connect to Wiport board first to be able for the Smart Home Application to connect to Wiport board.

Since we tried to make this application into a commercial product, being highly compact is very important requirement, as such small triacs were used instead of bulky relays. There is a minor problem when switching high current drain devices, such as a heater on for long periods of time. The triac increases temperature rapidly; it could go up to 200 °C, due to not enough space in the adapter box to have a heat sink. This could be solved by replacing Relays instead of Triacs, if wanting to use with heaters etc. However the device works really well when switching light bulbs ON/OFF or anything less than 5amps current.

As a result this application allows both laptop and mobile phone to activate/deactivate home appliances in a range of 70 meters.

5 Discussion

Further more development could be done to this application; such adding temperature sensors, integrating a surveillance camera system, implementing software to work with website; gives users even more flexible way to control and monitor their premises without having to pay extra.

6 Acknowledgements

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