Development of a system for "Home Control on Fingertips"

Nikolay R. Kakanakov Assoc. Prof. Grisha Spasov, Mitko Shopov, Ivan Stankov, Pavel Zaikov, Nikola Hadzhinikolov

Department of Computer Systems and Technologies, Technical University of Sofia, branch Plovdiv, 61 "St. Peterburg" Blvd. , 4000 Plovdiv, Bulgaria, phone: +359 32 659576, e-mail: gvs@tu-plovdiv.bg , web: http://temperature.tu-plovdiv.bg/

1. INTRODUCTION

The main reason for developing of Networked Embedded Systems 'home automation' is to fasilitate and optimaze everyday usage of all these appliances. We decided to combine the fast development of the technology and daily human habits in a centralized system that we called "Home Control on Fingertips" (HOCFIT).

We have used real-life approach to justify and establish the benefits of our system considering the following prereguisites and possibilities:

• Widely spread of computers and advanced technology in human lives in general;

• Automation of essential daily tasks, allows people doing more important and pleasant things;

• Easily control and work for people with physical disabilities in home environment.

• Monitoring status of your home, when you are at work or vacation. HOCFIT will notify you for emergencies;

• The heart of our system will be developed on widely used communication protocols and standards. In this way, it is very easy to be enhanced and customized.

All what you need to use the HOCFIT is just having a mobile phone, PDA, Laptop or workstation and they to be connected to the Global Network – Internet or just be in appropriate distance for wireless Bluetooth communication. HOCFIT is very flexible system – to access it, doesn't matter what hardware is using and what operating system is running. The only requirement at user side is integrated TCP/IP stack, some primitive web browser and network connection.

2. EXPERIMENTAL DESIGN

System Overview

The functional diagram of the HOCFIT system is shown on figure 1.

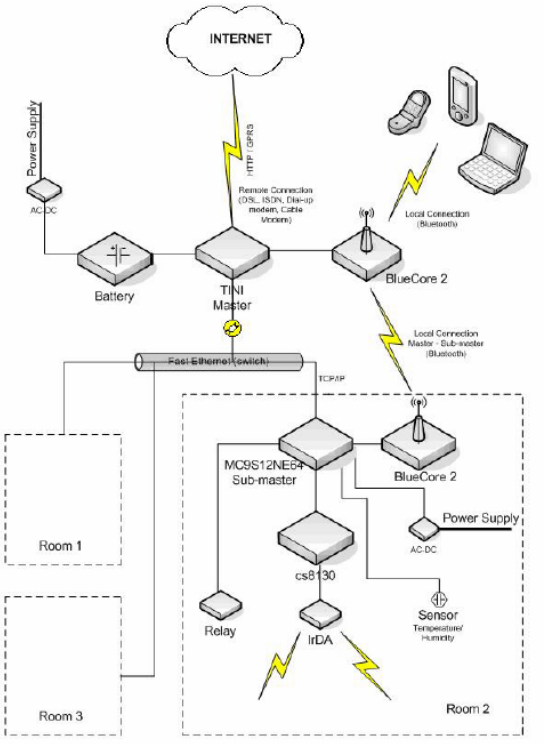

Fig. 1: The HOCFIT functional diagram.

The advantages of this design are:

• One sub-master device for each room controlling a variety of end devices;

• Universal method for communication between master and sub-masters at physical layer of TCP/IP protocol stack. Employing Ethernet for main connection and Wireless (Bluetooth) for back-up connection;

• Reduced need for cables, because one sub-master will represent many devices in the system;

• External connections to the master are provided by means of different connections to the Internet, because it depends on the ISP service. For example, most often the Internet connection is accomplished by PSTN using telephone line and PPP protocol. Another alternative is cable modems. Using USB or RS 232 interfaces on the master, there are no problems to connect any types of modems. The third possibility is usage of GSM communication – some providers give dial-up Internet via GSM.

• Redundant topology increases reliability of the system;

• Administration of the system is performed with Remote Login accomplished by PC or GSM (GPRS capable).

Dynamic content HTML pages

Friendly web interface for custom convenience:

Fig. 2.1 – Log In screen for Web interface

Fig. 2.2 – main menu screen for web interface

In the following part we are gone into the functionality of the system and the activities that are performed by the system in general:

- Configure – a table of currently active sub-master devices is displayed. Each controller could start up to 10 different tasks. Each task begins in predefined time (Date, Hour, Minute) and stops on specific condition – reaching temperature or humidity value or again in specific date, hour, minute. Each task has different living conditions – Active, Waiting, None (so user is free to add new);
- Monitor – the same as Configure sub-menu, but user can only watch started tasks and current configuration in table on specified sub-master controller. This menu is accessible in Guest mode;
- Logs & Exceptions – Exceptions that could be generated are divided in two levels. First level (top level) are these kinds of errors that have to be immediately processed like message from home alarm system – alarm on event, alarm from temperature or pushed 'panic' button. Reaction of the system is sending a SMS message. Second level messages are for information – last system log in, when defined sub-master is switch on/off to local network or user defined event. All these logs (level two exceptions) are written to file and could be viewed from Web interface;
- System Configuration (Init Phase) – after a new sub-master is added to the local connection, it is waiting for custom configuration – define sub-master pins – digital inputs, digital outputs and devices connected to via Infrared;

3. APPLICATION COMMUNICATION PROTOCOL

The configuration of the system is accomplished by the web interface and is divided into the following phases:

- **Init phase** – when the new connected sub-masters are switched on in the HOCFIT. Each sub-master gets own dynamic IP address by DHCP protocol. Then it transmits data for configuration of the ports and their status to the Master device.
- **Configure and Monitor phase** – the main phase of communication protocol in HOCFIT system, where the current data for end-devices are transmitted from sub-masters to the master device on request or in the other case to reconfigure the sub-master ports.
- **Exceptions phase** – it is activated in emergency situations, when some of the controlled parameters is out of predetermined range, or alarm situations go on (fire alarm, home security alarm, power supply break down, panic button, etc.)

4. DISCUSSION

We have designed a system, which purpose is to help people to be in touch with their home any time and anywhere. It will be helpful for people with physical disabilities and to their relatives. Let's look at real situation when our system can be useful. For example when someone is going to work or vacation and forget switch on domestic appliance. HOCFIT can inform the owner in real time before fire or technical damage is happen. User will switch off it remotely via pleasant Web interface.

5. CONCLUSION AND FUTURE WORK

This system is very useful with capability to be enhanced with a large number of sub-master controllers and end-devices. It will work without any problems in small homes, but in large houses, hotels and hospitals it is necessary to add new master devices (as distributed systems) and to modify the communication protocol.

The system is very flexible and scalable for future expansion. Concerning simple and useful ideas provides huge facilities for ordinary people as well as for small business.

The HOCFIT system is designed in the frame of the IEEE Computer Science International Design Competition 2005 and has passed the evaluation procedures to the final stage.