ISSN:0975-9646
N.Chintaiahi et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 2 (4) , 2011, 1598-1602

AUTOMATED ADVANCED INDUSTRIAL and HOME SECURITY USING GSM and FPGA

N.CHINTAIAH, K.RAJASEKHAR, V.DHANRAJ
Department of Electronics and Communications Engineering, B V C Engineering College, Odalarevu, Amalapuram,India.

***Abstract*- Home and industrial security today needs to make use of the latest technological components. In this paper I going to present the design and implementation of a remote and sensing, control and home security system based on GSM (Global System for Mobile). This system offers a complete, low cost, powerful and user friendly way of 24 hours of real –time monitoring and remote control of a home and industrial security. The system works as a remote sensing for the electrical appliances at home to check whether it is on or off, at the same time the user can control the electrical appliances at home by sending SMS (Short Messaging Service) message to the system, for example turning on t he AC before returning home. In case of fire/security the chip will receive signals from the different sensors in the monitoring place and acts according to the received signal by sending an SMS message to user's Mobile Phone, it also works as automatic and immediate reporting to the user in case of emergency for home security, as well as immediate and automatic reporting to the fire brigade and police station according to activated sensor to decrease the time required for tacking action.The design has been described using VHDL (VHSIC Hardware Description Language) and implemented in hardware using FPGA (Field Programmable Gate Array).**

***Keywords*- Field Programmable Gate Array, GSM (Global System for Mobile) , control and home security system, remote and sensing, remote control, SMS (Short Messaging Service)**

I. INTRODUCTION

To design and deployment of a GSM-based distributed control application platform for industrial automation. New control applications can be created and existing control applications can be reconfigured and tuned on the fly. The main objective of this project is to design and deployment of a GSM-enabled distributed control application platform for industrial automation and also for home appliances

Existing System:

- Wired System
- RF Based Security System
- Web enabled Industrial Automation

Disadvantage of Existing System:

- Difficult to maintain
- Need internet access
- Distance

Proposed System:

This project is designed to be executed in the modes as

- Stand alone mode that is H.W connected to the server system
- GSM Mode that is H.W connected to the GSM and accessible from mobile.

This system will be implemented using Nexys2 circuit board which is a complete, ready-to-use circuit development platform based on a Xilinx Spartan3E FPGA. Its onboard high-speed USB2 port, 16Mbytes of RAM and ROM, and several I/O devices and ports make it an ideal platform for digital systems of all kinds. The USB2 port provides board power and a programming interface .Section II detailed about operation of the system, section III Architecture, section IV introduction to FPGA. Section V nd VI gives the GSM and GPRS, Section VII result analysis.

II. OPERATION OF THE SYSTEM

In this section we will give some details about the system operation in case of control action or fire/security action. The system works as a remote sensing for the electrical appliances at home or industry to check whether it is on or off, at the same time the user can control the electrical appliances at home by sending SMS (Short Messaging Service) message to the system, for example turning on the AC before returning home. In case of fire/security the chip will receive signals from the different sensors in the monitoring place and acts according to the received signal by sending an SMS message to user's Mobil Phone, it also works as automatic and immediate reporting to the user in case of emergency for home security, as well as immediate and automatic reporting to the fire brigade and police station according to activated sensor to decrease the time required for tacking action.

III.ARCHTECTURE OF THE SYSTEM

It can be implemented to any levels of the security system. The architecture of the system mainly consists of three components the GSM MODEM, and the interface circuit that include the different sensors used. The function of the GSM MODEM is the remote communication between the user and the controller through the RS232 serial communication standard. The function of the controller is to continuously check the inputs coming from the different sensor and send message through the GSM network in case of emergency such that it acts as a 24 hours monitoring, and continuously checking for any received message from the user through the GSM MODEM to switch on the AC for example. The advantages of using FPGA as a controller is achieve multi inputs/outputs and low cost, where the used FPGA chip has 256 inputs/outputs that achieve the multi inputs and outputs. Since many components can be integrated into the FPGA chip that has 200 k Logic Gate, a low cost is also achieved.

The FPGA is connected to the different type of sensors

(smoke detector, motion detector, fire detector, magnetic detector, fluid detector), at the same time the FPGA is connected to the controlled devices like AC, TV, Refrigerator, washing machine, dishwasher, and light bulbs; the GSM connected to the user, police station, and fire brigade through the mobile cellular network. An interface circuit has been designed which includes sensors as input devices and 220 volt lamp as an output devices which represents the controlled devices. Then the programmed FPGA has been connected to the interface circuit and the GSM MODEM through the serial port of the GSM MODEM. The VHDL code includes a UART, and a communications through the AT commands of the GSM MODEM.

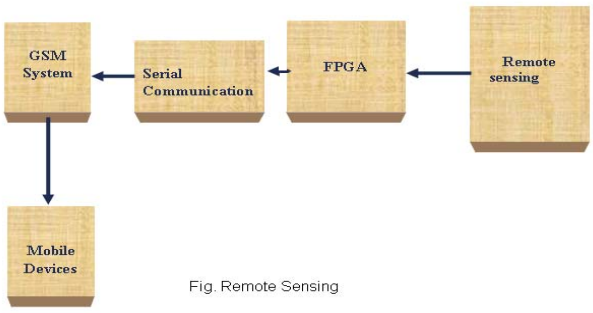

Fig.2.1 Remote sensing unit

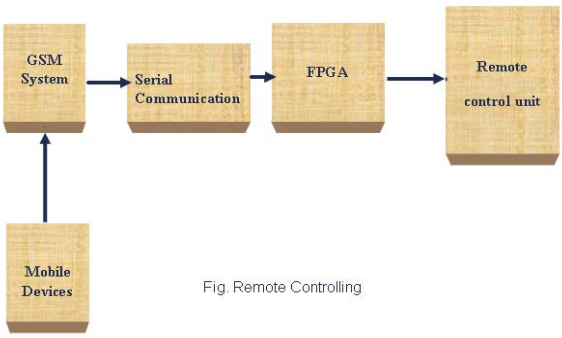

Fig.2.2 Remote control unit

This system will be implemented using Nexys2 circuit board which is a complete, ready-to-use circuit development platform based on a Xilinx Spartan 3E FPGA. Its onboard high-speed USB2 port, 16Mbytes of RAM and ROM, and several I/O devices and ports make it an ideal platform for digital systems of all kinds. The USB2 port provides board power and a programming interface.

IV. FPGA

FPGAs are programmable digital logic chips. What that means is that you can program them to do almost any digital function.

Here's the general workflow when working with FPGAs:

- We can use a computer to describe a "logic function" that you want. You might draw a schematic, or create a text file describing the function, doesn't matter.
- We compile the "logic function" on your computer, using software provided by the FPGA vendor. That creates a binary file that can be downloaded into the FPGA.
- We connect a cable from your computer to the FPGA, and download the binary file to the FPGA. `We can download FPGAs as many time as you want - no limit - with different functionalities every time if you want. If you make a mistake in your design, just fix your "logic function", re-compile and re-download it. No PCB, solder or component to change.
- The designs can run much faster than if you were to design a board with discrete components, since everything runs within the FPGA, on its silicon die.
- FPGAs loose their functionality when the power goes away (like RAM in a computer that looses its content). You have to re-download them when power goes back up to restore the functionality.

Internal RAM : While the first FPGAs didn't have internal memories, all new FPGAs have internal memories. That increases a lot their scope of applications. There are many parameters affecting RAM operation. The main parameter is the number of agents that can access the RAM simultaneously.

- "single-port" RAMs: only one agent can read/write the RAM.
- "dual-port" or "quad-port" RAMs: 2 or 4 agents can read/write. Great to get data across clock domains (each agent can use a different clock).

To figure out how many agents are available, count the number of separate address buses going to the RAM. Each agent has a dedicated address bus. Each agent has also a read, a write, or both data buses. Having both data buses doesn't always mean. An agent vac read and write simultaneously. Writing to the RAM is usually done synchronously. Reading is usually also done synchronously but can also sometimes be done asynchronously.RAM blocks are usually dedicated memory block ("block rams"). Xilinx has a lot of flexibility in the RAM distribution, because it also allows using the logic-cells as tiny RAMs ("distributed RAM"). Altera usually takes another approach and builds different-size block rams around the device.

V. GSM MODEM

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is

designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem.

In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, you can do things like:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

The number of SMS messages that can be processed by a GSM modem per minute is very low -- only about six to ten SMS messages per minute.

VI. GPRS MODEM

A GPRS modem is a GSM modem that additionally supports the GPRS technology for data transmission. GPRS stands for General Packet Radio Service. It is a packet-switched technology that is an extension of GSM. (GSM is a circuit-switched technology.) A key advantage of GPRS over GSM is that GPRS has a higher data transmission speed.

GPRS can be used as the bearer of SMS. If SMS over GPRS is used, an SMS transmission speed of about 30 SMS messages per minute may be achieved. This is much faster than using the ordinary SMS over GSM, whose SMS transmission speed is about 6 to 10 SMS messages per minute. A GPRS modem is needed to send and receive SMS over GPRS. Note that some wireless carriers do not support the sending and receiving of SMS over GPRS. If you need to send or receive MMS messages, a GPRS modem is typically needed.

In general, a GSM/GPRS modem is recommended for use with a computer to send and receive messages. This is because some mobile phones have certain limitations comparing to GSM/GPRS modems. Some of the limitations are described below:

Some mobile phone models (example: Ericsson R380) cannot be used with a computer to receive concatenated SMS messages. What is a concatenated SMS message? A concatenated SMS message is a message that contains more than 140 bytes. (A normal SMS message can only contain at most 140 bytes.) Concatenated SMS works like this: the sender's mobile device breaks a message longer than 140 bytes into smaller parts. Each of these parts are then fitted in a single SMS message and sent to the recipient. When these SMS messages reach the destination, the recipient's mobile device will combine them back to one message. What is the cause of the problem? When the mobile phone receives the SMS messages that are parts of a concatenated SMS message, it combines them to one message automatically. The correct behavior should be: when the mobile phone receives the SMS messages that are parts of a concatenated SMS message, it forwards them to the computer without combining them.

Many mobile phone models cannot be used with a computer to receive MMS messages. Because when they receive a MMS notification, they handle it automatically instead of forwarding it to the computer.

A mobile phone may not support some AT commands, command parameters and parameter values. For example, some mobile phones do not support the sending and receiving of SMS messages in text mode. So, the AT command "AT+CMGF=1" (it instructs the mobile phone to use text mode) will cause an error message to be returned. Usually GSM/GPRS modems support a more complete set of AT commands than mobile phones.

Most SMS messaging applications have to be available 24 hours a day. (For example, an SMS messaging application that provides ringtone downloading service should be running all the time so that a user can download ringtones any time he/she wants.) If such SMS messaging applications use mobile phones to send and receive SMS messages, the mobile phones have to be switched on all the time. However, some mobile phone models cannot operate with the battery removed even when an AC adaptor is connected, which means the battery will be charged 24 hours a day.

Besides the above issues, mobile phones and GSM/GPRS modems are more or less the same for sending and receiving SMS messages from a computer. Actually, you can consider an AT-command-enabled mobile phone as "GSM/GPRS modem + keypad + display + ...".There is not much difference between mobile phones and GSM/GPRS modems in terms of SMS transmission rate, since the determining factor for the SMS transmission rate is the wireless network

A GSM modem can be an external modem device, such as the Wavecom FASTRACK Modem. Insert a GSM SIM card into this modem, and connect the modem to an available serial port on your computer. A GSM modem can be a PC Card installed in a notebook computer, such as the Nokia Card Phone.

A GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port on your computer. Phones such as the Nokia 7110 with a DLR-3 cable, or various Ericsson phones, are often used for this purpose.

A dedicated GSM modem (external or PC Card) is usually preferable to a GSM mobile phone. This is because of some compatibility issues that can exist with mobile phones. For example, if you wish to be able to receive inbound MMS messages with your gateway, and you are using a mobile phone as your modem, you must utilize a mobile phone that does not support WAP push or MMS. This is because the mobile phone automatically processes these messages, without forwarding them via the modem interface. Similarly some mobile phones will not allow you to correctly receive SMS text messages longer than 160 bytes (known as "concatenated SMS" or "long

SMS"). This is because these long messages are actually sent as separate SMS messages, and the phone attempts to reassemble the message before forwarding via the modem interface. (We've observed this latter problem utilizing the Ericsson R380, while it does not appear to be a problem with many other Ericsson models.)

When you install your GSM modem, or connect your GSM mobile phone to the computer, be sure to install the appropriate Windows modem driver from the device manufacturer. To simplify configuration, the Now SMS/MMS Gateway will communicate with the device via this driver. An additional benefit of utilizing this driver is that you can use Windows diagnostics to ensure that the modem is communicating properly with the computer.

The Now SMS/MMS gateway can simultaneously support multiple modems, provided that your computer hardware has the available communications port resources. To define which modems are to be utilized by the gateway, select the **"SMSC"** tab from the gateway configuration dialog: If no modems are yet to be defined, only the **"Add"** button will be available on this dialog. Select **"Add"**, and then "**GSM Phone or Modem**" to display a list of available modem drivers on your computer. Select an available modem and press the **"Test and Add Modem"** button. The gateway will then attempt to initialize the modem, and confirm that the modem supports the necessary interfaces to send and receive SMS messages. The modem will only be added to the configuration if the gateway confirms that it can properly communicate with the modem.

VII. SIMULATION RESULTS

The system has been experimentally tested for both sensing and controlling purposes first with serial port of the PC, then in a real time using GSM. Figures (6.1 - 6.2) show the simulation results for the control Unit and sensing unit. Figure 6.2 shows the simulation for the sensing Unit which sends parallel data to UART Transmitter; the parallel data represents the ASII code for the characters; the character could be a message or an AT commands. Figure 6.2 shows the expanded output of sensing unit.

In the simulation we show the transmitted data in the form of characters but in hardware implementation it is stream of bits that represent the ASCII codes of the characters. In Figure 6.1, the simulation results of control unit is show This project is implemented mainly in real time applications using some led relays for explaining the domestic control.

And for some industrial control, in this project one potentiometer used, every time the program scans the values of the device and if any threat occurs (say here it is assumed the value of .8 as a critical value) immediate action will be taken and intimated to the concerned scientist or technical person through SMS.

This system can be implemented in stand lone mode and GSM real time mode. Since this project is implementing through GSM, it can be controlled form anywhere in the world and there is no distance limitation.

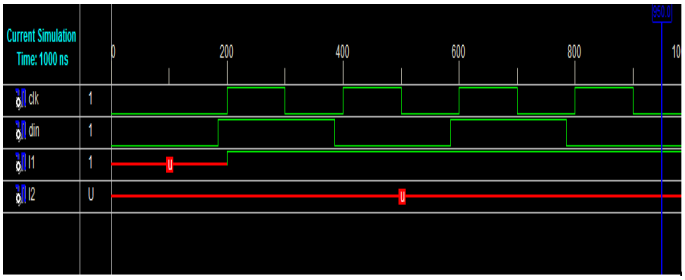

Fig.6.1 Simulation result of control unit

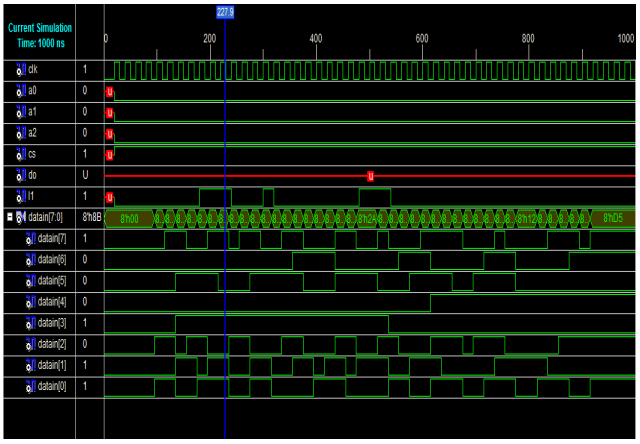

Fig.6.2 Extended simulation result of sensing unit

VIII. CONCLUSION

In this paper we introduced a remote sensing and control system based on using Global System for Mobil (GSM) and FPGA. The system is suitable for a real time monitoring in home security as well as controlling and sensing in home automation with large number of controlled devices. The system has been design and implemented in hardware using VHDL language and Xilinx Spartan 3E FPGA. GSM has been used for testing the circuit either for the sensing part of the circuit or the control part. The design was simulated and verified the correctness and working operation of the whole system

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