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Home Automation through FPGA Controller

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***Abstract*— In recent years, the home automation has seen a rapid introduction of network enabled digital technologies. These technologies offer new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation. In this paper, we present the design and implementation of home automation system. The design has been described using VHDL and implemented in hardware using FPGA (Field Programmable Gate Array). This system uses GSM (Global System for Mobile) network to establish the communication between mobile and controller. The system is SMS (Short Messaging Service) based and uses wireless technology to improve the standards of living.**

***Index Terms*—Home Automation, FPGA, GSM Network, SMS, VHDL.**

I. INTRODUCTION

Home automation mainly controls home appliances remotely and provides security, when the user is away from the place. The system is SMS based which uses wireless technology to modernize the standards of living. This system provides ideal solution to the problems faced by home owners in daily life. The motivation is to facilitate the users having universal access to automate their homes. The home automation system provides availability to develop a low cost solution which is affordable and allows home security The ease of deployment is due to wireless mode of communication. To realize the home automation networks, many sensor devices need to be deployed in the house to collect various real-time information of the home environment such as temperature, humidity, light and motion, etc. The users who get these data can then know what happens in their homes and may take some actions to control the home appliances, such as turn off the light that is still on in the bath room or turn on the air conditioner on the way home The system is capable enough to give feed back to user about the condition of the home appliance according to the user's needs and requirements. This system provides ideal solution to the problems faced by home owners in daily life. GSM module is a bridge responsible for enabling/ disabling of SMS capability. In this paper, the home automation system is designed using FPGA controller at the core to provide intelligent home solutions. The controller interfaces to a mobile device through GSM network to allow monitoring and controlling of the devices. This system can be used anywhere, as long as it in the range of phone network is available.

This paper is organize as follows. Section II briefly explains background work and section III describes the system overview of the proposed architecture. Section IV illustrates system architecture. Simulation section V and Conclusion, section VI briefly reviews the paper and discusses some future work to extend the proposed architecture.

II. BACKGROUND WORK

This section provides a preceding study of related work regarding the application of SMS services in a various fields. Some prior researches have been studied to gain more information about current existing GSM control system that was previously implemented. A GSM, Internet and Speech Controlled Wireless Interactive Home Automation System [1] shows the design and realization of a home automation system where communication technologies GSM (Global System for Mobile Communication), Internet, and speech recognition, Bluetooth have been used. All these techniques are successfully compound in a single wireless home automation system.

Design of a Networked Monitoring System for Home Automation [2] presents the design and realization of a networked monitoring system for home automation. Multiple communication interfaces are designed to enable local and remote user interactions through Internet or Bluetooth. This system offers a complete, flexible and reusable solution for various home monitoring and control applications The whole system architecture consists of a base station, a home server, wireless sensor modes and smart user terminals such as PC and PDA.

A zig-bee based home automation system [3] identifies the reasons for this slow adoption and evaluates the potential of ZigBee for addressing these problems through the design and execution of flexible home automation A ZigBee based home automation system and Wi-Fi network are integrated through a common home gateway. The home gateway provides network interoperability, a simple and flexible user interface, and remote access to the system. A dedicated virtual home is implemented to cater for the system's security and safety needs.

Dynamic Integration of Zig-bee Home Networks in to Home Gateways Using OSGi Service Registry [4] describes the design and realization of an effective design for dynamic integration of Zig-bee home networks into OSGi based home gateways. User-Friendly Home Automation on Based on 3D Virtual World [5] give details the user-friendly interface, 3D virtual world is adopted as the control interface for the home automation. It is composed of a Meta verse client, a Meta verse server and a home server. They have connections through the internet. The Meta verse client communicates with the Meta verse server through TCP/IP (Transmission control

Protocol/Internet Protocol). The Meta verse server communicates with the home server through the same protocol.. It has 3D rendering capability and a user can feel realistic graphic. With the help of 3D virtual world, a user can supervise the status of home devices and control them spontaneously anywhere and anytime through the internet.

This allows the users to set the home environment according to their personal needs. Current home automation systems are based on:

1) Bluetooth
2) ZigBee integrated with a Wi-Fi network
3) Internet
4) Java
5) 3D visual interface

III. System Overview

In this paper number of monitoring and controlling devices connected to central FPGA board. The different modules interfaced, these are a temperature sensor, a motion sensor, a light sensor, a relay switch, a Light Emitting Diode (LED) and a servo motor. The programmed central FPGA board is connected to interfacing unit and GSM modem through serial port of the GSM modem. The number of sensors used in the interfacing unit which permits the central FPGA controller to make decisions and send the status of the electronic appliances. The main function of the control unit is sending the AT(attention commands) to GSM MODEM then further checking for new messages from the GSM. The UART has two components UART transmitter and UART receiver. The architecture of the system mainly consists of four components as shown in Fig. 1.

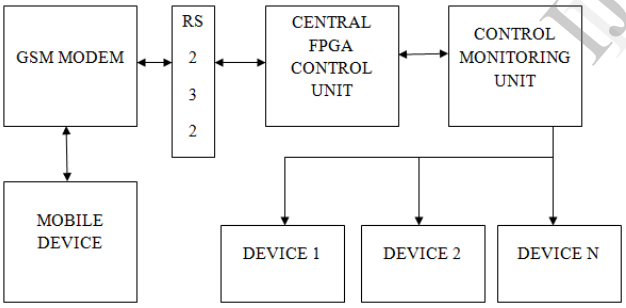

Fig.1. Block diagram of Home automation system

The central FPGA controller is connected to the interfacing unit and the GSM modem through serial port of GSM modem. By using Xilinx ISE software to program FPGA controller and control according to the interrupt in the form of message which are sending by GSM modem.

A. GSM Modem

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. 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 dialup modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. The GSM modem is an excellent choice in establishing communication from remote locations where internet may not be available. The communication between user and the home is established by sending and receiving the SMS protocol. In this GSM modem is carried out by AT (Attention) commands.

The communication between GSM and system takes place via RS232 serial port. Cell phone can be attached at the place of GSM hardware but it limits the hardware functionality such as sending or receiving.

B. Mobile Device

The system contains cellular phone or mobile device, which contains SIM (Subscriber identity Module) card has a specific number through which communication takes place. The device communicates with the GSM modem via radio frequency. Mobile user sends SMS using GSM.

C. Central FPGA Controller

FPGA is programmable digital logic chip. The FPGA controller has multiple inputs/outputs ports, so, many components can be integrated into it. The advantages of FPGA controller are its low cost, high speed operation, and internal RAM.

Altera's DE2 board and Xilinx Spartan 3 board are one of the most widely used FPGA board for development of FPGA design and implementation.

D. Control and Monitoring Devices

In this system number of monitoring and controlling devices is connected to central FPGA controller kit. The number of modules interfaced, these are a temperature sensor, a motion sensor, a light sensor, a relay switch, a Light Emitting Diode (LED) and a servo. The programmed FPGA board is connected to interfacing unit and GSM modem through serial port of the GSM modem. The number of sensors used in the interfacing unit which permits the central FPGA controller to make decisions and send the status of the electronic appliances are connected in home.

IV. System Architecture

The main function of the control unit is sending the AT commands to GSM MODEM then advance checking for new messages from the GSM.

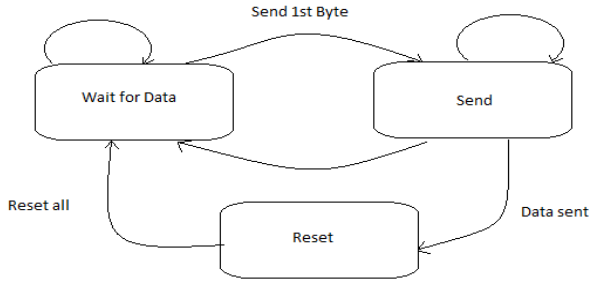

Fig.2. State machine diagram of Tx module

The UART has two components UART transmitter and UART receiver. The transmitter unit of UART mainly consists of Tx module. The function of UART transmitter is to convert

the processed data from parallel to serial, and then sending the serial data to GSM modem.

The Tx module starts with Wait cycle for Data state then it checks the transmitter is ready for transmission or not. If data is available in the Send state then counter starts performing. When counter reached 10th bit it will go to reset state. The UART receiver converts the whole serial stream flow of received bits into parallel data can be controlled by the control unit. Figure 3 shows the state machine diagram of Rx module. When input is 1, it will remain in Wait cycle for Data state. When input is 0, then it will start to receive bits and go to Receive byte state. When all bits are received it will come into store byte.

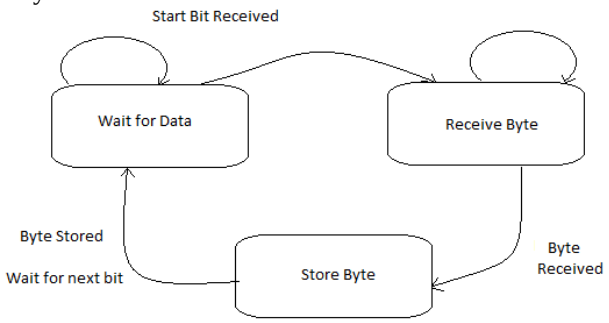

Fig.3. State machine diagram for Rx module

V. Conclusion

Home Automation through central FPGA controller introduce design for Home Automation and GSM network. The central FPGA controller has many advantages compared to microcontroller in terms of maximum no of input and output port which is present in FPGA. Using on board LCD display, it minimize wiring and power consumption. and reduces use of driver circuit. The system is suitable for real time monitoring and controlling of various home appliances. The system has been designed and implemented using VHDL language and FPGA controller,which is the basic part of the system. The system has many advantages such as remote controlling number of home appliances, availability and ease for use.

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