Implementation of Reliable Wireless Real Time Automation System Based on Android Mobile Phone and FPGA

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Abstract: **The concept of intelligent homes, offices, industries has attracted the attention of a number of researchers and practitioners during the last years. User needs that home, office, industries must satisfy and can vary from basic requirements to external and internal aesthetics to comfort within home, offices. The automation system that we are going to design provides great comfort not only to common people but also handicap people too. Its messaging or speech recognisation technique provided by an android mobile phone prove that the system provide great level of comfort. This paper presents design and implementation of reliable wireless real-time automation system based on android mobile phone and FPGA. The automation system improves the way of controlling the devices at home, offices, industries, colleges. It shows the possible solution whereby the user controls devices by employing FPGA as a central controller to which devices and sensors are interfaced. In proposed system FPGA act as a central controller which control number of devices. Such automation system improves the lifestyle of controlling the devices.**

Keywords: Android mobile phone, Bluetooth module, FPGA, UART.

I. INTRODUCTION

Recently man's work and life are increasingly tight with the growth in communication and information technology. The rapid economic expansion living standard keeps rising up day by day that people have a higher requirement for dwelling function. The intellectualized society brings diversified information where safe, economic, comfortable and convenient life has become the ideal for every modern family. The advancement of technology has increased the usage of the electronic devices in homes, offices, industries, hotels. The wireless technology is most popular technology to control the devices from distances. The requirement for a suitable technology that enhances the quality of life in homes, offices, industries have always been at the center of research. With the development of new electronic technologies and their integration with older, traditional building technologies, smart system is at last becoming a real possibility. Many researchers are working on smart automation system that can be easily design for homes, offices, industries, colleges. Initially the microcontroller based system was introduced. After that different methodology including LAB view, Arduino Uno single Board Microcontroller, JAVA application based systems were developed. We are going to introduce a smart system which is implementation over system explained above. Users needs or say demand for their comfort has been increasing day by day. Keeping this fact in mind here we are introducing a system. The system includes FPGA as a central controller to control the devices connected to it. We monitor the devices wirelessly by using the Bluetooth. We are using the android mobile for Bluetooth connectivity. In this system we are using the FPGA other than the microcontroller because we can connect many devices which can be monitored and the FPGA can be used as a controller or a processor.

II. BACKGROUND WORK

Technology advancements have made possible the implementation of embedded systems within appliances used in offices, industries and home. The automation system improves the lifestyle of controlling the devices at offices, colleges, industries and home. Most of these recent techniques focus on exploiting wireless communication to communicate with devices.

The Carl J. Debono and Kurt Abela[1] introduce a Field Programmable Gate Array (FPGA) controller at the core of the system to provide the intelligence for the home system. Moreover, the controller interfaces to a mobile device through the Bluetooth communications port to allow monitoring, configuration, and switching of devices. This allows the user to set the home environment according to the personal needs. They used a mobile phone supporting JAVA application and based on it they design a JAVA application for controlling the devices.

The Bader M. O. Al-thobaiti, Iman I. M. Abosolaiman, Mahdi H. M. Alzahrani, Sami H. A. Almalki[2] presents design and implementation concepts for a wireless real-time home automation system based on Arduino Uno microcontroller as central controllers. The proposed system has two operational modes. The first one is denoted as a Manually automated mode in which the user can monitor and control the home appliances using the cellular phone through Wi-Fi communication technology. The second one is referred to a self- automated mode that makes the controllers to be capable of monitoring and controlling different appliances in the home automatically in response to the signals comes from the related sensors.

The K. Gill, S. H. Yang, F. Yao and X. Lu, [3] introduced Zig-Bee based home automation system. In this paper for the devices operation they make use of Zig-Bee module. We are going to use Bluetooth communication via android phone.

Sweatha K N, Poornima M, Vinutha M H [4] presents a novel technology where the user controls the devices through mobiles. Implementation is done using FPGA (Field Programmable Gate Array) as a controller to which the devices are directly interfaced. They also use the pic microcontroller to control the sensors through the SMS having password. In this paper since we are using an android mobile phone.

III. PROPOSED WORK

Keeping in mind the users need or demand for their comfort, we are introducing a system. The system includes FPGA as a central controller to control the devices connected to it. We monitor the devices wirelessly by using the Bluetooth. We are using the android mobile for Bluetooth connectivity. In this system we are using the FPGA as we can connect many devices through it which can be monitored.

A block diagram of proposed system is shown in Figure 1. It consists of an android mobile phone, a central FPGA controller and number of devices which are connected to central controller. The system includes a novel technology where the user controls the devices through android mobiles. Implementation is done using FPGA (Field Programmable Gate Array) as a controller to which the devices are directly interfaced. Control to the devices is communicated to the FPGA from the mobile phone using speech recognition technique or text messaging.

A. *Mobile Device:*

The system requires an android mobile device having a Bluetooth module. The mobile phone communicates to devices through FPGA via Bluetooth module either by speech recognition or text messaging. It is used for the controlling of the devices which are connected to the controller using Bluetooth technology. Signals from mobile will receive by a Bluetooth receiver. Bluetooth receiver interfaced with FPGA, act as a central controller and there will be serial signal reception.

B. *Bluetooth Interface:*

The central FPGA controller communicates with the Bluetooth module through a serial interface depicted in Figure 2. The Bluetooth module that we are using here is 111330. In section A as already stated that instruction from the mobile phone is received by Bluetooth module via serial signal reception. This signal reception is done with some specific baud rate (approximately 9600). It requires a Universal Asynchronous Receiver /Transmitter (UART) which is employed on FPGA. UART is the kind of serial communication protocol which allows the full duplex communication in serial link. The UART consists of three main components namely transmitter, receiver and baud rate generator which are nothing but the frequency divider. This has been simulated on ModelSim SE 10.0a and has been implemented by using Verilog description language which has been synthesized on FPGA kits such as Virtex4 and Spartan3. In the proposed system only receiver and baud rate generator of Bluetooth module is important. Thus here we are designing an UART IP code which allows serial reception through FPGA. Thus UART allow the reception of signal with specific baud rate. This technology was selected over other solutions because it is available in most mobile phones, it can be implemented with low cost, it consumes low power, and provides a level of security through its use in short distances and through its pairing function. The mobile device communicates to its inbuilt Bluetooth module. On the other hand, a Bluetooth module must be interfaced with the FPGA, where accurate clocking must be generated for the UART to correctly interpret the received data.

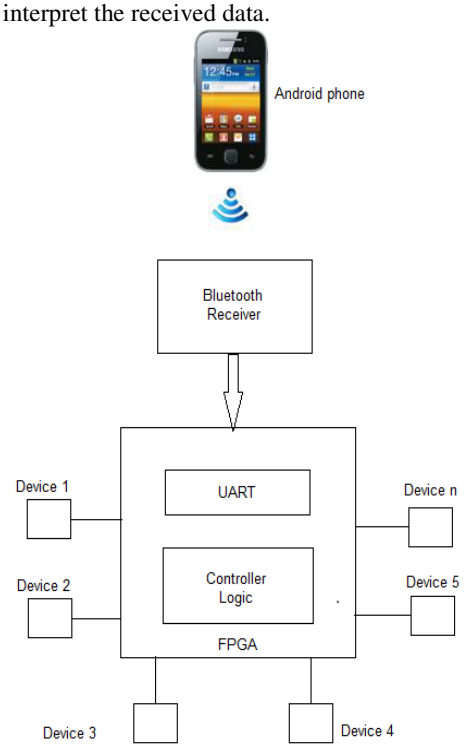

Figure1. System block diagram.

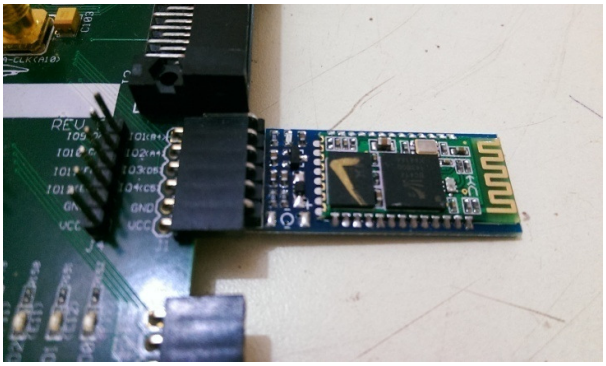

Figure2. Bluetooth module.

C. *Controlling and Monitoring Devices:*

In addition to UART it is also required to design a controller logic which controls the operation of devices. The controller logic can be designed using finite state machine (FSM), where different conditions for different device operation will be assigned. The number of controlling and monitoring devices attached to the FPGA depends on the number of free input/output ports available on the FPGA. The implemented system uses the parallel communication so that the speed is increased. The devices are directly connected to the FPGA Controller and is controlled using the speech recognition technique or text messaging. In order to show device operation here we are using relays that can be depicted in Figure 3.

Here we interfaced the RXD Of relays to the TXD OF FPGA controller. To indicate more number of device operations the pins are mounted on the board near relays.

Figure3. Relay Connection

IV. SYSTEM FLOW CHART

The overall internal operation of system can be depicted in Figure 4 which is a simple flow of the system that we are implementing.

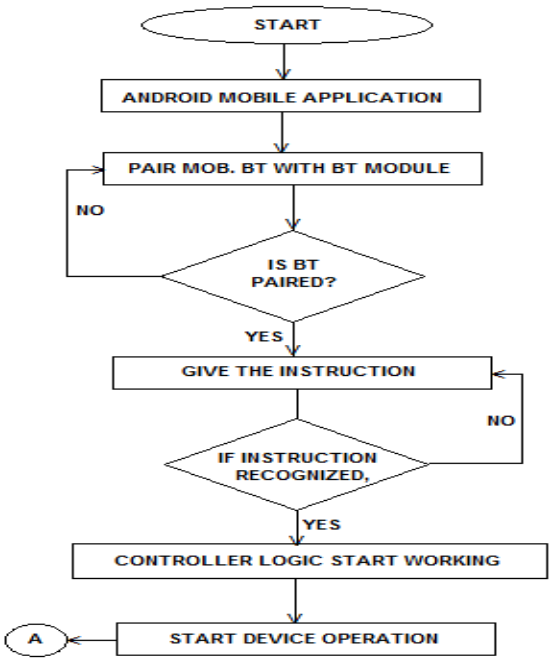

Figure4. System Flow Chart.

In Figure 4 the initial stage is to install an application in an android mobile phone. This application plays a vital role in controlling devices via speech recognisation. Once installation is completed pair mobile Bluetooth with Bluetooth module. If Bluetooth is not paired, operation again starts from pairing of Bluetooth. If Bluetooth is paired, give the instruction through downloaded mobile application to controller logic (FPGA). The controller logic starts working after recognizing speech instruction. And depending upon that instruction a particular device will operate. On the other hand if controller logic cannot recognize that instruction then operation starts from giving the instruction. Figure 3 shows the operation of devices through relays. The TXD of FPGA is interfaced with the RXD OF relays. And depending on the different conditions or say a dictionary that we have created for each device, it begins to operate. The above flow chart is nothing but the main objective of a proposed. That is the various cases or conditions that we are facing during the proposed work.

V. RESULT AND DISCUSSION

The flow chart of system represents an overall operation of system. Where after giving the voice instruction through the mobile phone, the controller logic checks the conditions. And if all the desired conditions are true then the particular device start operation. Also in FPGA number of I/O pin are available so, it will be efficient to operate more number of devices. The hardware implementation of proposed system can be depicted in Figure 5. The simulation result of UART receiver and baud rate generator can be as shown in Figure 6 and 7. The final device control simulation can be depicted in Figure 8. where five devices A, B, C, D, E are to be controlled. For device A waveform is at positive pick and is at negative pick for remaining devices. Thus depending on the device operations the corresponding wave form can be in Figure 8.

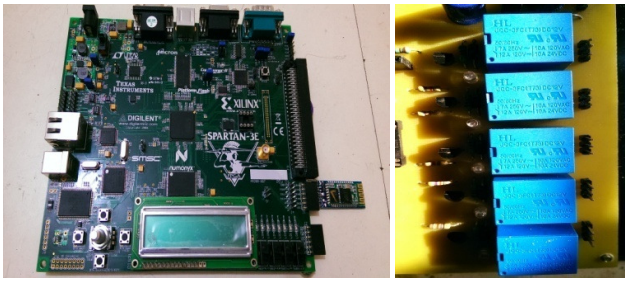

Figure5. Hardware Implementation.

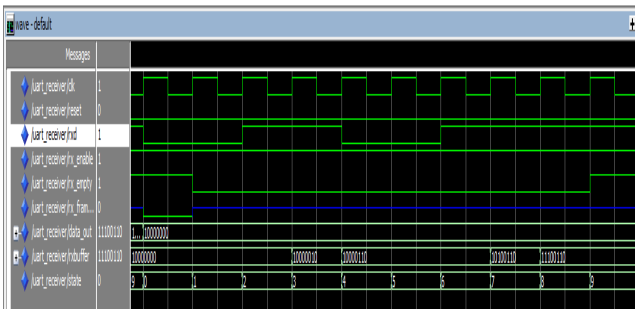

Figure6. UART receiver

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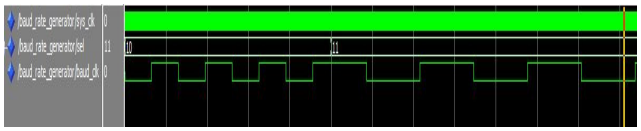

Figure7. UART baud rate generator

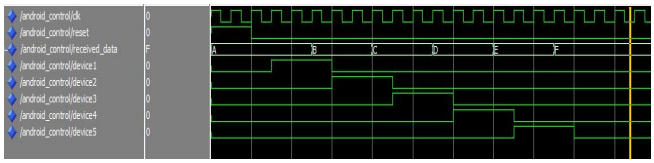

Figure8. Controller logic

CONCLUSION AND FUTURE SCOPE

This proposed system provides more comfort to human at home, offices, industries. Reduce time and effort required for device operation also Provide great comfort not only to common people but also handicap people too. Its messaging or speech recognisation technique provided by an android mobile phone prove that the system provide great level of comfort. This results in simple, flexible and good gadget for future smart automation system that can be easily design for offices homes, colleges, industries. In this proposed system devices/appliances controlling is done within a specified range but in future it can be possible to control the devices from anywhere over the world. Thus, this system is boon for future scope.

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