

VLSI- FPGA Based Device Controlling through Wireless communications

¹ Dr. S. Murali Mohan, ² Mr. M. Ajay Kumar, ³Mr. A. Devamani, ⁴Mr. R. Narayana Rao

¹Professor, ^{2,3}Associate Professor, ⁴Assistant Professor

^{1, 2, 3, 4} Mother Theresa Institute of Engineering and Technology, Palamaner, JNTUA University.

¹muralimohan.vlsi.dsp@gmail.com

²m.ajay.mtech@gmail.com

³devamani31008@gmail.com

⁴josephrevalla@gmail.com

Abstract— Security is playing a most important role everywhere these days. This paper represents the idea of controlling the devices remotely in industries. Bluetooth technology is used for operation in the industries mobile phone is used for such process and remote actions are taken place with the help of SMS which is abbreviated as Short Message Service. The operation of street lights which is on and off are also performed with the help of remote devices. For the remote devices core processor is been used. For automating the remote devices of the industries we have used FPGA which is generally abbreviated as Field Programmable Gate Arrays using SPARTAN III kit using Verilog. As the remote actions of the devices are performed using SMS those will be sent or receive through GSM which is abbreviated as Global System for Mobile to the device in emergency cases. In order to sense the parameters such as intensity of light, temperature and presence of CO2 analog sensors are used. To detect the presence of human being PIR is used which is abbreviated as Passive Infrared Sensor.

Keywords— Bluetooth, Verilog, FPGA, GSM, PIR, SMS.

1. INTRODUCTION

The atmosphere differs from place to place i.e., the atmosphere difference between home and industry. Based upon the location the precautions must be taken because there may be leakage of harmful gas and also due to the raise in temperature or electrical sparking accidental fire exhausts will be occurring. In order to take care of all these situations remote controlled devices are be implemented. Based upon the temperature and atmosphere the device will be automatically turns on and off. Street lights are also controlled using this remote device which will turn ON and OFF when there is a presence of human being and when there is no presence of human being respectively.

These lights will be turned ON when sunset and turned OFF when there is no darkness. The basic structure is been designed using SPARTAN kit and using Verilog with the implementation of FPGA. For the control of accidents in the atmosphere analog sensors are been used. Sensors like LM 35, MQ7, LDR and PIR sensors are been used in this implementation for sensing the temperature, sensor smoke

sense CO2 in case of fire, sense the intensity of light and the detection of human presence respectively. For the conversion of analog data to digital data ADC 809 is been used. Relay board will be gets the output which will automatically turns ON or OFF the sensors based upon the environment which is attached to it. GSM module will be sending and receiving the message to the registered device in case of emergency. The overall set is been implemented in such a way that it will turn ON or OFF in Verilog.

2. LITERATURE SURVEY

Remote control techniques are used to control the industrial areas in some automated process. For implementing the process GSM module is been used for the communication. There are some different methods which are been implemented using SMS, Telephone and via email. For SMS method we use GSM module which is been inserted with a SIM card which is can send messages whenever there is a case of emergency in the industry based upon the environment the SMS will be sent to the registered mobile number [1-3]. Automatically the relay board will be activated and switch ON the sensors. In telephonic method in order to activate the sensor in the relay board the telephone rings accordingly by inserting an extension card to the telephone based upon the telephone ring cycle the relay board will be activating based upon the environment and sensor activated. The communication is done by email in the PC based techniques which will be sending an email based upon the environment [4-5]. After receiving the email to the inbox it will be stored in .exe format and the memory will be executed accordingly so the relay board gets activated and activates the sensor to perform the particular action so that the sensor will gets ON and OFF accordingly.

The technique which is more popular generally uses ZIGBEE device with the configuration of IEEE 802.15.4 standard which is low of cost but the coordination and the maintenance is more effective compared to the other techniques. ZIGBEE device is fitted to the device so that it works accordingly. Here both the source and destination devices should be fitted with the ZIGBEE device so that it

works effectively. Wireless ZIGBEE will be more effective compared to normal ZIGBEE which will overcome the installation process. The wireless ZIGBEE is mostly used by the mobile phone with the configuration of IEEE 802.11 standard with the frequency of 2.4 GHz which is composed of modem and a router with four ports switch. The communication between modem and router will be done using local Wi-Fi network which costs low compared to normal ZIGBEE device [6 -10].

3. MATERIALS & METHODS

The implementation is done on SPARTAN III kit, which is composed of all the sensors, ADC, GSM, LED strips which are built on PCB board. IR sensors are been used for sensing the presence of human being. GSM module is been fitted for the communication which is been inserted with the registered SIM card which will be notifying the information for sending and receiving the information in case of emergency. LDR sensor is been fitted on the PCB board for sensing the intensity of light. Relays will be activated when there is a change in the environment by turning ON and OFF of the particular sensor [11-13].

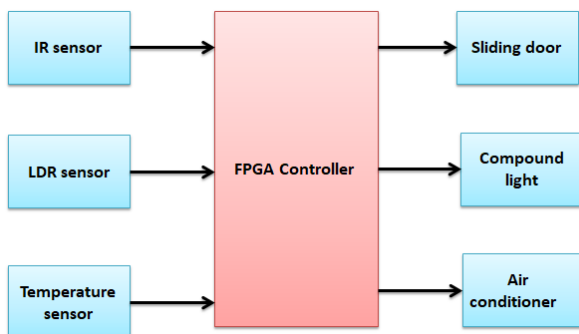


Fig No 1. Block representation of the Model design

3.1 Software Implementation

Here we have implemented this remote action of the device in industries using FPGA Verilog language. The sensors used are analog sensors in order to process the data we convert the analog data to digital data using ADC. GSM module is been used for the communication purpose. For simulating the written program we execute it on Xilinx ISE tool.

3.2 GSM- Global System for Mobile Communication

Services like Fax, data and SMS messaging GSM is launched in 1995 commercially for mobile communication. The frequency of the network is composed of 1900 MHz's this initiative is been taken by Unite states and now the subscribers crossed around 10 million all over the world. TDMA spectrum which is briefly abbreviated as Time Division Multiple Access is employed by GSM. The structure of GSM network is composed of many sub-stations namely network and switching substation, operations support

system, base station substation and GPRS core network. GSM is generalized as a cellular network where the mobile phones will be connecting the network by connecting to the cells available in that particular network. Cell size is categorized in five namely micro, macro, femto, pico and umbrella cells. The cells are designed according to their capability. Here base station for macro cells are been installed on a building above the average roof top, Base station of the micro cells are been installed on a building below the average height of roof top, Base station of the pico cells are been installed in the area measured in diameter of few dozen meters, for residential or small building femto cells are been installed accordingly, in order to cover the shadowed region of small gaps and fill those gaps umbrella cells are been installed. In practical, the longest distance that GSM module can support is 35KM. The carrier frequency of the 2G and 3G network operates at 900 MHz to 1800 MHz and 2100 MHz respectively. The channel data rate and frame duration of all 8 channels is 270.833kb/s and 4.615ms respectively. The hand set of the transmission power is limited up to a maximum of 2watts and 1 watt of GSM 850/900 MHz and GSM 1800/1900 MHz respectively.

In emergency cases, the communication will be provided by using GSM module which will be inserted with one SIM (Subscribers Identity Module) card which will be tracking the location to send or receive the information and even works when the registered device is switched off this is possible using GPRS (General Packet Radio Service) like browsing the web. GSM modems can also be an external modem device such as wavecorm FASTRACK Modem. In the GSM modems we will be inserting a SIM card and connect it to available serial port to the computers. PC Card installed in a notebook of the computer such as Nokia card phone in the GSM modem. GSM modem used can also be a standard GSM modem which will be connected with an appropriated cable and a software driver cable connected to the serial port of the computer. For the GSM modem most used phone are Nokia, DLR-3 and Ericsson phones. The cable or PC card is usually preferred to a dedicated GSM modem as this is because of some compatibilities issues. For example if we are wishing to receive some MMS message to our mobile phone then we need to use mobile which supports the MMS services too. This is because mobile phone should automatically process these messages without the interaction of modems.

3.3 Bluetooth Communication

In 1989, Bluetooth technology is been initiated by Dr.Nils Rydbeck and Dr.John Ullaman. In short is also called as short link. It is a wireless technology which helps in exchanging the data in short distance. The radio waves are been used for the data transmission and in ISM band from 2.4 to 2.485 GHz. The transmission of the data will be divided into packets and transmits each packet on designated

Bluetooth channels. Each channel will have a bandwidth of 1 MHz and performs 800 hops per second. The actual data rate is 1Mbits/sec and here the transmission of the data is in the form of packets and it can communicate only 7 devices at a time.

3.4 Verilog

In 1984, Verilog is been invented by Gate way design automated. Verilog is a software language which is generally called as hardware description language used for writing the programs. In digital systems, the programmer is allowed to design a digital design at different levels namely gate level, switch level, behavioral level and Register Transfer Level (RTL). In Verilog there are two different types of design namely Top-down-design and Bottom-Up-design. The gate level design process will be observed in bottom up design like standard gates. The high level and RTL coding will be observed in top down style. [14]

3.5 Xilinx ISE Suites

For programming the FPGA chips Xilinx ISE software tool is been developed by Xilinx. In order to analyses and synthesis the HDL designs we use Xilinx software tool. For configuring the target device, exam in the RTL diagram, timing analysis and simulate the design these all actions can be performed by the Xilinx ISE tool. The simulation process is done in the newly created project so that we will be getting the reports and required results in the data cable.

4. DEVELOPMENT & IMPLEMENTATION

In both home and industrial automation is mostly preferred because in case of any accidents occur and we are not there in that area we will be notified by SMS to our mobile which should be registered so that using GPRS it will be locating the location and trace it so that we will be able to address the incident and take particular action. This implantation is more concentrated on temperature, Light, gas and etc.[15-16].

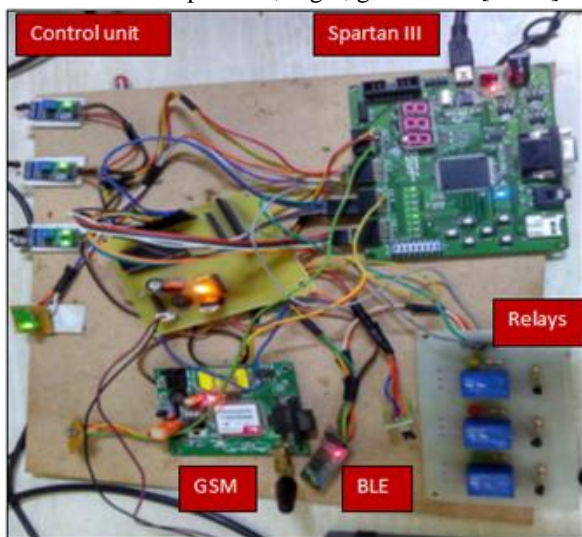


Fig No 2. Hardware Implementation Model Prototype

The devices will be connected to the FPGA based upon the environment the particular device will be activated. Here relay and motors play a very important role. For example, if the temperature is crossed the particular limit then the relay will be switched on so that it will be activating the sensor by keeping Temperature sensor as '1' and the SMS will be sent using GPRS to the registered number and the temperature sensor will be turned OFF when the heat in that particular area is reduced. Similarly the LDR and PIR sensors will be activated based upon the environment and the application. Implementation of hardware unit shown in Fig 2.

4.2 Additional Components - Utilized

Temperature Sensor

We use LM35 as a temperature sensor in this implementation. Mainly used for sense the temperature in practical in industrial area so that accidents may not occur frequently. This is used to take precautions for fire accidents occur in the industries. Generally temperature is been calculated in Celsius using thermistor but LM35 is more accurate than thermistor in order to calculate the temperature. By using LM35 oxidation will not be occurred as there will be sealing over the circuit. High voltage output be obtained using LM35 compared to thermocouple or thermistor. Here by using LM35 separate amplification need not be used so that it can produce high output. Some of the characteristics of the LM35 sensor is that maximum supply voltage is 35v and maximum output voltage is 6v and coming to the current output current is 10ma and maximum junction temperature is 150degrees.

Light Dependent Resistor

Light Dependent Resistor is mainly used for the sensing the light which is made up of photo conductive cells and for this making Cadmium sulphate is been used. By using the resistor photo conductive cells will be reduced by increasing the light intensity. For the spectral response which will be matching with the human eye we use cadmium sulphate. The response time of the photo conductive cells will be a very short duration of time. It is very small and very low of cost. Simple torch as a light of source also will also be identified by the photo conductive cells. Wavelength of the photo conductive cells is of 560nm to 600nm. When comparing both photo conductive cells and photo resistive cells the response time will be very slow for the photo conductive cells compared to photo resistive cells. Response time, light resistance and dark resistance is composed with 30ms, 18 to 50 Kilo ohms and 2 Mega ohms respectively.

PIR sensor

PIR is briefly abbreviated as Passive Infrared Sensor which is an electronic sensor which will be measuring Infrared light of the radiating form objects in the field view. PIR based motion detectors are most often used. By using PIR sensor it

is time saving for the circuitry. It is composed of adjustable sensor and output LED indicators. When the temperature above absolute zero which will emit heat energy in the form of radiation as these radiations are invisible for the human eye as these are in the form of infrared and these will be detected by PIR sensor as the electronic devices are designed in such a way to detect

Control and Monitoring Devices

The Devices which are need to be controlled and monitored are dependent on the number of devices which are connected to the FPGA device as the input and output ports. Implemented system can be expanded further by cascading the FPGA's for different sensors. By expanding the implementation the system will be scalable. The connected devices will of wired device or wireless device to the GSM modem. The modules connected to the FPGS are sensors such as temperature sensor, LDR sensor, PIR sensor and LED etc., This implementation is useful for the automatic ON or OFF of the particular device and also useful in order to avoid the accidents such as fire. The control is totally taken by the motor by switching the relay and the sensors.

4.3 Device operation – Flow Chart Representation

The automatic remote actions in the industries are shown in the below flow chart. When we turn on the device the device will be activated and if any emergency cases are been happen in a particular area of the industry then the relay switch will be activated and activate all the sensors accordingly. The communication is happened with the help of GSM module which is been inserted with SIM card which will send the emergency message to the registered mobile number. The message will be decoded so that the device will be switch ON or OFF accordingly.

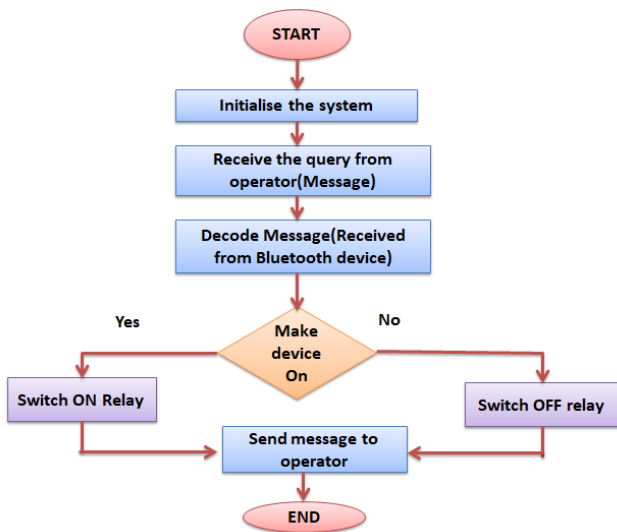


Fig. No 3. Flow chart for Device Operation

4.2 Flow chart for street light

For automatic ON or OFF of street light we have used LDR

and IR sensors for identify the intensity of light and detect the presence of human being respectively. When the human presence is been detected then the particular light will be Switched On and the remaining lights will be turned OFF according in order to save the power and to use the improved technology. LDR sensors are used for the intensity of light means the lights will be turned ON after sunset as there will be no lighting and will be turned OFF when there is no darkness.

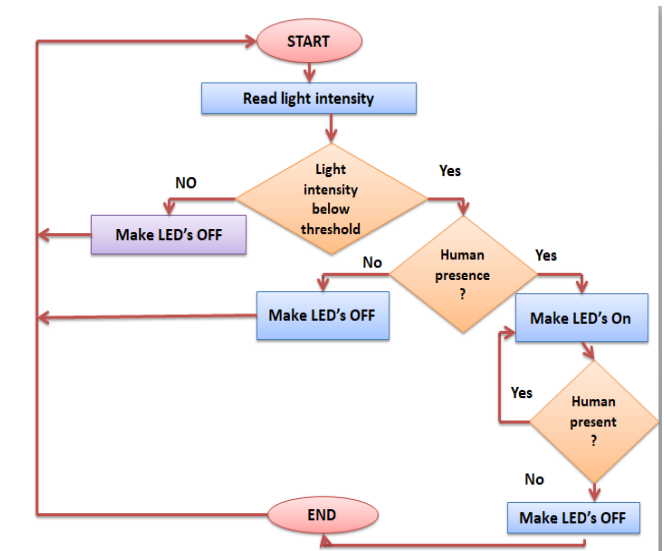


Fig No 4. Flow Chart for street Light

4.3 Simulation Result

In order to make the industrial devices automatic by using remote devices on and OFF we have used the relay SPDT. Here we have used the LED strip which is used to demonstrate the street lights on or OFF accordingly. In the output we have observed the formation of the output according to given Verilog code.

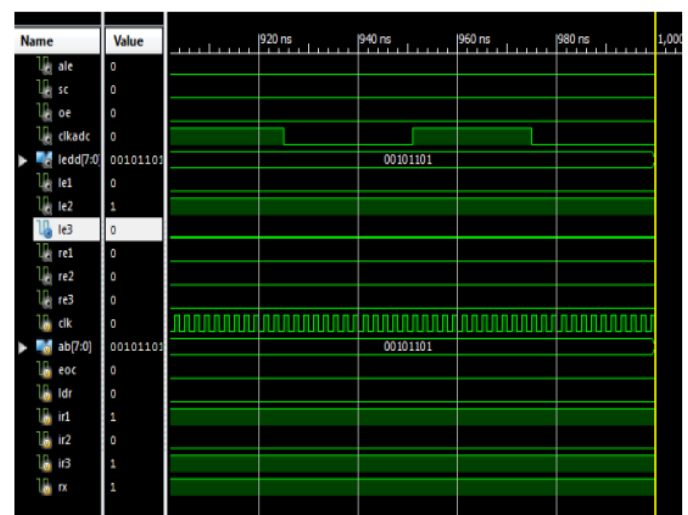


Fig No 5. Simulation Result

Once software based verification completed and succeed then we implemented the hardware prototype.



Fig No 6. Hardware Results

5. CONCLUSION

In this paper, i have implemented the automatic remote devices in industries so that the devices will be operated automatically. This prototype is been implemented on SPARTAN III FPGA kit using Verilog software language. For the simulation of this prototype Xilinx ISE suit is been used so that the simulation process will be recorded and the results will be stored accordingly. The main implementation of this prototype is to reduce the accidents happened in industries this is possible by using GSM module which is been inserted with a SIM card so that it can track the current location of the registered mobile number using GPRS, the relay circuit will be activated by activating the sensors like LDR and IR sensors. This prototype is also applicable on street light control which can automatically ON and OFF by using LDR sensors.

References

- [1]. Srinivas gopu and G Shyam Kishore “Monitoring Of Home & Activation of Automated System Via GSM Through FPGA”, International Journal of New Trends in Electronics and Communication (IJNTEC—ISSN: 2347) Vol. 2, Issue. 1, Jan. 2014
- [2]. “Implementation of a Home Automation System through a central FPGA Controller – IEEE Journal – Electro technical conference (MELCON) 25-28, March 2012
- [3]. Yadav Vajrangshakti.Ramdayal1, K. Srinivasa Rao, An Adaptive Industrial Automation Application Design using ASIC; International Journal of Reviews on Recent Electronics and Computer Science. IJRRECS/October 2013/Volume-1/Issue-6/1093-1099 ISSN 2321-5461
- [4]. Wael M El-Medany¹, Mahmoud R El-Sabry² “GSM-Based Remote Sensing and Control System Using FPGA”, Proceedings of the International Conference on Computer and Communication Engineering 2009 May 13-15, 2009 Kuala Lumpur, Malaysia, 978-1-4244-1692-9/08/\$25.00 © 2009 IEEE
- [5]. GSM Switching, Services and Protocols by Hans-Jorg Vogel, Christian Bettstetter
- [6]. Michel Mouly and Marie-Bernadette Pautet: GSM System for Mobile Communications, published by the authors 1992, ISBN 2-9507190-0-7
- [7]. T. Karuppiah, Dr. Periasamy, Dr. S. Muruganand; “Embedded System Based Industrial Power Plant Boiler Automation Using GSM Technology”, International Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 8, August 2013
- [8]. K.N. Sweatha, M. Poornima, M.H. Vinutha “Advance Home Automation Using FPGA Controller” Int J of Advan Research in Computer and Communication Engineering Vol. 2, Issue 7, July 2013
- [9]. S. Karthik, T.R. Prasanna Vishal, S.G. Jayaram, K. Priyadarsini "GSM Based Configuration of FPGA". IOSR J of VLSI and Signal Processing Vol. 4, Issue 4, Aug. 2014.
- [10]. H. Warren, “Telecommunications”, community college of southern Nevada, Prentice-Hall press USA 2001
- [11]. L. Larsson, A. Klindworth, K. Lagemann, “Teaching System Integration using FPGAs
- [12]. Floyd, “Electronic Devices”, Pearson Education International, 2005.
- [13]. S. Perelson and R. A. Botha, “An Investigation into Control for Mobile Devices”, ISSA, Gallagher Estate, Johannesburg South Africa, 2004
- [14]. I. Coskun H. Ardam, “A Remote Controller for Home and Office Appliances by Telephone”, IEEE Trans. Consumer Electron. , vol. 44, no. 4, pp. 1291- 1297, November 1998
- [15]. Ahmad, Arbab Waheed, et al. "Implementation of ZigBee-GSM based home security monitoring and remote control system." 2011 IEEE 54th International Midwest Symposium on Circuits and Systems (MWSCAS). IEEE, 2011

Author(s) Profile:

Dr. S. Murali Mohan, currently working as Professor at Mother Theresa Institute of Engineering and Technology, Palamaner, affiliated to JNTUA University in the Department of Electronics and Communication Engineering. He received his Doctorial Degree from S. V. University, Tirupathi, AP, He has published research papers in various international journals. His research interest areas are image processing, VLSI and neural networks.

Mr. M. Ajay Kumar is working as Associate Professor, Mother Theresa Institute of Engineering and Technology, Palamaner, affiliated to JNTUA University in the Department of Electronics and Communication Engineering. He received his Bachelor’s degree in ECE, 2008. He received his master’s degree with the specialization of DSCE in the year 2010. He has published various national and international journals with the interest areas of Image Processing and Embedded Systems.

Mr. A. Devamani is currently working as Associate Professor at Mother Theresa Institute of Engineering and Technology, Palamaner, affiliated to JNTUA University in the Department of Electronics and Communication Engineering. He received his master’s degree JNTUH, Kukatpalli in the year 2012. He received his Bachelor’s degree in ECE 2004. With the experience of 13 years he has published various international journals with the interest areas of VLSI and Image Processing.

Mr. R. Narayana Rao is currently working as Assistant Professor at Mother Theresa Institute of Engineering and Technology, Palamaner, affiliated to JNTUA University in the Department of Electronics and Communication Engineering. He completed his B. Tech. & M. Tech programmes in ECE stream. His area of interest is VLSI and Embedded systems.