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Remote Monitoring of Industrial Devices and Streetlights using Spartan III and Verilog.

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Abstract - *An Industrial security needs to pay more attention these days. In this paper I presented the idea of controlling the industrial devices remotely. The remote action is taken with the help of SMS(Short Message Servicing).Mobile phone is used for that purpose. Also for in room operation Bluetooth technology is used. I have also presented the idea of controlling the streetlights remotely. The difference between the other ideas and my idea is the core processor used. I have used FPGA(Field Programmable Gate Arrays)SPARTAN III kit for automating the industrial processes. The software is written in Verilog. The GSM(Global System for Mobile)technology is used for sending the messages to close or open the device in case of emergency. The analog sensors are used to sense the environmental parameters such as temperature,presence of CO2,intensity of light.The PIR(Passive Infrared Sensors)are used to detect the presence of human being.*

Key Words: **FPGA, SMS, GSM, Verilog, PIR, Bluetooth**

1. INTRODUCTION

In industrial area or on any industrial plant the atmosphere is different from that at any other places i.e. home of a person or a place like garden. Also even if almost precaution is taken there is possibility of leakage of harmful gases. Also accidental fire situations can occur because of rise in temperature or electrical sparking. To take care of this situations we need to have a device which can be controlled remotely. This device will turn ON or OFF industrial devices. I have also included the idea of streetlight illumination in my project. The lights in the premises of industry will be turn on after the detection of human presence. Also these lights will turn on only when sunset comes close or after that when there is darkness. The basic structure of the device is that it includes SPARTAN III FPGA kit. Analog sensors are used to sense the environmental conditions such as to sense temperature LM 35 is used. Smoke sensor MQ7 is used is used to sense the CO2 in case of fire. LDR is used to sense the intensity of light. PIR sensors are used to detect the human presence. ADC 809 is used to convert analog data to digital form. This data is processed by the FPGA chip. The output is given to relay board which in turn switches ON or makes OFF the devices connected to it. GSM module is used to send and receive the messages send by mobile phone. The software is written in a such a way that it identifies the device which to be turn ON or OFF. It also identifies/decodes whether device to be turn ON or OFF.

2. LITERATURE REVIEW

There are different remote control techniques which can be used to control the industrial processes. We can use SMS based control. In this technique GSM module is used which includes a SIM card with a number same as cell phone number. In case of emergency the operator sends a SMS on the number which is placed in GSM module. We can manually control the devices using remote. In this case sensors are fixed on the devices which are to be turned ON or OFF.A sensor is also fixed on remote. This is a simple method like remote control of TV or a box is fitted with sensors and relays. Remote is used to send the code for the device which to be turn ON or OFF. In the telephonic method extension card is attached to telephone which counts the ring cycles and actuates the relay connected to device. There is no need to move the cradle. In PC based techniques email is used .The email is send on concerned email idling the subject it is mentioned which device to be turned ON or OFF.Once the email is arrived in inbox .exe file stored in memory is executed.As a consequence instructions in this .exe file send a control word to the relay board to switch ON or OFF the device.Other than earlier mentioned technologies ZIGBEE devices are also used.ZIGBEE coordinator is responsible for creating and maintaining the network.Each device which is to be managed by remote control is fitted with ZIGBEE device.This device is managed by the ZIGBEE coordinator.All communication between devices propagates through the coordinator to the destination device. It is radio wave based standard based on IEEE 802.15.4.Wireless nature of ZIGBEE helps to overcome the intrusive installation problem with existing systems.Wi-Fi based control is an alternative to ZIGBEE based technology.It is available on mobile phones only.It also uses IEEE 802.11 standard which uses 2.4Ghz band of frequency.This system is more flexible.It consists of modem,router with a four port switch.The modem provides the communication between the internet and local Wi-Fi network.It is a low cost communication method.

3. EXPERIMENTAL SETUP

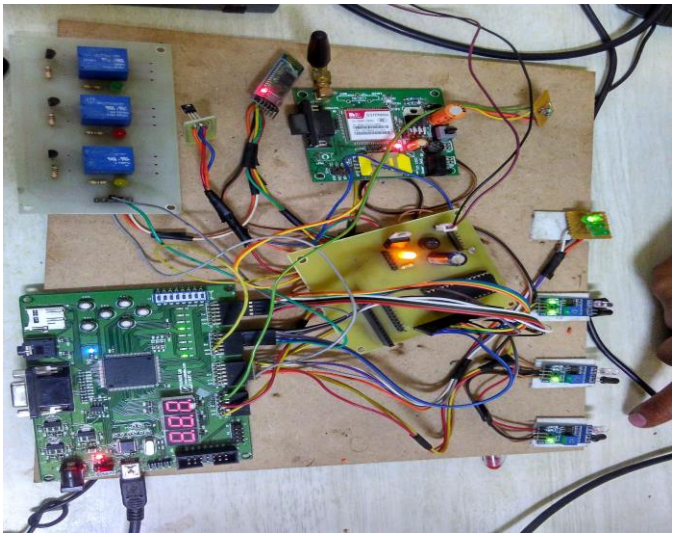

Fig- 1: Experimental Setup

The prototype as shown in above picture consists of SPARTAN III kit. Three IR sensors fitted on board for sensing human presence. A small PCB with power supply and ADC on it. GSM module fitted with SIM card having a number same as mobile number. LED strip consisting of three LEDS is used for demonstrating streetlight illumination.Temperature sensor,gas sensor are also fitted on board.LDR is also fitted on board to sense the intensity of light.Relay board consisting of three relays is used for demonstrating ON/OFF action of device.

4. SOFTWARE IMPLEMENTATION

In this particular system we collect the data from different analog sensors.This data is analog in nature.For processing it we convert it in to digital form.ADC 809 is used for that purpose.To process it programmes are written and loaded into FPGA chip.For writing the software programmes we use the Verilog language.For simulating we use the Xilinx ISE suite.GSM module which is fitted with a SIM card having its own number is used for sending and receiving messeges.

4.1 GSM-Global System for Mobile Communication

The Global System for Mobile Communication were launched commercially in 1995 for FAX,Data and SMS messeging services.The operational frequency of network was 1900Mhz.It was first introduced in United States and subscribers worldwide exceeded more than 10 million.GSM employs Time Division Multiple Access(TDMA) spectrum sharing.The GSM network structure has a number of different sections such as Base station subsystem,Network and switching subsystem,GPRS core network,Operations support system. GSM is a cellular network which means that the cell phones connect to it by searching for cells in the immediate vicinity.There are five different cell sizes in a GSM network macro,micro,pico,femto and umbrella cells.For macro cells base station antenna is installed on a building above average rooftop level.Micro cells antenna height is under average rooftop level.Pico cells are small cells whose area diameter is few dozen meters.Femeto cells are designed to use in residential or small business enviornments.Umbrella cells are used to cover shadowed regions of small cells and fill in gaps in coverage between those cells.The longest distance the GSM specification supports in practical use is 35 KM. The carrier frequency range for 2G network is 900Mhz. to 1800Mhz.3G network operates in 2100Mhz.It uses TDMA.The channel data rate for all 8 channels is 270.833kbits/s and frame duration is 4.615ms.The transmission power in the handset is limited to a maximum of 2 watts in GSM 850/900Mhz and 1 watt in GSM 1800/1900Mhz. Another important part of GSM is SIM card. SIM stands for Subscribers Identity Module.It is a detachable smart card containing users information and phonebook.It allows user to retain his or her information evenif the phone is switched off.GSM uses General Packet Radio Service (GPRS) for data transmission like browsing the web.

4.2 Bluetooth Communication

Bluetooth i.e."short-link" radio technology was initiated in 1989 by Dr. Nils Rydbeck and Dr. John Ullaman. The purpose was to develop wireless headsets. It is wireless technology for exchanging data over short distances. It uses radio waves in the ISM band from 2.4 to 2.485 Ghz. It divides transmitted data into packets and transmits each packet on one of 79 designated Bluetooth channels. Each channel has a bandwidth of 1 Mhz. It usually performs 800 hops per second. It use π/4-DQPSK(Differential Quadrature Phase Shift Keying) and 8 DPSK modulation. The data rate of 1Mbit/s is possible. It is a packet based protocol with master-slave structure. It can communicate with a maximum of seven device in a piconet.

4.3 Verilog

Like other software languages Verilog is a software language used to write the programmes.It is one of the Hardware Description Language.It is invented by Gateway Design Automation around in 1984.It is used to describe digital systems.Verilog allows the programmer to design a digital design at Behavior level,Register Transfer Level(RTL),Gate level and at switch level.There are two design styles Bottom-up-design and Top-down-design.In bottom up design style the design is performed using gate level.Standard gates like AND,OR,NOR,Ex-OR,NOT are used for that purpose.In top down style design is a structured system design.It allows high level design and also RTL coding.

4.4 Xilinx ISE Suite

Xilinx ISE software tool is developed by Xilinx for programming the FPGA chips.Using this tool we can synthesis and analyse the HDL designs.We can also perform timing analysis,examin the RTL diagrams,simulate the design

and configure the target device.For installing the ISE we require 30 GB space on your C drive and windows as operating system.For simulating the design we open new project.We enter the programme in editor.By using ADD Source option we create .V file.By using simulation option we simulate the design.In simulation it simulates behavioral model.In implementation we can synthesize,implement the design.We can configure target device.We can also get design summary and reports.After simulating the behavioral model the ISim window opens in which we can observe the design waveforms.After simulating and getting the required results we configure the target device by using the data cable.

4.5 Flowchart for Device Operation

The flow for remotely controlling the devices is shown.As shown in the flowchart when we turn ON the system the initial status of different devices is achieved

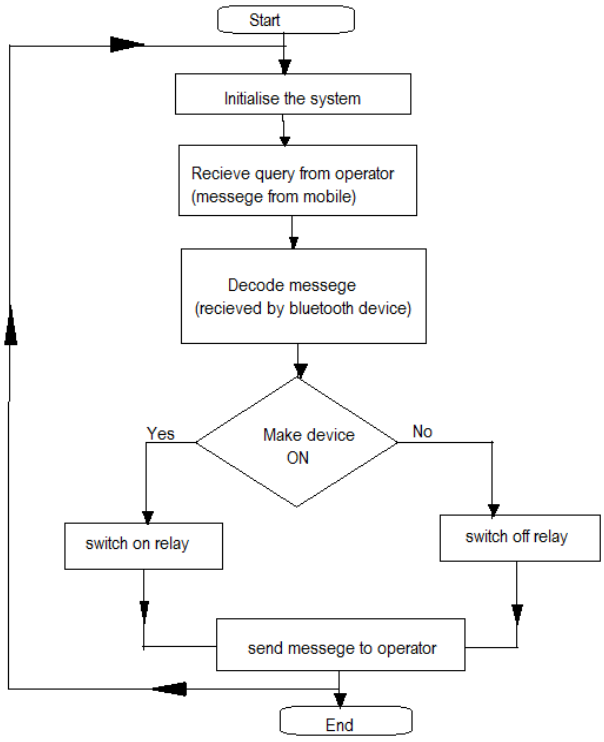

Fig- 2: Flowchart for Device ON/OFF

e.g. all the relays are in OFF position.When we receive messege from operator, the message is decoded,accordingly the device is made ON or OFF.If any emergency situation occures SMS is send to operator on its mobile number.

4.6 Flowchart for Streetlight Illumination

For streetlight illumination we use LDR as well as IR sensors.In this LDR senses the intensity of light and makes light ON.In addition we are using IR sensors.So only when human presence is detected that particular streetlight is made ON.

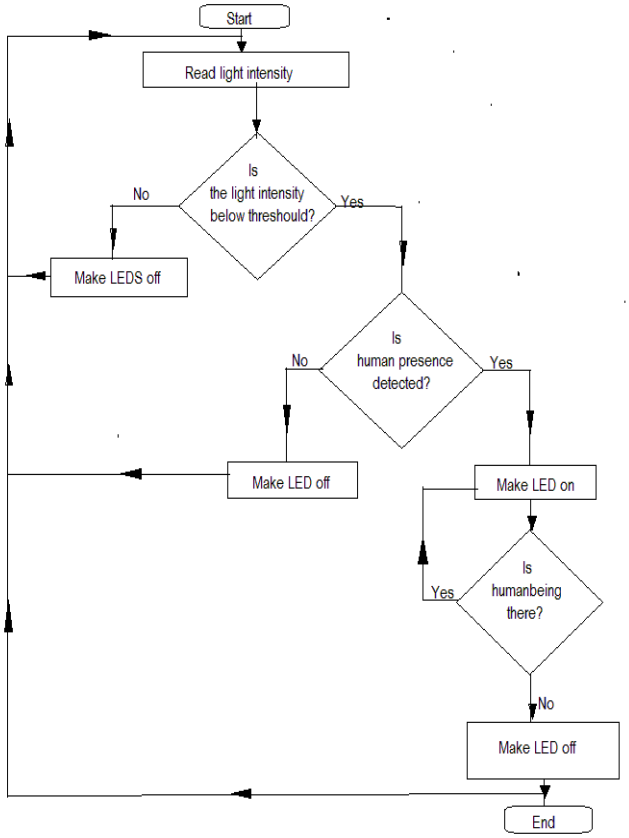

Fig- 3: Flowchart for Streetlight Illumination

In addition we are using IR sensors.So only when human presence is detected that particular streetlight is made ON. As the person moves forward or backward those lamps are switched on and other are kept in off position.

5. OVERALL OUTPUT

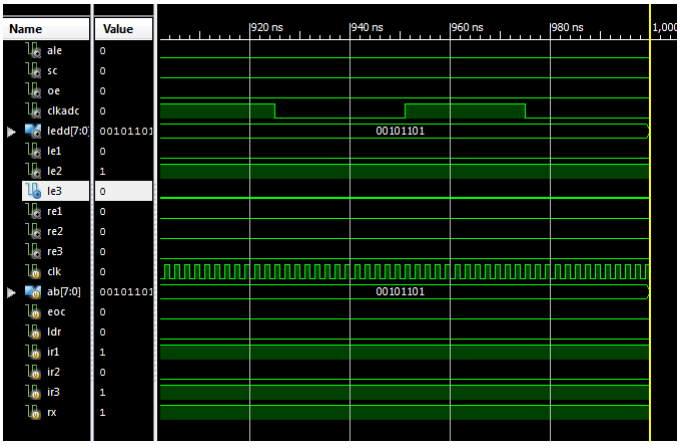

Fig- 4: Output waveform after simulation

In this prototype we require to make the industrial devices ON or OFF.For that purpose we use SPDT relays.LED strip is used to demonstrate the streetlight illumination.In the output shown different signals simulated can be

observed.First is the ale signal ie. address latch enable which latches the address of different output signals.oe ie.output enable signal is used to enable the output of ADC.clkadc is the clock required for ADC which is 1/3rd of the clock generated by the crystal.Output of three different LEDs is given as le1,le2 and le3.Output of three relays are given as re1,re2 and re3 is also shown in output.eoc ie.end of conversion signal of ADC indicates that the conversion process is completed.Output of LDR is shown as ldr.Output of IR sensors is shown as ir1,ir2 and ir3.Recieve enable is also shown.

6. CONCLUSIONS

In this paper I presented the idea of remotely controlling the industrial devices and illumination of streetlights.For simulating hardware we use SPARTAN III FPGA kit.The performance of kit is faster than the other processors available and also flexible for programming.Software used for simulation is Xilinx ISE suite.This software is easy to operate.Also we can simulate large programmes.We can see the output waveforms in Isim window.For in room operation we use Bluetooth communication.For remote operation we use GSM module fitted with SIM card.We can send and receive SMS on our mobile using that number.In this way we can handle the emergency situations effectively and energy conservation is achieved by using IR sensors.

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