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# Zigbee Based Wireless Fire Security Node Design using FPGA whose Monitoring and Controlling through LabVIEW

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***Abstract***

*The goal of this paper is to style a wireless detector node mistreatment FPGA for fireplace observance and management. FPGA is employed within the wireless detector node style so as to boost the process capabilities of the system to attain the target applications. The detector nodes during a wireless detector network square measure sometimes microcontroller based mostly that square measure having inadequate machine capability involving numerous applications. This paper depicts the choice, specification associate in nursing realization of wireless device node exploitation the field programmable gate array (FPGA) based mostly design for an early finding of dangers (e.g., fire and smoke). The FPGAs in its place area unit additional knowledgeable for classy computations in compare to microcontrollers. Another profit of exploitation FPGA is additionally thanks to its reconfigurable characteristic while not neutering the hardware itself. The node is enforced mistreatment Spartan 3AN FPGA board from xilinx. A style of straightforward hardware circuit with totally different sort of sensors allows every user to use this wireless hearth security system. The FPGA can endlessly supervise all the sensors and sends the data to the PC central observance and dominant station wirelessly mistreatment Zigbee technology. The system is predicated on the LabVIEW software.*

***Keywords:*** *Wireless sensor network (WSN), FPGA, zigbee, smoke sensor, fire sensor, temperature sensor, LabVIEW.*

## INTRODUCTION

The wireless detector nodes square measure the elemental element during a wireless detector network (WSN) [1]. These nodes square measure employed in type of applications such as health care,

setting watching, structural health watching, pipeline (water, oil, gas) watching, underground mining, target pursuit, supply chain management, preciseness agriculture, transportation active volcano watching, and act watching. A wireless sensor node is equipment in wireless sensor network, which contains integral sensors for monitoring several environmental as well as physical conditions. These devices are capable to sensing information, processing the sensed information and pass the processed data to neighbor nodes or some distant station (s). Wireless sensor node comprises of five significant subsystems as shown in the Figure 1. Sensing subsystem involves sensors, which are usually small devices which are capable of generating some computable response (frequently a change in voltage). These responses are generally served to an analog to digital converter (ADC). The digitized signal is then directed to the processor unit for further processing. Processor subsystem is the heart of the wireless sensor node. It is also acknowledged as the controlling unit and the selection of a processor defines the tradeoff between efficiency and flexibility in terms of both energy and performance. There are various processors as options: microcontrollers, digital signal processors, application-specific integrated circuits, and field programmable gate arrays. FPGA's are chosen as the control unit in the wireless sensor node due to its unique features of reconfiguration and reprogramming. Communication subsystem consists of a wireless antenna. It makes use of radio frequency (RF), infrared waves or optical communication as the communication media. The wireless radio unit operates in the ISM band. Memory necessity square measure dependent on applications. There square measure 2 varieties of memory supported the intention. Program memory is meant for programming the device. User memory is planned for storing application connected or personal information. Batteries square measure the vital supply of power offer for a wireless device node. Attributable to the constraint in size, batteries accustomed got to be in little dimension, that entails that the life of a wireless device node are comparatively low.

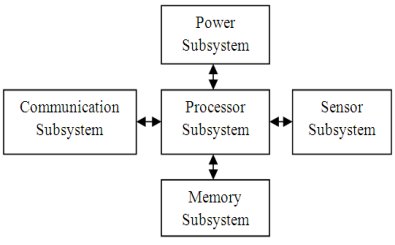


***Fig. 1:*** *General Sensor Node Architecture.*

In this paper, we have used the FPGA based sensor node architecture, including

the acquirement of information related to fire (i.e., temperature and smoke) and transmission of information by routing over wireless networks such as Zigbee [2, 3]. In data acquisition system, it is a rising task to obtain the data at a required rate and to collect the data in an on chip memory processor. There are devices like microcontrollers; DSP and microprocessors are available which can be programmed as a data acquisition system [4, 5]. The major disadvantage of using these devices is their sluggish data acquisition speed, non-availability of adequate on chip memory. The rigidity in the hardware configuration of these devices does not permit flexibility for the user in configuring these devices along with the requirement. To overcome these shortcomingsthis research work proposes a new method of design and develops a data acquisition system using FPGA which proposals flexibility in configuring the device according to the user necessity. The most significant defining characteristic of the FPGA is that it can be reprogrammed. Programming an FPGA is very distinct from a DSP processor or a microprocessor. Microprocessor is a stored program computer. A computer system encloses both a CPU and a separate memory that keeps the data and instruction. The FPGA program is combined into the structure of FPGA and FPGA does not fetch instructions. The FPGA's programming exactly implements the interconnections and logic functions. In the FPGA's there is no delay for completing the design to gain a working chip. The design can be programmed into the chip and can be tested instantaneously. When an FPGA is utilized in final design, the jump from prototype to product is much smaller and easier. They are having an enormous number of input and output lines compared to microcontrollers, DSP's and microprocessors. FPGA's are having a more processing speed compared tomicrocontrollers and microprocessors. With FPGA devices, it is likely to modify the design to fit the requirements of applications.

Fire security at home or at industry or at any place is the most vital one. For everybody either in an individual house or a building or industry or any place, safety is required and they must assurance that their home or industry is installed with the perfect and comprehensive fire security system to protect their own life and assets. This system can be used to offer fire security for all types of residential, domestic, commercial, and industrial purposes using Zigbee technique wirelessly [6–9].

## RELATED WORKS

Natheswaran S, Athisha G. discussed about the Remote Reconfigurable Wireless Sensor Node Design for Wireless Sensor Network [1]. Manoranjan Das, Banoj Kumar Panda discussed about the Prototyping a Wireless Sensor Node using FPGA for Mines Safety Application [2]. Suneel Mudunuru, V. Narasimha Nayak, G. Madhusudhana Rao, K. Sreenivasa Ravi discussed about The Real Time Security Control System for Smoke and Fire Detection Using ZigBee [3]. Shibi Fathima A. discussed about The Implementation of Data Acquisition System for fire Detection in Mines Area Using FPGA [4]. Basil Hamed discussed about the Design and Implementation of Smart House Control Using LabVIEW [5]. Zujue Chen discussed about the design of wireless sensor network node for carbon monoxide monitoring [6]. P.S. Jadhav, V.U. Deshmukh discussed about the Forest Fire Monitoring System Based on ZIG-BEE Wireless Sensor Network [7]. N. Muthu Prabhu, S. Sai Mithun discussed about A Remote Home Security System Based on Wireless Sensor Network and GSM Technology [8].

## SYSTEM ARCHITECTURE AND WORKING PRINCIPLE

The system structure is given in Figures 2 and 3. The smoke sensor, fire sensor and temperature sensor is connected to the FPGA unit. The signals detected by these sensors are sent to the FPGA unit. Then FPGA transmits the information to the PC central monitoring and controlling station, through Zigbee module (transceiver).Computer device provided with LabVIEW software is the main controller unit for all system [5]. It receives data from remotely placed wireless sensor node, process information and updates data for the system. When received data crosses the threshold values, it transmit control signal to remote wireless sensor node. At node side, in turn after processing data, FPGA activates the actuators such as alarm circuit, water sprinklers relay, during abnormal condition. In addition, LabVIEW makes the ability to monitor the important operations in the system to the users in order to be informed of the changes in the system. As the system is not only monitoring but controlling also.

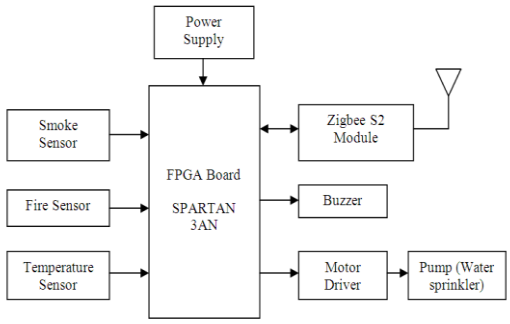


***Fig. 2:*** *Transmitter Wireless Sensor Node.*

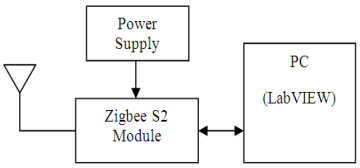


***Fig. 3:*** *Receiver Section.*

## COMPONENT DESCRIPTION

### Spartan 3AN FPGA (XC3S50) Board

Xilinx's SPARTAN 3AN, EVB is proposed to smooth the progress of developing and debugging of various designs encircling of Spartan-3A FPGA family [10, 11]. It Supports VHDL, Verilog, JTAG Programming Debugging, Facility to interface Add-on Cards and Project Developments. And having key features likeSingle Channel DAC, 2-Channel ADC (On-Board), 2x16-Char. LCD Interface, 8 No's of Slide Switches (Digital Input), 8 No's of Point LEDs (Logic Output), 5 No's of pushbutton Interface, 2 No's of UART, One Reset switch, 50 MHz crystal oscillator clock source, Buzzer, On-board 5V, 3.3V and 1.2V regulators, 40-pin I/O connector for interface external peripheral modules.

### Temperature Sensor

The LM35 series square measure exactitude integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature [12]. The LM35's low output electrical phenomenon, precise inherent activity and linear output create interfacing to readout or management electronic equipment particularly straightforward. The LM35 does not need any external trimming or activity to supply typical accuracies of ±1⁄4˚C at temperature and ±3⁄4˚C over a full −55 to +150˚C temperature vary. It has very small self-heating, less than 0.1˚C in still air. The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35CA, LM35C, and LM35D also exist in the plastic TO-92 transistor package.

### Fire/Flame Sensor

The Fire/Flame sensor is a simple and dense device for sensing the existence of fire/flame [13]. The module makes use of IR sensor and comparator to identify fire up to a range of 1 meter. The device can be easily mounted on the device body. It gives a 'High' output on detecting fire. This output can then be used to carry out the appropriate action. An on-board POT is given for the change of comparator voltage

and range. An on-board LED is also given for visual indication.

**Smoke Sensor**

Sensitive material of MQ-7 gas device is SnO2, that with inferior physical phenomenon in clean air [14]. Once the target inflammable gas exists, the sensor's physical phenomenon is higher together with the gas concentration increasing. Please use straightforward electro circuit, convert amendment of physical phenomenon to correspond signaling of gas concentration. MQ-7 gas device has high sensitivity to CO. The device may well be accustomed sense completely different gases contain CO, it is with very little value and suitable completely different application

**Zigbee S2 Module**

XBee is very simple and famous wireless device [15, 16]. It is a transceiver; it can transmit and also receive data wirelessly. There are various types of XBee module and it might be confusing. The most popular XBee is Series 1 (802.15.4), comes with the firmware to build connection for point to point or star network. XBee Series 2 does not provide any 802.15.4 only firmware, it is always running ZigBee mesh firmware. It is the novel XBee module that we are carrying now. XBee S2 has enhanced performance when you speak about mesh networking where it involves moderately a lot of nodes: Routers, Coordinators, and End Devices.

**ABOUT LABVIEW**

LabVIEW is a graphical programming language that uses icons rather than lines of text to create applications [17]. In contrast to text-based programming languages, where instructions decide program execution, LabVIEW uses dataflow programming, where the flow of data determines execution. In LabVIEW, you make a user interface by using a set of objects and tools. The user interface is known as the front panel. You then insert code using graphical representations of functions to control the front panel objects. The block diagram contains this code. In some ways, the block diagram resembles a flowchart.

LabVIEW is integrated fully for communication with hardware such as GPIB, PXI, VXI, RS-485, RS-232, and plug-in DAQ devices. LabVIEW also has integral features for connecting your application to the Web using the LabVIEW Web Server and software standards such as TCP/IP networking and ActiveX. Using LabVIEW, you can create

test and measurement, instrument control, data acquisition, data logging, report generation applications and measurement analysis. You also can generate shared libraries and stand-alone executables, like DLLs, because LabVIEW is a true 32-bit compiler.LabVIEW software is used for a broad variety of applications and industries. LabVIEW is a highly productive development background for creating custom applications that interact with real-world data or signals in fields such as engineering and science. The net outcome of using a tool such as LabVIEW is that advanced quality projects can be completed in less time with fewer people involved.

## RESULTS

### Settings

The setting of serial communication, temperature setpoints, and smoke setpoints in LabVIEW are given in Figure 4.

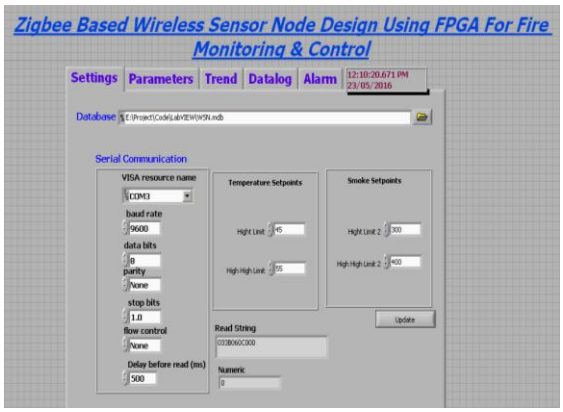


***Fig. 4:*** *Temperature and Smoke Setpoints.*

### Results in Presence of Smoke and Fire

The results in presence of smoke and fire are given below.

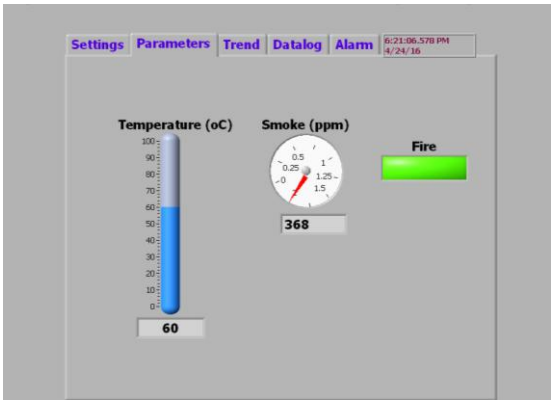


***Fig. 5:*** *Readings of Temperature, Smoke, and Fire.*

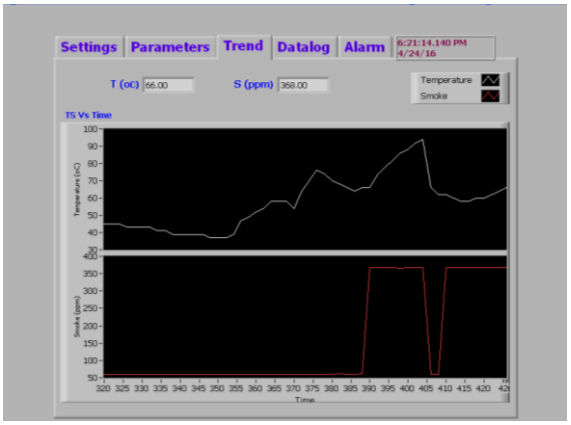


***Fig. 6:*** *Temperature and Smoke Graphs.*

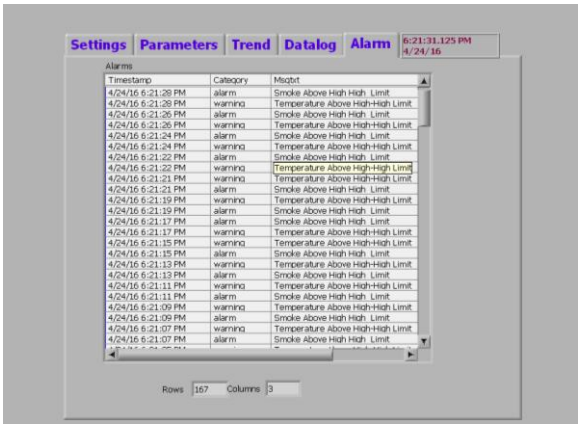


***Fig. 7:*** *Alarm and Warning Signals of Smoke and Temperature.*

## CONCLUSION

It is a real time monitoring and remotely controlled system. In this project different types of sensors such as temperature sensor, fire sensor and smoke sensor are interfaced successfully with single FPGA. In order that different fire sources which reasons fire coincidences could be detected simply by the node. In this fire security wireless sensor node, the challenges of interfacing different type of sensors areaccomplished and analyzed. The node is battery operated andconsumes less power. This system runs for elongated time. In future many additional gas sensors can be interfaced with this node and the algorithms are also customized to discover fire accident and to decrease power.We can use this system in the different types of fields like residential areas, commercial areas, industrial areas etc.

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