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Zigbee based Analysis of Solar based Powered Forest Fire Detection and Control System

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ABSTRACT: Forest Fires are one of the most important and prevalent type of disasters and they can create a great deal of Environmental Impacts due to which their early detection is very vital. The main need for choosing this particular application for the detection of forest fires is to overcome the demerits present in the existing technologies of MODIS and Basic Wireless Sensor Network-based Forest Fire Detection Systems and an advanced system is developed for the detection of forest fires. The two main modules present in the project are the Monitoring Area Module and the Forest Area Module. All these together are split into five sub-modules for step-by-step development and implementation. Those include Sensors' Module, Serial Communication Module using Zigbee, Optimized Solar Energy Harvester using Maximum Power Point Tracking (MPPT), PC-based Web Server and Mechanical Modelling. The first three sub-modules belong to the Forest Area Module. They are integrated together and mechanical modelling is done to place it in the forest, whereas, the PC-based Web Server is developed for the Monitoring Area. The outcome of the above implementations reveal that various sensors used in addition to the temperature sensor improves security level for areas located near the forests. It also shows that the Optimized Solar Energy Harvester increases the efficiency to about 85 % and the use of PC-based Web Server reduces the bulkiness and cost of the entire system.

KEYWORDS: ZigBee, Pic18f4520, Fire Sensor, Gas Sensor, LM35 Sensor.

I. INTRODUCTION

Forests are part of the important and indispensable resources for human survival and social development that protect the balance of the earth ecology. However, because of some uncontrolled anthropogenic activities and abnormal natural conditions, Forest Fires occur frequently. These fires are among the most serious disasters to forest resources and the human environment. In recent years, the frequency of forest fires has increased considerably due to climate changes, human activities and other factors. The prevention and monitoring of Forest Fires has become a global concern in Forest Fire prevention organizations. Currently, Forest Fire prevention methods largely consist of Patrols, Observation from watch towers. Satellite Monitoring and lately Wireless Sensor Networks (Han et al.). Although observation from watch towers is easy and feasible, it has several defects. In the first place, this method requires many financial and material resources and a trained labour force. Second, many problems with fire protection personnel abound, such as carelessness, absence from the post, inability for real-time monitoring and the limited area coverage.

II. RELATED WORK

Though the forest fire detection problem has received considerable attention recently, most existing methods cannot reflect the dynamic change of the temperature, or the smoke concentration, leading to very limited monitoring effect and unacceptable real-time performance. The causes of forest fires include lightning, extreme heat and aridity, human carelessness, and deliberate attempt to cause fires. In recent years, the frequency of forest fires has increased considerably due to climate change, human activities, and other factors [1]. According to prognoses, wildfires, including fire clearing in tropical rain forest, will halve the world forest stand by the year 2030 [2]. In Europe, up to 10,000 km² of vegetation is destroyed by fires every year, and up to 100,000 km² in North America and Russia. Wildfires are responsible for approximately 20% of CO₂ emission into the atmosphere. In Ref. [3], Samantha proposes an early forest fire detection system based on mesh sensor networks of temperature and humidity, light, and CO, where the sensor nodes communicate with the moving nodes deployed on the belt of forest animals, using the ZigBee technology. When animals move in the forest and come in range of stationary ZigBee wireless nodes, data will be collected and sent to the cloud for analysis.

III. METHODOLOGY

For the forest fire detection, a fire sensor has been used to detect the fire event. This fire sensor is incorporated in the transmitting module which is located at forest. Fire sensor has three terminals out of which two terminals are given for power supply (+5V and GND) and one pin is output pin, which will be made high in the event of fire. This digital pin is connected to one of the digital pin of Arduino UNO which has been configured as INPUT pin. When the fire will occur the digital output pin of sensor will be made logic HIGH, which will be detected by Arduino Uno and immediately after detecting the fire event the Arduino Uno will send a fire message through ZigBee wireless sensor network connected to its serial communication Rx and Tx pins. ZigBee module which is configured as Transmitter will transfer the message to another Remote ZigBee, which is far away from the transmitter ZigBee which is located at forest office surroundings.

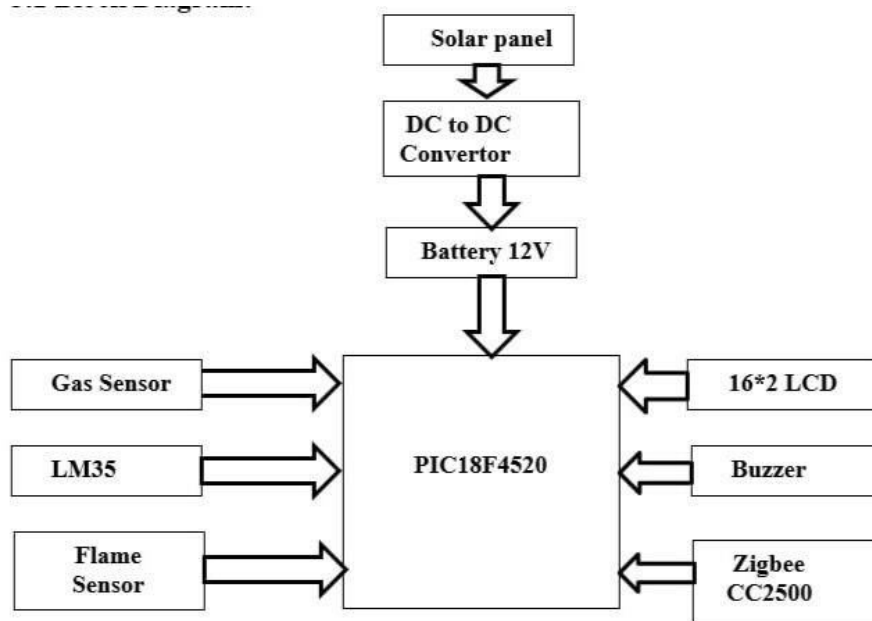


Fig. TRANSMITTER END MODULE

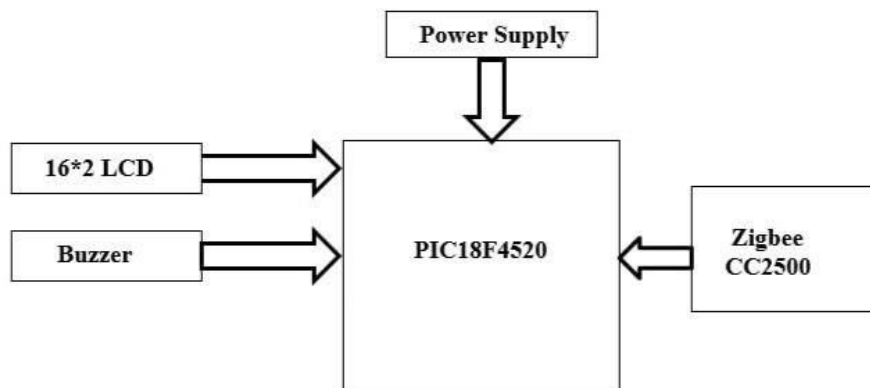


Fig. RECEIVER END MODULE

The receiver ZigBee is getting the power from the solar module followed by a boost converter. Solar photovoltaic module absorbs the sunlight as a source of energy to generate electricity. Each solar module is rated by its DC output power under standard test conditions. Typically ranges from 100 to 365 W. To reduce the voltage ripples, filters made of capacitors are added to boost converters output side and input side. A Boost Converter is a charge regulator or battery regulator that limits the rate at which the electric current is added to or drawn to from electric batteries. It

prevents the overcharging and deep discharging which can reduce battery performance and lifespan and may pose a safety risk. The lead acid battery is used because it has higher cell voltage and lower cost. This Receiver ZigBee is connected to Arduino Nano, after receiving the message from remote ZigBee (Transmitter XBee). Receiver ZigBee will transfer that Message to Arduino Nano by using serial communication pins. After the single receive the control system get activated and the water in the lake will sprinkled on that forest fire with using all control arrangement.

Software development

SOFTWARE REQUIREMENT –

- MPLAB IDE 8.91
- EMBEDDED C LANGUAGE
- PIC KIT3 PROGRAMMER
- PCB WIZARD (LAYOUT)
- PROTEL SE 99 (CIRCUIT DIA.)

PIC is a family of microcontrollers manufactured by Microchip Technology Inc. PIC stands for **Peripheral Interface Controller**. It is also referred to as **Programmable Interface Controller** or **Programmable Intelligent Computer**.



As all other microcontrollers PIC Microcontroller can be programmed using Assembly Language. As it is little bit difficult we prefer High Level Languages. Many high level language compilers are available for programming a PIC Microcontroller like MikroC, MPLAB XC8, Hi-Tech C, CCS C etc. In this tutorial we will use CCS C Compiler. CCS stands for Custom Computer Services, a Microchip PIC Microcontroller Tool Solutions company. MikroC and CCS C are the best compilers for beginners as they includes a lot of built in libraries which enable us to program a PIC Microcontroller without the deep knowledge of its internal architecture. I think CCS C is the best High Level Language Compiler for PIC Microcontroller as it is almost hardware independent.

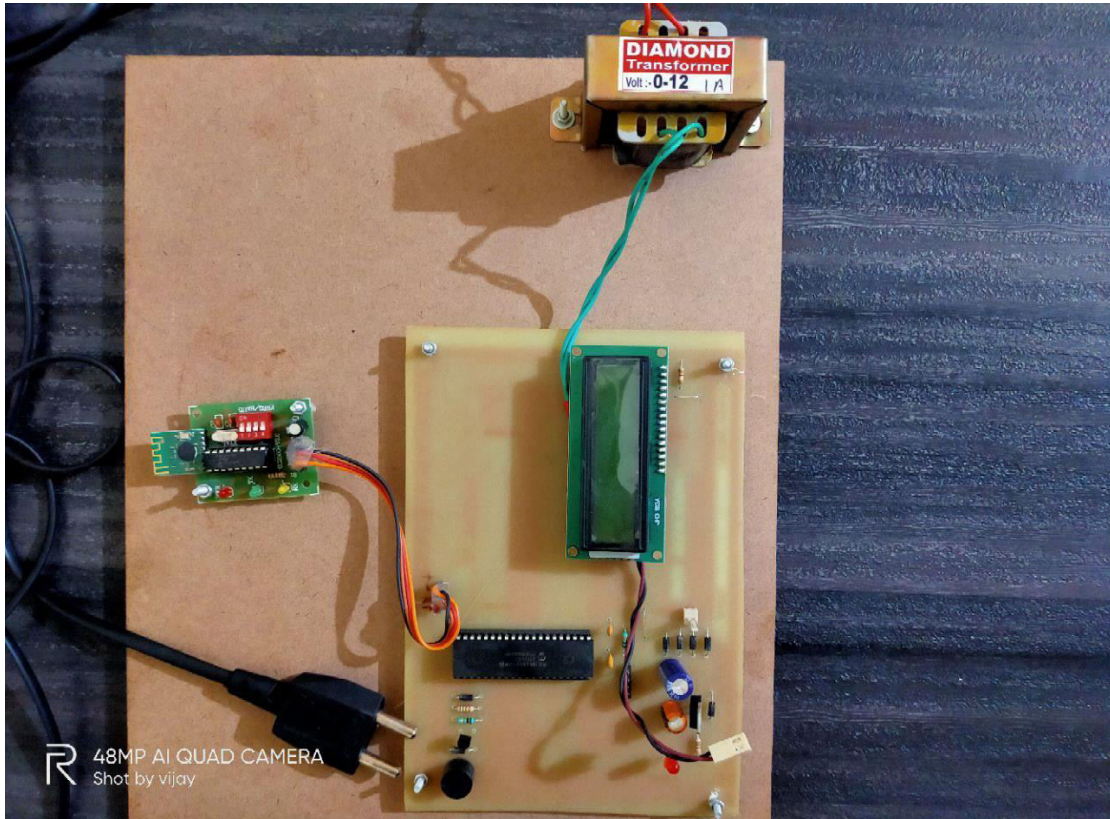


Figure 3: Transmitting End Module

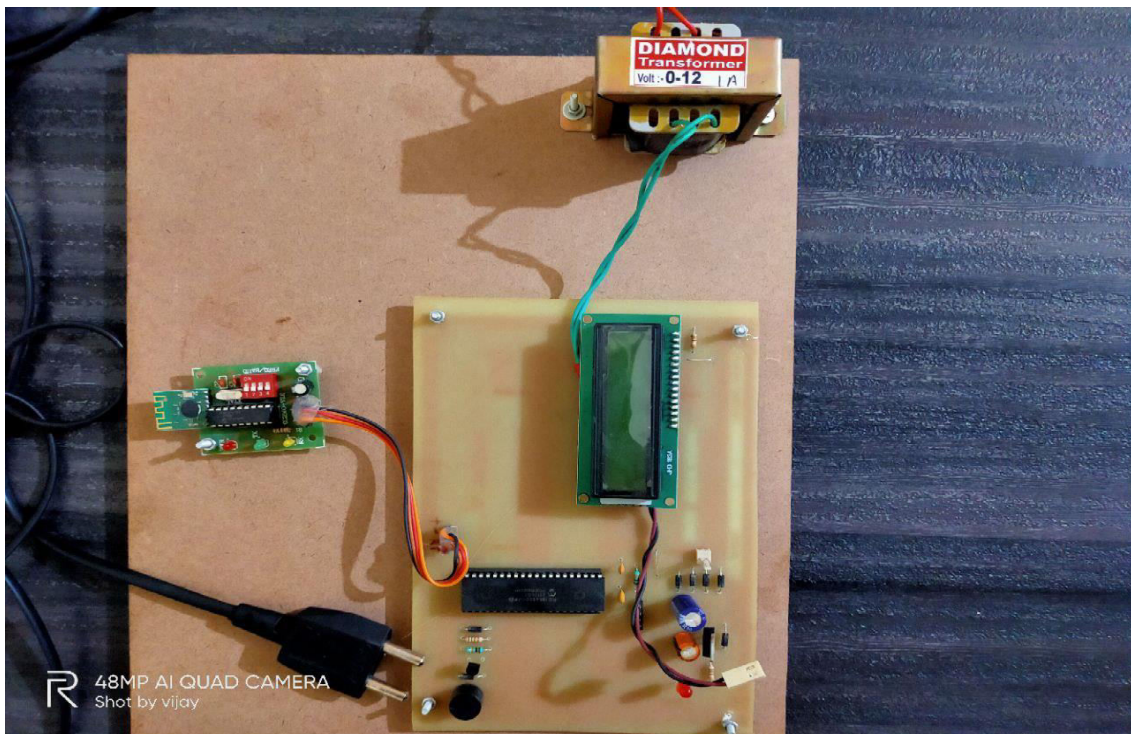


Figure 4: Receiver End Module



IV. EXPERIMENTAL RESULTS

RESULT TABLE:

Sr.no	Sensors	Normal Condition	After Fire Detection
1	Fire Sensor	Logical 0	Logical 1
2	Humidity Sensor	30%	56%-58%
3	Temperature sensor	35 C	50 C
4	Gas Sensor	25%	43%

V. CONCLUSION

This project describes the design and implementation of a system for forest fire detection by using wireless sensor network ZigBee and Arduino. This fire detection scheme can be used for many other applications too like in hospitals, malls, theaters and smart waste management etc. This system is developed to overcome the demerits of the existing system in order to protect the forest fire. Due to the accuracy of the project this system can be implemented on large scale and the system can be further developed. The higher version of ZigBee and with the use of solar module greater efficiency can be achieved.

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