ZigBee Based Wireless Fire Alarm

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Abstract- Undesired happenings cannot be predicted so, it's important to monitor these situations and take immediate actions. Fire outbreaks are one of the major concerns and although embedded systems are installed to fight such a situation but it becomes difficult to monitor vast areas like colleges, shopping malls etc. A ZigBee based wireless fire alarm is proposed to protect huge areas. The system will connect all fire-prone regions called nodes of the area to a single control unit using ZigBee. In case of emergency, a quick and direct signal will be passed to the control room so that necessary steps can be taken to alert public and other concerned departments with the help of a hooter. This system can be developed using temperature sensor, ZigBee module and a micro-controller. The proposed system can be incorporated in existing constructions as well as in under-construction projects.

Index Terms—Minimum 7 keywords are mandatory, Keywords should closely reflect the topic and should optimally characterize the paper. Use about four key words or phrases in alphabetical order, separated by commas.

1. Introduction

It is seen that the fire alarms using cable transmission have various problems majorly because they have distance constrains and they have high risk of getting worn out or bitten by animals. In comparison to these traditional alarms, wireless fire alarm based on ZigBee has a solution to these problems. The signal transmission distance is increased due to wireless technology. This also rules out the possibility of faults due to disturbances and defects in cables [1]. ZigBee has the capability to connect different nodes of an area to a single control unit. This will ease the monitoring of large areas against fire threats. It is effective than any other wireless technology mainly because it is low power-consumption and low-cost module [2]. This technology is better than Bluetooth or Wi-Fi and it passes data through a mesh of networks which ensures long working range of the device [3]. The three operating frequency segments for ZigBee are2.4GHz all over international, 868MHz and 915MHz in Europe and America respectively [4]. ZigBee technology also allows only active or sleep mode and this in turn optimizes the application code as the code is not busy in deciding on which mode the device should run. Also, the protocol code stack for ZigBee is very less as compared to Bluetooth's code stack and it has the ability to handle periodic data [5]. The collection of data, mainly the environment conditions of the area can be collected through various temperature, humidity and smoke-detector sensors. The action taken by main server is solely dependent on the data received by the sensors [6]. Incorporation of ZigBee will reduce the overall cost and will provide real time data to the control unit. This will reduce time lag as it reacts very fast to changing conditions [7]. Therefore, feature which makes ZigBee preferable over other alternatives is its reliability, ease of configuration, battery life, security and cost effectiveness [8]. The ZigBee wireless network includes three units: detection unit, transfer unit and control unit. Detection unit comprises of the various sensors that will constantly sense for suspicious and unexpected change in weather condition that can lead to fire. Transfer unit – The data collected from sensors is transferred through ZigBee channel of communication. Control unit is central unit which is collecting data from the detection node and taking necessary steps to ensure the safety of the building [9]. The transmitter end will have the sensors which will collect data and are connected to ARDUINO which will process the data for ZigBee – the communication module of the system. The receiver end will have similar kind of setup as the transmitter end and a main computer server will be connected to ARDUINO which is also having a ZigBee protocol on it. This completes the Wireless Sensor Network (WSN) [10].

2. Block diagram and its description

- DETECTION UNIT – This unit includes all the sensors deployed to collect data of their particular node. They constantly gather the data which is sent to the control unit as soon as they encounter fire conditions.
- TRANSFER UNIT – This unit sends the data to control unit. ZigBee is used to set a bridge among the other two units.
- CONTROL UNIT – This is the main unit where all the data is collected. This unit is connected to the host server and a supervision computer which stores all the data, map, contact details of emergency departments, etc. This unit also displays the hooter information.

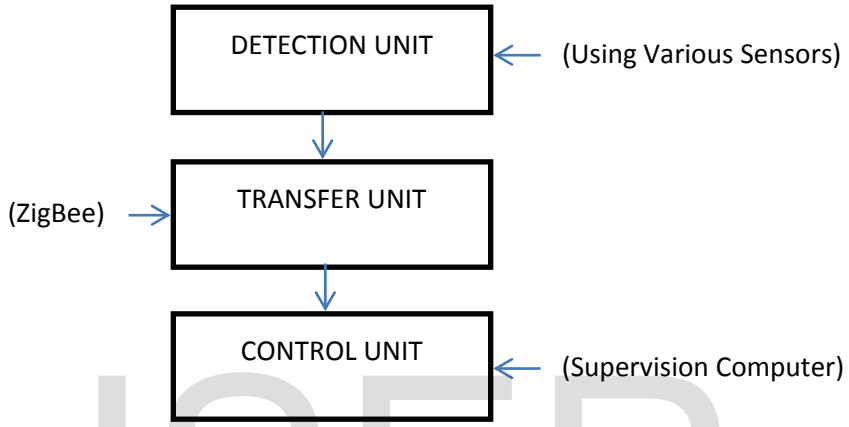

Fig.1 – Block Diagram

3. Hardware development

The major hardware peripherals include LM35 temperature sensor, ZigBee module, ARDUINO, LCD, Hooter and Power Supply as shown in Fig. 2. The 28-Pin ARDUINO UNO is chosen for the system. It can work well with 5V and allows connecting Hooter, LCD and ZigBee very efficiently. On the transmitter end as shown in Fig. 2, pin A0 of ARDUINO is connected to LM35 as it has the feature of ADC. The TX pin is connected to RX pin of ZigBee. Other pins are used for connecting LCD and power supply.

The receiver end of the system has another ARDUIONO board whose TX pin is connected to Hooter and RX pin is connected to TX pin of ZigBee. Similar to the transmitter end, LCD and power supply are also included in this segment of the system. An external crystal or ARDUINO'S internal clock can be used to provide clock to the microcontroller. The proteus version of the system shown in Fig. 2 is an overview of the system's hardware whereas the working of these segments is discussed ahead.

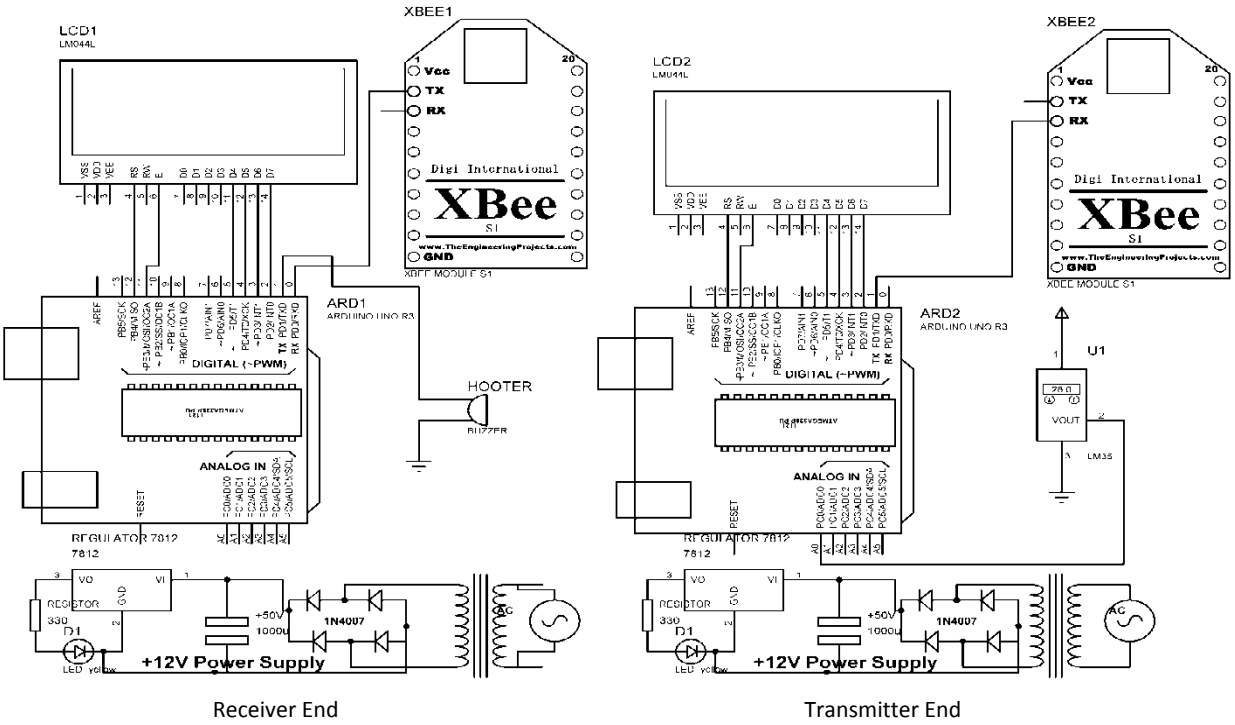

Fig. 2 – Circuit Diagram

The two main segments of the hardware – 1.Transmitter End. 2. Receiver End.

The transmitter end contains the temperature sensor, ARDUINO, ZigBee module and LCD Display. The LM35 temperature sensor developed by Texas Instrumentshaving operating temperature range from nearly -50^{0}C to 150^{o}C is connected to the ADC pin of ARDUINO. The temperature sensor constantly senses the surrounding temperature and feeds the data to the ARDUINO. The ARDUINO then starts the analog to digital conversion so that it can be directed to ZigBee. The temperature as recorded by the sensor is also displayed on the LCD. This comprises the transmitter end of the system and it keeps on collecting and displaying the data until any undesired change in weather condition is encountered.

The receiver end consists of a similar kind of system. The ZigBee connected on the receiver end receives the data from the transmitter end and transmits it to the ARDUINO. The ARDUINO constantly scans the data after conversion and decides whether the temperature conditions recorded in a particular area are expected or not. As long as the temperature conditions are normal, the recorded data is saved and the process keeps on going without any interruption. As soon as any unexpected temperature is recorded the ARDUINO quickly rings the Hooter and other necessary steps are taken to ensure that the situation is brought under control as soon as possible. When the situation is brought under control, the interruption for the ARDUIONO is finished and it starts with its collection andconversion process. The hooter is also turned off at this time. The quick process of receiving and transmitting is possible because of ZigBee as it has a short working cycle which enables low power dissipating in dispatching and receiving messages and this increases its life in single round of batteries. The short time lag also plays an important role for implementation of this system.it takes around 15ms for Zigbee to move into working mode from sleepmode.The wireless transmission segment consists of ZigBee connected to ARDUINO through SPI bus as shown in Fig. 3.

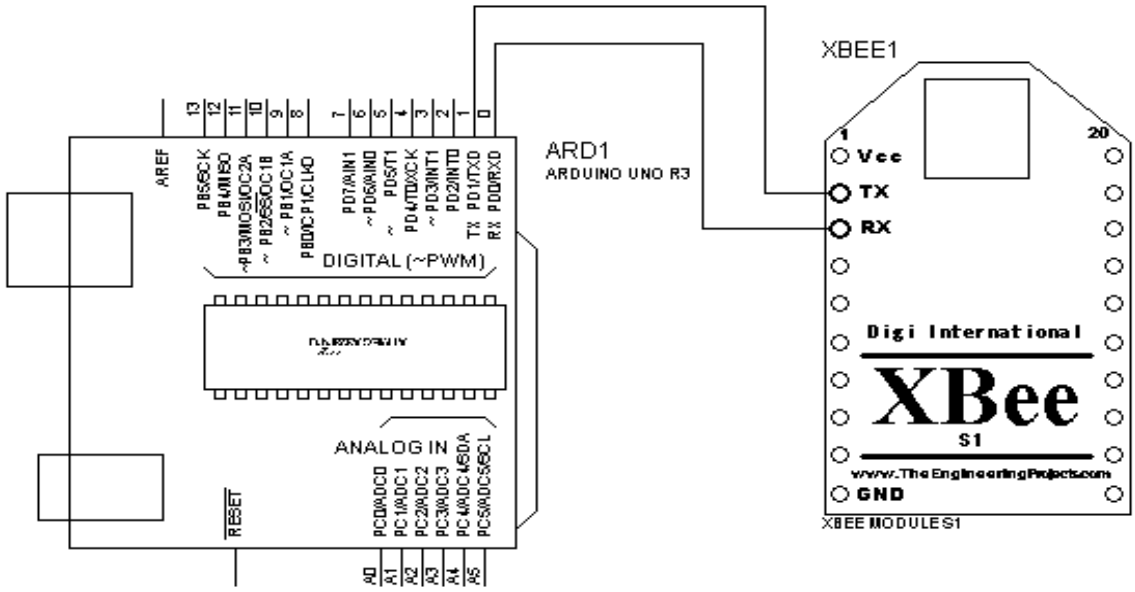

Fig.3 - Arduino and ZigBee Connection

4. Software development

Given below is the Proteus model of the system along with the peripherals and it allows the simulation of the device after a desired code

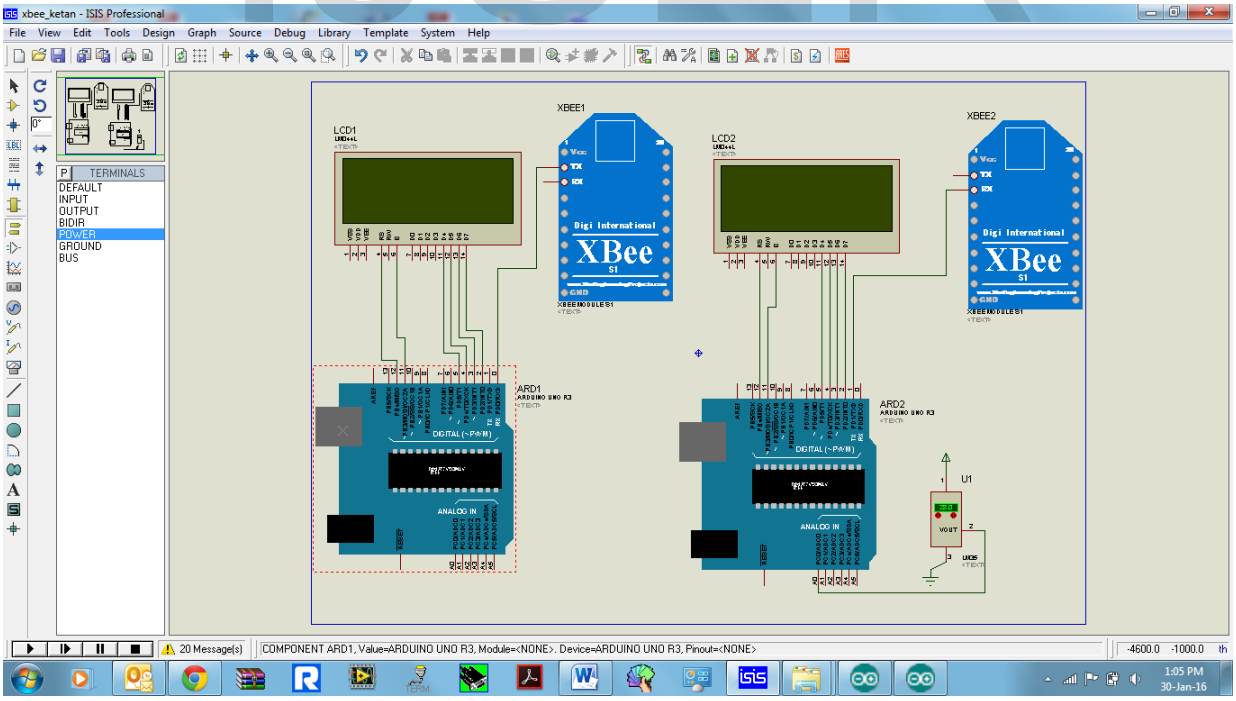

Fig.4 - Proteus Model

The system is initialized as soon as it turns on. The working parameters are chosen and the data collected by the sensors is fed to ARDUINO for the ADC conversion so that it can be directed to ZigBee. The temperature sensor can be set in such a way that it treats a range of outside temperature as 'normal' depending upon the area and whenever this range is exceeded, it can further sense other parameter and decide whether the temperature rise has been caused due to fire or not. All this can be achieved with the help of an application code. The monitoring method relies on the serial communication and the collected data can be saved at the main control unit for further analysis. If any fire-outbreak occurs, the transmitter end will wait till the situation gets under control and as soon as everything gets normal; the transmitter end starts its usual process of collection and conversion.

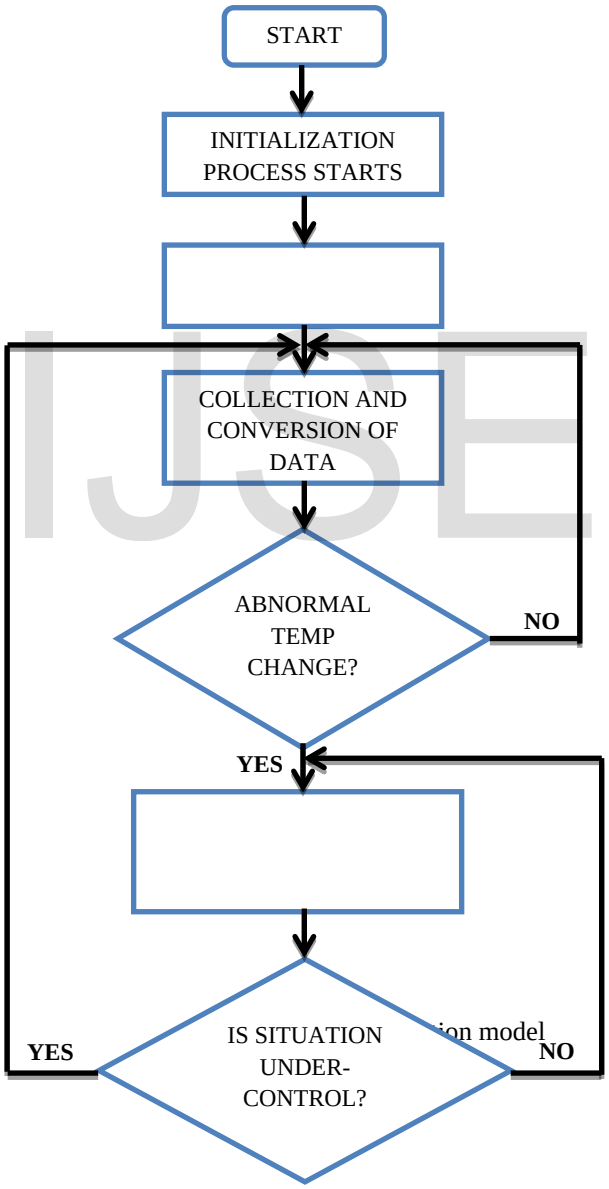

Fig. 5 - Algorithm for code

5. Result and Conclusion

A sample model of the system was developed on Proteus using ARDUINO UNO, LM35 sensor, XBEE S1 series and a hooter. The proposed system is expected to respond quickly to change in temperature which in turn informs the public and concerned departments about a fire-outbreak. ZigBee is preferred over other wireless communication techniques because of its features such as low cost, low power-consumption, easy to code and provide a longer range for operating the device as it uses mesh of networks. On combining with ARDUINO this system promises to automatically generate emergency messages in form of a buzzer from the hooterand itwill makes easier to monitor vast areas very efficiently. The system can be easily incorporated in the existing architectures and the ones which are under construction. The system can be upgraded to work in offline mode using GSM technology. It can also be upgraded to automatically send messages to fire department and nearest hospital as soon as the fire occurs so that immediate help can be available to the victims. With better sensing technologies, this system can also be used to protect forests from forests fires and dams from getting overflown. This low-cost system is the best choice from the existing ones as it uses the latest technology to tackle fire-outbreak situations and immediately responds to the undesired situations.

6. References

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