International Journal of Engineering Research and Technology.
ISSN 0974-3154 Volume 6, Number 3 (2013), pp. 307-314

http://www.irphouse.com

Sensor Network based Enviornmental Monitoring

[1]Anamika Chauhan and [2]Sunil Semwal

[1, 2]Dept. of Instrumentation & Control Engineering
Graphic Era University, Dehradun, India.

Abstract

In this paper, the problem of forest fire is considered and a comprehensive framework is proposed with the use of wireless sensor network for real-time forest fire detection. The wireless sensor network can give more accurate detection of forest fire danger rate over traditional monitoring approaches. The proposed framework mainly describes the data collection from designed data acquisition system and also gives the comparative study of various methodologies applied for similar problem. This paper mainly describes the use of various sensors to form a sensor node, which gives the record of basic environmental parameters: Temperature, Humidity & the also presence of flammable gases in the environment. Arduino serves as microcontroller board and the wireless transmission of data is made through BTBee Module to the remote location.

Keywords: Wireless sensor network, Arduino, BTBee Module.

1. Introduction

Today, wireless sensor network (WSN) is becoming the integral part of our lives. The sensory based monitoring technology is more popular, since it provide the end user with accurate and better understanding of the enviroment. A sensor network is composed of a large number of sensor nodes, which are densely deployed either inside the phenomenon or very close to it [1] and used for a wide variety of applications like: Military, health, home, environment, etc.

In this paper, the use of wireless sensor network technology is presented for the real-time forest fire detection. The forest fire is rising as an important issue throughout the world: it is reported [2] that for last decade, each year, a total of 2000 wild fires happened in Turkey and more than 100000 in all countries. Lookout tower and satellite

based monitoring are two commonly used methods for forest fire detection. Difficult life condition and unreliability of human observation [3], result as the limitations of lookout tower method.Since satellite based monitoring is another popular method but low spatial and temporal resolution of satellite imageries cause late fire detaection [3]. So, to overcome these limitations of traditional approaches, a sensory based technology is presented in this work. The prime goal is the designing of sensor nodes for real-time forest fire detection using wireless sensor network. In this proposed framework,sensor node collect measured data (e.g., temperature, relative humidity and presence of combustible gases) and send sensors data to the receiver end (i.e. at (i.e., at Hyperterminal). Breifly, Hyperterminal is a software program that allows your personal computer to function as a computer terminal [4], so that it can connect with other systems remotely. Also, in emergent condition (extreme high temperature and smoke is detected) the designed sensor node has the capability of sending the emergent report to the receiver end. So that the end user can take immediate action to prevent the uncontrollable spread of forest fire. In addition to real-time forest fire detection, the proposed sensor network approach can capture and save the sensor node data at the reciver end for future record. These features make this proposed system better and superior than other monitoring methods.

The remainder of this paper is organized as follow: Section II presents the related research gap, Section III describes the proposed sensor network for forest fire dectection. Section IV presents how to design the sensor node. Finally, Section V concludes this paper.

2. Related Research

In past a considerable number of studies have been carried out regarding the involvement of WSNs in early detection problem of forest fires. The following people work is being considered as a base of work for the detection of forest fire and provides the different approach for the same problem in more optimized way. A comparitive study of related research work is presented below in the tabular form. Comparision is made regarding the different applied methodologies for the forest fire detection using wireless sensor network, including the main contributions. Also the various measuring parameters are mentioned which serves as fire source and environmental elements for designing of sensor nodes and then early prediction of forest fire.

Table 1: Comparision of related research work.

	METHODOLOGY	MAIN CONTRIBUTION	MEASURED PARAMETERS
L. Yu, N. Wang, and X. Meng [5]	Applies NN for in network data processing	Data aggregation method, energy consumption and forcate capabilty	Temperature & humidity data

D. M. Doolin and N. Sitar [6]	10 sensor nodes with GPS capability are deployed with ranges upto 1Km	Gathering real observations from the field	Temperature, humidity and barometric pressure data
J. Lloret, M. Garcia, D. Bri, S. Sendra [7]	Mixes multisensory nodes with IP cameras in wireless mesh network	Combining sensor data with images	
C. Hartung, R. Han, FireWxNet [8]	Multi-tiered portable wireless system	Used webcam to get visual data of fire zone	Temperature, humidity and wind speed data
B. Son [9]	Apply a dynamic minimum cost path forwading protocol	Low and fair energy consumption strategy	Relative humidity, precipitation and solar radiation data
C.Lozano; O.Rodriguoz [10]	802.15.4 ZigBee standard is used as wireless medium. Mesh type topology is used for clustering	Design of early forest fire detection system	Temperature sensors (MTS300, MTS420 and STH11) Humidity sensors (STH11 and MTS420) Soil moisture and Temperature sensors (Echo 10 & Echo temp)

3. Proposed Sensor Network

In this propsed forest fire detection system, sensor nodes collect measurements data such as air temperature, relative humidity and presence of combustible gases. So, to accomplished this task three sensors are used here: Temperature sensor(Lm35), Relative humidity & temperaturte sensor(Rht03) and Flammable gas & smike sensor(MQ-2). Since, Radio frequency (RF) communications require modulation, band pass filtering, demodulation and multiplexing circuitry, which make them more complex and expensive [1] thus, BTBee (Bluetooth Bee) is used as communication protocol in this work. Three factors compose the basis of a forest fire:the fire sources,environmental elements and combustible material. A forest fire usually occurs as the result of their combined effects [11]. According to the United States National Fire Danger Rating System [12], there exist some other factors including lightning activity level, man-caused risk, slop class, and vegetation class. But these factors are not discussed in this work. Fig 1, shows the proposed system for wireless sensor network.

The below mentioned framework includes- n sensor nodes, which are deployed in the sensor field. These sensor nodes can wirelessly communicate with the host computer located at the remote location using BTBee wireless network [13], [14]. Each sensor node consist of three sensors: Lm35, Rht03 and MQ-2; for measuring environment temperature, relative humidity and smoke content. The sensors data at the

manager node provide the end user with information from respective sensor node. Thus, the end user can easily predict the chances of forest fire based on the captured data at HyperTerminal. Fire alarms are also used for each sensor node, which alert the end used about the critical condition. To extend the potential of this system, nodes location needs to be addressed. For this, global positioning system (GPS) with at least 5m accuracy is often required [1].

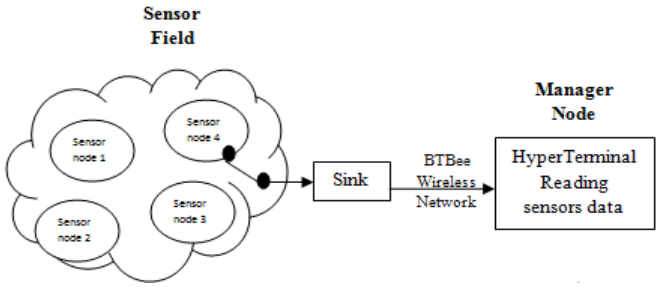

Figure 1: Proposed system for real-time forest fire detection.

4. Sensor Node Design

In this section, a detail of sensor node design is presented, including components required and data collection.

4.1 Components Required

The sensor network consists of large number of sensor nodes, thus designing of sensor node is becoming a basic requirement for any sensor network. Energy consumption and production cost are two major factors affecting the design of sensor node. Since the cost of single sensor node is very important to justify the overall cost of the network [1] and maximum energy consumption take place in transmission & reception process, thus considering these constraints the proposed sensor node focuses on low-cost and low powered sensor node design. The Arduino Mega 2560 is used here as the main microcontroller board, which is based on ATmega 2560. As a whole this hardware consist of total 54 digital input/output pins (of which 14 PWM pins), 16 analog pins, a power jack, 16 MHz crystal oscillator, a LED indicator at pin number 13 and also a reset button is provided. It works on 5v but the recommended power supply for this board is 7-12v [15]. Now to serve this Arduino Mega 2560 microcontroller board for wireless transmission of data, a wireless SD shield is used along with it. The wireless SD shield consists of a wireless module socket a SD card slot for making future record of stored data. It also consists of a switch with two positions: micro position and USB position [16]. For this work micro position is preferred.

Since wireless SD shield allows the Arduino Mega 2560 microcontroller board to communicate wirelessly using a wireless module. Thus BTBee module [13] is used here for wireless transmission of data. BTBee module used UART Bluetooth 2.0

communication protocol and operates at 3.3v. Considering that temperature, relative humidity and smoke are the prime parameters for prediction of forest fire, three sensors are used here as: Lm35 (Temperature sensor) is a analog precision integrated temperature sensor whose output voltage is directly proportional to temperature in Celsius. Its temperature sensing range is from -55°C to +150°C [17]. This is most widely used sensor for remote application.

Rht03 (Relative humidity & temperature sensor) is a digital sensor of capacitive type. Sensing material is polymer humidity capacitor [18]. Range for humidity is from 0-100% and for temperature 40°C - 80°C. It operates at 3.3-6v.

MQ-2 (Flammable gas & smoke sensor) is a semiconductor sensor. Sensing material is SnO_2. It measures the presence of combustible gases upto 10,000ppm [19], [20]. A Pololu sensor carrier is used for this sensor.

4.2 Data Collection

The manager node obtains two types of information from the designed sensor node: Regular report (RR) and Critical report (CR). The designed sensor node collects the data from all three sensors, encapsulating them into Regular report whose destination is HyperTerminal. Also if any abnormal event exist in the forest area, then the sensor node deployed in that area will detect it and send the Critical report immediately to the manager node. This makes the proposed system more efficient in predicting the forest fire as early as possible.

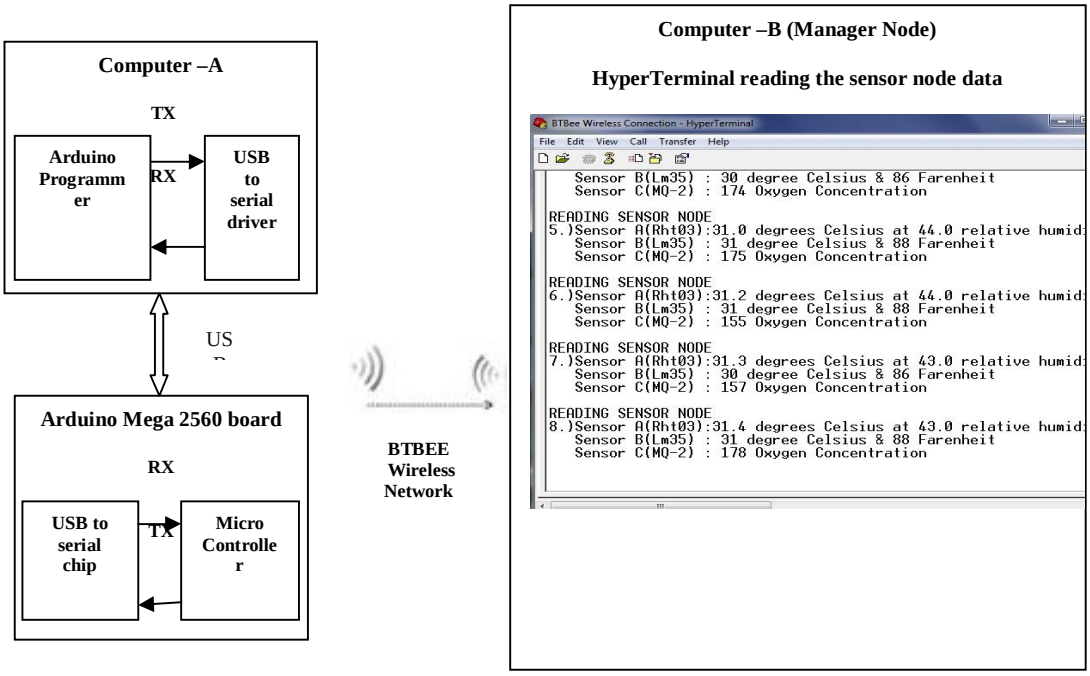

Figure 2: Wireless data transmission.

5. Conclusion

This paper has presented a novel approach for real-time detection of forest fire using wireless sensor network. Since the problem of forest fire is now becoming a fatal thread all over the world, thus a number of measures are done to overcome it. The proposed approach presents one of the way to give early prediction of forest fire based on captured data at the manager node. Also the designed data acquisition system is flexible and overcome constraints on the sensor node design. Several ANN-based models were developed and can be tested for captured sensor node data in future. To extend the potential of the system and improve forest fire monitoring technology, the problems of energy consumption, nodes location and clock synchronization need to be addressed in the future. These are some of the remaining problem areas to be considered, before the level of forest fire monitoring can be improved.

6. Acknowledgement

Anamika Chauhan received her B.Tech degree in Electronics & Instrumentation from Radha govind engineering college, Meerut- U.P., India and completed M.Tech. in Instrumentation and Control Engineering from Graphic Era University Dehradun, Uttrakhand, India

Sunil Semwal received his B.Tech degree in Instrumentation Engineering from University Science and Instrumentation Centre Srinagar Garhwal, Uttrakhand, India and M.E. degree in Electronics from Punjab Engineering College, Chandigarh, Punjab, India. Currently he is working as Assistant Professor in Electrical and Electronics Engineering department at Graphic Era University Dehradun, Uttrakhand, India. He is presented 11 papers in national/ international conferences/journals.

References

[1] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirc, “Wireless sensor network: a survey”Computer Networks vol. 38, no. 4, pp. 393-422, March, 2002.

[2] Republic of Turkey, Ministry of Environment and Forestry, General Directorate of Forestry, http://www.ogm.gov.tr/, Last accessed August 2010.

[3] Majid Bahrepour, Nirvana Meratnia, Paul Havinga “Automatic fire detection: A survey of wireless sensor network-perspective”; UT Publication, a survey report, 2008.

[4] Online/http://technet.microsoft.com/en-us/library/cc7361 1(v=ws.10).aspx/ Last accessed on April 2013.

[5] L. Yu, N. Wang, and X. Meng, "Real-time Forest Fire Detection with Wireless Sensor Networks", In Proc. of International Conference On Wireless Communications, Networking and Mobile Computing (WiMob), pp. 1214-1217, 2005.

[6] D. M. Doolin and N. Sitar, "Wireless Sensor Nodes for Wildfire Monitoring", In Proc. of SPIE Symposium on Smart Structures and Materials, San Diego, pp. 477484, 2006.

[7] J. Lloret, M. Garcia, D. Bri, S. Sendra, "A Wireless Sensor Network Deployment for Rural and Forest Fire Detection and Verification, Sensor Nodes", Vol. 9, Issue 11, pp. 8722-8747, 2009.

[8] C. Hartung, R. Han, FireWxNet: "A Multi-tiered Portable Wireless System for Monitoring Weather Conditions in Wildland Fire Environments", In Proc. of 4th International Conference on Mobile Systems, Applications and Services, pp. 28-41, 2006.

[9] B. Son, "A Design and Implementation of Forest-Fires Surveillance System Based on Wireless Sensor Networks for South Korea Mountains", International Journal of Computer Science and Network Security, Vol.6, No. 9B, pp. 124-130, September 2006.

[10] C.Lozano;O.Rodriguoz.Engineering School, Universidad Sergio Arboleda, Bogota ,Colombia "Design of Forest Fire Early Detection System Using WSN" Online Journal on Electronics and Electrical(OJEEE);vol.(3)-No.(2).

[11] Song W G, Ma J, Satoh K, Wang J (2006) "An analysis of multi-correlation between forest fire risk and weather parameters" ,Eng Sci, 8(2): 61–66 (in Chinese).

[12] http://www.wrh.noaa.gov/sew/fire/olm/nfdrs.htm,"National Fire Danger Rating System.".

[13] Online/http:/www.elecfreaks.com/wiki/indexphp?title2_ channelRelay_Shield_For_Arduino(With_XBee/BTBee_interface.)/Last accessed on February 2013

[14] Online / http://tutorial.cytron.com.my/2011/08/13getting-started-with-bluetooth-bee/ Last accessed on February 2013.

[15] http://arduino.cc/en/Main/arduinoBoardMega2560 / Last accessed on June 29, 2013.

[16] Online/ http://arduino.cc/en/Main/ArduinoWirelessShield /Last accessed on March 2013.

[17] Online /http://www.alldatasheet.com/datasheet-pdf/pdf /8866/NSC/LM35.html/ Last accessed on February 2013.

[18] http://hackerrevie.ws/2011/09/the-rht03-digitaltempera ture-and-humidity-sensor /Last accessed on February 2013.

[19] http://www.cooking-hacks.com/index.php/smoke-sensor- mq2.html /Last accessed on January 2013

[20] http://arduino.cc/en/Reference/HomePage/Last accessed on December 2013.