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Design of Environment Monitoring and Control System

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Abstract: ***For last few years, challenges of monitoring and control of distant environmental parameters accurately has emerged as new field of research. The concept of Internet of Things (IOT) is also emerging very fast where everything around us comes with an internet connectivity for monitoring and control. Monitoring the environmental parameters and initiating a control action from internet is also part of this concept. In our proposed work, we design an environment monitoring system, capable of monitoring and control of environmental parameters like temperature, pressure and humidity. Also, we focus on design of a low cost system that is capable of not only remotely monitoring the environment variables like temperature, pressure and humidity but also initiates some control action like switching devices ON/OFF from the internet. This system uses Wireless sensor Networks for sensing the environment parameters in the area under supervision. Sensors Node has been designed to measure the temperature, pressure and humidity. The Control node has been designed to initiate the control action. The Central Monitoring is based on ARM11 raspberry pi board.***

Keywords: ***Raspberry pi, WSN, Zigbee, AVR, python, CMU***

1. Introduction

Environment monitoring system is a system that is capable of measuring several environmental parameters like temperature, humidity, pressure, illumination and quantity of gasses like LPG etc. These parameters are important in many applications like in industry, smart homes Greenhouse [2] and weather forecasting. Advanced Environment monitoring systems offer many features like remote access to the measurement data and also can initiate some control action from distant location. These systems use Wireless sensor Networks for sensing the environment parameters. Wireless Sensor Network (WSN) has sensors to sense the physical parameters and they are interconnected wirelessly to exchange information. They have a central monitoring system that is connected to the internet to access the data remotely. Several sensors are equipped in each remote location to measure environmental parameters and these measurements are sent to the central office for storage and analysis purpose. In addition, the central office can give command to remote location for output control execution.

These features offer a way to maintain condition and allow obtaining caution on occurrence of any abnormal conditions like parameters exceeding. A WSN allows deployment of number of sensor nodes which configure themselves depending upon the network topology and neighborhood situation. After sensing their physical environment and processing the obtained data locally, nodes communicate their data (or an extract) towards a network sink, where data is further processed and made available for readout. As transmitted data should find the best route towards its destination automatically, the network can be remotely controlled and therefore be handled as one large measurement instrument. Some systems also offer the remote logging facilities that are the parameters can be stored at regular intervals at the remote server so that they can be referred any time.

2. METHODOLOGY

First of all a Block diagram of the complete system is prepared. The each part of the block has been implemented step by step. Methodology for this research work can be detailed in the following steps.

2. Proposed Design

Figure.1 shows the block representation of the proposed Environment monitoring and control system. It has the following parts.

- Central Monitoring Unit
- Sensor and Control Nodes

Central Monitoring Unit (CMU) is connected to the internet. Through internet it can communicate with any internet enabled computer terminal or a mobile terminal which can be a smart phone. The sensor data is displayed on remote computer

terminal and mobile terminal. The control command can also be initiated from the remote computer terminal or mobile terminal. The system makes use very fast and accurate Google spreadsheet service to log the data online. The control action is initiated using the Google forms service. As the response is received the central monitoring unit detects the response and gives the command to the control node. Sensor node continuously monitors the temperature and humidity and sends the value to control unit which then stores values in the Google spreadsheet. This spreadsheet can hold the data for any amount of time and this data can be used for analysis purpose. So Record of data is always available online.

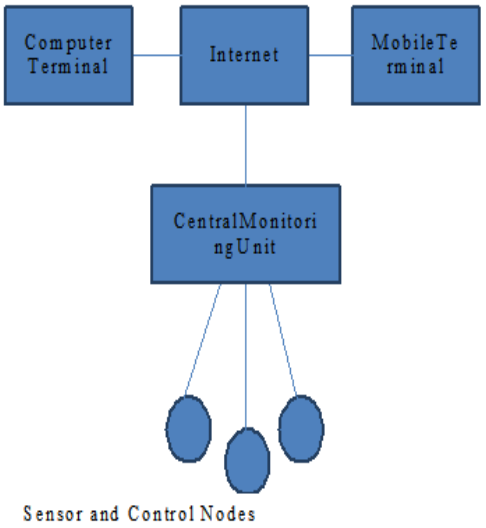


Figure 1: Block Diagram of Environment.

Central Monitoring Unit(CMU)

Central Monitoring Unit have been designed using 32 bit ARM controller based single board Linux based board called raspberry pi. A Zigbee [5] series 2 modules is interfaced with the raspberry pi through the UART interface. A python script runs on central monitoring unit which performs the task of continuously polling the sensor node for the reading of temperature and humidity. It also gives command to the control node when there is some control action required. Central Monitoring Unit can be connected to the internet either through the available Wi-Fi or Ethernet. Both raspberry pi and Zigbee work on 3.3V. The Zigbee module connected with the raspberry pi is configured as the coordinator in AT mode. This coordinator is able to communicate with other nodes in which the Zigbee modules are configured as Router AT.

Interfacing Zigbee with Raspberry pi

Both the raspberry pi and Zigbee work on 3.3V hence their pins can be connected directly without any level shifter in between. Pin 8 of raspberry pi is the TX pin and it is connected to the Data In of Zigbee that is pin 3. Pin10 of raspberry pi is RX and it is connected to Data out of Zigbee that is pin 2. Power to the Zigbee is given from the raspberry pi. Software on the raspberry pi interacts with the Zigbee module through UART serial communication protocol. The Zigbee module offers a range of 50 to 70 meters indoor and around 100 meters outdoor.

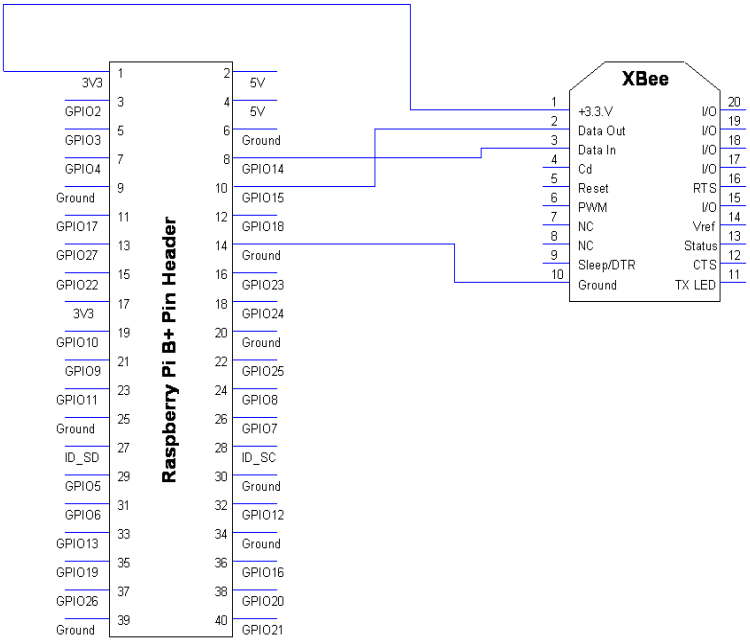


Figure 2: Connections of Raspberry pi with Zigbee module.

This circuit operates on 5V and it this can be provided with any mobile charger that gives 5V at 500 ma. The raspberry pi has USB ports that can be used to connect any USB device and it also has Ethernet port. A USB Wi-Fi dongle can also be connected to the raspberry pi to have the internet access from the available Wi-fi Network. This is very compact and highly portable Central Monitoring unit that can be deployed anywhere.

Programming using python

Python have been used to program the raspberry pi. UART have been used to communicate with Zigbee. Also raspberry pi stores the data in the Google spreadsheet. Following libraries are required to be installed before writing down the main program. The python script starts at the boot and it looks for the available internet connection and if there is active internet connection then it sends the command to the nodes to get the latest values of the sensor parameters then it store these values to the spreadsheet.

Figure 3: Flow chart of the Central Monitoring Unit Program.

Design of Sensor Node

Sensor node has been designed on 8 bit AVR microcontroller. It has sensors and Zigbee module Interfaced to it. Figure 4 shows complete circuit diagram of sensor node. Software of the sensor node have been written in Embedded C. It waits for the command from the central monitoring unit to give the current sensor information.

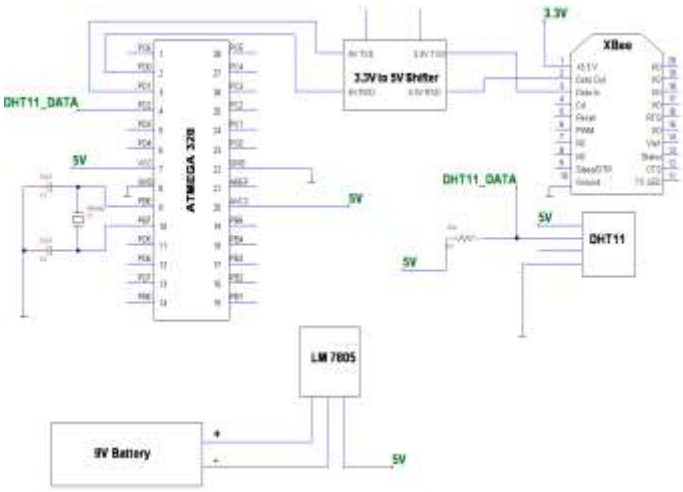


Figure 4: Circuit diagram of Sensor Node.

Design of Control Node

Control Node is designed to control the devices remotely. Software of the control node has also been written in Embedded C. It receives the device status from the internet through CMU and the switches the corresponding device.

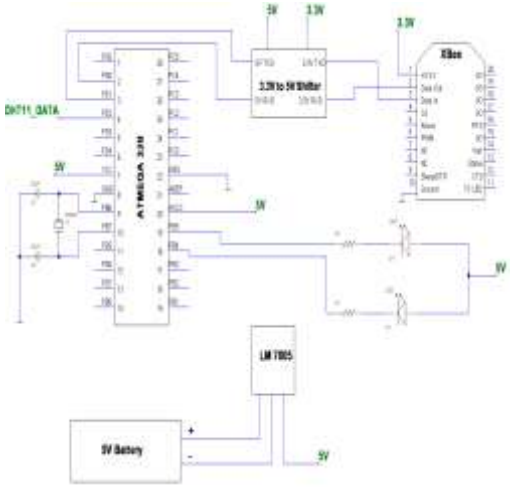
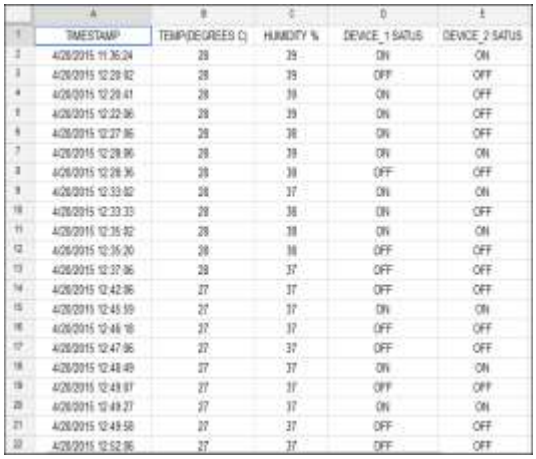


Figure5: Circuit diagram of Control Node.

3. RESULT AND DISCUSSIONS

Remote Terminal Log Window

The values of parameters are logged into the spreadsheet. Figure 6 shows the remote terminal Log Window



	A	B	C	D	E
1	TIMESTAMP	TEMP(DEGREES C)	HUMIDITY %	DEVICE_1 SATUS	DEVICE_2 SATUS
2	4/28/2015 11:36:24	28	39	ON	ON
3	4/28/2015 12:28:02	28	39	OFF	OFF
4	4/28/2015 12:28:41	28	39	ON	OFF
5	4/28/2015 12:22:06	28	39	ON	OFF
6	4/28/2015 12:27:06	28	38	ON	OFF
7	4/28/2015 12:28:06	28	39	ON	ON
8	4/28/2015 12:28:36	28	39	OFF	OFF
9	4/28/2015 12:33:02	28	37	ON	ON
10	4/28/2015 12:33:33	28	38	ON	OFF
11	4/28/2015 12:35:02	28	38	ON	ON
12	4/28/2015 12:35:20	28	38	OFF	OFF
13	4/28/2015 12:37:06	28	37	OFF	OFF
14	4/28/2015 12:42:06	27	37	OFF	OFF
15	4/28/2015 12:45:59	27	37	ON	ON
16	4/28/2015 12:46:18	27	37	OFF	OFF
17	4/28/2015 12:47:06	27	37	OFF	OFF
18	4/28/2015 12:48:49	27	37	ON	ON
19	4/28/2015 12:49:07	27	37	OFF	OFF
20	4/28/2015 12:49:27	27	37	ON	ON
21	4/28/2015 12:49:58	27	37	OFF	OFF
22	4/28/2015 12:52:06	27	37	OFF	OFF

Figure 6: Remote terminal log window

Device Status Command Window

Figure 7 shows the device Status Command Window. It has following commands:

Figure 7: Device Status Command Window

Android smart phone as mobile terminal

The android smart phone has been used as mobile terminal. Special android application has been designed which can display the measured parameters on any internet enabled android smartphone. Fig. 8a shows the welcome screen for the Mobile application. Welcome screen has three control buttons. STATUS is to go to the status screen which indicates the temperature, humidity and current device state. Control is to go to control screen which is used to give command to set the device status. Fig. 8b shows the Status Screen on mobile terminal. Fig.8c shows the control screen.

Figure 8: (a) Welcome screen. **(b)** Shows the Status Screen on mobile terminal. **(c)** Shows the control screen.

This system is deployable in any location where there is requirement of monitoring of the environment parameters. The system can be deployed at any small scale industry which cannot bear the cost of such kind of systems available in market. There can be further advancements made in this system by attaching more senor nodes or by providing alternate mode of internet connection to the central monitoring unit like GSM interface. The designed system have scope in field of industrial automation, Green house Monitoring, Smart Home systems, Dairy Farms and Automated Agriculture Farms.

References

[1] Abdullah ,A., Sidek ,O., Amran ,N.A. and Za'bah ,U.N. (2012), "Development of Wireless Sensor Network for Monitoring Global Warming", Published in IEEE International Conference on Advanced Computer Science and Information Systems, pp. 107-111.

[2] Al-Adwan,Ibrahim and Al-D,Munaf, S. N. (2012) ," The Use of Zigbee Wireless Network for Monitoring and Controlling Greenhouse Climate", Published in International Journal of Engineering and Advanced Technology (IJEAT),ISSN: 2249 – 8958, Volume-2, Issue-1,pp. 35-39.

[3] Bahattacharjee, D. and Bera, R. (2014). "Development of smart detachable wireless sensing system for environmental monitoring", Published in International Journal on Smart Sensing and Intelligent Systems, Vol. 7, September 2014.

[4] Cetinkaya, Oktay and Akan, OzgurBaris (2015) "A Zigbee based reliable and efficient power metering system for energy management and controlling",Published In International Conference On Computing, Networking And Communications (ICNC), Garden Grove,CA,USA, pp. 515-519, 16-19 Feb 2015.

[5] Cheong ,P., Chang ,K.F, Lai ,Y.H and Ho ,S.K. (2011) , "A Zigbee-Based Wireless SensorNetwork Node for Ultraviolet Detection of Flame", Published in IEEE Conference on Transactions on Industrial Electronics, Vol. 58, pp. 5271-5277.

[6] Colitti, W. (2011) ," REST Enabled Wireless Sensor Networks for Seamless Integration with Web Applications", Published in IEEE 8th International Conference on Mobile Adhoc and Sensor Systems (MASS),pp. 867-872, Valencia, 17-22 Oct. 2011.

[7] Corke, Peter and Wark, Tim (2010), "Environmental Wireless Sensor Networks" Published in Proceedings of IEEE,Vol. 98, No.11,Nov. 2010.

[8] Fang Jian (2014), "Harmful Gases Wireless Network Monitoring System Design", Published in International Symposium on Computer, Consumer and Control (IS3C), pp. 551-553, Taichung, 10-12 June 2014.

[9] Jimenez-Fernandez, S. (2013),"Usability and Interoperability in Wireless Sensor Networks for Patient Telemonitoring in Chronic Disease Management" , Published in IEEE Transactions on Biomedical Engineering, Volume:60, Issue: 12 ,pp. 3331-3339, Dec. 2013.

[10] Kalaivani ,T., Priya, P. and Allirani, A. (2011) , "A Survey on Zigbee Based Wireless Sensor Networks in Agriculture", Published in 3rd IEEE International Conference on Trendz in Information Sciences and Computing, pp. 85-89, Chennai, 2011.

[11] Kelly Sean DieterTebje , SuryadevaraNagender Kumar and Mukhopadhyay S. C. (2013) , "Towards the Implementation of IoT for Environmental Condition Monitoring in Homes" , Published in IEEE Sensors Journal, Vol. 13, No. 10, pp. 3846-3853, Oct. 2013.

[12] Kumar,Anuj, Kim,Hiesik and P. Hancke ,Gerhard (2013), " Environmental Monitoring Systems: A Review", Published in IEEE Sensors Journal, Vol. 13, No. 4, pp. 1329-1339.

[13] Li, J. and Liu, Q. (2010) , "Application and Research of ZigbeeTehnology in the Miner's Lamp Monitoring", Published in IEEE International Conference on Future Information Technology and Management Engineering, Vol. 1, pp. 317-320, Changzhou, 2010.

[14] Lo, B.(2013), "Bioinspired Design for Body Sensor Networks", Published in IEEE SignalProcessing Magazine, Volume 30, Issue 1,pp. 165-170, Jan. 2013.

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