IJRIT International Journal of Research in Information Technology, Volume 1, Issue 11, November, 2013, Pg. 436-444

International Journal of Research in Information Technology (IJRIT)

www.ijrit.com ISSN 2001-5569

Design and Implementation of Sensor's information Monitoring System Using Wireless Sensor Network

Peddapalli Saikumar[1], V. Naveen Kumar[2], Md Ateequr Raheman[3]

[1]*Research Associate, Department of Electronics and Communication Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India*
Peddapallisaikumar@gmail.com

[2]*Project Engineer, Department of Electronics and Communication Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India*
Praveen.naveen@gmail.com

[3]*PG student, Department of Electronics and Communication Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India*
ateeqmd3027@gmail.com

Abstract

The aim of this project is to design a wireless sensor network to monitor several sensor values at different nodes and transmits data to the central station when the sensor values are deviated from their respective threshold levels. A central station controls the node with the user commands with respected to the received sensors information from that particular node. A wireless sensor network (WSN) is established with two routers and one coordinator. MSP430 Micro Controller will monitor the sensor parameters send the data to central station, when they are beyond the threshold levels using ZigBee. Central station will continuously monitor the nodes information and displays in PC using turbo C application. If user wants to control the motor operations at particular node, it will transmit a packet to the node to switch on/off the motor. This system is developed to for targeting the low power consumption, low data rate in remote areas.

Keywords--MSP430 Micro Controller, wireless sensor network, low power consumption

1. INTRODUCTION

The project proposes a generic system for monitoring the sensor parameters [1], and transmitting the sensor information to the central station when the sensor values are above or below the threshold levels. This system is designed with 4 potentiometers instead of sensors[5], so that user can connect any sensor to this system to monitor the parameters. The user will sets the threshold levels for the sensors in the micro controller program. The potentiometers are connected between the power supply and a micro controller pin, when we rotate the nob of a potential meter, the output voltages from the potentiometers varies.

If it gives low, we are assuming that sensor value is lower than the threshold levels. And if it is high, the sensor levels are higher than the threshold levels. As the system targeting for remote application, it should work for many years. To reduce the power consumption of system, instead of transmitting the complete sensor information, the node sends 4 bytes of information which replicates the threshold levels of four sensors 3]. If the sensor information byte is 0x30 (ASCII value of '0') sensor value is lower than the threshold level, 0x31 (ASCII value of '1') represents sensor value is in the threshold limits, andIfit is 0x32 (ASCII value of '2') sensor value is higher than the threshold level. The node will fix this threshold levels in the frame format, and sends this frame to central station. The information is collected at the central station using zigbee[4][8], and the application

program will displays the nodes sensor information on screen. Now, if user want to control the node motor operations like switch on/off the motor, he need to press the respective commands from central station, then application program will decode the pressed key, and sends the predefined packets to the particular node with its address.

2. HARDWARE DESIGN

2.1 Block Diagram of the System

The MSP430FG4618 [2] micro controller contains an internal 12-channel, 12-bit Analog to digital converter. These pins are routed to port 6 in the controller internally. The *P6SELx* provide the ability to disable the port pin input and output buffers, in order to eliminate the parasitic current flow and therefore reduce overall current consumption. The four analog sensors are connected to 0^{th}, 1^{st}, 2^{nd}, 3^{rd} pins of the port 6. The MSP430FG4618 Exp. Board contains on-board 4-Mux LCD Display, the sensor values are displayed in the 2,3,4,5 locations in the 2^{nd} row. If the sensor values not in the threshold levels then a transmitting frame will be initiated from the sensor node to the central station.

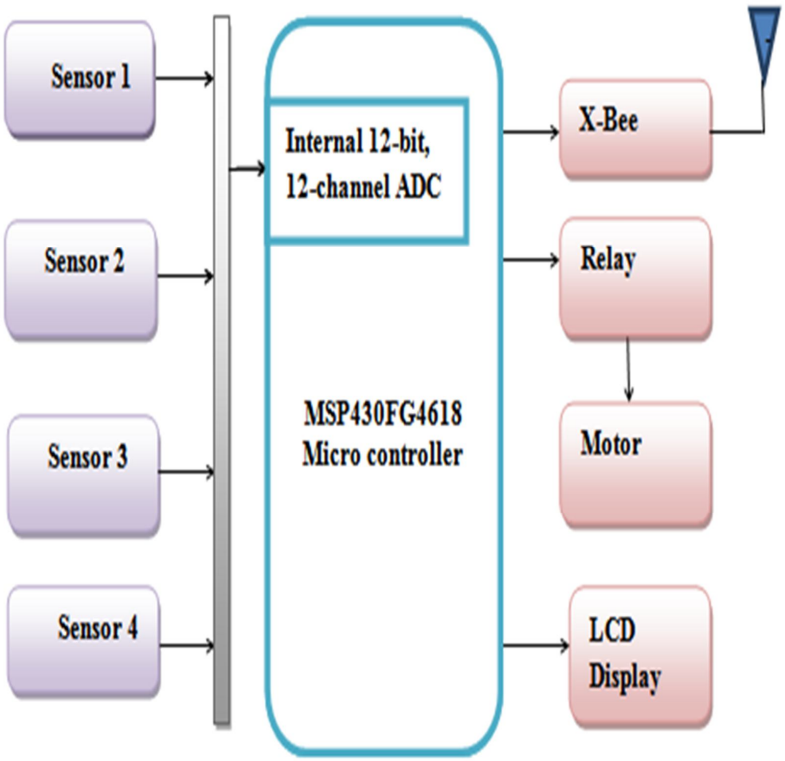

Figure 1.Block diagram of a node at remote location

In case, if the user wants to control the node operations like switch the motor on/off, then he needs to press the respective key from keyboard at central station, then a transmitting frame will be initiated from central station to the Particular node along with its address and data bits of 0x4F, 0x4E (represents the hexadecimal form of ON command) or 0x4F, 0x46 (represents the hexadecimal form of OFF command) from central station. At the Node side, if it receives the "MOTOR ON" command then node will enable the motor supply to rotate valve or to pump the water. If it receives a "MOTOR OFF" command then it will power off the motor. The x-bee module is connected to the 4^{th} and 5^{th} pins of port2 for serial communication to transmit/receive the frame to/from the central system.

2.2 Block diagram of central station

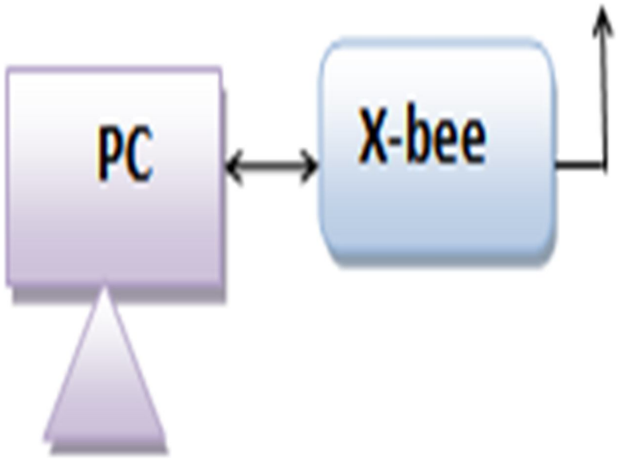

Figure 2.Block diagram of central station

The central system contains one ZigBee module connected to the personal computer which enables the C-application to monitor the sensor information and can control the motor operation of individual Nodes. The C application displays the Node A and Node B sensor levels separately, if the user wants to switch the motor power at particular node, he need to give the input commands to turn on/off the motor i.e. **1**- Motor on @ node 1, **2**-Motor off @ node 1, **3**- Motor on @ node 2, **4**-motor off @ node 2. Under every node individual sensor parameters will display levels with **HIGH** (if above the threshold), **LOW** (if below the threshold), and **NORMAL** (in the range of actual threshold).

2.3 Theory of operation

This system forms a wireless sensor network [10] with two routers and one central station. The above fig 1 show the block diagram of a node, containing four potential meters treated as four analogue sensors. The potential meters offers 0 to 1kilo ohm resistance while rotating the notch. Initially four sensors are adjusted to the normal resistance in between the value of 300-500 ohm's. When any of the sensor (potential meter) value is varies the output voltages changes. The output of the sensor value is converted into digital form using the internal analog to digital converter using MSP430FG4618. The micro controller will check sensors value with the predefined threshold levels which are source code. For example, If 2^{nd} sensor level is higher than its actual threshold level then 3^{rd} location in 2^{nd} row of the LCD display will display the alphabet 'H' (short form of High), and If 4^{th} sensor level is below than the actual threshold level then 5^{th} location in 2^{nd} row of the LCD display will replaced with the alphabet 'L' (short form of LOW).

After representing the above or below the threshold level in the LCD, then a transmitting[6][7] frame will be initiated (only if any one of the sensors is not in the threshold level) from the sensor node to transmit the abnormality of sensor information at the central station. This processes will continuously/periodically repeated with subjected to the battery powered or criticality of the sensor parameters. If a frame (either MOTOR ON/OFF) is received from the central station, then node will differentiate the received information and finds what kind of a command it was received from the central system.

The central station contains an x-bee[9] module connected to a pc, and a turbo C application is pre-installed in it. After opening the application the connected x-bee module will deliver the sensor information to PC (if node sends when the sensor values are exceeded) in the form of a packet.

The central station application program (turbo c application) will filter the information from the packet and identifies whether it is node 1 or node 2. After that it will filters the data bits from the received frame and checks the threshold levels. If the frame data is a 0x30, it will displays the sensor level as LOW, if it is 0x31 then the sensor level as Normal, or if 0x32 then it will display the sensor level as HIGH in the central station PC.

After displaying the abnormality of sensor levels in the PC, now user have a choice to switch on/off the motor. User need to enter the key from key board ('**1**'-Motor ON @ Node 1, '**2**'-Motor OFF @ Node 1, '**3**'-Motor ON @ Node 2, '**4**'-Motor OFF @ Node 2). If it's a MOTOR ON command is received, then central station will

transmit the predefined frame from central x-bee module. The node which received the frame will identify the data bits and then it will power on the motor.

2.4 MSP430FG4618 Micro Controller

The MSP430xG461x series are microcontroller configurations with two 16-bit timers, a high-performance 12-bit A/D converter, dual 12-bit D/A converters, three configurable operational amplifiers, one universal serial communication interface (USCI), one universal synchronous/asynchronous communication interface (USART), DMA, 80 I/O pins, and a liquid crystal display (LCD) driver with regulated charge pump. Typical applications for this device include portable medical applications and e-meter applications.

2.5 Zigbee

ZigBee is a recently developed two-way wireless communications protocol designed to meet very low power consumption (6 months-2yrs on 2 AA) and low cost (half that of Bluetooth) requirements. The higher protocol layers are being defined by the ZigBee Alliance group while interests in the lower layers of the stack (MAC, PHY) are being defined by the IEEE 802.15 working group 4 (802.15.4) which is aimed at achieving data throughput of 250kbps in the 2.4GHz band.

2.6 Transmitting frame from node

This transmitting frame is used to transmit the sensor information from the node to central station. The frame format is showed below with sensor information.

Table 1
Transmitting frame format from node 1

7E	00 10	10	00	13 A2 00 40 30 FF E3 00	00 02	31 31 30 31	E1

In the above frame, 7E- start of the delimiter, 00 10- frame length, 10-API identifier of transmitting frame, 00-frame id, 13 A2 00 40 30 FF E3 00- a 64-bit device id, 00 02- a 16 bit pan address, 31 30 30 31- represents the user (sensor) information of sensor 1 to sensor 4 respectively, E1- represents the check sum. The user information/sensor information represents the status of 4 sensors. From the above frame, excluding the 3rd sensor remaining three sensors are in the predefined threshold level. The 3rd sensor value is below the threshold level. For this reason the value is replaced by 0x30. The frame bits are stored in the form of hexadecimal value.

2.7 Receiving Frame at Central Station

The sensor node has sent the four sensors threshold levels in a packet format. This receiving frame will be at central station as shown below.

Table 2
Receiving frame format at central station

7E	00 0F	10	00	13 A2 00 40 30 C1 E3 00	02	4F 46 46	49

In the above frame, 7E- start of the delimiter, 00 11- frame length, 90-api identifier for transmitting frame, 00-frame id, 13 A2 00 40 30 C1 F2 00- a 64-bit device id, 00 02- a 16 bit pan address, 00-Packet Acknowledged, 31 30 30 31- represents the user (sensor) information of sensor 1 to sensor 4 respectively, D2- represents the check sum.

The user information/sensor information represents the status of 4 sensors. From the above frame, excluding the 3rd sensor remaining three sensors are in the predefined threshold level. The 3rd sensor value is below the threshold level. For this reason the value is replaced by 0x30.

After selecting the correct COM port, baud rate the 4 sensor values will be filtered from the received frame, and shows the levels as high, low or normal .From the above received frame 3rd sensor frame tab at node 1 will be displayed with below indication.

2.8 Transmitting Frame from Central Station

Central station can sends only two frames to its nodes which are subjected to either motor on or motor off conditions. The frames will vary from Node A to Node B because the frame contains the x-bee network address that is unique.

2.9 Motor-ON Frame

A motor on frame is individual to every node. Because the frame contains the X-bee 64-bit network address which is unique from all.

Table 3
Motor on frame format from central station to node 1

7E	00 0F	10	00	13 A2 00 40 30 C1 E3 00	02	4F 4E	87

The user data contains two bytes of information of 'O','N'. When the node with the matched network address will grab the frame and switch on the motor.

2.10 Motor-OFF frame

A motor on frame is individual to every node. Because the frame contains the X-bee 64-bit network address which is unique from all. The frames will vary from node a to node b because the frame contains the x-bee network address that is unique.

Table 4
Motor off frame format at central station to node 1

7E	00 11	90	00	13 A2 00 40 30 C1 F2 00	00 02	00	31 31 30 31	D2

The user data contains two bytes of information of 'O', 'F','F'. When the node with the matched network address will grab the frame and switch off the motor.

2.11 User inputs at central station

The below table shows the list of commands to power on/off the motors at different nodes. If the user wants to switch the motor power supply he needs to press the respective key in the turbo C application.

Table 5
Motor off frame format at central station to node 1

Command (numerical number)	Description
1.	Motor ON @ Node 1
2.	Motor OFF @ Node 1
3.	Motor ON @ Node 2
4.	Motor OFF @ Node 2

3. EXPERIMENTAL RESULT

Design and implementation of real time water monitoring system using wireless sensor network has implemented successfully. Sensor nodes will monitor their respective four sensors values and sends data when anyone of the sensor value is beyond the threshold levels, and waits for central station commands to start or stop the motor at its position. The results have been obtained through X-CTU software as shown in figure 3 or by a C-program as shown in figures 4 at central station. Figure 3 shows receive frame formats consisting four sensors information at different nodes.

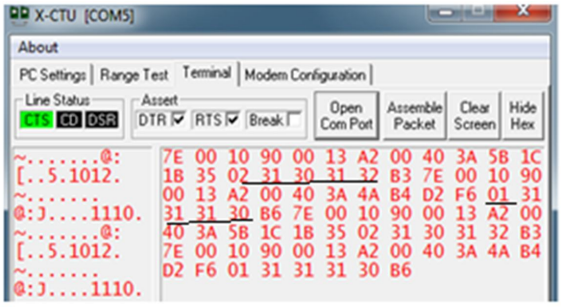

Figure 3 Received frame formats with sensors data in X-CTU terminal

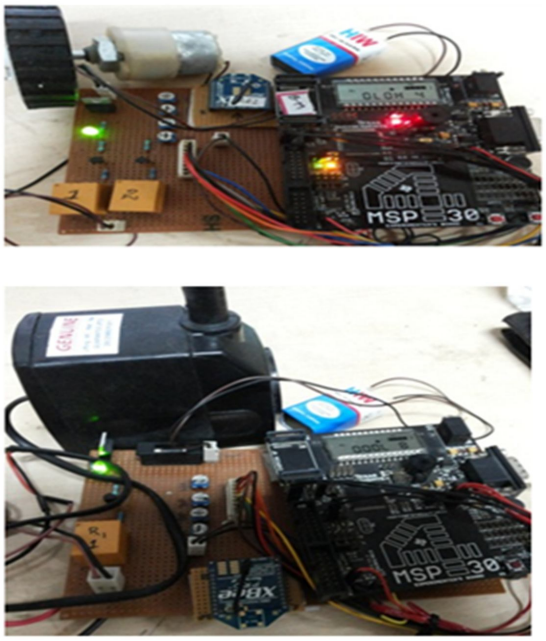

Figure 4: wireless nodes at remote locations

The above figures are the node-1 and node-2 pictures at remote locations. Node -1 is placed at water releasing valve position, and Node-2 is placed at water pumping station as described in the block diagram. The sensor threshold levels are showed in the LCD at each sensor node with the alphabets ('L'-lower than the threshold, 'O'-normal, 'H'- higher threshold level,).

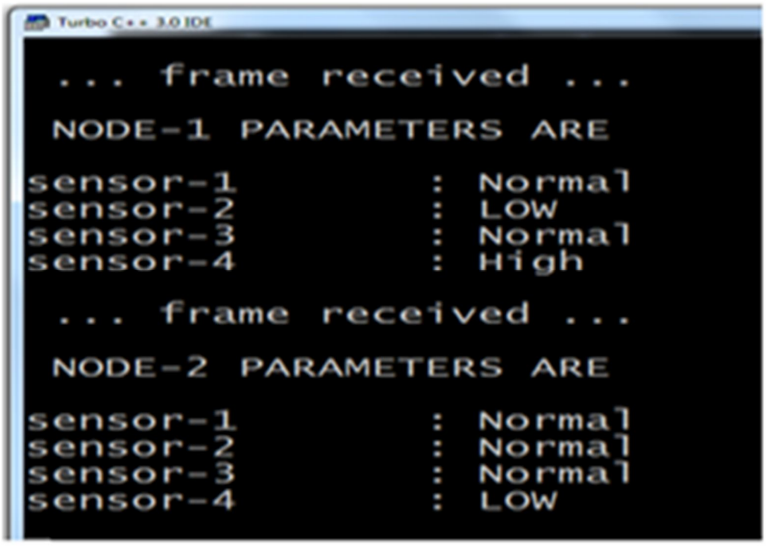

Figure 5: received sensor information from nodes at central station.

The above screenshot shows a differentiation between two nodes with respective to their sensor levels. The application program which written in C will keep monitors the user input from keyboard and transmits the commands to the nodes to start or stop the motor. And also it will collect the data from the sensors node and displays in PC.

4. CONCLUSION

This design has proven to be very effective at providing reliable data handling and node Communications. This proposed research project refers to technologies in the move towards next generation water quality and quantity monitoring to provide simple, efficient, cost effective, and socially acceptable means to detect and analyze water bodies and distribution regularly and automatically. The Design and implementation of real time water monitoring system using wireless sensor network is done with the ZigBee communication. The communication between the nodes is established and nodes are sending their sensors information to the central station when they are beyond the threshold levels. Central station will control the motor operations at the nodes with the user commands from central station is done successfully without data loss. It can be concluded that this project is best suitable for remote areas where low power and low data rates are playing a key role

5. FUTURE SCOPE

The future development seeks to detail some of the important improvements required and recommends ways to go about implementing them. There is still significant work to be done to improve the usefulness of WSN's for sensing. The system is developed with the four potentiometers, and can be implemented in the future by placing the actual water quality and quantity sensors. The project is implemented with the normal electronic components, resulting in a large chip size. If we implement this project with SMD (surface mount device) components we can reduce the chip size. In this project the nodes are sending the sensor information but actually we don't know where it exactly the node is located in the wireless zone. To avoid these conflicts GPS&ZIGBEE modules can be employed. The next area of work needed is the development tools to maximize the actionable results that require less grower effort and training than the existing techniques. Another key area for future work is to continue to add features to the user interface. For example this system demonstrates a spatial view of data, however expanding that to a 3D view looks better

REFERENCES

[1] I. Akyildiz, W. Su, Y. Sankarasubramaniam and E.Cayirci, 'A survey on Sensor Networks', IEEE Communications Magazine, vol. 40, Issue: 8, pp.102114, August 2002.

[2] Chris Nagy. Embedded System Design Using TI MSP430 Series Elsevier: Newnespublications, Burlington,MA 01803, USA,2003

[3] Cambridge Univ., Yan Wu , "Wireless sensor network: Water distribution monitoring system" , IEEE Int. Conference. on WSN,

[4] Simon R. Saunders, "Antennas and Propagation for Wireless Communication Systems", WILEY, 1999.

[5] Erich P. Stuntebeck, Dario Pompili, TommasoMelodia, "Wireless Underground Sensor Networks using Commodity Terrestrial Motes", IEEE SECON 2006, Reston, VA, September 2006.

[6] Jwei Dan Yu, Siemens Corporate Technology, China dan.yu Yan Ma, Wei Jiang, "A Tracking Algorithm in RFID Reader Network", Beijing University of Posts and Telecommunications, Beijing University of Posts and Telecommunications.

[7] SUNLimin, LIJianzhong, CHENYu, etc. Wireless Sensor Network [M].Beijing: Tsinghai University Press,2005:1-25.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[8] KwangKoog Lee, SeongHoon Kim and Hong Seong Park, "Cluster Label-based ZigBee Routing Protocol with High Scalability", Dept. of Electronic Communication Engineering, Kangwon National University, South Korea.

[9] M.K. Khaw, F. Mohd-Yasin, and M.I. Reaz, "Recent Advances in the Integrated Circuit Design of RFID Transponder", In proc IEEE Int.conf Semiconductor electronics,Dec,2004

[10] Mao-Cheng Huang, Jyun-Ciang Huang, Jing-Cyun You, Gwo-Jia Jong, "The wireless Sensor Network for Home-Care System Using ZigBee",

Authors

P. Sai Kumar was born in Andhra Pradesh, India in 1989. He is working as a Research Associate in Vnr-Vjiet. He is completed M.Tech in embedded systems at vnr-vjiet from 2011-2013. He got B.Tech degree from Vivekananda Institute of Technology& Science, karimnagar in 2010. His current interests include Embedded Systems, Wireless sensor networks, Artificial Intelligence and Robotics.

V. Naveen Kumar was born in Andhra Pradesh, India in 1983. He is working as Project Engineer at Research and Consultancy Center (RCC) in VNR Vignana Jyothi College of Engineering & Technology (VNRVJIET), Hyderabad, Andhra Pradesh, India. He is Completed M.Tech in Embedded systems in 2009 from VNRVJIET and B.Tech in Electronic & Communication Engineering from AZCET, JNTU Hyderabad. He has four years of research experience. His interests include Wireless sensor networks, Embedded Systems, RFID, Microprocessors & controllers. He has two patents in wireless stream.

MD Ateeq Ur Raheman received B.E. degree in Instrumentation engineering from Muffakham Jah College of Engg. & Tech., affiliated to Osmania University Hyderabad, AP, India, in 2009,he is pursuing the M.Tech in Embedded systems at VNR Vignana Jyothi Institute of Engineering & Technology, Bachupally, Hyderabad, India. His research interests include Wireless sensor Network, Embedded Systems and Industrial Automation.