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Wireless Sensor Network Based Environmental Temperature Monitoring System

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Abstract: A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is compact and doing task of the sensing, processing, etc. The implementation of monitoring of environment is hard task. This Sensor applications are to be implemented in multiple fields such as smart power grids, smart buildings and smart industrial process control significantly contribute to more efficient use of resources. Each node has sensor interfacing with signal conditioning and processing unit such as MSP430G2553 ultra low power device. The interfacing of the temperature sensors to MSP430 ICs on all nodes and light dependent resistor to source and destination node. Destination node is assembled with 16*2 LCD display to get the values continuously on the display module. Continuous monitoring of all the nodes and observation is done on Master Computer. This operating system is designed to work on Windows 7.

Keywords: LDR, wireless sensor network, environment, *monitoring, detection.*

I. INTRODUCTION

A wireless sensor network consists of a set of nodes powered by batteries and collaborating to perform sensing tasks in a given environment. It may contain one or more sink nodes (base stations) to collect sensed data and relay it to a central processing and storage system. A sensor node can be divided into three main functional units: a sensing unit, a communication unit and a computing unit[1]. My project aim is to make generalized platform for monitoring of the environment in suitable and non suitable conditions. As the emulation includes five nodes (slaves) are used out of which one is connected to PC/master computer called master slave and other four nodes are kept at some distance. Communication is done by RF2500[2] transceivers i.e. 2.5GHz ISM license free band (zigbee). This module is CC2500 Serial Transceiver Wireless Module made by Vegarobokits. This module is interfaced with each node. Each node has sensor interfacing with signal conditioning and processing unit such as MSP430G2553 ultra low power device[1]. We have interfaced the temperature sensors on all nodes and light dependent resistor to source and destination node. Destination node is assembled with 16*2 LCD[5] display to get the values continuously on the display module. Continuous monitoring of all the nodes and observation is done on Master Computer. This operating system is designed to work on XP, or Windows 7, platforms. The sensor networks are often deployed in unattended remote geographic areas, such as inside a large machinery at the bottom of an ocean, in contaminated field, battlefield, in home or large building. In a multi-hop sensor network, communicating nodes are linked by a wireless medium such as radio, infrared, or optical media.

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II. SENSOR NODE STRUCTURE

A. Processing Unit

In order to control the components of the sensor nodes and perform the required computations this subsystem is responsible for it. There are two sub-units, storage unit and processor unit[7]. Microcontroller MSP430G2553: The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from lowpower modes to active mode in less than 1 μ s. The MSP430G2x13 and MSP430G2553[6] series are ultra-lowpower mixed signal microcontrollers with built-in 16-bit timers, up to 24 I/O capacitive-touch enabled pins, a versatile analog comparator, and built-in communication capability using the universal serial communication interface. In addition the MSP430G2553[7] family members have a 10-bit analog-to-digital (A/D) converter.

B. Communication Unit

The sensor nodes due to this component interact with the base station and to the other nodes. Usually this subsystem is radio of short range but other fields has also been explored like ultrasound, infrared communication and inductive fields, communication by using CC2500 modules made by Vegarobokits[11] and these are able to interface with microcontroller IC MSP 430G2553[7] as both these device have interfaced easily. As modules has capability of analog to digital conversion (ADC). So user has to just configure the module once for ADC, & the module will send the data to the respective receiver, at the given interval of time. Interfacing includes the communication of the microcontroller MSP 430G2553[7][8] IC of every node with other node. As we are implementing the sensor network for 5 nodes, four nodes are communicated with each other. Diagram for communication with microcontroller is as shown in below figure. It is only the communication of pins of RX of CC2500 with TX of Microcontroller and TX of CC2500[11] with RX of microcontroller with voltage of 5.12V DC as Vcc and ground is connected same of Launchpad[12].

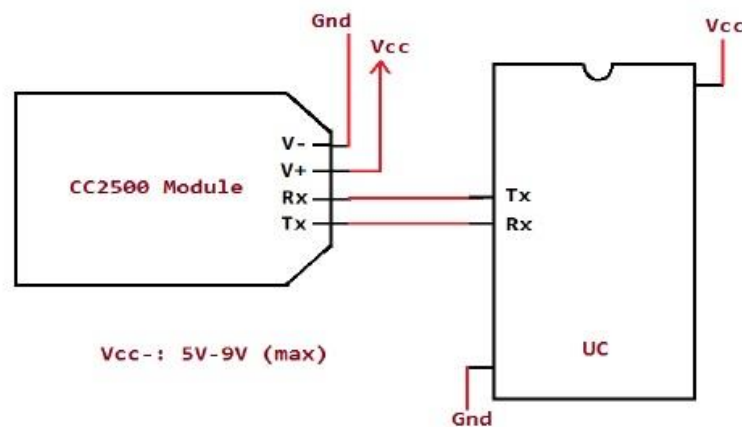


Fig. 1. Interfacing of CC2500 module with MSP430IC

C. Power Unit

Here power supply is provided to all the sections of the Node. Each node has sensing unit, processing unit, communication unit. Communication unit is provided with 5.12 DC V from power unit, as conversion of 12.52V DC to 5.12V by using 7805 voltage regulator. The processing unit includes the launch pad kit so it is provided with 3.3V. The range of the supplied voltage is 2.2 V to 3.6 V DC. We are providing it 3.3 V DC form power supply unit. Here 3.3 V is achieved by converting 5.12V into 3.3 V by using LM1117 IC it is the linear regulator having 800 mA low dropout IC, it gives continuous output of 3.3 VDC. We have obtained these 12.52 V DC from Adaptor and it is connected to every node. And then this voltage is converted as per our requirement. Adaptor converts 100-230V AC to 12.52 V DC with 1A rating at 50 Hz frequency. We are applying this to all five nodes.

D. Sensing Unit

Sensors are converting the temperature into electrical signals or light detection into electrical signals. In our project we are using only temperature sensor[14] (LM 35 DZ) and Light dependant resistor LDR only for Source node. Temperature sensor on all other four nodes these transducers are provided with voltage supply form voltage regulator. Signal Conditioning Section In the sensor node we have developed, LM35 DZ[14] serves as the temperature sensor. It is TO 92 Package. It generates an output voltage proportional to the temperature of the surroundings. Hence if we observe the output voltage to be 200mV at some time, we can say that the temperature at that moment is 20 degree Celsius. The output of the sensor is fed as the input of the ADC available in MSP 430 IC. In our configuration, the interfacing with the microcontroller, would give a digital output corresponding to the temperature.

E. Source Node

Source node is master node it is connected to personal computer through USB as it is made up of MSP430G2553 launch pad it is provided with DC power supply form adaptor as it is already mentioned in the power unit. As source node is beginner of the communication. When we starts the power supply of all the nodes, then we are initializing the node and begins the serial

communication through UART port by pressing the reset (S1) and S2 switch on the launchpad kit. This node is interfaced with LDR also called as photo resistor.

F. Destination Node

Destination node is last node of communication; this node is interfaced with temperature sensor of LM35DZ in TO-92 Package and it is provided with 12 V DC adaptor and CC2500 communication module. Work of destination node starts after routing done and it is shown, the sensor value is kept at P1_5 pin, the data is shown on LCD 16*2 character display. Incoming bytes to the source node is noted by Val character. After route path is identified by source node, it will initialize the destination node and serial communication begins, then LCD[13] begins as shown in program then, data of character '_incoming bytes' is defined and it is of 6 bytes.

G. Intermediate Nodes

As the intermediate node includes three nodes, Node-1, Node-2, and Node-3, these nodes are interfaced with temperature sensors of LM35 DZ with TO-92 package, and processor MSP430G2553 of launchpad kit and CC2500 communication module powered with 12 V DC adaptor and in programming section path routing is done with after serial communication its main work is to check the data and transfer it to next node.

III. IDENTIFY THE ROUTE

As the source node is doing the important task of identifying the route it is the AODV protocol implementation. This node is the starting node of communication in the protocol, as this node starts serial communication it will get into the route setup of the communication, then it will check each nodes, first it will check node-1, as there is PC Frame is formed before strts of communication, in PC Frame it is noted with \$1 sign for Node-1, and then it will check sensor value of node-1 and stores response time of the node-1. After that the source node will similarly check node-2 and node-3 and its notations are \$2 for node-2 and \$3 for node-3, and stores the interval of response and sensor value of both nodes. According to the node intervals stores the source node get the position of the nodes and assign it as the assign the node positions.

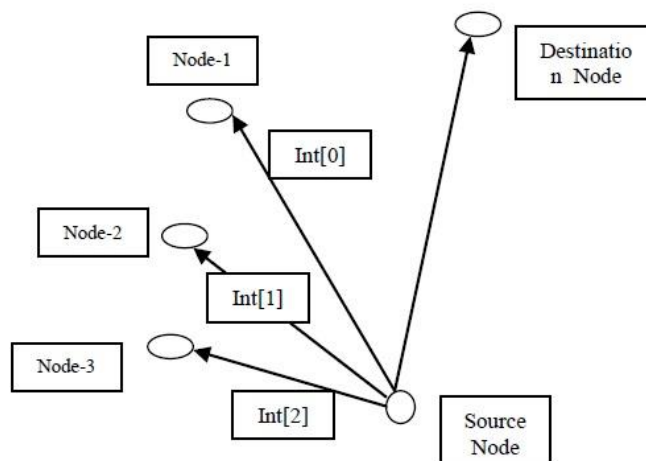


Fig. 2. Condition-1 for Node Position Assigning

Here interval[0] is time required to get acknowledgement to source node from node-1 in milliseconds. Here interval[1] is time required to get acknowledgement to source node from node-2 in milliseconds. Again here interval[2] is time required to get acknowledgement to source node from node-3 in milliseconds. This figure is made from our condition-1 in which $\text{interval}[0] > \text{interval}[1]$ and $\text{interval}[1] > \text{interval}[2]$ then we can say that node three is very close to source node then node-3 is given position at Data Frame[1], and node -2 is longer than node-3 but nearer than node-1 hence it is given position at Data Frame[2]. And node-1 is longer than node-2 and node-3 hence it is given position at Data Frame[3]

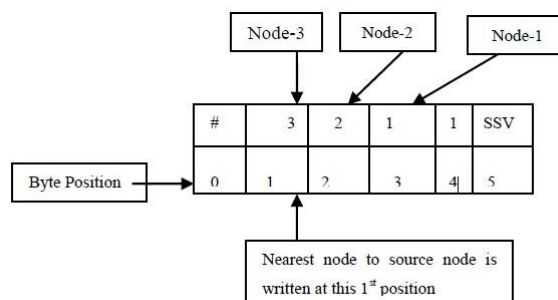


Fig. 3. Data Frame Format

Notations of the dataframe format

Data Frame[0] = #, means it is data frame for source node

Data Frame[1] = 3, node-3 is nearest to source node

Data Frame[2] = 2, Node-2 is longer than node-3 but nearer than node-1

Data Frame[3] = 1, Node-1 is longer than node-2, and node-3

Data Frame[4] = counter

Data Frame[5] = source sensor value

Notations of the PC frame format

& indicates this data is for PC

SV is sensor value for 1st intermediate node

SV is sensor value for 2nd intermediate node

SV is sensor value for 3rd intermediate node In this way the node position is assigned to the all three center nodes for first condition

Case -2: If $\text{interval}[0] > \text{interval}[1]$ this condition is yes and $\text{interval}[1] > \text{interval}[2]$ this condition is false, then source node will again check for $\text{interval}[0] > \text{interval}[2]$ and this condition is true then data frame format becomes, Dataframe[1]=3, dataframe[2]=1, and dataframe[3]=2.

Case-3: If $\text{interval}[0] > \text{interval}[1]$ this condition is yes and $\text{interval}[1] > \text{interval}[2]$ this condition is false, then source node will again check for $\text{interval}[0] > \text{interval}[2]$ and this condition is false then data frame format becomes, Dataframe[1]=2,

Dataframe[2]=1, Dataframe[3]=3.

Case-4: If $\text{interval}[1] > \text{interval}[2]$ it is true, $\text{interval}[0] > \text{interval}[2]$ it is true, then data frame format is Dataframe[1]=2, Dataframe[2]=3, Dataframe[3]=1.

Case-5: If $\text{interval}[1] > \text{interval}[2]$ it is true, $\text{interval}[0] > \text{interval}[2]$ it is false then Dataframe becomes Dataframe[1]=1, Dataframe[2]=3, Dataframe[3]=2.

Case-6: If $\text{interval}[1] > \text{interval}[2]$ and it is false then Data frame becomes Dataframe[1]=1, Dataframe[2]=2, Dataframe[3]=3

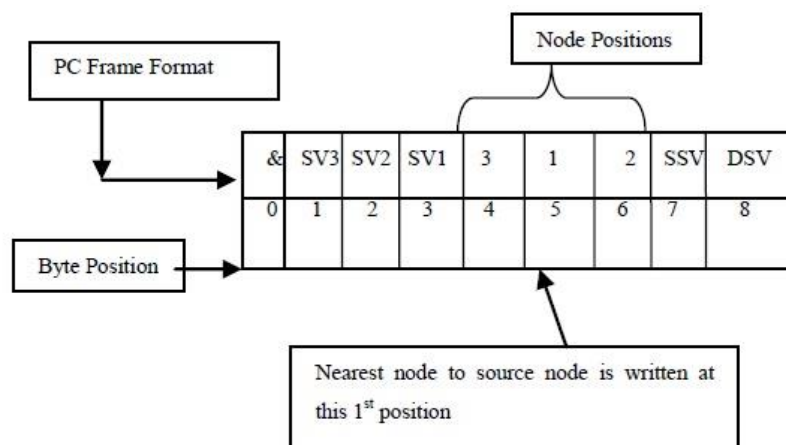


Fig. 4. PC Frame Format

All these are possibilities of the Node positions, on every identification of route discovery these path is identified and come in effective for routing purpose. In this way the node positions are assigned by using the above data frame format, and PC frame format will this data is sent to the PC which will be monitored on PC.

A. Implementation of Source Node

Source node is master node it is connected to personal computer through USB as it is made up of MSP430G2553 launch pad it is provided with DC power supply form adaptor as it is already mentioned in the power unit. As source node is beginner of the communication. When we starts the power supply of all the nodes, then we are initializing the node and begins the serial communication through UART port by pressing the reset (S1) and S2 switch on the launchpad kit. This node is interfaced with LDR also called as photo resistor. As the source node is doing another task of identifying the route it is the AODV protocol implementation and it is described in the software development section. This node is the starting node of communication in the protocol, as this node starts serial communication it will get into the route setup of the communication, then it will check each nodes, first it will check node-1, as there is PC Frame is formed before strts of communication, in PC Frame it is noted with \$1 sign for Node-1, and then it will check sensor value of node-1 and stores response time of the node-1. After that the source node will similarly check node-2 and node-3 and its notations are \$2 for node-2 and \$3 for node-3, and stores the interval of response and sensor value of both nodes. According to the node intervals stores the source node get the position of the nodes and assign it as the assign the node positions. This assigning node positions is the main work of the source node and after getting the node positions, another task of the source node begins after routing is completed and data start flowing form destination node to source node, and incoming bytes form desination

node are denoted by @, so its PC frame starts form @ sign then it is considered as PC frame. This data is transferred to PC and monitored on the PC.

B. Monitoring of Nodes on PC

While at first power on then USB of source node is connected to the PC, through this USB the communication between them is started. To achieve this task we have prepared .Net based platform in which the program for monitoring of all the nodes is done. The program is explained in program section some basic steps are as follows. When program is started we will load the TMS file saved in our PC. Then we check the communication port where we are connecting the USB of source node. Then next stage is debug the file, then we enter the number of communication port in to the tab shown. Then click the '_Start System' on system as tab is shown, then message of '_working' is observed on the screen. Then we wait for communication and collection of data on the source node and lastly all the values of nodes are shown on PC. When we want to stop the monitoring of node then press '_Stop System'. As we have made this operating system for 5 nodes[14], we are showing 8 different values on the PC, we have defined the 8 characters as per the code mentioned in the program of all the nodes. It is the screen shot of monitoring of nodes on PC

1. It shows node path for that routing in this 2->3->1 is the routing path
2. In first line 2(23)->3(23)->1(21) here these three are intermediate nodes and 2(23) means 23 Degree Centigrade is the temperature of 2nd intermediate node. in the same way temperature of other two nodes is also mentioned on the screen.
3. Then Self Value means we have attached photo resistor to the source node its rating given as 0 to 255 nos, as the Self Value shown
4. Destination Value shown is the Temperature of Destination node, here in first line it shows 22 Degree centigrade. At that time mentioned at 9:06:30 AM, mentioned
5. All this reading line come after every 35 to 39 seconds in three lines

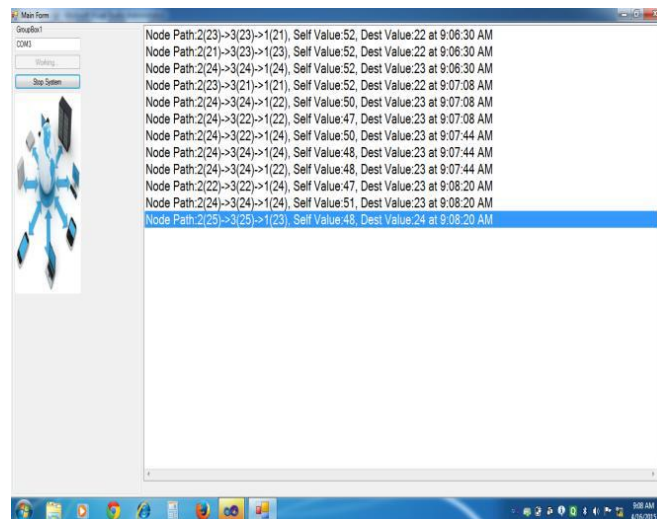


Fig. 5. Monitoring of Nodes on PC

IV. RESULTS & DISCUSSIONS

Result of this project is the monitoring of the all nodes on the PC, as this is MSP 430 based project so it is ultra low power device and its maximum power consumption is only 60 miliWats.

V. SCOPE OF PROJECT

□ Implementation in Industries As the development of the sensor network is continuously in progress in the field of wireless communication, power efficiency, extreme miniaturization every section of node is in development and embedded computing technologies have led to the rise of viable wireless sensor networks for demanding Industrial environments. We can put lot of parameters on a single node and concurrently it is kept monitored on the control room of the industry.

□ Industrial Monitoring on Internet As the advancement leads to the development of nodes and its applications to the higher level. There are thousands of the applications where these nodes are utilized hence by using the cloud computing and taking IP address to the each node, and by putting that IP on the internet address we can monitor these nodes form anywhere from the any country of the world.

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