Industrial Temperature Monitoring in Wireless Sensor Networks

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Abstract:Wireless Sensor Networks (WSN) networks consist of nodes that are deployed in the environment and can interact with it by sensing or controlling physical parameters. These nodes have to associate to fulfill their tasks as a single node is limited in doing so, and they use wireless communication to exchange data among them and the receiver also known as a sink. In industries, monitoring temperature is a vital process. Due to machines working, a small variation in temperature may damage the machines and put people's lives at risk. In this paper, the temperature is monitored using two nodes. First, two nodes are designed, the user interface is designed, and finally, the temperature from two nodes is monitored.

IndexTerms **- WSN, Sensor nodes, CC2500**

I. INTRODUCTION

AWireless sensor networks (WSN) or Wireless sensor & actuator networks (WSAN) are self-configuring networks of small sensor nodes communicating among themselves using wireless communication, and deployed in a large number to sense, monitor and understand the physical world. WSN provide a bridge between the real physical and virtual worlds. Data from sensors are sent to the receiver using transceivers at the node and at the receiver. In industries, temperature monitoring is vital. There are places in industries where it is not easy to reach due to hardware complexity, and temperature of such places needs to be monitored.

This is solved by placing sensor nodes to such places and monitor temperature at the receiver in an office. There is no need to have someone at the place the whole time when the system is running. In this paper, an efficient system for temperature monitoring in industries is designed and implemented for a 24-hour monitoring and in the case of emergency, the receiver immediately senses it and informs the user.

II. MATERIALS AND METHODS

For Building a WSN network, primitively, constituting nodes have to be ready and available. Depending on what kind of application, the nodes have to satisfy its requirements. Nodes need to be as diminutive as possible, inexpensive, consume as less power as possible, and can be equipped with the right sensors or actuators, necessary calculations, memory resources, and they need efficient communication apparatus.

A basic sensor node also known as mote puts together five main components [1] which are controller, memory, sensors and/or actuators, a communication device (wireless) and power supply.

PIC16F877A *microcontroller*: PIC (*Peripheral Interface Controller)* has 16- Byte capability, Flash memory, and 877A represents IC number or version.It is a 40-pin microcontroller that is made of two 8-bit and one 16-bit timer. PIC16F877A has inbuiltAnalog to Digital Converter (ADC) which makes it easy for us to use any type of sensor whether it is analog of digital. It attains its applications in a large number of devices. The cost of this controller is low and its handling is easy.

LM35 is a selective IC temperature sensor with its output proportional to the temperature in ºC.The operating temperature range is from -55°C to 150°C. The output voltage changes by 10mV in response to every ºC rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ ºC

CC2500 RF Module is a trans-receiver module which provides easy to use RF communication at 2.4 GHz. It exchanges data at 9600 baud rates from any standard CMOS/TTL source.

Power Supply *and* ***Personal Computer (PC)***

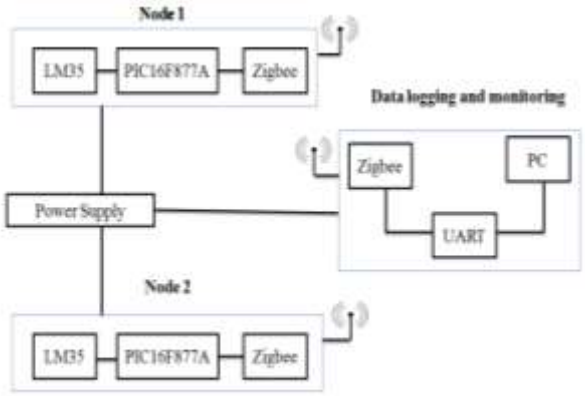

Fig 1: Overall system diagram

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III. EXPERIMENTAL WORK

Two nodes are designed. Each node is equipped with CC2500 RF trans-receiver and temperature sensor LM35. The temperature is continuously monitored so that whenever any temperature from any node goes above 45 ^{o}C, the receiver immediately becomes aware and informs the user. Temperature is also stored in a database for future reference.
The receiver is equipped with LabView software which monitors the nodes. Data Acquisition is an approach of accumulating signals from the environment and Digitizing them [2]

It is feasible to construct a WSN for emergencyresponse notification using IEEE 802.15.4 and Zigbee. Moreover, there is a range of sensing applications which can be developed using 802.15.4 MAC and PHY along with ZigBee stack [3]

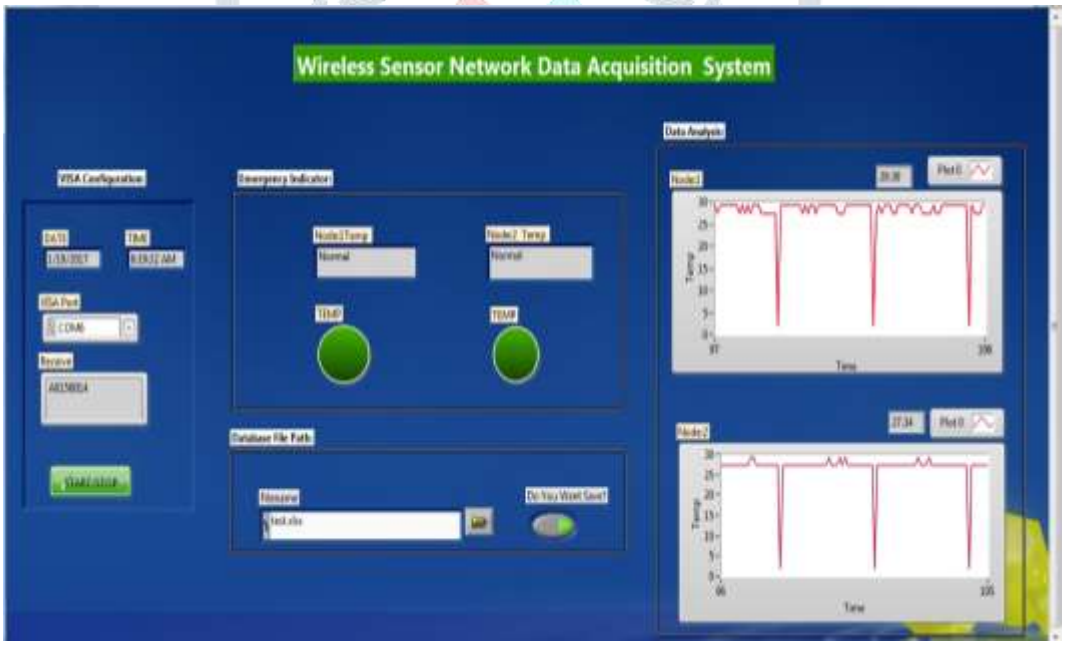

Fig 2: Temperature monitoring

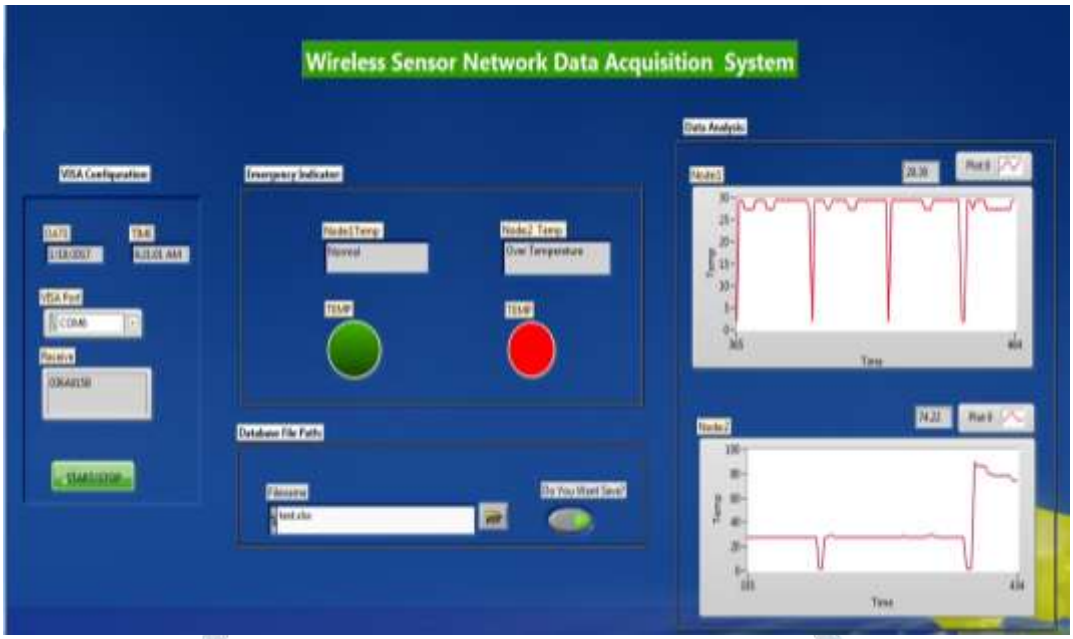

Fig 3: Over temperature: When temperature goes above 45

The CC2500 does not directly support the IEEE 802.15.4 frame format but uses aproprietary format similar to the one defined in the 802.15.4 protocol. [12]

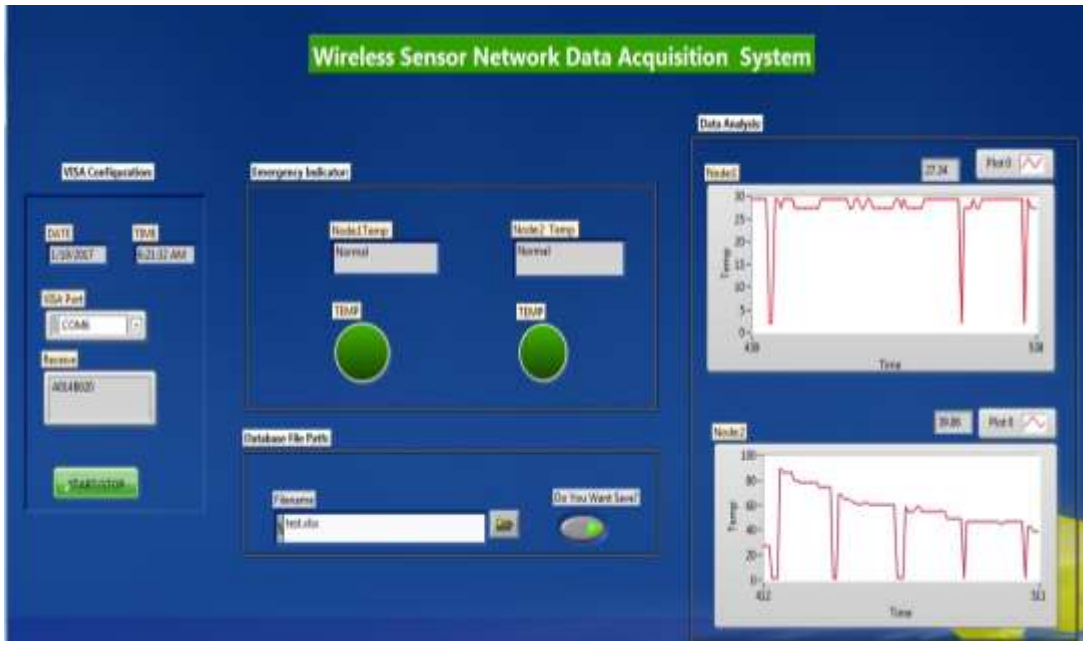

Fig 4: Normal: Below 45, the knob returns to green

The sensor position must be assigned to ensure that the value of the readings that we receive is the average temperature of the area and not a particular place in the area in order to be sure that the temperature is measured correctly [4].

Table1:Temperature stored

NODE 1		NODE 2	
Date and Time (MM/DD/YYYY)	Temp (°C)	Date and Time (MM/DD/YYYY)	Temp (°C)
01/19/2017 06:19:22.926	29.296875	01/19/2017 06:19:22.926	29.296875
01/19/2017 06:19:23.095	29.296875	01/19/2017 06:19:23.000	29.296875
01/19/2017 06:19:25.637	29.296875	01/19/2017 06:19:25.637	1.953125
01/19/2017 06:20:49.478	93.75	01/19/2017 06:20:49.478	29.296875
01/19/2017 06:20:49.752	93.75	01/19/2017 06:20:49.752	29.296875
01/19/2017 06:20:50.867	85.9375	01/19/2017 06:20:50.867	29.296875
01/19/2017 06:20:51.154	85.9375	01/19/2017 06:20:51.154	29.296875
01/19/2017 06:20:52.818	80.078125	01/19/2017 06:20:52.818	29.296875
01/19/2017 06:20:56.560	74.21875	01/19/2017 06:20:56.560	29.296875
01/19/2017 06:20:58.004	68.359375	01/19/2017 06:20:58.005	29.296875
01/19/2017 06:21:08.761	60.546875	01/19/2017 06:21:08.761	29.296875
01/19/2017 06:21:09.060	58.59375	01/19/2017 06:21:09.060	29.296875
01/19/2017 06:21:09.370	58.59375	01/19/2017 06:21:09.370	29.296875
01/19/2017 06:21:31.125	42.96875	01/19/2017 06:21:31.125	1.953125
01/19/2017 06:21:31.450	37.109375	01/19/2017 06:21:31.450	1.953125
01/19/2017 06:21:47.127	37.109375	01/19/2017 06:21:47.127	29.296875
01/19/2017 06:21:47.470	33.203125	01/19/2017 06:21:47.470	29.296875

IV. RESULT AND DISCUSSION

The process of temperature monitoring is established successfully. Due to complexity in hardware implementation, the number of nodes was limited to 2.

WSN uses wireless communications and it suffers from path loss, Fading, Interference, and multipath propagation mechanisms like Reflection, Diffraction, and scattering [11]. This results in some temperature fluctuations at the receiver and they occur in a short period of time.

It is noticed that whenever the temperature goes beyond 45 °C, the receiver automatically displays red and normal temperature changes to over temperature (figure 3) and unless the temperature goes below 45, the display cannot go back to green. Another feature is that of storing temperature, date, and time, and the node (table 1) from which temperature came from in database for better investigations and future reference.

V. CONCLUSION

In this paper, real-time temperature monitoring in industries is done successfully. 2 nodes were designed, equipped with a transceiver and LM35 temperature sensors.

The receiver is equipped with a transceiver and data acquisition (DAQ) system. Temperature is successfully monitored by PC and a threshold is set as 45 and above it, the receiver informs the user instantly. Here, a knob is used but it can be replaced with alarms and /or fire sprinkler systems for more accurate convenient response. The received temperature is stored in a database for future reference.

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