WIRELESS TEMPERATURE SENSOR NETWORK

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ABSTRACT

Sensor networks are being widely deployed for measurement, detection and surveillance applications. Today, humidity becomes very important in many aspects especially in manufacturing industry. Therefore, the use of tools or systems that can monitor the humidity level is very significant. Sensor networks can be used to identify larger trends in temperature which could be used to report energy usage, HVAC problems, computer failures based on high temperatures and fire evacuation route reporting. This project presents a design of Wireless Temperature Sensor Network that capable to monitor the humidity level. This Wireless Temperature Sensor Network comprises of two parts; temperature detection and monitoring. The detection section will sense the temperature and transmit the signal to the monitoring section. All the sensors are connected mote to mote to ensure that each mote can communicate and exchange the data with each other. The collection of temperature data would be obtained by a sensor network. The data was collected using a temperature sensor network connected to a stand-alone computer. This approach can makes the monitoring process becomes more efficient and cost effective. The data (temperature level) will be display by using GUI. In the case of mote to mote system, the GUI capable to display the overall level of temperature.

KEYWORDS

Temperature, Sensor Network, Wireless

1. INTRODUCTION

Wireless sensor networks have been identified as one of the most important technologies for the 21st century. A wireless sensor network (WSN) is a computer network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations[1][2]. The development of wireless sensor networks was originally motivated by military applications such as battlefield surveillance. However, wireless sensor networks are now used in many civilian application areas, including environment and habitat monitoring, healthcare applications, home automation, and traffic control[1][3].

In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. The size a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust[1]. The cost of sensor nodes is similarly variable, ranging from hundreds of dollars to a few cents, depending on the size of the sensor network and the complexity required of individual sensor nodes.[1] Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth.[1]

The applications for WSNs are many and varied. They are used in commercial and industrial applications to monitor data that would be difficult or expensive to monitor using wired sensors. They could be deployed in wilderness areas, where they would remain for many years (monitoring some environmental variable) without the need to recharge/replace their power supplies. They could form a perimeter about a property and monitor the progression of intruders (passing information from one node to the next).

Typical applications of WSNs include monitoring, tracking, and controlling. Some of the specific applications are habitat monitoring, object tracking, nuclear reactor controlling, fire detection, traffic monitoring, etc. In a typical application, a WSN is scattered in a region where it is meant to collect data through its sensor nodes.

- Environmental monitoring
- Habitat monitoring
- Acoustic detection
- Seismic Detection
- Military surveillance
- Inventory tracking
- Medical monitoring

This project presents a design of Wireless Temperature Sensor Network that capable to monitor the humidity level. This Wireless Temperature Sensor Network was detected and monitored the environment temperature in laboratory over a period of five days. According to the laboratory size which is 26m x 14m , 5 sensor motes was placed randomly with certain spacing among each mote. Each mote consist of temperature sensor, processing unit with limited computational power and limited memory, Infra Red Data

Acquisition (IrDA), Tiny Operating System(Tiny OS) and power source. The collected data from Tiny OS was displayed on PC screen.

For monitoring part, the collected data was displayed on PC by using GUI. The program for the GUI was built to display the temperature level. In the case of mote to mote system, the GUI capable to display the average level of temperature.

2. BACKGROUND

2.1 History of Research in Sensor Networks

Networked sensors technology is a key technology for the future. In September 1999 [4], *Business Week* heralded it as one of the 21 most important technologies for the 21st century. Cheap, smart devices with multiple onboard sensors, networked through wireless links and the Internet and deployed in large numbers, provide unprecedented opportunities for instrumenting and controlling homes, cities, and the environment. In addition, networked sensors provide the technology for a broad spectrum of systems in the defense arena, generating new capabilities for reconnaissance and surveillance as well as other tactical applications.

Smart disposable sensors can be deployed on the ground, in the air, under water, on bodies, in vehicles, and inside buildings. A system of networked sensors can detect and track threats and be used for weapon targeting and area denial. Each sensor node will have embedded processing capability, and will potentially have multiple onboard sensors, operating in the acoustic, seismic, infrared (IR), and magnetic modes, as well as imagers and radars. Also onboard will be storage, wireless links to neighboring nodes, and location and positioning knowledge through the global positioning system (GPS) or local positioning algorithms.

3. STATEMENT OF THE PROBLEM AND RESEARCH OBJECTIVES

3.1 Problem to be Studied

- Temperature monitoring system is not systematic due to monitoring process was done manually – use human energy / manpower.
- Wasting of time, energy and cost.
- Measurement is not accurate and precise.
- Less of efficiency in detecting changes of temperature.

3.2 Research Objectives

- To design a systematic monitoring temperature system by using wireless network sensor.

- To build cost effective and more efficient temperature sensor system.
- To develop a more accurate and precise measurement equipment.
- To increase the efficiency in detect the changes of temperature reading.
- To develop a database for fast tracking and analysis.
- To invent a new approach for temperature detection and monitoring.

4. RESEARCH METHODOLOGY

Wireless Temperature Sensor Network comprises of two parts; temperature detection and monitoring.

The temperature detection part comprises of temperature sensor circuit, Microcontroller, Infra Red Data Association (IrDA) Board and Tiny Operating System(Tiny OS). For the temperature sensor circuit, to get a temperature reading we use the Dallas DS1620 integrated circuit. It is an 8 pin chip that has a built in system that measures the temperature and converts the reading into a 9 bit binary value. It has an accuracy of 0.5 degrees C and a range of -55 to 125 C. The temperature reading is updated about once per second. A digital interface is included in the chip that allows us to connect a microcontroller to the chip and send it commands and receive the temperature data back from the chip.

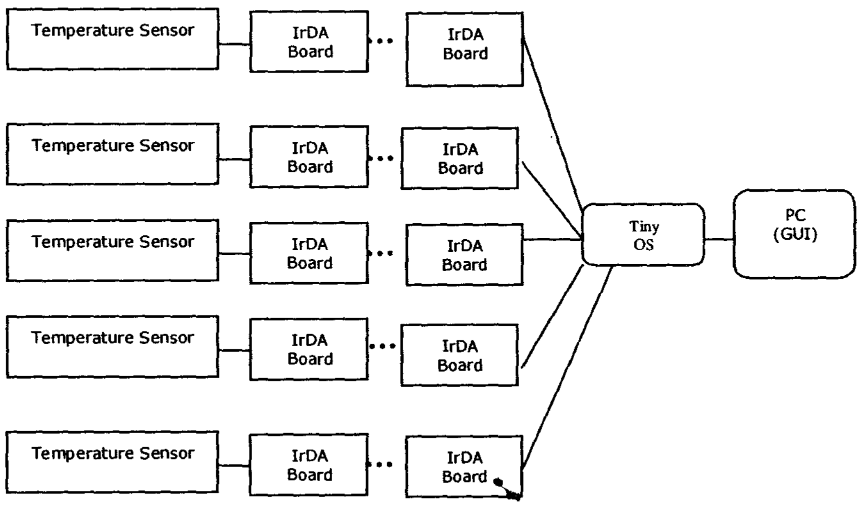

Fig 4.1. Block Diagram of Wireless Temperature Sensor Network

The temperature is received in the microcontroller as 2 bytes. The second byte only contains a sign bit to signify whether the temperature is above or below 0 degrees Celsius. For this project we are ignoring the sign bit and just using the first byte. We will assume the temperature is above 0 degrees C (32 F). The value in the first byte is the number of 0.5 degree increments. For example, if we get a 1 then the temperature is 0.5 degrees C. If we get a 10 then the temperature is 5 degrees C. The range of possible values is 0 to 250 which is 0 to 125 degrees C. (The DS1620 can also measure down to -55 degrees C).

For this project we are only using the serial interface pins, 1, 2, and 3. The pins 5, 6, and 7 have other functions that are used in thermostats. They change from 0 to 1 when a certain temperature is reached. The MAX232 acts as a buffer driver for the processor. It accepts the standard digital logic values of 0 and 5 volts and converts them to the RS232 standard of +10 and -10 volts. It also helps protect the processor from possible damage from static that may come from people handling the serial port connectors.

In this project, IrDA board was used as a wireless connectivity or as a secondary device for point to point applications. There is also a facility to directly access the infrared transceiver (IR transmitter and receiver). The data from the sensor circuit was sent from IR transmitter to the IR receiver which was connected with TinyOS. TinyOS is an open source component-based operating system and platform targeting wireless sensor networks and provide interface to the standard kinds of hardware inputs, outputs, and sensors. All the data from the TinyOS was sent to the PC for monitoring and analysis purposes.

5. RESULT

The data acquisition was conducted for five working days with the sampling rate of about 4 times per hour or 96 samples per day. Someday had less samples due to network performance.

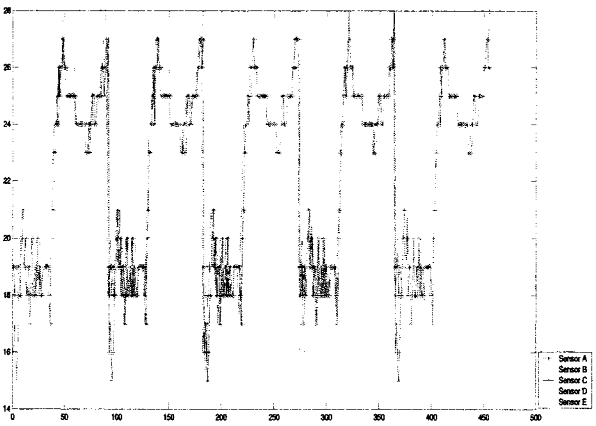

Fig 5.1. Overall data streams for five working days.

Looking at the summary of the data streams in Figure 5.1, we can see that the temperature in the Computer Lab changed between 16 ^{0}C to 27 ^{0}C. The changes were due to lab activities during office hour, lab without activities during break or lunch hour and lab close after office hour. The data from each sensor (sensor A to E) do not show much different since all the sensors are placed in the same lab but at different position. Thus, we can say that the average of data collected by the five sensors represent the temperature in the lab.

Figure 5.2 shows the average temperature in the Computer Lab for five working days. While the number of records varied per day, when all samples per hour are averaged, the number of records shows that the number of samples per hours varies.

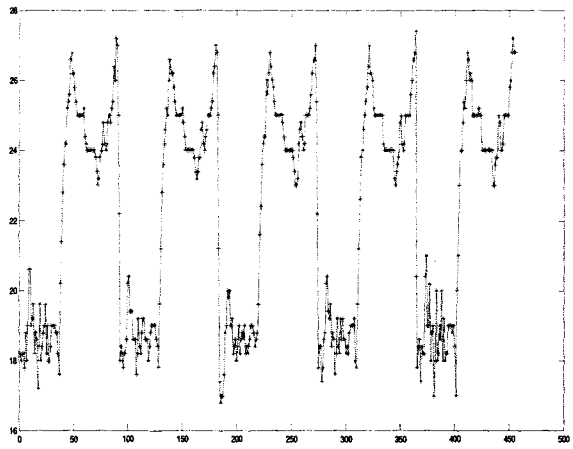

Fig 5.2. Average data streams for five working days.

Figure 5.3 depicts the temperature that acquired from all sensors during office hours. The office hour is from 8am to 5pm. But, we can see that during this period there were 40 data collected including data from 5pm to 6pm as well. This is because the centralized air conditioner is turn off at 6 pm. The temperature varied depends on laboratory activities. If there were no activity conducted, the temperature equals to the temperature of the lab which is approximately 16 ^{0}C to 18 ^{0}C. During laboratory session, the temperature captured was slightly high about 2 ^{0}C to 5 ^{0}C depends to the number of students.

After office hour the laboratory temperature rose slowly from the turn off temperature until roughly 27 ^{0}C. The increment of the temperature was not so high because it was affected by the surrounding condition such as rain and the low night temperature itself. The average temperature in lab is as depicted in Figure 5.4 .

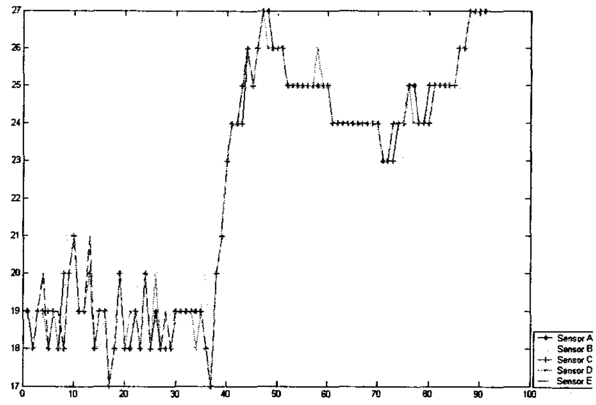

Fig 5.3. Overall data streams for one working day.

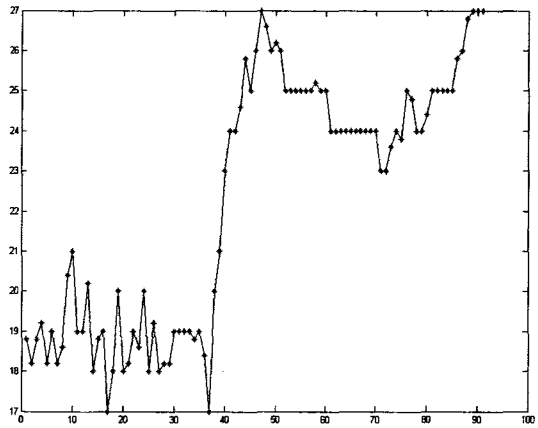

Fig 5.4. Average data streams for one working day.

6. SUMMARY AND CONCLUSION

The aim of this project is to design a systematic and smart monitoring temperature system by using wireless network sensor due to monitoring process was done manually. Built cost effective and more efficient, accurate and precise system monitoring. To increase the efficiency in detect the changes of temperature reading by developed a database for fast tracking and analysis. The new technology approached is networked sensors technology. Networked sensors technology is a key technology for the future. Especially wireless sensor networks that been identified as one of the most important technologies for the 21st century. We can do networking for temperature, sound, vibration, pressure, motion or pollutants, at different locations by using Wireless sensor network (WSN). However, wireless sensor networks are now used in many civilian application areas, including environment, chemical process in industrial, habitat monitoring, medical and healthcare applications, smart home, object tracking, nuclear reactor controlling, fire detection, traffic monitoring, etc.

Typical applications of WSNs include monitoring, tracking, and controlling. The applications for WSNs are many and varied. They are used in commercial and industrial applications to monitor data that would be difficult or expensive to monitor using wired sensors. They are robust, and long lasting where they would remain for many years (monitoring some environmental variable) without the need to recharge/replace their power supplies. The benefit using WSN are we can reduce cost and less maintenance because it is pc monitoring systems.

The hardware part combined the temperature detection part which comprises of temperature sensor circuit, Microcontroller, Infra Red Data Association (IrDA) Board and Tiny Operating System (Tiny OS). For the temperature sensor circuit, to get a temperature reading we use the Dallas DS1620 integrated circuit. It is an 8 pin chip that has a built in system that measures the temperature in digital.

The data acquisition was conducted for five working days with the sampling rate of about 4 times per hour or 96 samples per day. Someday had less samples due to network performance. Looking at the summary of the data, we can see that the temperature in the Computer Lab changed between 16 ^{0}C to 27^{0}C. The changes were due to lab activities during office hour, lab without activities during break or lunch hour and lab close after office hour. The data from each sensor (sensor A to E) do not show much different since all the sensors are placed in the same lab but at different position. Thus, we can say that the average of data collected by the five sensors represent the temperature in the lab. So from the result we get we can conclude that the temperature varied depends on laboratory activities. If there were no activity conducted, the temperature equals to the temperature of the lab which is approximately 16 ^{0}C to 18 ^{0}C. During laboratory session, the temperature captured was slightly high about 2 ^{0}C to 5 ^{0}C depends to the number of students or persons in the lab. After office hour the laboratory temperature rose slowly from the turn off temperature until roughly 27 ^{0}C. The increment of the temperature was not so high because it was affected by the surrounding condition such as rain and the low night temperature itself.

6.1 Suggestions

In advance we hope the knowledge that we gain can help us to invent or produce the high technology WSN with other beneficial application such:

1. WSN can be applied to sense the vibration for monitoring tsunami, and volcanoes.
2. WSN also can be used to monitor air pollution where we can put the sensor at the specific place, to monitor the air pollution index.

3. WSN also can be used in collaboration with sound sensor in 3D sound theater or cinema to monitor sound effect.

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