**FACTORY ENVIRONMENT MONITORING BASED ON
WIRELESS SENSOR NETWORK**

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Bachelor of Mechatronics Engineering

MAY 2009

I hereby declare that I have read through this report entitle "Factory Environment Monitoring Based on Wireless Sensor Network" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronics Engineering.

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Supervisor's Name   : Mr. Zulhani B. Rasin

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This report is submitted in partial fulfillment of requirements for the degree of Bachelor of Mechatronics Engineering

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MAY 2009

I hereby declare that this report entitle " Factory Environment Monitoring Based on Wireless Sensor Network" is the result of own my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature   :…………………………………………

Name   :…………………………………………

Date   :…………………………………………..

To my beloved father and mother,

Mohd Zainuddin B. Mohamad and Zainah Bt. Ab.Manap,

In appreciation of supported and understanding.

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In the Name of Allah, Most Gracious, Most Merciful. All praise and thanks are due to Allah, and peace and blessings be upon His Messenger.

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ABSTRACT

Wireless Sensor Network (WSN) consists of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions. This system is the key to detecting the relevant quantities, monitoring and collecting the data, assessing and evaluating the information, formulating meaningful user displays and performing alarm functions. In some application, the running wires and cable is impractical and also at certain field where the wire is not reachable. Hence, WSN can be applied for many applications such as for condition base monitoring, security and military sensing, asset tracking and supply chain management, intelligent agriculture and environmental sensing, home automation and health monitoring. In this project, the monitoring system is developed to monitor the environmental condition of the factory such as temperature and humidity based on wireless sensor network. The project divided into three main parts, for the first part is developing the Graphical User Interfaces (GUI). GUI is developed by using software C++ Builder which allow user to monitor the measurement of the desired parameters and perform data analysis from the personal computer. The second part of this project is to develop the hardware for the monitoring system. The hardware consist the combination of many wireless sensor nodes to measure the physical quantities and also the co-ordinator which is used as a router in signal transmitting. The final part is to integrate the graphical user interfaces with the hardware part and the performance analysis has been done after the system is able to collect the data in wireless medium.

ABSTRAK

Rangkaian sensor tanpa wayar mmengandungi alat-alat automasi di dalam satu taburan ruang yang luas menggunakan sensor untuk menjalankan pengawasan ke atas keadaan fizikal dan juga keadaan sekeliling. Sistem ini adalah kunci untuk mengesan jumlah yang relevan , menjalankan pengawasan dan mengumpul data , menilai maklumat , menunjukkan paparan pengguna yang berguna dan juga sebagai penunjuk pencegah bahaya . Di dalam beberapa aplikasi , penggunaan wayar tidak praktikal dan di dalam bidan tertentu wayar tidak dapat dicapai . Jadi, sistem ini boleh diaplikasikan di dalam pengawasan keadaan mesin , pengawasan di dalam keselematan tentera, mengesan aset , kebijaksanaan agrikultur dan pengesanan keadaan persekitaran , automasi rumah dan mengawasi kesihatan. Di dalam projek ini , sistem pengawasan dibangunkan untuk mengawasi keadaan persekitaran kilang contohnya suhu dan kelembapan berdasakan rangkaian sensor tanpa wayar. Projek ini dibahagikan kepada tiga bahagian utama iaitu bahagian pertama menghasilan Graphical User Interfaces (GUI) . GUI dibangunkan dengan menggunakan perisian C++ Builder dan berfungsi untuk mengawasi pengukuran keadaan persekitaran dan menjalankan analisis maklumat dari komputer. Bahagian kedua untuk membangunkan segala peralatan untuk system pengawasan. Peralatannya terdiri daripada gabungan rangkaian sensor-sensor dan juga co-ordinator sebagai pengawal penghantaran signal . Bahagian terakhir ialah menggabungkan GUI dan peralatannya seterusnya analisis pencapaian boleh dilakukan setelah system pengawasan ini berjaya mengumpul data tanpa wayar.

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LIST OF SYMBOLS

GHz	Giga Hertz
MHz	Mega Hertz
Kbps	Kilo bit Per Second
µA	Micro Ampere
m	Mili
$p^{*}_{(H_2O)}$	The partial pressure of water vapor in the mixture
$p_{(H_2O)}$	The saturated vapor pressure of water at the temperature of the mixture
ft.	Feets
R	Resistance
αR	Temperature Coefficient of Resistance
T	Temperature
Ω	Ohm
C++	Programming Language
V	Volts
Vcc	Power Supply
°C	Celcius

LIST OF ABBREVIATION

RF   Radio Frequency,

WSN   Wireless Sensor Network

GUI   Graphical User Interfaces

DARPA   Defense Advanced Research Projects Agency

ISM band   The Industrial, Scientific and Medical Radio Bands

U.S.   United States

EKG   Electrocardiograms

EMT   Emergency Medical Technician

CBM   condition based maintenance

IEEE   Institute of Electrical and Electronics Engineer

PHY   Physical

MAC   Media Access Control

OSI   Open System Interconnection

CSMA/CA   Carrier Sense Multiple Access with Collision Avoidance

RSSI   Received Signal Strength Estimation

LQI   Link Quality Indicator

FFD   Full Function Device

RFD   Reduced Function Device

RAM   Random Access Memory

ROM   Read Only Memory

LAN   Local Area Network

RTD   Resistive Temperature Detectors

PTC)   Positive Temperature Coefficient

NTC   Negative Temperature Coefficient

RH   Relative Humidity

IDE   Integrated Development Environment

DAC   Digital to Analog

ADC	Analog to Digital
I/O	Input orOutput
USB	Universal Serial Bus
RS-232	Standard for Computer Serial Port
DC	Direct Current
LED	Light Emitting Diode
JTAG	Joint Test Action Group
GPIO	General Purpose Input Output
JP	Jumper Pin
ANSI	American National Standard Institute

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CHAPTER 1

INTRODUCTION

This chapter presents about the project motivation, project objective, problem statement and the scope of the project.

1.1   Project Background

Wireless communication is the transfer of information without the use of electrical conductor. Some application is impossible or impractical to implement with the use of wires. The term wireless is commonly used in telecommunications industry system such as radio transmitters and receivers, remote controls, computer networks and network terminals which use some form of energy kind off radio frequency (RF), infrared light, laser light, visible light, and acoustic energy, to transfer information without the use of wires.

Wireless Sensor Network, (WSN) are collections of compact-size, relatively inexpensive computational nodes that measure local environment conditions or other parameters and forward such information into a central point for appropriate processing. One of the applications of WSN is to monitor the environment parameter in industrial field such as temperature, pressure, humidity of the air, level measurement, vibration performance and many others based on wireless technology which offers more benefits compare with existing wired system [1].

This project is to develop the hardware for monitoring system which measure the temperature and relative humidity and all the parameter is read through the Graphical User Interfaces (GUI). The hardware implementation is based on wireless sensor technology.

1.2 Objective

The Objectives of the project are:

   i.   To develop the hardware for monitoring system based on wireless sensor network.

  ii.   To design and develop the Graphical User Interfaces (GUI).

 iii.   To integrate the Graphical User Interfaces with the hardware part of the project.

 iv.   To make the performance analysis of wireless sensor network characteristics.

1.3 Problem statement

A large, industrial facility typically has a relatively small control room, surrounded by relatively large physical plant/factory. The control room has indicators and displays that describe the state of the plant (the states of valves, the condition of equipment, the temperature and pressure of the machine and room) , as well as input devices that control actuators in the physical plant (valves, heaters and compressor) that affect the observed state of the plant. The sensor describing the state of the physical plant, their display in control room, the control input devices, and the actuators in the plant or factory often are all relatively inexpensive compared with the cost of the armored cable that must be used to communicate between them in a wired installation. Significant cost savings may be achieved if an inexpensive wireless means were available to provide this communication. Because of the information being communicated is state information, it often changes slowly. Thus, in normal operation, the required data throughput of the network is relatively low, but the required reliability of the

network is very high. A wireless sensor network of many sensor nodes, providing multiple message or data routing paths of multi-hop communication can meet these requirements.

There are a lot of instruments in the factory. The most current are so-called smart modules, which microprocessor is built in. There is a lot of information in a smart instrument besides a measurement values such a settings, operational status and so on. However to read out such maintenance information, plants operator usually have to connect cable to the terminators manually. If such information can be accessible by a wireless network, it should be grateful helpful.

The monitoring and control of rotating or otherwise moving machinery for an example is cooling system with fan drive motor that is another area required for wireless sensor network. In such applications, wired sensor and actuators are often impractical, yet it may be important to monitor the temperature , pressure and lubrication flow of the rotating components of the machine to optimize the time between maintenance periods, when the machine must be taken off –line. To do this, it is important that the wireless sensor network with very low energy requirements. The sensor nodes often must be physically small and inexpensive as well.

1.2   Scope

The scope of this project is to develop the monitoring system which able to monitor the environmental condition and physical quantities that is temperature and the air humidity measurement. In order to achieve the objective of the project, the graphical user interfaces is developed which it is user friendly and display the measurement value with relates information according to the data collected from the wireless sensor. Then, the hardware part which consists of sensor node and the coordinator is developed. The performance analysis of the monitoring system is implemented and the last part is to prove the wireless sensor characteristics in term of power duration, the signal transmission reliability and the transmission range capability.

1.3   Report Outline

Chapter 1 is explained about the project background, objective of the project, problem statement and also the scope of the project.

Chapter 2 is exposed to the technology of WSN, the components of WSN, WSN's characteristics and the range application of the WSN.

Chapter 3 described the details the Zigbee overview which is the main components in the WSN, characteristics of Zigbee and Zigbee standard.

Chapter 4 is consists the description of the project methodology included the components of the project. The hardware and software being used in the project are described as well.

Chapter 5 described the results of the project, including the components of the hardware and software of the project. The performance analysis of the implemented project also is discussed.

Chapter 6 is discussed about the recommendation for the future work and also the conclusion of the project.

CHAPTER 2

LITERATURE REVIEW

This chapter review existing project created to get an idea about the project technology, the background, the application of the system and also some technical researches relates to this project.

2.1   Wireless Sensor Networks

Wireless Sensor Network is a set of large number of sensors which provide a smart environment; the sensors respond to its particular sensing characteristic changes around them and send the information to centre of processing unit. SmartDust program which is sponsored by The Defense Advanced Research Projects Agency (DARPA) defined sensor networks as:

"A sensor network is a deployment of massive numbers of small, inexpensive, self-powered devices that can sense, compute and communicate with other devices for the purpose of gathering local information to make global decisions about a physical environment." [2].

A Sensor Network is an infrastructure comprised of sensing (measuring) , computing, and communication elements that gives an administrator the ability to instruments, observe and react to events and phenomena in a specified environment . The administrator typically is a government, commercial or industrial entity. The environment can be physical world, factory environment and also a biological system. Typical applications include but not limited to, data collection, monitoring surveillance and medical telemetry.