WATER RESERVATION CONTROL BASED ON WIRELESS SENSOR NETWORK

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Date : 13 MAY 2009

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Bismillahirrahmanirrahim. In the name of ALLAH, who is the most Gracious and most Merciful. Without HIS blessing I‟m not here now and would not be able to complete this report.

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ABSTRACT

The purpose of this project is to build the wireless automation system to control the water reservation system from control centre base on wireless network. This is meaning to use the application of zigbee module with the water level sensor to control the opening and closing the water gate. ZigBee is a new wireless standard introduced for low power consumption and low cost wireless communication with moderate data rates. It is intended to be used in embedded applications for home or office automation, industrial control and sensor networks. In such applications there is generally a need for a master controller, which will be responsible for data acquisition and communicate with other systems. In order to improve the conventional water reservation system, the water level sensors detect and sent the data using the application of wireless zigbee module. water flow from reservation zone into either watering zone or outlet zone. The opening gate is control by comparing water level at each zone. The main purpose of the project is to prevent the zone around the water reservation from flood and to maintain the watering system during the drought season by automatically control and also by human control base on data sent by wireless network.

ABSTRAK

Tujuan utama projek ini adalah untuk membina satu system automatik tanpa wayar untuk mengawal satu sistem simpanan air dari pusat kawalan berdasarkan rangkaian tanpa wayar, iaitu menggunakan module zigbee bersama pengesan takat air untuk mengawal pembukaan dan penutupan pintu sekatan air. Zigbee ialah standard baru yang diperkenalkan untuk penggunaan kuasa rendah dan komunikasi tanpa wayar kos rendah dengan ‚*data rate'* yang sederhana. Ini bertujuan untuk menggunakan aplikasi terbenam automasi di pejabat, kawalan perindustrian, dan rangkaian tanpa wayar. Dalam aplikasi sebegini, keperluan am adalah kawalan utama yang mana akan bertanggungjawab untuk penerimaan data dan berkomunikasi dengan system lain. Dengan tujuan untuk memperbaiki tadahan air konvensional, pengesan takat air akan mengesan dan menghantar dat menggunaka aplikasi tanpa wayar zigbee module. Pengaliran air adalah dari kawasan simpanan ke kawasan pengairan atau kawasan pembuangan. Pembukaan dan penutupan pintu sekatan dikawal dengan membandingkan takat air bagi setiap kawasan. Tujuan utama projek ini adalah untuk mencegah kejadian banjir di kawasan simpanan air dan untuk mengekalkan bekalan air di bahagian pengairan sepanjang musim kemarau. Menggunakan sistem kawlan automatik dan juga kawalan manusia berdasarkan data yang di hantar menggunakan rangkaian tanpa wayar.

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CHAPTER 1

INTRODUCTION

The purpose of this project is to apply the wireless system network Zigbee for the water reservation control to build a simple and cheap system. ZigBee is a specification for a suite of high level communication protocols which is targeted at radio-frequency applications that require a low data rate, long battery life, and secure networking. This project is using the Cirronet ZMN2405HP Zigbee module as the wireless sensor data transmittion. It is using the CC2430 transceiver IC from Texas Instrument.

The control for this system is about how much high or low the level of the water at two different partitions. Water level sensor is connected to the dc motor to control the opening and closing of the gate to add or remove the water in purpose to controlling the suitable water level for the system. At the same time, the sensor output is connected directly to the Zigbee as end device to transmit the data wirelessly to another Zigbee device at the control point. The zigbee at the control point which is connected to the computer will display the data that received from end device using Graphical User Interface(GUI). So, for every changing of the water level when it reaches at the limit point for example the maximum level at the reservation zone, it will start the motor at the outlet to open the gate. The same movement and motor feedback will be display and records at the graphical user interface

1.1 Problem Statement

Normally the water reservation system is manually control by human base on the observation of the water level. The data of water level is collect manually either no data is collected. Although the latest SCADA technology which applies to certain water

reservation is the compatible control program, this project is propose to build a simple wireless SCADA but simple and cheap control system besides offer the wireless application using the wireless sensor network.

The other reason is wired control system SCADA needs more maintenance service and more complex. Of course wired system is more expensive to install wiring and demand more time and cost for maintenance.

Flood is common problem at the zone around the water reservation. Nevertheless, at the watering zone always faced the lack of water supply during the drought season. Hopes by using the automatic control, this problem can be solved. The manual systems need the full experience person in charge to control the gate opening and closing because every earliest or late action taken will cause the large damage in critical cases. With this control system, the water reservation controlling is easier and more accurate.

1.2 Project Objective

Nowadays, some of the jobs or tasks need us to control from miles away. Everything wireless is relatively very practical in such fast moving world. The less wire is the better. We can see people always like to use the remote control in every task in the day life. Due to the problem have state before, the objectives of this project are:

1) To design and create a system using the application of wireless sensor network based on zigbee standard.
2) To detect the water level at reservation and watering zone and sent the data to the control system using wireless sensor network.
3) To design the appropriate Graphical User Interface (GUI) to work with the wireless control system.
4) To show and keep the data of the current water level and the situation at the water gate in real time.

5) To allow the users to control the opening and closing the gate base on monitoring data and the system work by automatically.
6) To prevent the zone around the water reservation from flood and control the watering system from drought season.

Other than the objective state above, this project is proposed for the purpose to improving classification problem. Although there are some existed automation system nowadays, this project is proposed to apply for the water reservation system for agriculture activities such as KADA‟s water reservation which is still operated manually. It is suitable for simple control system with small installations budget and of course not suit for hydro electric system. The system control also can be varied for each system by a simple modification on the program easily.

1.3 Scope

This project will use wireless Zigbee standard based to transmit and receive the signal. The reason why zigbee is choosing for data transmission will be discuss in next chapter. The zigbee technology was applied with sensor and software to provide fully automatic control system with display monitoring and data collection. Several step to realize this project is;

1. Build Graphical User Interface (GUI) using Visual Basic software for real time monitoring and data collection purpose.
2. Using at least two water level sensors to control the motor and give the input the data to the system.
3. Integration of sensor system to the zigbee module and connection to the user interface.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The purpose of this chapter is to review introduce the wireless sensor network which is this project will focus on the application. Wireless system nowadays really practical as the fully connected networks suffer from problems of NP-complexity as additional nodes are added, the number of links increases exponentially. Therefore, for large networks, the routing problem is computationally intractable even with the availability of large amounts of computing power.

The next evolutionary development step in building, utilities, industrial, home, and transportation systems automation represent the smart environments. The sensory data comes from multiple sensors of different modalities in distributed locations. The challenges in the hierarchy of detecting the relevant quantities, monitoring and collecting the data, assessing and evaluating the information, formulating meaningful user displays, and performing decision-making and alarm functions are enormous. The information needed is provided by Wireless Sensor Networks, which are responsible for sensing as well as for the first stages of the processing hierarchy.

2.1 Wireless Sensor Network

A wireless sensor network is a collection of nodes organized into a cooperative network. Each node consists of processing capability may contain multiple types of memory, have a RF transceiver, have a power source, and accommodate various sensors

and actuators. The nodes communicate wirelessly and often self-organize after being deployed in an ad hoc fashion.

A Wireless Sensor Network (WSN) consists of base stations and a number of wireless sensors. Systems of 1000s or even 10,000 nodes are anticipated. 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. The envisaged size of a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust, although functioning 'motes' of genuine microscopic dimensions have yet to be created. The unique characteristics of a WSN include:

a) Limited power they can harvest or store
b) Ability to withstand harsh environmental conditions
c) Ability to cope with node failures
d) Mobility of nodes
e) Dynamic network topology
f) Communication failures
g) Heterogeneity of nodes
h) Large scale of deployment
i) Unattended operation

2.1.1 Existing topology in WSN

A wireless sensor network is composed of nodes, each of which has computing power and can transmit and receive messages over communication links, wireless or cabled. The basic network topologies are shown in the figure and include fully connected, mesh, star, ring, tree, bus. A single network may consist of several interconnected subnets of different topologies. Networks are further classified as Local Area Networks (LAN), e.g. inside one building, or Wide Area Networks (WAN), e.g. between buildings.

Mesh networks are regularly distributed networks that generally allow transmission only to a node‟s nearest neighbors. The nodes in these networks are generally identical, so that mesh nets are also referred to as peer-to-peer (see below) nets. Mesh nets can be good models for large-scale networks of wireless sensors that are distributed over a geographic region, e.g. personnel or vehicle security surveillance systems. Note that the regular structure reflects the communications topology; the actual geographic distribution of the nodes need not be a regular mesh.

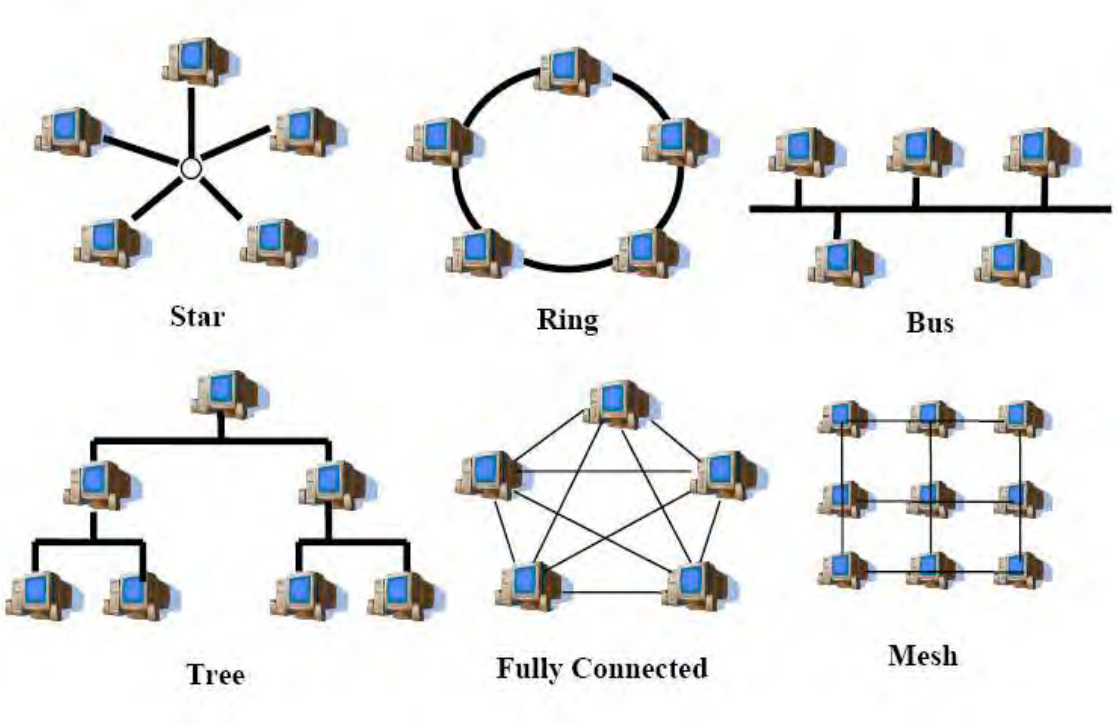


Figure 2.1 Basic Network Topologies

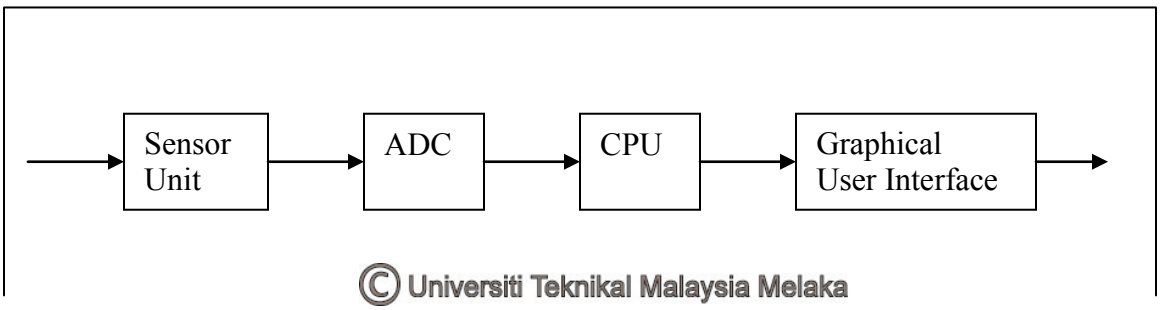
Since there are generally multiple routing paths between nodes, these nets are robust to failure of individual nodes or links. An advantage of mesh nets is that, although all nodes may be identical and have the same computing and transmission capabilities, certain nodes can be designated as „group leaders‟ that take on additional functions. If a group leader is disabled, another node can then take over these duties.

All nodes of the star topology are connected to a single hub node. The hub requires greater message handling, routing, and decision-making capabilities than the other nodes. If a communication link is cut, it only affects one node. However, if the hub is incapacitated the network is destroyed. In the ring topology all nodes perform the same function and there is no leader node. Messages generally travel around the ring in a single direction.

2.1.2 Sensor Node

A sensor node is a node in a wireless sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network.

A sensor is hardware devices that produce measurable response to a change in a physical condition like temperature and pressure. Sensors function is to sense or measure physical data of the area to be monitored. The continual analog signal sensed by the sensors is digitized by an Analog-to-digital converter and sent to controllers for further processing. The characteristics and requirements of sensor node is should be in small size, consume extremely low energy, operate in high volumetric densities, should be autonomous and operate unattended, and be adaptive to the environment. As wireless sensor nodes are micro-electronic sensor device, can only be equipped with a limited power source of less than 0.5 Ah and 1.2 V.



Real World To User

Figure 2.2 Components of WSN

2.2 Zigbee

ZigBee is a worldwide open standard for wireless radio networks in the monitoring and control fields. The standard was developed by the ZigBee Alliance (an association of international companies) to meet the following principal needs:

a) low cost
b) ultra-low power consumption
c) use of unlicensed radio bands
d) cheap and easy installation
e) flexible and extendable networks
f) integrated intelligence for network set-up and message routing

Some of the above requirements are related - for example, the need for extremely low power consumption is motivated by the use of battery-powered nodes which can be installed cheaply and easily, without any power cabling, in difficult locations. Some of the application areas that benefit from this type of network are described below.

2.2.1 Typical Application Areas

Application areas that are suitable for ZigBee networks are likely to have the following characteristics or requirements:

a) low data rates (less than 250kbps)
b) nodes which are idle (not transmitting/receiving) for long periods
c) node locations where cables would be difficult or expensive to install
d) a need to modify the network (add, remove or move nodes) while in service

The following are typical application areas in which ZigBee provides a low-cost solution (this is not an exhaustive list):

a) Commercial

Building and Home Automation: Electronic control within a building or home can be implemented through wireless networks - example applications are HVAC (heating, ventilation and air-conditioning), lighting, curtains/blinds, doors, locks and home entertainment systems.

b) Security

Another important application within commercial buildings and the home is security – both intruder and fire detection.

c) Healthcare

This field employs sensors and diagnostic devices that can be networked by means of a wireless network. Applications include monitoring during healthcare programs such as fitness training, in addition to medical applications such as patient monitoring.

d) Vehicle Monitoring

Vehicles usually contain many sensors and diagnostic devices, and provide ideal applications for wireless networks. A prime example is the use of pressure sensors in tyres, which cannot be connected by cables.

e) Agriculture

Wireless networks can help farmers monitor land and environmental conditions in order to optimist their crop yields. Such networks may require wide geographical coverage, but ZigBee addresses this issue by offering network topologies that allow the relaying of messages from node to node across the network.

Zigbee stack layer is technological standard created by the ZigBee Alliance for control and sensor networks based on the IEEE 802.15.4 standard. It is part of wireless sensor (WSN) family. This standard was setup the lower layer; Physical and Media Access Control layers which is the hardware part. Together with IEEE standard there are organization Zigbee Alliance as the software brand management for Zigbee. Zigbee Alliance was setup the 3 upper layer; Network, Security, and Application layers. It using the global common band of 2405 - 2480MHz with 16 channels in 5MHz interval.

There is always one node that takes a coordinating role in a network. It should be the central node in a star topology and the top node in a tree or mesh topology. There must also be nodes with the role of relaying messages from one neighboring node to another.