IMAGE TRANSMISSION OVER WIRELESS SENSOR NETWORK

(TEST BED ANALYSIS)

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To my beloved mother and father……

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In the Name of ALLAH, the Most Gracious and the Most Merciful

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ABSTRACT

Image Transmission Over Wireless Sensor Network (WSN) is a constructive information gathering mechanism for an image transmission in certain situation. Essentially, this project will utilize a XBee's transceiver module with an IEEE 802.15.4 radio module standard for transferring an image to a specific location. The existing image transmission equipment that been used today is still bounded with a wired system and not portable. The implementation of this project will encounter the limitation of the wired and not portable system. The main purpose of the project is to study on the existing protocol in WSN, develop a prototype of the sensor node for image transmission process and do an analysis of the image transmission related to the occupied range and delay of the system. The scope covered by the project is starting from developing a sensor node camera that is outfitted with JPEG color camera and transmitter XBee, the receiving parties of the nodes which is a receiver XBee that been connected to monitoring PC with camera GUI as an interface. The result of the project shows that portable wireless image transmission device can be developed and the analysis on the image transmission sequence and delay can be studied and monitored.

ABSTRAK

Penghantaran Imej Melalui Rangkaian Pengesan Tanpa Wayar (WSN) adalah sangat berguna sebagai mekanisme perhimpunan untuk penghantaran imej dalam keadaan tertentu. Pada asasnya, projek ini akan menggunakan model penghantar dan penerima XBee dengan IEEE 802.15.4 sebagai standard radio untuk memindahkan imej ke lokasi tertentu. Peralatan penghantaran imej yang sedia ada yang telah digunakan pada hari ini masih terikat dengan sistem berwayar dan tidak mudah alih. Dengan pelaksanaan projek ini, ia akan mengatasi batasan sistem berwayar dan tidak mudah alih. Tujuan utama projek ini adalah untuk mengkaji tentang protokol sedia ada yang digunakan di dalam WSN, membangunkan prototaip nod pengesan untuk proses penghantaran imej dan melakukan analisa tentang penghantaran imej dalam sesuatu jarak kendalian dan kelewatan dalam penghantaran. Antara skop yang meliputi projek ini adalah bermula dari membangunkan nod pengesan yang dilengkapi kamera warna JPEG dan penghantar isyarat XBee, dan bahagian penerimaan penghantaran yang mana terdapat menerima isyarat XBee yang disambung terus ke computer dan menggunakan kamera GUI sebagai antaramuka. Hasil daripada pelaksanaan projek ini menunjukkan bahawa peranti mudah alih penghantaran imej boleh dibangunkan dan analisa pada urutan penghantaran imej dan kelewatan boleh dikaji dan dipantau.

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SPI   - Serial Peripheral Interface

UART   - Universal Asynchronous Receiver Transmitter

PCB   - Printed Circuit Board

WSN   - Wireless Sensor Network

ADC   - Analog-to-Digital Converter

RF   - Radio Frequency

USART   - Universal Synchronous Asynchronous Receiver Transmitter

JPEG   - Joint Photographic Experts Group

RAM   - Random Access Memory

VGA   - Video Graphic Array

API   - Application Programming Interfaces

PDU   - Protocol Data Unit

MAC   - Medium Access Control

FIFO   - First-In First-Out

CHAPTER 1

INTRODUCTION

1.1   Background

For a pass decade, wireless sensor network technology had been developed and implemented massively in various area. Many researched parties concentrated their attention in developing the technology for several purpose. The introduction of wireless sensor network in surveillances and information gathering method had make it an important technology to have [1].

A wireless sensor network (WSN) is a network that consist several amount of sensor that span a large geographical area. It can connect to each other to send data from one node to other node until the data reach the destination. At each of the nodes is equipped with devices to monitor, collect, process and transmit the data to a specified location [2]. It has become an important technology especially in environment monitoring, military application, disaster management and so on.

In a sensor node, there are many type of sensor node designed for a various application. In this project, the sensor node is designed with a built in camera. Since of

the availability of small size and low cost camera technology that can capture still image [2]. This project will concentrated on capturing an image from the camera module and transfer it from node to node until it reach to desire location and displayed at computer. It include the process of microcontroller collect the image from camera and process it before being sent to Zigbee module. The wireless module will transmit the process data to the network and the data will be displayed at the monitoring computer.

1.2   Problem Statement

In developing this platform, this project need to counter several problem. For a hardware, the first problem is about the microcontroller selection in order to meet the requirement for low power consumption and cost. Since batteries is used as a power supply, microcontroller that meet the requirement must be selected.

Next problem is about to choose the radio module that are in compliant with IEEE 802.14.5 standard. IEEE 802.15.4 compliant radio is widely used for WSN infrastructure because of its low cost, low power attributes [3]. The standard specifies that the maximum data rate that may be achieved is up to 250kB/s only [8]. Therefore, the data that need to be transmitted is usually small.

The selection module must be ease of use for communication process and have a reasonable price. For a software development part, the problem is in choosing the operating system and design the coding for the program. The software that used in displaying the received image at the computer must be choose.

As conclusion, to achieve image transmission over wireless network. Concern on bandwidth requirement, processing speed, power consumption efficiency, and latency must be analyze and considered.

1.3   Objective

The objectives of this study are:

i.   To design a prototype of the node for image transmission over WSN.
ii.   To study an existing image transmission protocol for WSN.
iii.   To analyze the performance of developed protocol

1.4   Scope of Project

This project will be divided in two part. The first part is in is in developing the software for the microcontroller. The program is designed to interface the wireless module and camera to microcontroller using Universal Asynchronous Receiver Transmitter (UART).

And the second part is in implement and integrate the developed protocol on sensor node for an analysis purpose.

Designing the program for microcontroller involve the uses of C programming. The program must be design to operate the microcontroller based on desire use. The microcontroller must interface with the camera, radio module and the display platform. For a displayed part, a graphical user interface (GUI) software is develop for interfacing process

1.5   Thesis Outline

This thesis comprises of several chapters.

i.   The first chapter briefly describe about background, problem statement, objectives and scope of the project.
ii.   The second chapter reviews the previous related research that had been conducted. This chapter stating the information which helps to develop the project

iii.   The third chapter is about hardware development. The chapter provides information about the components used to prepare the circuit of the sensor node and why such components are chosen for this project.

iv.   The forth chapter is about the development of the project and the analysis done for gathering the information from the testing process.

 v.   The last chapter is about the process of getting the result and discussion. The chapter provides with step involve in achieving the objective and the result from the testing progress.

CHAPTER 2

LITERATURE REVIEW

2.1   Wireless Sensor Network (WSN)

In wireless sensor network, it consists of large number of sensor nodes. Each of the nodes is set with sensoring device which will be used in specific application. For instant, the sensor device was a camera and it will use to receive the environmental data in visual. Another example is microphone is use for sound detection and thermometer is used for temperature changing detection.

Each of the sensor nodes is also paired with wireless module for a communication process to each other. The communication process between each nodes are done by establish the routing technique in the architecture so the data can be transmitted from the sensor nodes to the end node or monitoring point.

There are so many application of wireless sensor network in the world. As example, in military application, wireless sensor network is use for intelligence secure, surveillance and exploration [1]. In health monitoring, wireless sensor network is use for monitoring patient and assist the disable patience. For any commercialize application,

wireless sensor network is used for managing list, monitoring product quality and monitoring disaster areas. Figure 2.1 illustrate a wireless sensor network architecture.
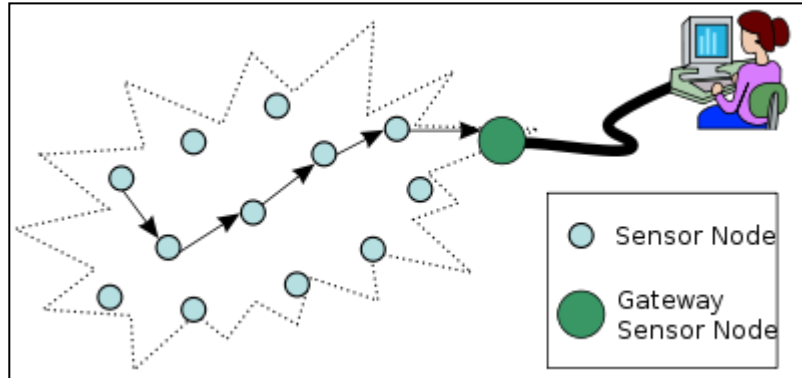
Figure 2.1 : Wireless Sensor Network Architecture

2.2   Sensor Node

Sensor nodes is the key part of wireless sensor network when they are distribute in the sensoring field while having the data that should be transfer. Sensor nodes are formed by some component that have particular function so that all nodes will function correctly. It has some functional components such as microcontroller, transceiver, sensors, external memory, analog to digital converter, and power source in the sensor nodes [3]. Figure 2.2 will shows the sensor node architecture.

Figure 2.2 : Architecture of Sensor Nodes

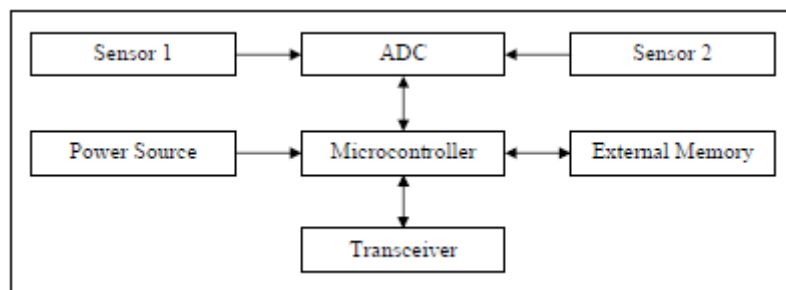The main function of the sensor nodes is for collecting sensory data and convert the sensory data to digital. Then it will process the data and communicate with the receiving parties and transmit the data that had been processed. Its main criteria must be a low cost, low power consumption and having a small size.

In any single sensor nodes, microcontroller will be the important part in sensor nodes. It functions by controlling other devices and interface, collect a data from device and send the data to other device, and lastly it will also processing the data. To connect with a different devices and for a low power consumption, the flexible system such a microcontroller is require. In other application, we need larger memory to store temporary data before it be sent to other place. That why the external memory is essential to use for additional storage. In the communication part, we are using a transceiver as a sensor nodes since it ability to transmit and receive data. The transceiver is use widely in other application via radio frequency (RF), infrared and optical laser. It is usually operate in four modes such as a transmitting mode, receiving modes, idle modes and sleep modes.

For retrieving an information data, sensoring devices is used since it will detect a a slight change in any information such as temperature, light, sound, vibration and electrical pressure. This sensoring devices used a low rate of data because of his bandwidth and power limit. Another important element in this sensoring nodes is a power supply. The power supply need for this nodes because it will help nodes operate correctly. For the supply at the sensoring nodes, the battery is use since it is portable and the nodes is using a low power usage.

2.3   Sensor Nodes Development

For the development of the sensor nodes, the using of JPEG color camera are suitable with a requirement of low cost, low power consumption and small size. The development of this essential camera has widen the ability of the sensor nodes in this application. But since the development of a good sensor nodes require a memory storage

for data storage. The process of development of the perfect sensor nodes is still in progress by other communities.

Therefore, the development of this sensor nodes are been doing massively by the developer at a certain places. At University of California, Los Angeles, they have developed a sensor nodes with a built in camera called eCAM, it is capable of receive a visual data instead of data that form of number and graphical image. It consists of C328-7640 camera module, Eco wireless sensor node and used 170mAh Li-Polymer battery as power supply. Eco wireless sensor node uses VLSI's nRF24E1, a 2.4 GHz RF transceiver with an embedded 8051-compatible MCU (DW8051) as its transceiver.

Other sensoring node with built in camera had been develop at Stanford University that is located in Palo Alto, California, it is called as WiSNAP. The sensor node have an Agilent's ADCM 1670 camera module with a maximum resolution of 352 x 288 pixels at 15 frames per seconds, and used Chipcon CC2420 as it transceiver. It been apply for occasion detection or node purpose. furthermore, another example of sensor node with built in camera that had been developed at University of California, Los Angeles (UCLA) is called Cyclops.

This kind of sensor node consists of Agilent's ADCM-1700 camera module, complex logic device (CLPD), external SRAM and FLASH while the microcontroller used is Atmega128L. Here is an example of the sensor node with larger memories which is called RISE. RISE stand for Riverside Sensor is equipped with external flash card memory that provides the sensor with several Megabytes of storage. The sensor node works with 24 MHz 8051 core processor which interfaces with SD Card memory through SPI bus. The RF transceiver used operates at low power with 10MB/sec read/write speed.

2.4 Flooding Routing Protocol

Flooding routing protocol is the one commonly routing protocols that been used in wireless network system. The concept is about the network that had a capability to

determine the destination of the packet data based on the packet examination. But, when the receive packet is not sending to destination, the packet will be broadcast again. The protocol also is design to always remember the packet that been receive so incase the packet is receive again and it will dropped suddenly .

The flooding routing protocol technique is, the nodes is broadcasting any single packets that been received. Then, when the network consist of a numbers of packet broadcasting by every nodes, The network traffic will be crowded and this need characteristic be acquire by nodes as mentioned above. The flooding routing protocol have several advantages.

The first one is, it is guarantee that the packet will be send to reach destination based on the protocol, all of potential route between source and destination will be try. And there shall be at least one pathway that connect the source and the destination. Then, since all route had been tried, there are probality to find a minimum hop route and shortest route that will be use in order to setup the near path.

And lastly, broadcast technique that been use will make sure that all the nodes are visit. It is a useful quality when it a case where important information is needs to be distribute to all nodes. The disadvantage of the techniques is that it is too extensive. The retransmission process that will be doing will certainly decrease the power source and shortened the network lifetime.

2.5 Hardware Design

Sensor nodes is the key part of wireless sensor network since they are spread in the sensor field while having a communication with each other for data transmission. The sensor nodes consist of some components that have some functions so that the nodes is able to work correctly. The main components use in the sensor nodes are transceiver, sensors, analog to digital converter, camera module and power source. Figure 2.3 shows the sensor node in block diagram while Figure 2.4 shows the sensor nodes connection.