PERFORMANCE ANALYSIS OF ZIGBEE BASED POINT TO POINT COMMUNICATION SYSTEM FOR LAND PUBLIC TRANSPORT

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Bachelor of Mechatronics Engineering

June 2012

I declare that this report entitle "Performance Analysis of Zigbee based Point to Point Communication System for Land Public Transport" is the result of 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.

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"I hereby declare that I have read through this report entitle "Performance Analysis of Zigbee based Point to Point Communication System for Land Public Transport" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronics with Honours"

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Date : 29 June 2012

PERFORMANCE ANALYSIS OF POINT TO POINT COMMUNICATION FOR LAND PUBLIC TRANSPORT VIA WIRELESS COMMUNICATION

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ABSTRACT

The bus schedule provided by Bus Company today is not accurate and this situation causes the passengers travel time management to be interrupted. The bus station also does not provide an easy to spot visual display that can show the incoming bus distance to the bus station. The objectives of the project are firstly to design a reliable point-to-point bus system, then to design a user friendly display for the passenger and to study the performance parameter of Zigbee wireless module for the project. The performance of using the Zigbee wireless module is tested which consists of the detection range, the data transfer rate and the data logging process. The detection range of the Zigbee wireless module is tested by setting up an experiment by testing and measuring the range of detection between transmitter and receiver. The maximum range of detection is identified in this procedure, in order to determine the maximum Zigbee transmitter range of detection. Hence, from the successfulness of the communication between the bus and the bus station, the display of the details about the bus journey to the bus station can be displayed to passengers. The bus schedule information is displayed in visual terms by designing a distance and time display for the bus schedule at the bus station. As conclusion this project is potentially aims to help in improving the quality of bus as a public transportation as well as to improve and help public transport user in scheduling their travel time management systematically.

ABSTRAK

Jadual bas yang disediakan oleh syarikat bas adalah tidak tepat dan boleh menyebabkan pengurusan masa perjalanan para penumpang bas akan terganggu. Stesen bas juga tidak menyediakan kemudahan kepada penumpang bas untuk melihat paparan visual yang boleh menunjukkan jarak antara bas ke stesen bas.Objektif utama projek ini adalah untuk mereka bentuk sistem komunikasi titik-ke-titik yang boleh dipercayai, kemudian mereka bentuk paparan pengguna yang mesra penumpang dan untuk mengkaji parameter prestasi modul tanpa wayar ZigBee untuk projek ini. Kajian prestasi menggunakan modul tanpa wayar ZigBee yang menggunakan ujian yang terdiri daripada ujian pengesanan jarak, kadar pemindahan data dan proses pendaftaran data. Julat pengesanan modul tanpa wayar ZigBee diuji dengan menjalankan prosedur ujikaji dimana jarak pengesanan antara pemancar dan penerima modul Zigbee di uji. Julat maksimum pengesanan perlu dikenal pasti dalam prosedur ini untuk menentukan jarak pengesanan maksimum pemancar Zigbee. Oleh itu, dari kejayaan komunikasi antara bas dan stesen bas, paparan butir-butir tentang perjalanan bas ke stesen bas boleh dipaparkan kepada penumpang Maklumat jadual bas dipaparkan dalam jangka visual dengan mereka bentuk paparan jarak dan masa untuk jadual bas di stesen bas. Sebagai kesimpulan, projek ini berpotensi untuk membantu dalam meningkatkan kualiti bas sebagai pengangkutan awam untuk memperbaiki dan juga membantu penumpang dalam pengurusan masa perjalanan mereka dengan lebih sistematik.

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LIST OF ABBREVIATIONS

m	-	Meter
B/s	-	Bite per second
Hz	-	Hertz
mA	-	mili Ampere
PIC	-	Peripheral Interface Controller
UWB	-	Ultra Wide Bandwidth
LOS	-	Line Of Sight
LCD	-	Liquid Crystal Display
USB	-	Universal Serial Bus
PVC	-	Polyvinyl Chloride

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Public transportation in nowadays era is one of the important medium of transportation for daily usage of citizens. Public transportations differentiate from each other according to their characteristics in term of size, capacity, speed and many more aspects. In this project, the type of public transportation is specified to public bus. Since it is used every day by many passengers to get from place to place, the efficiency of the bus travel is important in order for the passengers to reach their destination according to their plan. However, nowadays bus only have one-time planned bus schedule which has so many disadvantages for the passengers. The main problem in the classic style of bus time scheduling is that the schedule is not in real-time and is unreliable to help in time planning purpose for the passengers. This means that the bus schedule is not updated according to the bus travel time. By having this situation, the passengers who have planned their time travel earlier will have to face delay in their time planning due to the inaccurate bus travelling time.

Hence, in order to overcome and provide solution for this problem, this project which is Development of Point-to-point Communication for Land Public Transport via Wireless Communication, was initiated. This project aim is to provide a real time bus schedule for the bus passengers at each bus station. In order to ease the passengers with the details of the schedule, a display that show arriving time to the bus station and the distance from the bus to the bus station is installed at each bus station. In this project, ZIGBEE wireless protocol is used as the wireless communication device for the network.

For this project, the experimental are limited only to test the characteristics of Zigbee wireless module in order to obtain the performance of the point-to-point wireless communication of this system. The experimental setup of this project does not involve the usage of a real bus.

1.2 Problem Statement

In nowadays public bus system, the time schedule of public bus journey is set up without using the proper time management. The schedule usually is set up by the bus company and it is not constantly updated. This situation causes the bus system to be unreliable for the passenger in term of time management because the bus travel time is not following accordingly the bus schedule.

Other than that, the information about the bus schedule is not properly displayed at the bus station. Some bus station does not even have the schedule due to lost or physical damage on the schedule itself. This situation is causing the passenger to waste time looking for the schedule at the bus station.

1.3 Objectives

The main objectives of this project are:

- To design a reliable point-to-point communication system by using Zigbee Pro wireless module.
- To study the performance parameter of detection range for the Zigbee Pro wireless module.
- To design a visual display of the bus schedule at the bus station.

1.4 Scope

The scopes in this project define the limits and boundaries in the process of completing this research. These scopes include:

- Type of public transport for the project: bus (intra-city bus service)
- Wireless device compared in this project is short range wireless communication device (Bluetooth, Zigbee, Wi-Fi). We use them instead of long range communication device (GSM, GPS, 3G) due to the need in transmitting and receiving information from a point to another point with higher response time and accuracy. Common long range communication device is limited in capability and expensive; for example, GPS, it can only give away their coordinate. For GPS device gives information, there will be rise in the project budget. Thus, short wireless communication device is used for this project.
- Mobile processing and control unit for experiment: PIC microcontroller
- For Line Of Sight (LOS) test, only 1100 meter maximum distance can be covered from Zigbee Pro 1500 meter maximum range from data sheet. This is because the straight unobstructed line of sight environment for distance up to 1500 meter is unavailable.

CHAPTER 2

LITERATURE REVIEW

2.1 Point-to-point Wireless Communication

In this project, which is Point-to-Point Communication for Land Public Transport via Wireless Communication has not yet been done before and any journals that are specifically focusing on this topic are not available yet. Hence, for literature review part, it will be focusing on the explaining the comparison between types of possible wireless devices that can be used as the communication medium. About the information needed for the comparison purpose, journals on the correlated application of the shot listed wireless devices are obtained. The wireless devices that are considered in this project as the communication medium are Bluetooth, Zigbee and UWB.

These devices have one same characteristic which is they use mainly wireless communication as the data transferring medium. The usage of wireless communication is more advantageous to this project compared to wired communication. Table 2.1shows the comparisons between the wired and wireless communication.

Table 2.1: Comparison of Wireless and Wired Communication [4]

Wireless Communication	Wired Communication
No need for physical communication medium	Need physical communication medium which is cable
No problem in extending the detection range of the signal	Need to change cables length if need to change connection distance
Reduce cost from buying cables	Need extra cost for cables purchasing
Not affected by environment condition	Get affected by environment condition
Less affected by noise produce from surrounding machinery	Easily affected by noise produce from surrounding machinery
Changeable data transfer rate	Data transfer rate is according to the material of the wires.
Possible for mobile applications	Not suitable for mobile application

Point-to-point communication is one of the types of connection that can be established between the transmitter and the receiver of a communication process. The process occurred between the two nodes or endpoint where the signal from many transmitters and receivers are situated in different places. This type of connection depends on the coverage or detection range of the module in certain area of the communication process. If the coverage area of the transmission module is wide and huge, the smoothness of the data transmission is becoming more efficient and the data received at the receiver has less losses. Example application of point-to-point communication is the mobile phone. In telephone call application, there are two mobile phones that are connected to each other and the caller voice can be heard by another mobile phone user in the other area [9].

In contrast of point-to-point communication, there is point-to-multipoint communication or also known as broadcasting communication topology. In this mode, the transmitter in one node has the capability to transmit the data to multiple amounts of receivers in other nodes. Examples of broadcasting are radio and television. Table 2.2 shows the main comparison between point-to-point communication and point-to-multipoint communication.

Table 2.2: Comparison between point-to-point and point-to-multipoint communication

Point-To-Point Communication	Point-to-multipoint communication
Communication between a transmitter to an end device simultaneously.	Communication between a transmitter and multiple end devices simultaneously.
Data transmission is limited between two devices.	Data transmission to any devices that are connected to the transmitter.

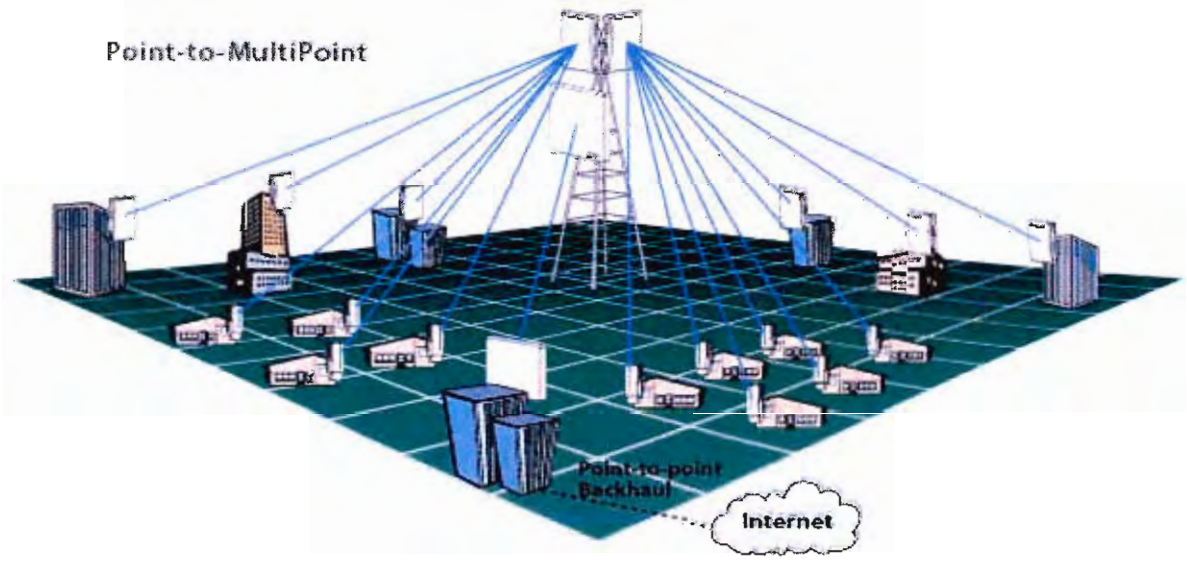

Figure 2.1: Point-to-Multipoint Communication [10]

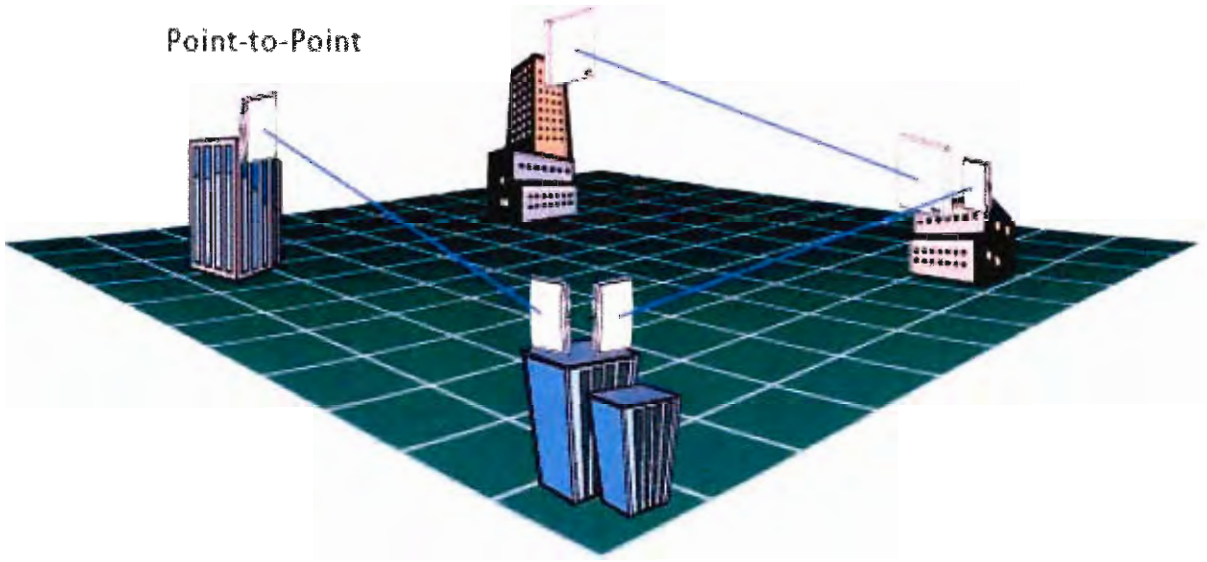

Figure 1.2: Point-to-Point Communication [11]

2.2 Specifications Comparison for Short Range Wireless Devices Performance

For the comparison of performance parameter between each of the wireless device, there are four specifications that are related to the research that can be considered in the process of choosing the appropriate wireless device. Every specification is taken into consideration and the final choice of the device is made based on the most usable and suitable for the project application. The four requirements considered in choosing the wireless device are detection range parameter, data transfer rate, power consumption and number of connections for each device. The shortlisted wireless devices are Bluetooth, UWB and Zigbee module.

2.2.1 Detection Range Parameter

The detection range of the device in this project defines the farthest connection that can be made between the transmitter and the receiver. Long connection distance of detection between the devices can allow the data transferring process to be done earlier. The need of early data transferring process is beneficial in this project since the information of the arriving bus can be determined earlier and this situation can allow the passengers to use this information for their journey planning earlier. Hence, for the detection range parameter, each module has its own unique maximum operating detection range. For both Bluetooth and UWB wireless devices, the maximum detection range that can be covered is up to 10 meter and while for Zigbee wireless device, the maximum detection range that it can be covered is up to 100 meter [4]. For this project, it can be stated that Zigbee wireless module is suitable to act as the communication medium since it has the highest detection range radius.

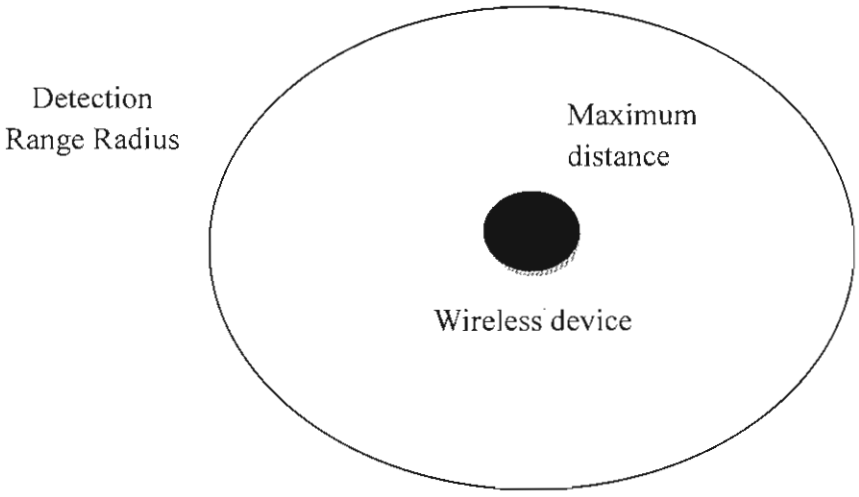

Figure 2.3: The detection range radius view for the wireless device

2.2.2 Data Transfer Rate

For this project, the capability of the device to transmit and receive data is also based on the data transferring rate among them. The amount of data that can be transferred is important since every application need different data values to be conveyed. Hence, by relating to this project, the data transferring needed is medium since the data transmitted is only consisting of character and integer. The data amount is also based on the processing unit used since the capability data processing of different processor is limited. The usage of PIC microcontroller in this project only allows the data to be processed limited only to 368 x 8 bytes of Data Memory (RAM) [5]. For the wireless devices, Bluetooth device can transmit 1 MB/s data [1], UWB can transmit over 110 MB/s data [3] and Zigbee device can transmit 250 kB/s data [2]. Hence, the suitable device for this project is Zigbee wireless device where it has medium data transfer rates compared to other two devices that have high data transfer rate. The Zigbee device is more preferable since it has less waste of data transmission usage compared to other two devices.

2.2.3 Power Consumption

Power consumption of a device is important in order to maintain the functionality of the device at the optimum level. Lower power consumption of a device is better for the project since the public bus and bus station need to make continuous connection attempt. This process is an important part of the system and low power consumption of the device can allow the functionality to maintain at optimum level until the system is shut down. In cost perspective, by having low power consumption device, the power source such as batteries do not need to be changed regularly and the cost of replacing the batteries can be reduced.