WIRELESS REMOTE CONTROL UTILIZING XBEE FOR MOBILE ROBOT APPLICATION

JARIPAH BINTI ADZHAR

This Report Is Submitted In Partial Fulfillment of Requirements For
The Bachelor Degree in Electronic Engineering (Computer Engineering)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

June 2014

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	**WIRELESS REMOTE CONTROL BY UTILIZING XBEE FOR MOBILE ROBOT APPLICATION**
Sesi Pengajian	:	1 3 / 1 4

Saya **JARIPAH BINTI ADZHAR** mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐	**SULIT***	*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD****	**(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	**TIDAK TERHAD**	

Disahkan oleh:

_____ (TANDATANGAN PENULIS)

_____ (COP DAN TANDATANGAN PENYELIA)

Tarikh: ……..

Tarikh: ……..

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya telah saya jelaskan sumbernya."

Tandatangan : ……..

Nama Penulis : JARIPAH BINTI ADZHAR

Tarikh : 6 JUNE 2014

"Saya/kami akui bahawa saya telah membaca karya ini pada pandangan saya/kami karya ini adalah memadai dari skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Elektronik (Elektronik Komputer)."

Tandatangan : ……...

Nama Penyelia : PUAN NUR FATIHAH BINTI AZMI

Tarikh : 6 JUNE 2013

To my beloved parents and siblings

Adzhar abdul

Anang Abdulmoin

Mardianah

Fatma

Shylyna

Siti khadija

Armina

Raisya

ACKNOWLEDGEMENT

Praise to Allah S.W.T that with His blessings I‟m able to finish this project in time successfully. I would like to express my greatest gratitude to my supervisor Miss Siti Aisyah Binti Anas her guidance in finishing this project. My next deepest appreciation is dedicated to my parents and family for their money and moral support. Thanks to my friend who had helped me a lot in finishing this project. Last but not least to whom directly or indirectly contribute to this project.

ABSTRACT

A wireless remote control is needed to control a robot from a certain range. This project intend to design a wireless remote control to control mobile robot by using XBee as the transmission medium and to design the communication protocol between the microcontroller of the transmitter and receiver. The existing wireless remote control was having problem with the reliability and the communication protocol between the microcontroller of the transmitter and receiver. Therefore to overcome the problem, a reliable wireless transmission medium has to be used and the new communication protocol to suit the functions of the mobile robot has to be developed. The designing process includes the designing of the circuit using the Proteus Software. The configuration of the XBee was done by using the XCTU software provided by the DiGi. MPLAB was used to create the communication protocol as required. Finally, a complete wireless remote control has been successfully developed with the new communication protocol. All the objectives have been successfully achieved.

ABSTRAK

Alat kawalan jauh tanpa wayar diperlukan untuk mengawal sesebuah robot daripada jarak tertentu. Tujuan projek ini adalah unuk menghasilkan alat kawalan jauh tanpa wayar untuk mengawal sesebuha robot menggunakan XBee sebagai alat untuk menyediakan medium penghantaran isyarat dan menghasilkan protocol komunikasi antara dua "microcontroller". Alat kawalan jauh yang sedia ada menghadapi masalah berkaitan dengan kebolehpercayaan dan protocol komunikasi antara dua "microcontroller". Oleh itu sebagai jalan penyelesaian, medium penghantaran tanpa wayar yang "reliable" perlu digunakan dan protokol komunikasi yang baru harus direka untuk disesuaikan dengan fungsi robot mudah alih telah dihasilkan. Proses merekabentuk termasuk merekabentuk litar dengan menggunakan Perisian Proteus. Konfigurasi XBee dilakukan dengan menggunakan perisian XCTU yang disediakan oleh DiGi. MPLAB telah digunakan untuk mencipta protokol komunikasi seperti yang dikehendaki. Akhirnya, alat kawalan jauh tanpa wayar yang lengkap siap telah berjaya dihasilkan begitu juga dengan protokol komunikasi baru. Semua objektif telah berjaya dicapai.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Chapter 1 covers the introduction part of this Final Year Project of Degree. It contains subchapters of objectives, problem statements, scopes of project and methodology.

1.1 Introduction of Project

With the development of science and technology, rapid development of robotic has been increasing from year to year. According to Robotic Institute of America (RIA), a robot is a re-programmable, multi-functional manipulator (or device) designed to move materials, parts, tools or specialized devices through variable programmed motion of a variety task whereas s mobile robot is an automatic machine that is capable of movement in any given environment. Mobile robots have the capability to move around in their environment and are not fixed to one physical location and it can be found in industry, military and also in university that do research on it.

There are many types of mobile robot navigation and this report will just focusing on Manual remote or tele-operated. According to Consortium on Cognitive Science Instruction (CCSI), teleoperated robots are controlled remotely by a human being. Controlling mobile robots through teleoperation is a challenging task that demands a flexible and efficient user interface as well as a reliable connection.

Teleoperation requires a user interface to translate operator commands to the robot and provide feedback from the robot to the operator [2].

Controller is a device that is used to control devices from certain ranges. The remote control signals can be sent through wired or wirelessly. A There is no doubt that wired controller provide a more reliable connection and much faster compared to wireless controller but somehow it is not practical for some application especially for mobile robot application. The limitations are due to the distance constraints and the wired might get snagged or cut. Wireless controller has longer distance coverage depending on the device specifications that being used but there is a potential that the transmission speeds can suffer from outside interference. Wireless connection is also more expensive compared to wired connection.

The limitations of the existing wireless connection such as cost and power consumption can be improved by using Xbee. An Xbee module is based on 802.15.4 and operates at 2.4GHz frequency with maximum data rate of 250kbps [xbee module]. Each XBee radio (for example Series 2) has the capability to directly gather sensor data and transmit them without the use of an external micro-controller [4]. This means, the XBee offers some simple output functions so that basic actuations can also take place without an external micro-controller being present. There are a few types of XBee and this project utilizes XBee Pro Series 1 that allows coordinator, routers or end devices to communicate with the coordinator by default. This makes point to point communication easy. Serial data is sent to the XBee router (or end device) connected to the PIC and received by coordinato

1.2 Objectives of Project

The main objective of this study is to develop a wireless remote control utilizing Xbee for mobile robot application. This objective is supported by the following sub objectives:

1) To develop a wireless remote control system by using Xbee.
2) To design the communication protocol between the PIC (Transmitter) and the PIC (Receiver).

1.3 Problem Statements

A wireless remote controller nowadays is more preferable compared to wired controller. This is due to the fact that wired controllers are not practical for some application especially for mobile robot application. However, the wireless signal of the existing wireless connection has distance constraints and the signals are easy to be interfered making the signal is less reliable. The communication protocol also needs to be modified to meet the new designed function of the controller.

1.4 Scope of Project

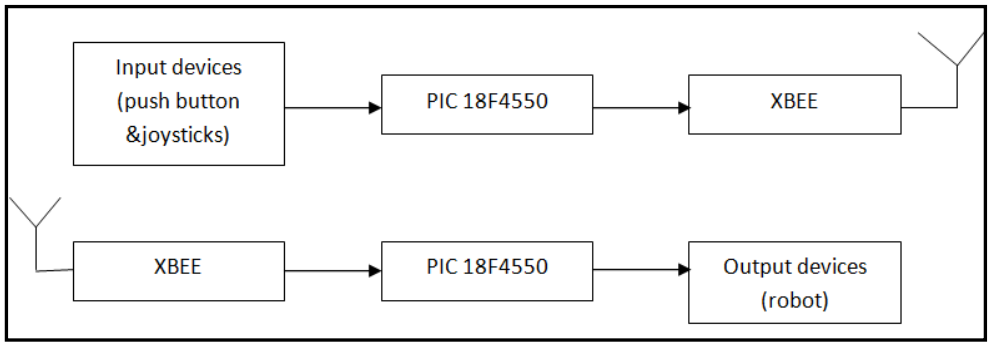

Figure 1.1 Block diagram for the whole system

The wireless remote control for mobile robot application uses Xbee Pro series 1 that can covers range up to 750m for outdoor line-of-sight. The frequency band is 2.4 GHz. This is very suitable for outdoor usage as it can provide a reliable

connection. Figure 1.1 shows how the setup of the controller is done. It is divided into two parts, transmitter and receiver.

PIC that will be used is PIC18F4550. MP Lab Programming will be used to create the communication protocol between the microcontroller of the receiver and transmitter. The input devices will be push button and joystick.

1.4.1 Software design

MP Lab Programming will be used to create the communication protocol between the microcontroller of the transmitter and receiver. The assignation of the parameter will be referring to the ASCII code table.

1.4.2 Target User

Target user is for a group that needs a wireless controller to control a mobile robot. It can practically be used for Robot Competition that requires a reliable wireless controller.

1.5 Project Significance

This wireless controller provides a reliable yet cheaper compared to the other wireless controller in the market. This controller allows user not to worry about the loss of signal and the distance range that can be supported by the controller. Notice that this controller can support up to 750 meters line of sight with 2.4 GHz frequency.

The network connection can be locked to prevent any unauthorized users controlling the robot. Besides that, the network is not limited to point-to-point communication, it can also be set up create a multiple network connections.

In addition, it eliminates nest of wires to connect mobile robot with the controller itself. The chances of the wired being snagged or cut is also eliminated.

1.6 Report Structure

The report consists of five chapters. Chapter 1 discusses the introduction of the project which includes the objectives of the project, problem statements; scope of the project, project significance and report structure.

Chapter 2 discuss about the Literature review. This chapter included literature review on Q2 and Q4 controller by Quantum Robotic, SKPS by Cytron Technology and lastly is about 4PLS Controller by Futaba.

The next chapter, chapter 3 discusses about Project Methodology of the project. The methodology involved system analysis, system design, system development and system testing.

Then, chapter 4 discusses about Result and Discussion of the project. It is about result full decision after the completion of this project.

The final chapter is chapter 5 that explains about conclusion and recommendation for future work related to this project

CHAPTER II

LITERATURE REVIEW

This chapter presents an overview on the related topic and the background related to this study. This chapter covers three controllers literature review.

2.1 Q2 and Q4 controller

A controller is not just use in playing games but it is become even more useful as controller today‟s are being used to control particular robot. A wired controller does exist but it is not practical in controlling a distance robot. Thus, a wireless with a reliable connection is needed.

There was a need to purchase XBee based controller similar to a PS2/PS3 controller, but with more options. With nothing available on the market, a project was started and several prototypes later the Q4 was developed as shown in Figure 2.1. It was taken one step further, with some minor changes to the case; the Q2 was developed as well.

Figure 2.1 Q4 controller

According to the Quantum Robotics crew, there is not much difference between these two controllers only that Q4 is using four analog joystick gambles whereas Q2 is using two RC gambles. Quantum Roboticas came out with Q2 and Q4 based on their needs to control many parts of the robot and the available controller in the market does not provide that type of controller.

Both of the controllers have 10 push buttons, 6 switch toggle controls and 4 (10K Ohm Linear) Potentiometer Dial Controls to meet up their requirements. The Q4 and Q2 are a line of controllers based on a Parallax Propeller as the main processor and a XBee for transmitting data. The Propeller is a multi-core microcontroller that excels at parallel processing. It contains eight processors, or cores, (called cogs) which can operate simultaneously.

The XBee and XBee-PRO RF Modules were engineered to meet IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other. Figure 2.2 shows the Xbee Pro module. Using XBee Pro Series 1 allows coordinator, routers or end devices to communicate with the coordinator by default. This makes point to point communication easy. Serial data is sent to the XBee router (or end device) connected to the PIC and received by coordinator.

Figure 2.2 Xbee Pro

The differences and similarities of Q4 and Q2 are summarize in Table 2.1.

Table 2.1 Q2 and Q4 differences

Features	Q4 controller	Q2 controller
Number of channels	32 Channels	24 Channels
Input device	4 Gimbals Joysticks (Horizontal, Vertical, & Push-button control)	2 RC Gimbals (Horizontal & Vertical control)
Number of potentiometer	4 (10K Ohm Linear) Potentiometer Dial Controls	
Number of push buttons	10 Push-buttons	
Number of Toggle Switch Control	6 Toggle Switch Controls	
Switch	1 Power On/Off Toggle	
Micro SD Card slot	Micro SD Card Slot	
LCD	2x20 Serial LCD	
Power requirements	Power requirements: 6-9 VDC (2S 500mAh Lipo or 9V battery)	

It is undeniable that this controller has its own advantages compared to the other controllers available in the market. The best controller comes with the best price. This controller is more expensive than others along with its advanced functionality.

2.2 SKPS (PS2 Controller Starter Kit)

Play station 2 offers a good human manual input for control system and can be obtained from any play store easily. The issue is problem will be arose if the controller applied to control particular system. The major problem is a new protocol to connect with PS2 socket is needed as PS2 socket is very unique and difficult to obtain [7]. Therefore, Cytron Technologies has designed PS2 Controller Starter Kit called SKPS to overcome this problem. Figure 2.3 shows the PS2 controller with its receiver and SKPS to control a mobile robot.

Figure 2.3 PS2 controller with SKPS and receiver

SKPS has low current consumptions, less than 150mA [6]. It communicates with host microcontroller through 5V TTL UART and need simple inquiry command and button status feedback for host to process. Wired and wireless is fully compatible with this device (SKPS) [6]. The SKPS system overview is as shown in Figure 2.4.

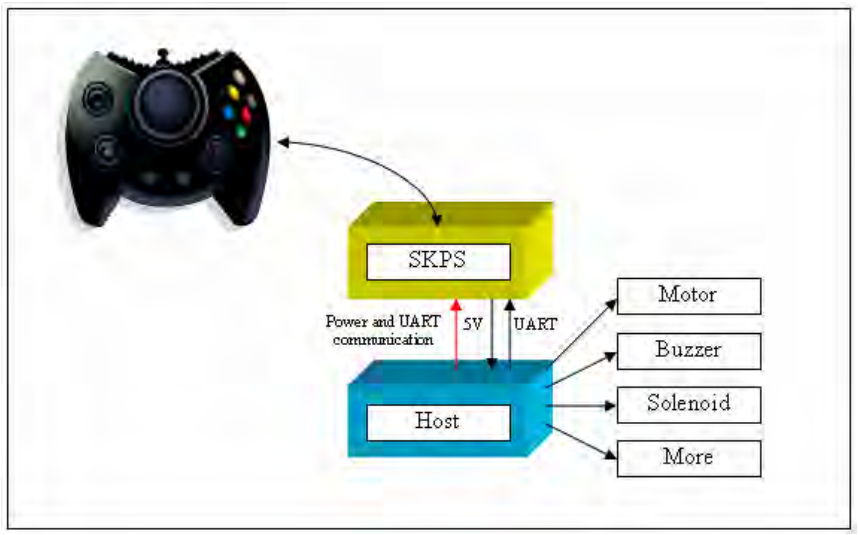

Figure 2.4 SKPS System Overview

Generally, there are two methods of using SKPS. It has been designed for interface to embedded system with 5V TTL (microcontroller) or connection to computer (normally for functionality test) [6].

Since SKPS is PS2 Controller Starter Kit, the transmission medium is through Bluetooth connection. Bluetooth is an open standard that enables communication among diverse with their peripherals [3]. According to Michigan State University, Bluetooth's discovery protocol lets devices automatically find and start interacting with each other. This unintentionally exposes access and data to unauthorized users, leaving users at risk for potential hijacking incidents and identity theft. This theory is supported by the George Mason University, Bluetooth technology is omni-directional, meaning that their signals cover all directions. When other devices are present in the same space, signals from Bluetooth can get distorted in the direction of its intended recipient.

Connection between a Bluetooth device and its recipient device is not perfect. If an object is placed between the devices, transmission could easily be cut off and signal loss might occur. This can cause the loss control of a particular system. There are many types of PS controller in the market and the sensitivity for each type also different. Therefore, Cytron Technologies does not guarantee compatibility for all PS2 controllers.

2.3 4-PLS Controller

Based upon the experience and know-how obtained from Aircraft transmitters, Futaba has designed a new telemetry transmitter 4PLS as shown on Figure 2.5. It has the newly developed telemetry system T-FHSS that is faster and more reliable. It allows the user to monitor receiver voltage and other important functions of a car in real time by optional sensors as can be seen in Figure 2.5. Telemetry is formally defined as the use of telecommunications for automatically indicating or recording measurements at a distance from the measuring instrument. Telemetry is the highly automated communications process by which measurements are made and other data collected at remote or inaccessible points and transmitted to receiving equipment for monitoring [3]. The word is derived from Greek roots: tele = remote, and metron = measure. Telemetry has been used by weather balloons for transmitting meteorological data since 1920.

Figure 2.5 4PLS controller