THE DEVELOPMENT OF TRANSMITTER AND RECEIVER FOR REMOTE CONTROL HELICOPTER

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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THE DEVELOPMENT OF TRANSMITTER AND RECEIVER FOR REMOTE CONTROL HELICOPTER

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Robotics & Automation) (Hons.)

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I hereby, declared this report entitled "The Development of Transmitter and Receiver for Remote Control Helicopter" is the results of my own research except as cited in reference.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics & Automation) (Hons.).
The member of the supervisory is as follow:

……

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ABSTRAK

Tujuan projek ini adalah untuk membangunkan pemancar dan penerima untuk helikopter kawalan jauh. Pertama sekali, jenis helikopter yang telah digunakan adalah sebuah nitro helikopter kawalan jauh dengan nama jenamanya "KYOSHO", dan bahagian-bahagian kawalan untuk helikopter ini adalah terhad untuk 4 hingga 6 saluran. Dalam projek ini, jenis teknologi tanpa wayar yang telah dipilih ialah komunikasi frekuensi radio. Kemudian, proses pembangunan boleh dibahagikan kepada dua bahagian utama iaitu pembangunan litar dan pembangunan program. Pembangunan litar adalah sebahagian untuk menerangkan bagaimana litar pemancar dan penerima yang dibangunkan dengan menggunakan perisian Fritzing. Manakala bagi pembangunan program, ia adalah bahagian yang digunakan untuk menerangkan bagaimana pengaturcaraan untuk pemancar dan penerima yang dibangunkan dengan menggunakan perisian Arduino (IDE). Selain itu, carta aliran untuk semua pengaturcaraan juga telah dimasukkan untuk menerangkan bagaimana program ini berfungsi. Projek ini melibatkan dua bahagian pengujian, iaitu ujian pemasangan motor servo dan ujian jarak penghantaran data. Bagi ujian pemasangan motor servo, pergerakan untuk setiap motor servo telah diperhatikan supaya dapat diperiksa sama ada sambungannya adalah betul atau salah berdasarkan setiap saluran tertentu. Manakala bagi ujian jarak penghantaran data, pemancar dan penerima telah diuji untuk menentukan maksimum jarak penghantarannya. Berdasarkan keputusan yang diperolehi daripada ujian jarak penghantaran data, jarak maksimum untuk pemancar dan penerima buatan sendiri adalah sehingga 120 meter, manakala jarak penghantaran adalah hanya 80 meter untuk pemancar dan penerima yang sedia ada. Walau bagaimanapun, pemancar dan penerima yang sedia ada adalah lebih bagus kerana ia boleh digunakan untuk mengawal kapal terbang dan sistem helikopter. Akhir sekali, cadangan untuk kerja-kerja masa depan adalah dengan meningkatkan pemancar dan penerima buatan sendiri supaya dapat berfungsi sehingga 6 saluran, menstabilkan fungsi penghantaran data dengan menambah kapasitor, dan juga menstabilkan voltan bekalan dengan menambah pengatur voltan.

ABSTRACT

The aim of this project is to develop the transmitter and receiver for the remote control helicopter. Firstly, the type of helicopter that has been used is a nitro remote control helicopter with the brand name of "KYOSHO", and the control parts for this helicopter are limited for only 4 to 6 channels. In this project, the type of wireless technology that has been selected is the radio frequency communication. Then, the development process can be divided into two main parts which are the circuit development and the program development. The circuit development is a part used to explain on how the circuits for transmitter and receiver are developed by using the Fritzing software. While for the program development, it is a part used to explain on how the programming for the transmitter and receiver are developed by using the Arduino Software (IDE). Besides that, the flowcharts for all of the programming are also included to explain on how the program works. This project involves with two testing parts, which are the servo motors setup test and the data transmission range validation. For the servo motors setup test, the movement of each servo motor has been observed to check whether the connection is right or wrong based on each particular channel. While for the data transmission range validation, the transmitter and receiver has been tested to determine their maximum transmission range. Based on the results obtained from data transmission range validation, the maximum range was up to about 120 meters for the homemade transmitter and receiver, while the transmission range was only 80 meters for the existing transmitter and receiver. However, the existing transmitter and receiver are more sustainable since it can be used to control the airplane and the helicopter system. Lastly, the suggestions for the future works are to upgrade the homemade transmitter and receiver to function up to 6 channels, stabilize the function of data transmission by adding the bypass capacitor, and also stabilize the voltage supply by adding the voltage regulator.

DEDICATION

This report is dedicated to my lovely parents who always been there to support me, congratulate me, and show me always the best path to follow. Also, I sincerely grant my highest gratitude to my project supervisor, panels, technicians, and friends who always provide me with helpful guidance and direction for my project.

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LIST OF ABBREVIATIONS

AC	-	Alternative Current
BS	-	Base Station
CCW	-	Counter Clockwise
CMOS	-	Complementary Metal Oxide Semiconductor
CW	-	Clockwise
DC	-	Direct Current
DSSS	-	Direct-Sequence Spread-Spectrum
ELF	-	Extremely Low Frequency
FCC	-	Federal Communications Commission
FHSS	-	Frequency Hopping Spread Spectrum
FYP	-	Final Year Project
GND	-	Ground
ICSP	-	In-Circuit Serial Programming
IDE	-	Integrated Development Environment
IEEE	-	Institute of Electrical and Electronics Engineers
IF	-	Intermediate Frequency
IR	-	Infrared Radiation
ISM	-	Industrial, Scientific, and Medical
LED	-	Light Emitting Diode
LOS	-	Line-of-Sight
MAS	-	Multiple Address System
MAX	-	Maximum
MIN	-	Minimum
MS	-	Mobile Station
PWM	-	Pulse Width Modulation
RC	-	Remote Control
RF	-	Radio Frequency

RM	-	Ringgit Malaysia
Rx	-	Receiver
SPI	-	Serial Peripheral Interface
SPST	-	Single Pole Single Throw
TV	-	Television
Tx	-	Transmitter
UGV	-	Unmanned Guided Vehicle
U.S.	-	United States
USB	-	Universal Serial Bus
VLF	-	Very Low Frequency
Wi-Fi	-	Wireless Fidelity

LIST OF SYMBOLS

Hz	-	Hertz
kHz	-	Kilohertz
MHz	-	Megahertz
GHz	-	Gigahertz
Kbps	-	Kilobits Per Second
Mbps	-	Megabits Per Second
m	-	Meter
mm	-	Millimeter
mA	-	Milliampere
mAh	-	Milliampere Hour
mW	-	Milliwatt
μF	-	Microfarad
dB	-	Decibel
dBm	-	Decibel Milliwatts
V	-	Volts
Ω	-	Ohms
I	-	Current
R	-	Resistance

CHAPTER 1
INTRODUCTION

This chapter presents the background, problem statement, objectives, and scopes of the project.

1.1 Background of the Study

The remote control helicopter requires some devices use to control their movement and direction. In this case, the radio frequency transmitter and receiver are selected as the wireless communication devices use to send and receive the commands given by the humans. Thus, for the whole wireless communication devices, it contains two main parts which are the transmitter part and also the receiver part.

For the transmitter part, the device that will be included is a radio frequency transmitter. It is a device used to transmit the data through wirelessly, and it will be installed inside the remote controller. In order to transmit the data to the environment, the first thing to do is to switch on the remote controller. Then, the joystick needs to be moved so that the microcontroller will be able to read the analog input values from the joystick. Once the input from the joystick is received by the microcontroller, it will start to write the analog output values for radio. When there is a radio available, the electricity will start flowing into the antenna and it will make the electrons to vibrate so that the radio waves will be produced. Thus, the radio will begin to transmit the radio waves to the environment.

For the receiver part, the device that will be included is a radio frequency receiver. It is a device used to receive the data through wirelessly, and it will be installed inside the body of the helicopter. In order to receive the data from the environment, the radio will begin to listen whether there are some radio waves in the surrounding areas. Once the radio

is available, the receiver will start to receive the radio waves in which it will make the electrons to vibrate in the antenna so that the electric current will be produced. Thus, the analog input values from the radio will be received by the microcontroller, and then it will start to write the analog output values to control the movement and direction of the remote control helicopter.

From the above explanation, it is stated that the study of the wireless communication is very important for the remote control devices. The basic components such as the radio frequency transmitter and receiver are needed so that the remote control helicopter will be able to perform based on the desired motion. Figure 1.1 below shows the fundamental of radio waves transmission.

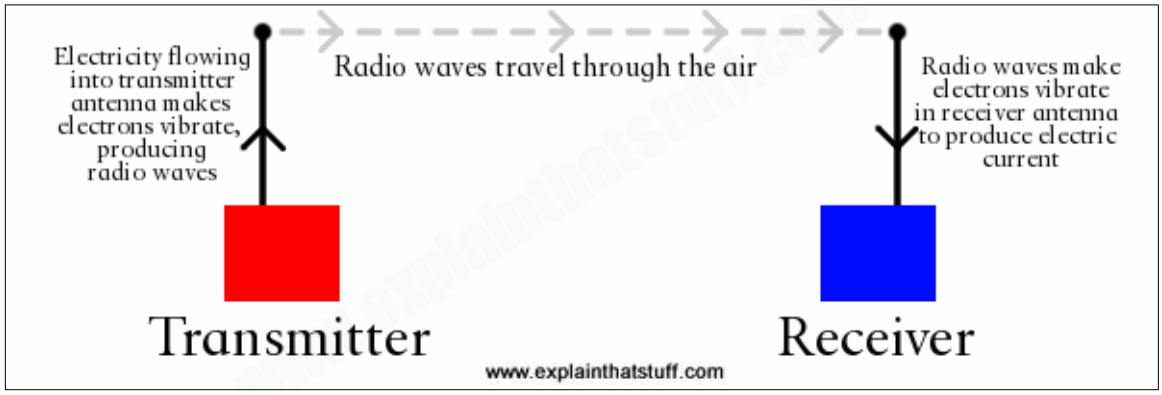

Figure 1.1: The fundamental of radio waves transmission
(Source: http://cdn4.explainthatstuff.com/transmitterandreceiver.png).

1.2 Problem Statement

It is not too difficult to make some devices that can send or receive the wireless data. In this 21th century, the wireless technologies have been widely used in order to control something such as the remote control helicopter. However, the remote control helicopter will not be able to function if it is without a transmitter and receiver. Thus, to overcome this problem, the main devices to include inside the remote controller and the body of the helicopter are the radio frequency transmitter and receiver. In order to make a transmitter and receiver, the important basic knowledge to explore is regarding to the wireless signal communication. The transmitter and receiver are the wireless communication devices in which the signal is transferred from one part to another so that

the remote control helicopter will be able to function based on the instructions sent by humans. Therefore, the radio frequency transmitter and receiver are the main devices needed in which it will be able to overcome the problems to monitor a remote control helicopter wirelessly.

1.3 Objectives

1. To develop the radio frequency transmitter and receiver for the nitro remote control helicopter.
2. To install the radio frequency transmitter and receiver on the remote controller and the body of the helicopter, respectively.
3. To validate the range of data transmission by using the homemade and the existing radio frequency transmitter and receiver.

1.4 Scopes

The radio frequency transmitter and receiver are developed to control a nitro remote control helicopter with the brand name of _KYOSHO‘. The control parts are limited for only 4 to 6 channels and the range of data transmission is limited for only 100 meters.

1.5 Summary

As a conclusion, the basic fundamental of radio waves transmission is needed in order to know on how a pair of transmitter and receiver works as a device to send and accept the signals wirelessly through the environment.

CHAPTER 2
LITERATURE REVIEW

This chapter presents the previous studies or researches done by the other people so that it will help to get some related information or data to apply in this project.

2.1 Fundamental of Wireless Communication

According to King (2014), the determination of a network‘s structure should focus on either licensed network or unlicensed network. The lower licensed network has the frequency ranges such as 100MHz, 200MHz, and 400MHz. While the upper licensed network has the frequency range of about 900MHz. Then, all of the lower licensed frequency ranges will be considered as MAS (Multiple Address Systems) networks. Once the distance coverage is determined, it requires a license acquisition from the FCC (Federal Communications Commission). It means that all of these lower frequencies are only for the proprietary use for the owner and the operating in these frequencies will be cited by the FCC. Then, the cost for a pair of licenses is about a few thousand dollars to tens thousand dollars. For the unlicensed network, the range of the frequencies is fall within 902MHz to 928MHz, which is considered as the ISM bands. The operating of these unlicensed frequencies does not need to cite by the FCC. However, there are rules for utilizing the frequencies of the ISM bands in which it has a built-in mechanism to carry out the frequency hopping across the frequency spectrum known as FHSS (Frequency Hopping Spread Spectrum).

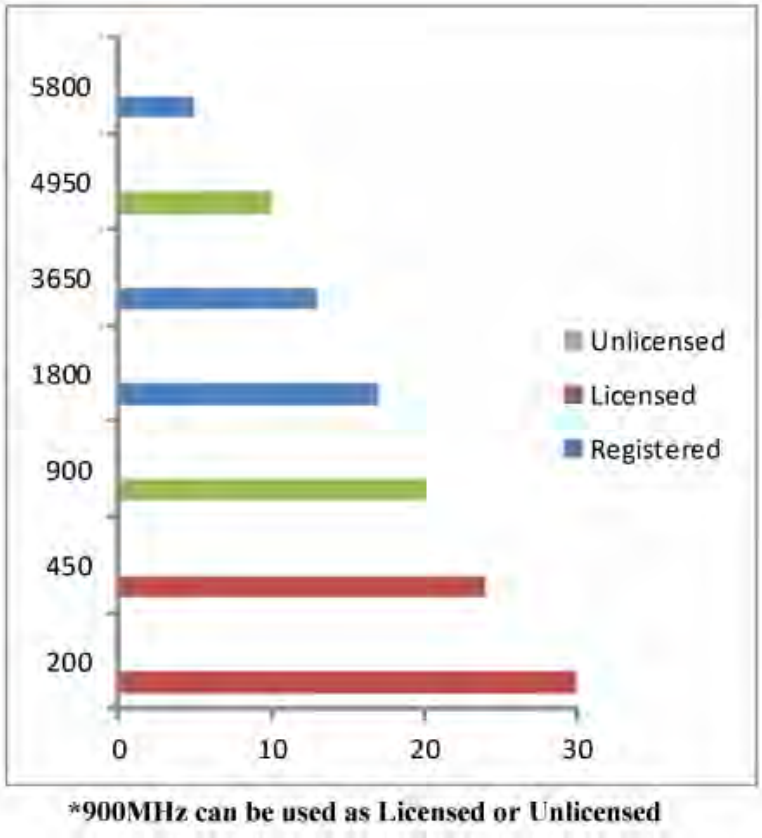

Figure 2.1: The distance coverage for frequency ranges (King, 2014).

According to Saputra and Mirdanies (2015), the wireless communication is a technology used to control the multiple patterns of movement on the Unmanned Guided Vehicle (UGV). Normally, the frequency that is used to work on the remote control device is about 2.4GHz. In the wireless system, the remote controller is used to direct the moving path of the omni-directional mobile robot. In order to drive a DC motor to move in clockwise or counter clockwise directions, the received six channel data from receiver module is converted by using the microcontroller into the 4 bits data.

Deng, Zhang, and Jiang (2012) proposed the short-range wireless communication technology in which the transmission are all work in the ISM band such as industrial, scientific and medical. In the Europe country, the common frequencies used in the ISM band are 27MHz, 315MHz, 433MHz, and 868MHz. While, the frequencies used in the U.S. country is a little bit higher than Europe, which are around 902-928MHz and 2.4GHz. For China, currently the frequencies used are still about 27MHz, 315MHz, 433MHz and 2.4GHz.

2.2 Radio Waves Propagation

According to Modi (2014), the radio waves propagation can be related with the phenomena in which it is happen in the medium between both transmitting antenna and receiving antenna. During the wireless signal transmission, the radio waves that radiated from the transmitter antenna are propagated into the environment in all directions. The amplitude of the radio waves will be decreased as the distance between both transmitter and receiver antennas are increased. The frequency of transmission that within the range of 3kHz to 300GHz is considered as a radio frequency because it is commonly used in the radio communication. The radio frequency spectrum can be divided into different frequency bands based on their particular range of frequency and wavelength. The fundamentals that allow the radio waves to work and spread through the environment are the same since 100 years ago.

Bowditch (2002) stated that a radio wave can be considered as a carrier wave in which it transferred the signal information from the transmitter part to the receiver part. Each radio wave has a particular frequency or band of frequencies which belongs to it. A mobile phone will not be able to work if the area without a radio tower. In order to connect the calling, the small amounts of radio waves that are emitted from the mobile phone will be sent to the radio tower. Then, these towers can only transfer the radio waves to a certain distance and they need to connect with each other so that the calling from one phone will be received by the other phone through the radio waves transmission. The radio waves also can be applied in the leisure activities such as radio controlled cars, helicopters, and airplanes. The radio waves work exactly in the same way because it propagation occurs in the medium between both transmitting antenna and receiving antenna. However, the low quality radio controlled vehicles will have the same frequency or band of frequencies so that they might be controlled by the other controller due to the interference.

Yousuf (2010) proposed that the very low frequency (VLF) radio waves have the frequency range of about 3 to 30kHz and it can pass through the sea water down to almost the depth of 20 meters. While the extremely low frequency (ELF) radio waves has the frequency range of about 3 to 3000Hz and it can pass through the sea water to the depth of almost hundreds feet. Thus, the quality of the transmission is all depend on the water conditions. This means that if the frequency used for a radio transmission is lower, the signal that is transferred to the ocean will be pass through deeper.