DESIGN, DEVELOPMENT AND TEST OF MICROSTRIP ANTENNA FOR SHORT RANGE COMMUNICATION

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FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Design and Development of Microstrip Patch Antenna for Short Range Communication

Sesi Pengajian : 2 1 6 1 7

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DEDICATION

Special dedication to my lovely parents, Basaruddin bin Taib and Nor Hashimah binti Hashim, my siblings, my kind hearted supervisors Dr. Noor Azwan Bin Shairi and Dr Imran bin Mohd Ibrahim, and lastly to all lecturers in Faculty of Electronic and Computer Engineering and to my dearest friend.

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I pray to Allah SWT may He bless all of you.

ABSTRACT

In microstrip patch of short range communication system, an antenna is very important part that used to enhance and strength the signals. However, in many cases of short range communication system, the gain of the designed antenna that used is quite low so that it results in low power and affect the target frequency to transmit and receive signal in well condition. This project aims to design an antenna that provides a gain so that the transmitted signal and the efficiency of radiating signal would be increased. A small microstrip patch antenna is designed in CST Studio Suite Software. Optimization in CST software for the microstrip antenna is done prior to fabrication process that is carried in the laboratory. Once the simulation and fabrication process are done, comparison of the antenna performance is carried, in terms of antenna parameters such as gain, return loss, bandwidth, efficiency and radiation pattern. The microstrip antenna is designed for short range communication device operating at frequency of 915MHz with return loss less than -10dB and producing gain of 5dB. The produced antenna can be up with short range device communication system that can be used during natural disaster. This project tends to cater the problem for the people to communicate during the natural disaster especially flooding dedicated for short range communication. This project will also focus on ways to communicate like texting or messaging during natural disaster directly without having to pass through the base station. This project will also develop antenna and provide coverage within short range radius.

ABSTRAK

Dalam mikrostrip patch sistem komunikasi jarak dekat, antenna adalah bahagian yang sangat penting yang digunakan untuk meningkatkan kekuatan isyarat. Walaubagaimanapun, dalam banyak kes sistem komunikasi jarak dekat, gandaan antenna yang direka dan yang digunakan adalah agak rendah supaya menghasilkan tenaga yang rendah dan menjejaskan kekerapan sasaran untuk menghantar dan menerima isyarat dalam keadaan baik. Projek ini bertujuan untuk mereka bentuk antenna yang menyediakan keuntungan yang baik supaya isyarat dan kecekapan terpancar isyarat yang dipancarkan akan meningkat. Antenna mikrostrip patch bersaiz kecil direka dalam perincian CST Studio Suite. Pengoptimum dalam perisian CST untuk antenna mikrostrip yang direka dilakukan sebelum proses fabrikasi yang dijalankan di makmal. Setelah proses simulasi dan fabrikasi selesai, perbandingan prestasi antenna itu dijalankan, dari segi parameter antenna seperti keuntungan, kehilangan pulangan kurang daripada -10dB, lebar jalur luas pada 915MHz dan keuntungan sebanyak 5dB. Antenna yang dihasilkan boleh datang dengan sistem komunikasi jarak dekat yang boleh digunakan ketika terjadinya bencana alam lebih-lebih lagi banjir untuk komunikasi jarak dekat. Projek ini dijalankan untuk mengatasi masalah masyarakat untuk berkomunikasi sesama sendiri ketika terjadinya bencana alam. Projek ini juga berfokus tentang kaedah untuk berkomunikasi seperti bermesej ketika bencana alam terus tanpa harus melalui stesen asas. Projek ini juga akan menghasilkan antenna yang menyediakan liputan jarak dekat.

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LIST OF ABBREVIATIONS

RFID	-	Radio Frequency Identification Device
UHF	-	Ultra-High Frequency
MWF	-	Microwave Frequency
CST (MWS)	-	Computer Simulation Technology (Microwave studio)
Γ	-	Reflection Coefficient
VSWR	-	Voltage Standing Wave Ratio
RL	-	Return Loss
dB	-	Decibels
RF	-	Radio Frequency
LF	-	Low Frequency
HF	-	High Frequency
ERP	-	Effective Radiated Power
dBi	-	Decibels relative to isotropic
WLAN	-	Wireless Local Area Network

CHAPTER I

INTRODUCTIONS

This chapter will discuss about the project background, objectives, scope of project, problem statement and project planning.

1.1 PROJECT BACKGROUND

A catastrophic event is a major adverse event resulting from natural processes of the earth; example floods, hurricane, tornadoes, volcanic eruptions, earthquakes, tsunamis and any other geologic processes.

A natural disaster can bring about death toll or property damage and regularly leaves some economic harm afterward, the seriousness of which relies on the influenced population's versatility or capacity to recoup and also on the infrastructure available.

A person who has been through a natural disaster will find out how difficult it is to establish communication immediately after. Usually power is down and landline communications are interrupted due to tower loss and other technical difficulties.

Christina Richards in her paper reported that a sudden and a wide scale breakdown or interruption of the communication infrastructure will be one of the most immediate impact during the flood and any natural disaster. The bad impact can be widely felt when the public communication fail. It also has the ability to wipe out access to standard mobile or landline telecommunications, in addition to internet and even satellite-based emergency communication devices [11].

Whether these systems are completely or just partially knocked off offline, communications systems during a natural disaster can be the difference between life or death for those affected. Locating those who may be trapped or injured becomes standard methods of communication [11].

Even though we live in an extremely technological era, an alternative communication system during disaster is an absolute necessity in such times. Rescue teams use their systems to get in touch with people who have been isolated.

B.S Manoj and Alexandra Hubenko said that a primary challenge in responding to both natural and man-made disasters are communications. A problem frequently cited by responders is the lack of radio interoperability [17].

Communications is very important in our-day-to-day life but it become crucial during and after disaster. People need to let their loved ones know that they are safe and that

all their family members are safe as well. Also there are situations when family members get separated.

Communications Infrastructure fails during a disaster will eventually cause physical damage to network devices and network congestion. Physical damage can create physical disturbance that can bring damage to the cities and communications equipment. If a cell tower is severely damaged, it will cause major disruptions in the area's wireless communication. When disaster strikes, the 'pipes' that make up our communications networks often become congested [11].

The main technological challenge after a disaster is rapid deployment of communication system for first respondent and disaster management. This concluded to be true regardless of when the communication network has been completely destroyed (power, telephone, and/or network connectivity infrastructure) [17].

The consequences of communications infrastructure failure are when they will prevent any emergency response, confusion and false information will be spread. When network connections are limited or unavailable, the effective coordination becomes further complicated, and the lack of command structure and create miscommunications and delays in action. On top of that, there can also be an imbalance in the volume of information flowing out of a disaster zone and the information going into it. Next, the result from the imbalance of communication channels also has the potential to create a great deal of confusion, which may widely lead to misinformation and panic situation [11].

1.1.1 Antenna

An antenna is defined “a usually metallic device for radiating or receiving radio waves.” In other word the antenna is the transitional structure between free-space and guiding device. The guiding device or transmission line may take the form of the coaxial line or a hollow pipe (waveguide), and it is used to transport electromagnetic energy from the transmitting source to the antenna, or from the antenna to the receiver. In former case, we have a transmitting antenna and in the latter a receiving antenna [18].

Figure 1 : Antenna

Antenna is one of the important elements in our daily life. Antenna is one of the radio frequency (RF) system for receiving or transmitting the radio wave signals from and into air as a medium. The signal will not be generated by the system as it will not receive or transmit without a proper design. Many types of antenna with various frequency has been designed to meet the application that suits the human needs. All the applications of the antenna consist of many types of frequencies which are controlled by the highest frequency of the antenna; this is because the process of receiving of the transmitting are fully controlled by the high gain antenna.

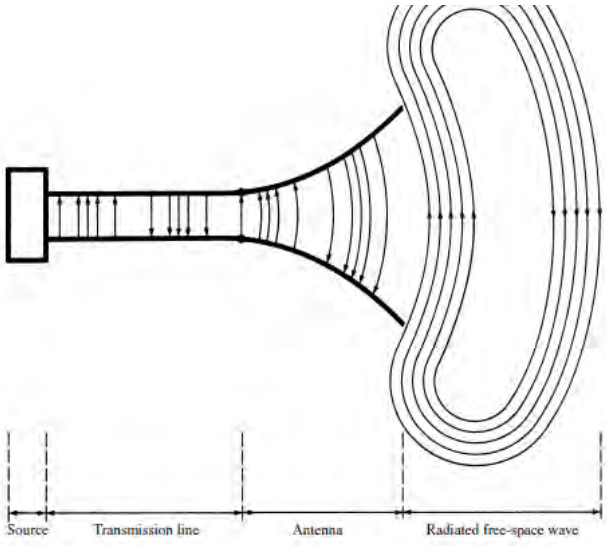

Figure 2: Antenna as a transition device

There are many types of high directional antenna such as :

i) Parabolic antenna
ii) Yagi Uda antenna
iii) Horn antenna
iv) Phase array antenna

1.2 OBJECTIVES AND SCOPE OF PROJECT

This part will discuss about the objectives of the project and the scope of work regarding this project.

1.2.1 Project Objectives

This project is carried out on the following objectives :-

To design, develop, test and validate the micro strip patch antenna at the frequency of 915MHz for short range communication system within nearest radius, with the gain of 5dBi.

1.2.2 Scopes of project

This project is carried out based on the following scopes of project :-

(i) This purpose of this project is to design, develop, test and validate the micro strip patch antenna performance for short range communication system.
(ii) To test the antenna at outdoor.
(iii) To test the micro strip patch antenna at the frequency of 915MHz.
(iv) To use the CST to design the antenna and fabricate the FR4 substrate.
(v) To produce a minimal size antenna with 5dBi.

1.3 PROBLEM STATEMENT

A person who has been through a natural disaster will find out how difficult it is to establish communication immediately after. One of the immediate and significant impact of flooding and natural disasters is a sudden and wide-scale breakdown or interruption of communication infrastructure. The power is down and landline communications are interrupted due to tower loss and any other technical difficulties. When public communication network fail, the impact can be widely felt and has the ability to wipe out access to standard mobile or landline telecommunications.

This project tends to cater the problem for the people to communicate during the natural disaster especially flooding dedicated for short range communication. This

project will also focus on ways to communicate like texting or messaging during natural disaster directly without having to pass through the base station. This project will also develop antenna and provide coverage within 1km radius.

Problem arises when the frequency proposed which is 915MHz will eventually produce a large size of antenna; and eventually the antenna will become heavy. This project tends to develop and produce a light weight antenna with only full-palmed size but yet still manage to provide a good gain of 5 dBi within the nearest radius and lastly compatible to be used on the mobile device. Overall, this project will focus on the short range communication during the natural disaster by introducing the off grid communication.

1.4 SYSTEM OPERATIONS

Studying about the antenna has been one of the crucial task of this project. It has become parts of the literature review in order to determine the best way in designing the specifications of the antenna and hence to complete all the calculations needed to produce the gain aimed in this project.

Besides antenna's knowledge is needed, in this project software development using the CST is used in order to design variation types of antenna in order to meet the specifications stated. Integrate the result from the CST with the FR4 substrate fabricated, as the part of the hardware development. Properties of antenna and the variations in designing antenna including the calculations requirement were studied especially on how to synchronize the designs of the antenna to get the gain and reach within the radius expected in the objective of this project.

The synchronization between both of this software and hardware as an integral part of this project. Lastly, when the integration including the simulating and fabricating are done, all must be testes in the lab and outside of the lab with specifications and troubleshoot any problem that may occur.

1.5 ORGANIZATION OF THESIS

There are five chapters that will be contained in this thesis. In the first chapter, which is the introduction of this project, it clarifies about the foundation of the project, the objectives, scope of the project, problem statement and the system operations. In the second chapter, it potrayed the literature review regarding the project, which includes the current knowledge including substantive findings. The third chapter is about strategy and approach that has been gone up against how the project is completed. It likewise discussed about software improvement that has been applied in this project. Chapter four will talk about additional on the outcome and examination of this project. Last chapter, which is chapter five is comprises of conclusions, a few upgrades and recommendations.

CHAPTER II

LITERATURE REVIEW

A literature review is a text of scholarly paper, which includes the current knowledge, including substantive findings, as well as theoretical and methodological contributions in this project. This chapter reviews articles, book and journals to understand about the concept that need to be understood in order to complete this project such as for producing a micro strip patch antenna dedicated for short range communications.

2.1 INTRODUCTIONS

The works from other researchers had been explained into this chapter that is related to the design and development of this project which is “Design, development and test of micro strip antenna for short range communication”. This project is successfully developed by continuously doing the literature review until it is completed with the antenna design. By doing the comparison with several types of antennas that had been developed at 923MHz.

Antenna is device that converts a guided electromagnetic wave on transmission line into a plane wave propagating in free space. Along this line, one side of antenna shows up as electrical circuit component, while the opposite side as an interface with proliferating plane wave. Antenna can be used for both transmit and function [18].

A variety of antenna have been developed for different functions. They are the wire antennas, aperture antennas, printed antennas and lastly the array. Wire antenna is used at low frequency such dipole, monopole and horns. Aperture antenna are mostly common used at microwaves and millimeter wave frequency (rectangular and waveguide). Lastly is the array antenna which consists of regular arrangement with feed network.

2.2 RADIO FREQUENCY IDENTIFICATION (RFID)

RFID stands for radio frequency identification [12]. RFID is a modern term used to label a system that wirelessly transmits the identity of an object, using radio waves. These transmissions are of novel serial numbers, or codes. This is known as a contact-less innovation, whereby the tag or item does not to be physically touched or wired [14]. It is an automatic identification technology. In the paper written by Neha Saini and Vijay, they reported that this technology provides wireless identification and tracking capability that is more convenient than use of bar codes and optical scanners [12].

In recent years, radio-frequency identification (RFID) technology has been expansively integrated into modern society applications, ranging from barcode replacement to remote monitoring sensing and healthcare [16]. RFID systems in an ultra-high frequency (UHF) band have become a popular technology in several commercial applications, eg., retail and consumer packaging, industrial and manufacturing, security and access control, transportation, and distribution systems [15].

Table 1 : RFID bands applications [14]

Types of frequency	**Frequency**	**Applications**
Low frequency (LF)	30-300 KHz	1. Implant in trees 2. Animal tracking
High frequency (HF)	3-300 MHz	1. For short up ranges, with metal and water not influencing the signs.
Ultra high frequency (UHF)	300 MHz- 3 GHz	1. Offers better read ranges with speedier perusing speeds. 2. Uses more power and more improbable through material
Super high frequncy (SHF)	2.4-2.48 GHz	1. Avoid impedance from metal and water. 2. Practically used for climate monitoring and pallet.

A RFID system typically consist of tag, reader and information management platform [12]. In journal [16], the authors reported that in general, a RFID tag or transponder consists of an antenna and an application-specific integrated circuit chip. Alternatively, a chip-less RFID transponder comprises of resonant antennas whose characteristics can be extracted and digitized. For low cost production of RFID tags, the fabrication methods and materials for antenna are considered to be challenges.

M. H. Ariff, I. Ismarani and N. Shamsuddin, in their journal revealed that a reader (also called the RFID interrogator) is basically a transceiver that reads the substance of RFID tags in a region. They included that the most extreme separation between the reader's antenna and the tag vary, contingent upon the application. Likewise, the role of the antenna for reader and tag are very imperative. The antenna enables the chip to transmit the data that is utilised for identification. Lastly the authors detailed that the RFID reader with the circular polarized antennas radiate in a 90 degree pattern and are less delicate to the tag's introduction on the package [14][5].

Anil Kr Gautam in his paper revealed that ordinarily an RFID device system operates in UHF band (902 MHz-928 MHz). He additionally announce that to get the most proficient RFID system, because of the irregular orientation of the tags in real applications, a circularly polarized antenna is required for the RFID reader. Thus an RFID antenna must have circular polarized radiation pattern to enable the information transmission to be autonomous of the orientation of the transmitter and the receiver as well as reduction in the loss brought on by the multipath effects between the reader and the tag antenna [15].

There are several frequency bands used in RFID which are low frequency (LF), high frequency (HF), ultrahigh frequency (UHF) and microwave. Neha Saini and Vijay Kumar in their paper also reported that owing to its longer read range, higher data transmission rate as well as larger storage capacity, UHF system are gaining more popularity compared to other system [12].

In recent years, there are many sorts of outlined antenna produced for hand-held RFID reader, for example :

1. Helical antenna [13]
2. Loop antenna [19]
3. PIFA antenna [31]
4. Monopole antenna [32]
5. Three elements printed Yagi antenna [33]

Table 2 : Operating frequencies of some countries [12]