MULTI-BAND ANTENNA FOR GSM, 3G, BLUETOOTH AND WIRELESS LAN APPLICATION

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ABSTRACT

In the last few years, there has been an increasing demand for multi-band antennas. In particular, the focus has been on PIFA antenna designs. With the third generation (3G) wireless communications systems going to be introduced worldwide, the demand for handheld devices to support both old and new standards via a single antenna becomes compulsory. Therefore, the most immediate task for the new antennas is to operate in both the new UMTS (3G standards) frequency bands and the already established frequency bands. However, there is also a requirement on handheld devices to serve cellular bands and new communication technologies (e.g. WLAN and Bluetooth). In this thesis, a new embedded antenna that operates in (four frequency bands) two major global mobile communications frequency bands including GSM1800, 3G, Bluetooth and wireless LAN frequency band has been designed. The antenna is a double feed and low profile Planar Inverted-F Antenna (PIFA) using software, ZELAND, simulations has been carried out to investigate the antenna's performance and characteristics. From the simulation results, it has been found that the antenna is able to operate at the desired resonant frequencies.

ABSTRAK

Dalam beberapa tahun terakhir, terdapat peningkatan permintaan atas antenna jalur ganda. Secara khusus, perhatiannya ditujukan pada perancangan antena PIFA. Dengan sistem komunikasi wayarles generasi ketiga yang sedang diperkenalkan ke seluruh dunia, permintaan atas alatan jinjing untuk mendukung kedua standar lama dan baru melalui satu antena menjadi hal yang bersifat wajib. Oleh itu, kerja-kerja yang paling mendesak untuk antena yang baru adalah untuk bekerja pada kedua jalur frekuensi UTMS (3G) yang baru dan jalur frekuensi yang sudah ada. Bagaimanapun juga, terdapat sebuah keperluan pada alatan jinjing untuk melayani jalur-jalur selular dan teknologi komunikasi yang baru (semisal WLAN dan Bluetooth). Dalam thesis ini, sebuah antena terpacak baru yang menjalankan dalam (empat jalur-jalur frekuensi) dua jalur frekuensi komunikasi menyeluruh perdana termasuk GSM 1800, 3G, Bluetooth, dan LAN wayarles telah dirancang. Antena ini adalah masukan ganda dan penampakan rendah antena planar F Songsang (PIFA). Menggunakan perisian, ZELAND, simulasi dilakukan untuk mengujikaji perlaksanaan dan ciri-ciri sifat. Dari hasil simulasi, didapat bahwa antena boleh bekerja pada frekuensi gema yang dikehendaki.

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FDTD	Finite Difference Time Domain
GSM	global system mobile
IFA	Inverted F antenna
MSA	Micro Strip Antenna
MOM	Method of Moment
PCS	personal communication system
PDA	personal digital assistant
PIFA	planar Inverted F Antenna
WLAN	wireless local area network
UMTS	Universal Mobile Telecomm System

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The origination of wireless communications started in 1886 when Heinrich Hertz did an experiment to confirm the presence of electromagnetic waves based on James Maxwell's (1864) theoretical foundation for electromagnetic radiation. It was then in 1897, Guglielmo Marconi first establishes the capabilities of wireless communications through continuous contact with ships sailing the English Channel. Since then, antennas have always been evolving due to the development of wireless technologies, which has led to radio, television, mobile phone and satellite communications.

However, during the last decade, the mobile radio communication industry started to grow at a very fast rate, fuelled by new digital and RF circuit fabrication improvements, new large-scale circuit integration, and other miniaturization technologies which make portable radio equipment smaller, cheaper, and more reliable. All these advancement in wireless technologies, have seen a trend of increasing mobile radio communications users along with smaller handheld transceivers especially in the cellular telephone industry. This has promoted more

research into embedded antenna designs, which became very popular for use with mobile phones.

As we begin the 21st century, the growth in cellular telephone industry continues to rise throughout the world with an increase of 40% or more per year in cellular telephone subscription. To date, more than 900 million people, about 15% of the world's population, pay a monthly subscription for cellular telephone service, and this figure is estimated to approach 30% of the population in the next few years. Due to this widespread growth in cellular telephone subscribers, mobile phone market has also increase tremendously and this means the demand for mobile antennas is also on the rise. As shown in Figure 1.1, mobile handsets market has surpassed the 750 million mark in first quarter of 2005.

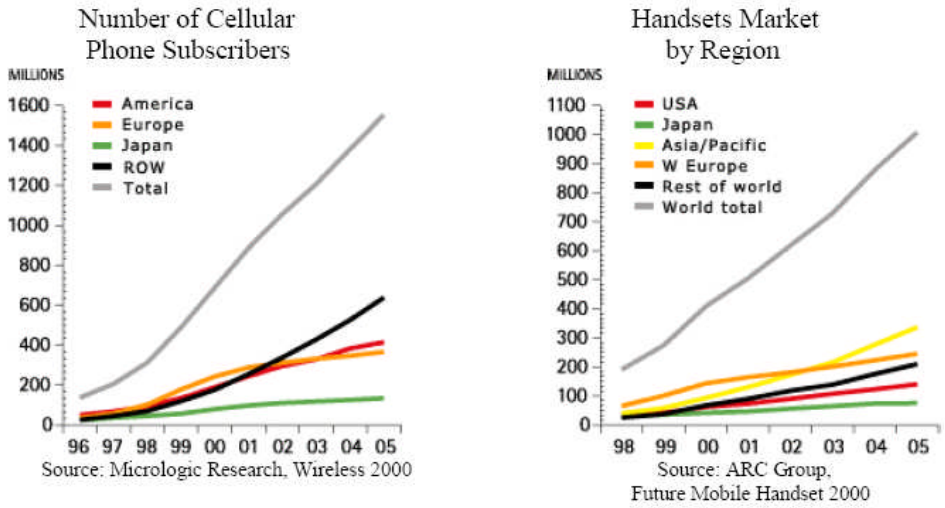

Figure 1.1: Graph showing cellular phone subscribers and handset market in the world

In recent years , a new generation of cellular network (i.e. the third generation wireless network, 3G) has bee introduced worldwide to create a single standard for all cellular phone users and provide fast connection to the Internet. With very high-speed data communications in addition to voice calls, this new 3G systems promise unparallel wireless access in ways that have never been possible before.

New standards and technologies are also being introduced to allow new revolution wireless systems, which will replace fiber optic lines and copper wires.

These new wireless systems such as Bluetooth and wireless local area networks (WLANs), which offer invisible wireless connections, are becoming more and more popular due to the use of low power and license free spectrums. As these new technologies start to roll out and become common to the world, more new antenna designs have to be introduced to cope with the anticipated demand.

1.2 Project Background

Generally the mobile communication systems are using monopole antenna. Monopole antennas are very simple in design and implementation as well as construction, in addition it's suited to mobile communication applications the most common monopole antenna is whipped antenna that can be operating at wide range of frequencies and can deal with most environmental condition compared to other monopole antenna.

The monopole antenna process a number of drawbacks which are relatively large in size and protrude from the handset case in awkward way this problem with the monopoles obstructive and space demanding structure also complicate any effort taken to equip a handset with several antennas to enable multi lane operation .

In recent years the demand for compact and held communication devices has a significant growth included the devices size to be smaller than the palm size available in the market where the antenna size is measure factor that limits device miniaturization.

There are wide variety of methods have been studied to deal with the deficiencies of the common monopole ,many of these methods being based on micros trip antenna design such as inverted F antenna IFA ,a distant derivative of the monopole antenna where IFA utilizes a modify inverted low profile structure as frequently been used for aerospace application .the common IFA posses a rectangular element with an omni directional radiation pattern and has exhibited a reasonably high gain a bandwidth of IFA is also broad enough for mobile operation as well as high sensitivity to the polarization access which make the IFA well suited to mobile application.

In addition the structure of the device require more than one frequency of operation .Multiband wireless phone become popular recently to use the same phone with different type s of net work has various operating frequency . Which led to utilize a multiband operation mobile system?

1.3 Problem Statement

i. The rapid growth in mobile communication system leads to a great demand in developing a small size antenna with multi band function.

ii. Internal antenna has several advantages over conventional antennas like antenna for mobile handset.

iii. They are less prone to damage compact in total size and aesthetic from the appearance point of view.

iv. Small and low profile structures such as planar inverted-F antennas (PIFA) that can be mounted on portable equipment are becoming very attractive for mobile communications.

v. Many new multi band designs based on PIFA concepts for achieving operation at two or more of the GSM900,1800 MHz , Bluetooth and WLAN bands.

1.4 Motivation

As mentioned earlier, in the next few years, 3G cellular network will be introduced worldwide to create a single standard for cellular phone users. Although the evolution of 3G will have a single standard implementation worldwide, the hope for that has not materialized as the worldwide user community remains split between two camps: GSM / IS-136 / PDC and CDMA, as can be seen in Figure 1.2 Moreover, implementations of new 3G communications systems require expensive new base station equipment thus the installations will be slow and gradual.

Therefore, to have an ideal 3G implementation worldwide, multi-band antenna is required to switch between the current 2G networks and 3G networks where it is available. Besides, multi-band antenna development will also benefit the many cellular phone users who will require such function to access different communications networks in different countries.

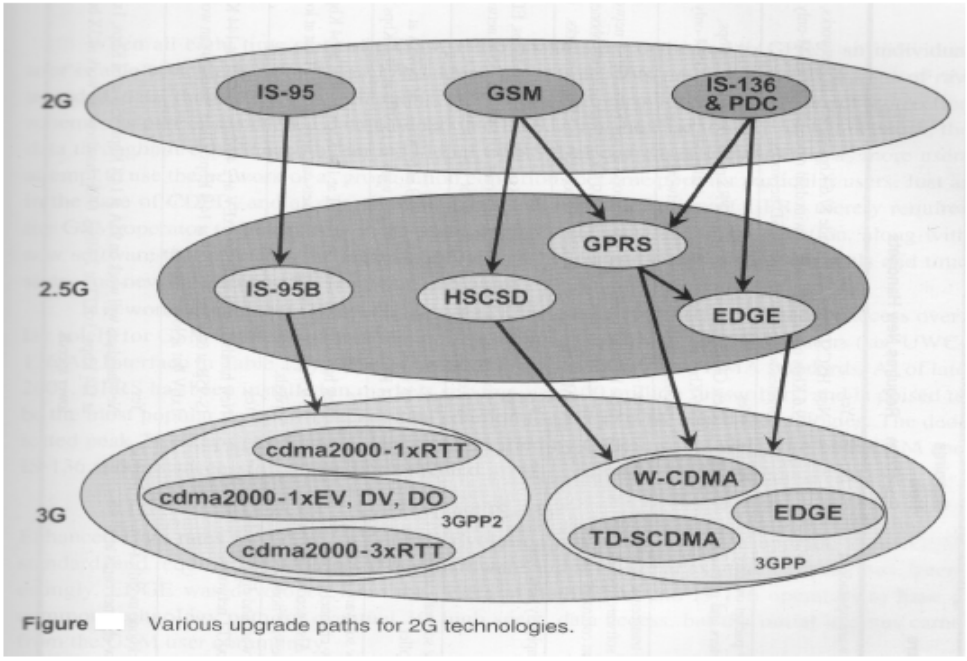

Figure 1.2: Diagram showing various paths that lead to 3G wireless communication systems

New technologies or new wireless systems such as Bluetooth and WLANs have another impact on the new antenna designs. The introduction of these new technologies has called for integration with the cellular communications systems. Despite the fact that some new antennas available in the market have already introduced the world to such integration, cellular phones with such antennas are still not commonly used.

This is mainly because the implementation of such new technologies has not reach the majority users. Therefore, new antenna designs for mobile phones should include such integration before these new technologies take the world by surprise.

1.5 Aim of Thesis

With the estimated large increase of cellular telephone subscribers in years to come, the upcoming introduction of 3G wireless communications networks and new wireless systems such as Bluetooth and WLANs, there is a growing trend towards the design of multi-band antenna for use on multi purpose mobile phone.

However, at present, most of the current antenna designs for mobile phone are focus mainly on the second- generation cellular network (2G), mostly offering only single band and dual band operations with a few having tri band capabilities (e.g. GSM, DCS and PCS operations). Thus the most important task now is to design new antennas that not only cover the present and future cellular frequency bands but also non-cellular frequency bands.

In this thesis, a new antenna is to be designed to operate at 4 main frequency bands (i.e., GSM1 800, UMTS and Bluetooth frequency bands). In addition, this antenna has to provide an embedded solution so as to harness the inherent advantages of the mobile phone.

As a result, Planar Inverted-F Antenna (PIFA) is chosen to form the basis in this thesis due to its miniature in size, along with its abilities to have multi frequency operations shown in previous research. PIFA has also proved to be the most widely used internal antenna in commercial applications of cellular communication.

1.6 Scope of the Thesis

The Planar Inverted-F Antenna (PIFA) is a very complicated antenna. Despite extensive research and numerous reading, PIFA's design theory still remains as a mystery. However, much of the PIFA's characteristics begin to reveal and work on the antenna design starts to fall in place. And with the steps listed below, the objectives of this thesis are finally accomplished.

i. Research on various internal multi-band antenna designs. Study and understand each antenna's characteristics.

ii. Select a suitable antenna design to form the basis for the thesis. Study and understand the antenna's theory and characteristics

iii. With a good understanding of PIFA, design a new antenna to perform to the requirements listed in the criteria. Simulations were being done to obtain the results on the performance of the antenna.

iv. Investigate on the characteristics of the new antenna and compare the results with the theory.

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1.7 Project Methodology

The objective of this project will be implementing using the features of Zeland Fidelity software and the over all project methodology are illustrated in the Figure 1.3 Which it is divided into shown steps

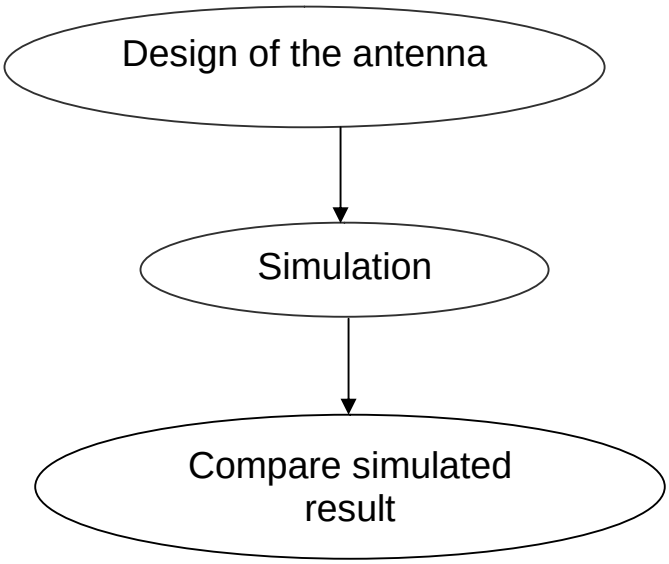

Figure 1.3 The overall methodology flow of the project

1.8 Organization of the Project

Chapter1; Included the introduction and the problem statements, objectives, scope of the project, methodology and organization of the thesis

Chapter 2; In this chapter, we will be looking at various multi-band antenna designs for use on handheld devices, many of which are potential candidates for use in the future mobile phone. These antennas include Microstrip antenna (MSA), Planar Inverted-F Antenna (PIFA), and some other antenna designs including the helical antenna. Most of these antennas that were developed are used to meet the demand of the increasing cellular telephones' market.

Chapter 3; Will describe the features and the techniques that can be used in the planar inverted antenna and its advantages to be implemented in handheld devices.

Chapter 4**;** In this chapter we discussed the soft ware ZELAND fidelity and described its advantages over other electromagnetic software ,and we described the consideration for the design and the structure of the antenna and its dimension .

Chapter 5; In this chapter we will discuss the accomplished results such as return loss curve and radiation pattern for each frequency band. In addition, the directivity of the antenna and analysis of the results.

Chapter 6 ; Contain the facts that we have gained from this project and what can be done in the future to provide efficient evolution in the mobile antenna technology . .

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