ANTENNA ARRAY (DESIGN AT 28 GHz FOR 5G MOBILE NETWORK

BASIL JABIR SHANSHOOL

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Specially dedicated to

My beloved Parents for their supporting, kindness and their support.

Especially to spirit of my father Prof. Dr .Jabir Sanshool for what he have done for me.

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ABSTRACT

Mobile technology is a fast developing technology which gives a huge impact on social life nowadays. This non wired technology urges a study need for antenna development where antenna can be said as the core device for this technology. Researches on antenna are rapidly developing in the current research trend resulting in many antenna designs in modern wireless technology because it allows single antenna to be employed in many systems. 5 Generation is the next generation for mobile technology, which have many advantages such as better data rate, better reliability, network scalability and flexibility, amazingly fast, super real time, better efficiency and great service in a crowded area. This research work is focusing on the array antenna that operates at 28 GHz band. The configuration of antenna consists of single patch which is replicated to construct an array in horizontal direction with coaxial feeder from behind. This gives better distribution for the current and better radiation pattern. The length of single patch control the operating frequency. The width of short side and long side controls the gain and the shape of the radiation pattern. This antenna has a high gain, which can reach 17dB and its impedance bandwidth is more than 1 GHz. The radiation efficiency is measured is more than 92% with a return loss of not less than -20dB. Also this project suggested formulas for calculating the gain versus the number of arrays and how the gain can be increased with respect of thickness. Computer simulation Technology (CST) was been used as the simulator and the results was measured through Network analyzer.

ABSTRAK

Teknologi mudah alih adalah satu teknologi yang pesat membangun yang memberi kesan yang besar terhadap kehidupan sosial pada sekarang Teknologi tanpa wayar ini merangsang keperluan kajian untuk pembangunan antenna, di mana antena boleh dikatakan sebagai peranti teras untuk pembangunan teknologi ini. Kajian mengenai antena sedang pesat membangun dalam trend penyelidikan terkini yang menghasilkan banyak reka bentuk antena dalam teknologi moden tanpa wayar dan ia membolehkan satu antena digunakan dalam banyak sistem. 5 Generasi adalah generasi seterusnya untuk teknologi mudah alih, yang mempunyai banyak kelebihan seperti kadar data yang lebih baik, kebolehpercayaan yang lebih baik, kebolehsekalaan rangkaian dan fleksibiliti, kepantasan yang menakjubkan, masa nyata lebih baik, kecekapan yang lebih baik dan perkhidmatan yang baik di kawasan yang sesak. Penyelidikan ini memberi tumpuan kepada antena tatasusunan yang beroperasi pada jalur 28 GHz. Konfigurasi antena terdiri daripada tampalan tunggal yang direplika untuk membina tatasusunan dalam arah mendatar dengan penyuap sepaksi dari belakang. Ini memberikan pengagihan yang lebih baik untuk arus dan corak sinaran yang lebih baik. Panjang tampalan tunggal mengawal kekerapan operasi. Lebar bahagian pendek dan bahagian panjang mengawal gandaan dan bentuk corak sinaran. Antena ini memberi gandaan yang tinggi kerana boleh mencapai 17 db dan lebar jalur galangannya adalah lebih dari 1 GHz. Kecekapan radiasi diukur adalah lebih daripada 92% dengan kehilangan kembali tidak kurang daripada -20dB. Projek ini juga mencadangkan formula untuk penggiraan gandaan melawan bilangan tatasusunan dan bagaimana gandaan boleh ditingkatkan berkaitan dengan ketebalan. Teknologi simulasi komputer (CST) telah digunakan sebagai penyelaku dan keputusan diukur melalui penganalisis rangkaian.

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LIST OF ABBREVIATION

C	-	Speed of light
D	-	Outer probe feed diameter
d	-	Inner probe feed diameter
ϵ_r	-	Permittivity
ϵ_e	-	Effective permittivity
e_0	-	Total efficiency
e_r	-	Reflection (mismatch)
e_c	-	Conduction efficiency
e_d	-	Dielectric efficiency
λ_0	-	Free space wavelength
f_c	-	Center frequency
f_H	-	High frequency
f_l	-	Low frequency
h	-	Thickness of substrate
L_p	-	Length of patch
L_{eff}	-	Effective length
ΔL	-	Delta Length
W	-	Width of patch
W_{eff}	-	Effective width
W_p	-	Width of patch
W_s	-	Width of short side
W_l	-	Width of long side
Γ	-	Reflection coefficient
V_0^-	-	Reflected voltage

V_0^+	-	Incident voltage
Z_L	-	Load impedance
Z_o	-	Characteristic impedance
BW	-	Bandwidth
CST	-	Computer Simulation Technology
dB	-	Decibel
EM	-	Electromagnetic
UV	-	Ultra Violet
VSWR	-	Voltage Standing Wave Radio
PCB	-	Printed circuit Board

CHAPTER 1

INTRODUCTION

1.1 Introduction

It has been projected that in the next decade, a mobile traffic will be increased on the order of 1000 times as expected compared to what is experienced today .To meet the dramatic traffic growth, next generation mobile networks are also expected to achieve a 1,000-fold capacity increase compared to the current generation of wireless network deployment (Jangeun and Mihail, 2003). Based on the Cisco report of yearly visual network index (VNI), there are quantitative proof which show explosion of data in Wireless communication is true and will continue. This data is largely driven by smartphones, tablets, and video streaming .the most recent VNI report and forecast makes clear that an increasing approach will not be enough for demanding of the networks by 2020. In few decades, the size of data for IP handled by the networks of wireless will have incremented by more than a factor of 100: from less 3 exabytes in 2010 to more than 190 exabytes in 2018, on a speed to override 500 exabytes by 2020. So, increasing network infrastructure visualization is needed, and the need for greatly incremented energy efficiency, (Theodore et al., 2013).

The 5 generations will be a model shift that will contains a very huge carrier with enormous bandwidths, device densities and extreme base station and new numbers of antennas (Theodore et al., 2013). Mobile communications are becoming progressively demanding as far as bandwidth is concerned due to the increased content requirements. In order to face this challenge, the telecommunication community will

channel towards higher frequencies where more spectrum could be accessible. Furthermore, the local multipoint distribution service (LMDS) band around 28 is a potential entrant for short range outdoor wireless communications. However, at higher frequencies, since the wavelength becomes increasingly, the antenna design challenges change from declining size and shrinking to increasing gain and enabling beam navigation. The new spectrum is mostly expected to be allocated in the super high-frequency bands (3-30GHz) as well as the extremely high frequency bands (30-300 GHz), also referred to as mm Wave bands, where the channel transmission characteristics are different from those of frequency bands below 3 GHz .This difference will require a new strategy of the air-interface and network architecture (Jangeun and Mihail, 2003)

The 28 GHz band has not been studied for mobile application and there are very few researchers actively pursuing this topic .Therefore, the need to develop antenna solutions for mobile components at these frequencies is a key enabler .Printed solutions for Ka-band are rare (Parrish, 1982)

1.2 Background

Initially introduced wire antenna was invented by F. Braun in 1898. Subsequently, numerous different antenna wires have been introduced such as the dipole and its counterpart monopole over a ground screen, Yogi, helix log periodic and spiral antennas, etc. An inductive process is engaged for the scheme of these antennas, in order to formulate equations for the current distribution on every antenna's structure, Maxwell's equations were adopted so that one can calculate the electromagnetic properties of each antenna. In case of complicated structures that may not be manually calculated, a computer program using simulation and approximating the structure and calculating the properties may be introduced.

Generally, the design tactic is limited to the modest structures, and an engineer could prefer to use an existing design which is desired in terms of electromagnetic characteristics. Afterwards, the engineer may use approximate or exact equations to find the proper design of dimensions and parameters needed. Then a simulator program may be used to predict its performance. If the simulation results were not totally acceptable, redesigning and re-simulating of the antenna should be done by the engineer. This could be achieved by using intuition to find out that changing of parameter may enhance performance. Over time, several different antenna designs have been manufactured by the design rotation with different characteristics; however, it takes time and unlikely to yield indeed optimal results. There is a requirement for the engineer to be familiar with several different existed designs and he must have enough experience and expertise in order to reach a desired solution in a rational period of time.

Since high performance computers with high duty capacity are exist recently, more complicated wire constructions become analyzable in shorter time. It is also possible to use these computer aided design technologies in improving wire antennas. In such cases, the common design of the wire antenna is programmed and the wire that creates configuration is enhanced. While greater complexities may be designed by computers, there is still lack of automated design's tools. This nonappearance of tools, which means the intuition must still be used to design different types of antenna. Some preliminary numbers at the last solution which must be impartially near to the optimal answer surely faster than using paper and pen or even a computer, however, there are still too many variables to improve effectively even in a modest design. However, years of different experiences are not beneficial to result an intuition of certain aspects of electromagnetic issues. Moreover, the types of designs that are trying to those with inbuilt logic about them are limited by design rotation. In order to have an easier understanding and analysis, the structures are being kept modest. Most of the designs which are created by the engineers, when they are being observed by someone else, have comparable characteristics of "making sense". Most of them seem to work accurately. Such is not the state with the design of antenna by the GA process which discussed here. Although they work in simulation or actual measurement, however, it does not appear logical or rational reasonable that they should work. They are totally

far from those a normal human designer could have ever thought of (Derek and Edward, 1999).

1.3 Problem statement

Progress in the technology of wireless communication systems has created a strong need for the development of new antenna structures. In systems of wireless communication, microstrip planner technology is fundamentally bounded in directional antennas. A conventional antenna has the capability of producing single fixed directional radiation pattern. This is not the case which are used in reconfigurable antennas for modern wireless communication (5^{th} Generation mobile Networks). Reconfigurable antennas make it possible use of a single antenna for multiple application. Therefore, the concept of reconfigurable antenna array and characteristics of beam switching by controlling the switches at 28 GHz is proposed in the current research.

Because of increasing the attenuation for high frequency, we need to design an antenna with high gain, small size, and directive beam.

1.4 Objective of the work

The objectives of this work will be described in the following points:

I. To design and fabricate of high gain of microstrip grid antenna array capable of operating in 28 GHz for the fifth generation mobile network (mobile base station or mobile antenna).
II. To make the Beamwidth for narrow angle with small and low side lobes

1.5 Scope the Study

The main idea of work is to read and understand the suitable formula and theory in order to get the parameters which are used in designing the antenna array for 28 GHz .Moreover, solving above mentioned parameters by using EXCEL or CST micro, this can provide an interface in ACCESS .Furthermore, a new design will be simulated by using CST and fabricated a prototype to test its characteristics .Then ,by compile the simulated results with the measured ones and comparisons between them we can analyze and make a report .Antenna radiation characteristics like S_{11},bandwidth and radiation pattern will be presented and discussed

1.6 Significance of the Study

This work will be useful in antenna grid for 5^{th} Generation Mobile base stations .To show the relationships between the gain and the number of array and how it can be used to design an optimum antenna with small shape and high gain (more than 12 dB) with narrow beamwidth .Antenna array will be designed for 5G application operating at 28 GHz with high gain more than 12 dB and bandwidth 1 GHz.

1.7 Organization of Thesis

This thesis consists of five chapters, which are incorporating the design, fabrication and measurement of microstrip antenna array for beam 5 generation mobile Networks .The thesis is organized as follows:

Chapter 2 discuss previous work in field and gives overview of the development that have taken place on antenna array .Several types of antenna

geometries which form the concept for microstrip antenna design are also discussed in this chapter .Also included is description of the concept of 5 generation Networks and the suggested standards for this kind of Networks also the concept of millimeter waves and microstrip antenna .finally, it included the concept of antenna array.

Chapter provides an explanation and analysis of microstrip antenna and the concept of the antenna array .It also expand the description of antenna array technology including various methodologies for achieving grid antenna array, along with the physical components used in grid antenna array.

Chapter 4 explains the results for project .simulation results are presented to demonstrate the excellent performance of the antenna design.

Chapter 5 describes the Experimental results and provides a comparison between the simulated and experimental to demonstrate the best design of the antenna.

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