A Minor Project Report

on

DESIGN OF MICROSTRIP PATCH ANTENNA FOR UWB APPLICATIONS USING CST SOFTWARE

Submitted in partial fulfilment of requirements for the award of the

Degree of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

Under the guidance of

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M.KUMARASAMY COLLEGE OF ENGINEERING,

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BONAFIDE CERTIFICATE

Certified that this project report "DESIGN OF MICROSTRIP PATCH ANTENNA USING CST SOFTWARE" is the bonafide work of KARTHICKRAJAK (927621BEC073),MADESHWARANS(927621BEC106),KARTHIKEYANS(927621BEC075),KAVINV(927621BEC080)who carried out project work under my supervision in the academic year 2022-2023.

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This Minor project-III report has been submitted for the **18ECP103L - Minor Project I**

Review held at M. Kumarasamy College of Engineering,Karur on____________

PROJECT COORDINATOR

Vision of the Institution

To emerge as a leader among the top institutions in the field of technical education

Mission of the Institution

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges

M2: Create a diverse, fully engaged, learner-centric campus environment to provide quality education to the students

M3: Maintain mutually beneficial partnerships with our alumni, industry, and Professional associations Vision of the Department

Vision of the Department

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research, and social responsibility.

Mission of the Department

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

Program Educational Objectives (PEOs):

PEO1: Core Competence: Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering.

PEO2: Professionalism: Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: Lifelong Learning: Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

Program Outcomes (POs):

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations

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Mapping of project with POs and PSOs

Abstract	**Matching with Pos,POs**
Keywords	PO1,PO3,PO9,PSO1

ABSTRACT

As technology is growing, it has created a need for the microstrip patch antennas to transmit signal at fast rate **.**The objective of this paper is to design microstrip patch antenna for WiMAX application. The proposed antenna is designed by using CST studio suite software. A rectangular patch antenna with small circular slot has been imprinted on FR4 substrate material whose relative permittivity is 4.3 with 1.6 mm thickness. Microstrip line feed has been used in the design. The length and width of the substrate is 20.69mm & 40.69mm.ground have same dimensions alike substrate .The operating band of antenna lies between (3.38- 3.47)GHz & the resonating frequency of microstrip patch antenna is 3.43 GHz. WiMAX technology covers the IEEE 802.16e for mobile users using 3.3-3.7 GHz frequency band.the voltage standing wave ratio in the resonating frequency 3.428 GHz is 1.02 VSWR. The proposed antenna exhibits resonant frequency at 3.428GHz with a return loss of -41.4dB

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CHAPTER 1

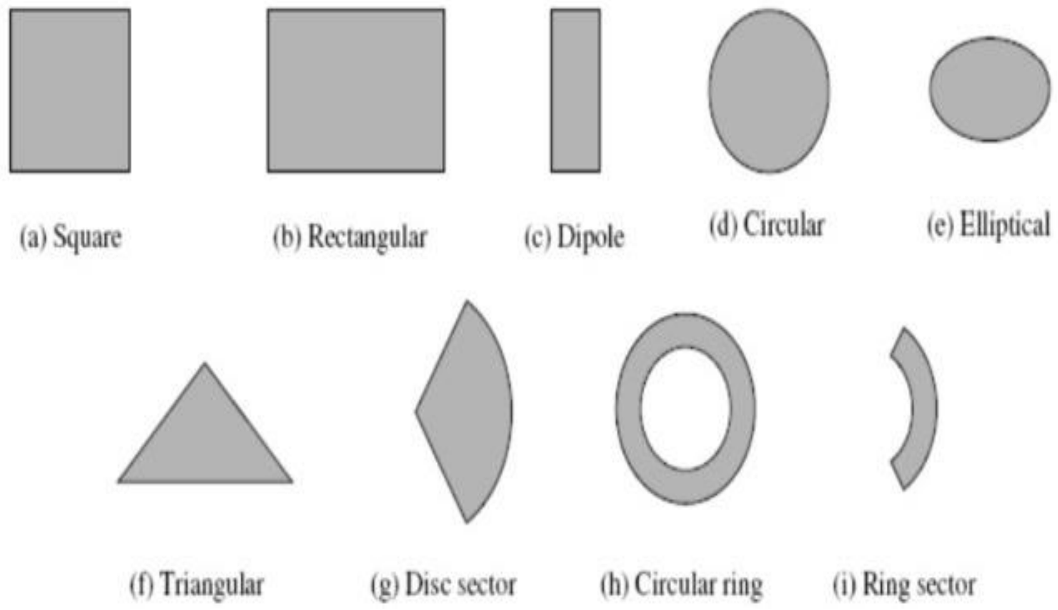
INTRODUCTION

1.1 ANTENNA

Antenna is a specialized transducer that converts the radio frequency fields into alternating current.An antenna plays an important role in modern wireless communication systems.In the recent years ,the miniaturization and multi-functionalization of communication devices require that the internal antenna has strong integration capabilities. There are many merits of microstrip patch antenna such as low profile, light weight, simple realization process and low manufacturing cost. The Microstrip Patch antennas are generally narrow band antennas and the design of Microstrip patch antennas for wideband applications is an area of extensive research. generally, microstrip patch antenna consists of a radiating patch, dielectric substrate and a ground plane. There are several types of patches like rectangular, square, circular, pentagon, hexagon, etc.The proposed antenna is designed using a rectangular patch. Hight (h) should be greater than 0.025 of a wavelength otherwise, the antenna efficiency will be degraded. The WiMAX Forum has published three licensed spectrum profiles: 2.5 GHz (2.5-2.69 GHZ), 3.5 GHz (3.4-3.69 GHZ) and 5.5 GHz (5.25-5.85 GHZ)

1.2 MICROSTRIP PATCH ANTENNA

Microstrip antennas have been around since the 1950s, but it wasn't until the 1970s that this technology received more attention. This is mostly because high-quality substrates are readily available. Since then, in-depth study and development of microstrip antenna and arrays, utilising the many benefits like light weight, low volume, low cost, planar configuration, and compatibility with integrated circuits, have resulted in a variety of applications and the topic's establishment as a distinct entity within the larger field of microwave antennas Microstrip antennas have emerged as one of the most cutting-edge areas of antenna theory and design in recent years. Utilizing printed circuit technology for both the radiating components of an electronic system as well as the circuit components and transmission lines gave rise to the fundamental concept of the microstrip antenna. Because of their ease of usage and compatibility with printed-circuit technology, they are used in a variety of contemporary microwave applications. In its most basic form, a microstrip antenna is simply a rectangular shape (or other forms like circular, triangular, etc.) on top of a substrate with a ground plane backing it.The IEEE 802.16 working group has created a new standard called as WiMax (Worldwide Interoperability for Microwave Access). The maximum coverage range for WiMax is 50 kilometres. WiMax antennas have generated a lot of interest recently. How to build antennas for WiMax technology is the main area of research. There are three assigned frequency bands for WiMax. the upper band, the middle band, and the low band, which are all in the range of 2.5-2.69 GHz (5.2-5.8 GHz). The microstrip patch antenna is a strong contender for integration in systems like wireless communication systems, mobile phones, and laptops because of its benefits including low cost, small size, low weight, and ability to combine with microwave integrated circuits.



Feeding techniques

A microstrip patch antenna can be fed using one of four basic methods: edge feeding, probe feeding, aperture coupling, or proximity coupling .

One of the original methods of microstrip excitation is the first. The microstrip line and patch are in direct touch in this manner. The main benefit of this feeding method, according to 2a, is how simple it is to make because both the microstrip line and patch can be engraved on the same piece of wood.

Unwanted radiation from the feed, which alters the antenna's radiation pattern, is a key disadvantage.

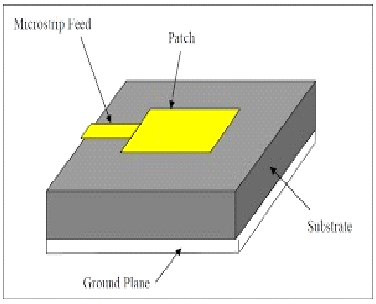
The inner conductor of a coaxial cable is extended through the ground plane and linked to the patch in the straightforward procedure known as "probe feeding."

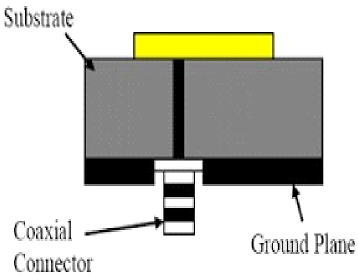
There are four fundamental techniques to feed a microstrip patch antenna.

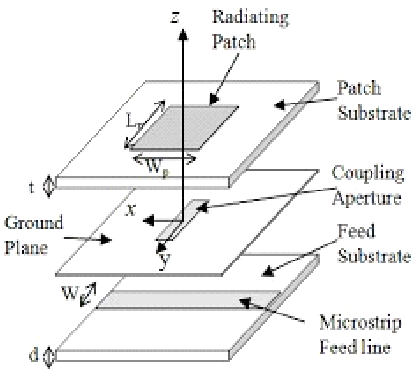
Antennas which separate the power to the radiating element through the base plate. This feature minimizes stray radiation and makes it an effective method because the element is in direct contact. However, the narrow bandwidth is still **.**The next way to comment is to change the aperture**.** It is the first non-contact mechanism introduced to overcome the disadvantages of direct input technology: narrow bandwidth and surface waves. The power of the powersupply is coupled through a gap in the backplane that separates the power substrates and position . This method simplifies manufacturing and allows independent optimization of the power and antenna substrates**.** The last method presented in this appendix, is called proximity switching**.** The microstrip line is located on the grounded substrate and the dot is etched on top of another substrate located abovethe **.** The two substrates are separated**,** allowing current from thepower supply to electromagnetically couple the spot. Unlike direct contacttechniques, this mechanism is capacitive in nature. So total bandwidth increases by **.**

The disadvantage is that this method produces strong false radiation, because the feed and antenna layers are not completely independent.

a.probe feeding **b.edge feeding**







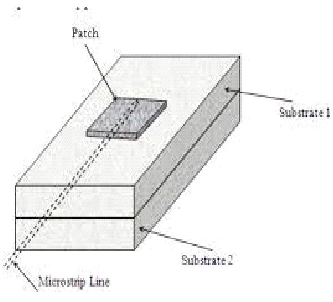


Fig. 6 Proximity Coupled Feed

c.aperture coupling **d.proximity coupling**

1.3ANTENNA DESIGN

The proposed antenna is designed by using CST studio suite software. For the better performance of the patch antenna, it requires impedance matching circuits. Input impedance of the patch antenna is associated with (w/l) ratio. The operating frequency is3.428GHz which has been conceived utilizing the substrate FR4(lossy) of dielectric constant = 4.3. The height and width of the substrate is 20.69mm and 40.69mm WiMAX technology covers the IEEE 802.16e for mobile users using 3.3-3.7 GHz frequency band. Microstrip Line feed has been used in the design and the position of feed in the design was changed to get the optimized results and goodresults were achieved when the feeding was provided at the center of the patch.The given dimensions of the antenna are calculated using following

PARAMETERS	**VALUES**
DESIGN FREQUENCY(fr)	3.428GHZ
GROUND PLANE WIDTH(Wg)	61.42mm
GROUND PLANE LENGTH(Lg)	73.42mm
PATCH LENGTH(L)	30.71mm
PATCH WIDTH(W)	36.71mm

FORMULAE:

A.Width of patch

$$W = \frac{c}{2f_r\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

c.Dielectric constant

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2\sqrt{1 + \frac{12h}{W}}} \quad \text{F/m}$$

B.Effective length:

$$L = \frac{c_o}{2f_r\sqrt{\varepsilon_{re}}} \quad \text{mm}$$

CHAPTER 2

OBJECTIVE

The main objectives of this work to design and analyse a Recangular microstrip patch antenna for WiMAX applications Using the CST microwave studio suite
Optimizing patch antenna size for WIMAX applications with resonance frequencies of 3.428 GHz will be the key focus.
Since the previous two decades, the attenuation of microstrip patch antennas in various WiMAX applications has increased. With potential applications in mobile devices and satellite communication, the field of microstrip antenna research is quickly expanding.
In this study, we examine, design, and validate rectangular patch antenna for microstrip.

CHAPTER 3

LITERATURE REVIEW

Guglielmo Marconi invented wireless communications in 1895 when he used electromagnetic waves to send the letter "S" in three-dot Morse code over a three-kilometer distance. Beginning with this, wireless communicationshas grown to be an important component of contemporary society. Wireless communications have altered how societies operate, from satellite transmission through radio and television broadcasting to the now-ubiquitous cell telephone (Schiller, 2000). Guglielmo Marconi travelled 1800 miles across the Atlantic Ocean in 1901, sending telegraphic messages from Cornwall to St. Johan's Newfoundland. His creation made it possible for two persons to converse by exchanging alphanumeric characters encoded in analogue signals via (Stalling, 2004). Over the past century, wireless communications has experienced its fastest growth era in history.802.16 is a set of growing IEEE standards that apply to a wide range of spectrum from 2 to 66 GHz, currently including both licenced and unlicensed bands. Access (WiMAX) fits under 802.16 d/e. A quick summary of some of the many 802.16 specifications is provided in the following table.

Standard	comments
802.16	Wireless WAN, Hiper Access
802.16d	WiMAX, HiperMAN (fixed)
802.16e	WiMAX, (fixed and mobile)

CHAPTER 4

TOOLS USED :

CST Software

CST Studio Suite is used in leading technology and engineering companies around the world.

CST Studio Suite is a high performance **3D EM analysis** software package for designing, analyzing and optimizing electromagnetic (EM) components and systems.

Electromagnetic field solvers for applications across the EM spectrum are contained within a single user interface in CST Studio Suite. The solvers can be coupled to perform hybrid simulations, giving engineers the flexibility to analyze whole systems made up of multiple components in an efficient and straightforward way. Co-design with other SIMULIA products allows EM simulation to be integrated into the design flow and drives the development process from the earliest stages.

It offers considerable product to market advantages, facilitating shorter development cycles and reduced costs. Simulation enables the use of virtual prototyping.

Using the CST microwave studio suite to design and analyse a Recangular microstrip patch antenna .

Using the CST microwave studio suite, design a traditional Wilkinson equal and unequal power divider.

Device performance can be optimized, potential compliance issues identified and mitigated early in the design process, the number of physical prototypes required can be reduced, and the risk of test failures and recalls minimized CST Studio Suite provides fast, accurate, accessible electromagnetic simulation for engineers, designers, and researchers working in many fields, including microwaves, RF & optical, EDA & electronics, electromagnetic compatibility (EMC), particle dynamics, statics, and low frequencies.

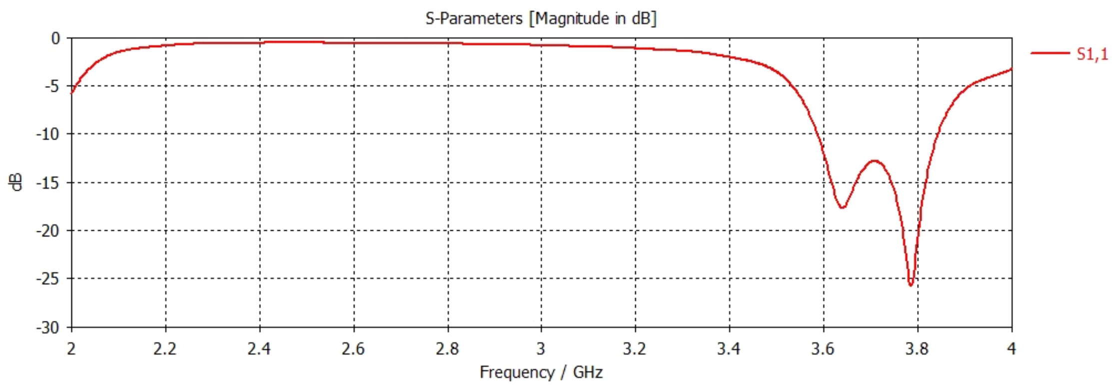
CHAPTER 5

RESULTS AND DISCUSSION:

RETURN LOSS(S11):

The return loss is the proportion of a signal that is reflected as a result of an impedance mismatch. Return loss in telecommunications refers to a measurement of the relative strength of the signal reflected by a break in a transmission line or optical fibre. A mismatch between the termination or load connected to the line and the characteristic impedance of the line may be to blame for this discontinuity. typically stated as a decibel (dB) ratio.

In order to get the effective output return loss should be less than -10dB.The proposed antenna exhibits resonant frequency at 3.428GHz with a return loss of 41.43Db.The s11 vs frequency curve for the parameters is given below

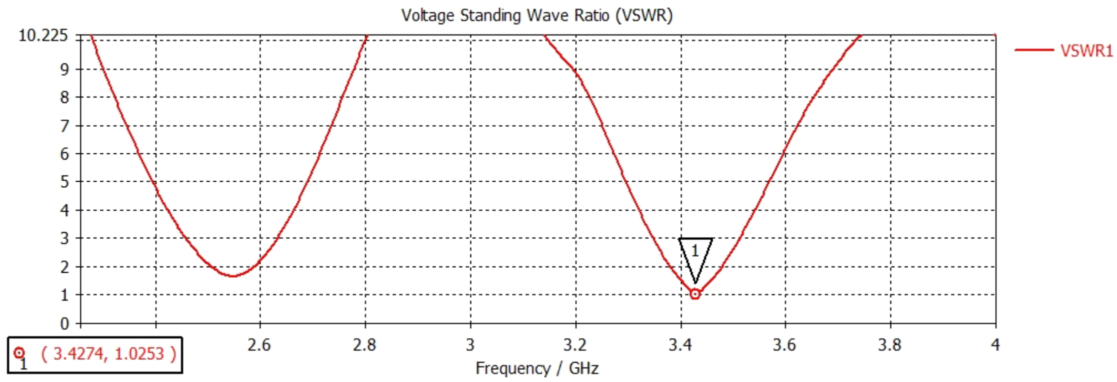


VSWR:

VSWR stands for Voltage Standing Wave Ratio. “The ratio of the maximum voltage to the minimum voltage in a standing wave is known as Voltage Standing Wave Ratio.” It is also called as SWR. The impedance of the radio and transmission line must be properly matched to the impedance of the antenna for a radio (transmitter or receiver) to supply power to an antenna. The impedance matching performance of the antenna with respect to the radio or transmission line it is linked to is quantified by the VSWR parameter.

Voltage Standing Wave Ratio, commonly known as Standing Wave . The reflection coefficient, which specifies the power reflected from the antenna, is a function of VSWR.
The higher the impedance mismatch, the higher will be the value of VSWR. the value of VSWR should be less than 2.Here it’s 1.02.

Voltage Standing Wave Ratio(vswr)



FAR FIELD:

The field, which is far from the antenna, is called as far-field. It is also called as radiation field, as the radiation effect is high.The radiation intensity when measured nearer to the antenna, differs from what is away from the antenna.

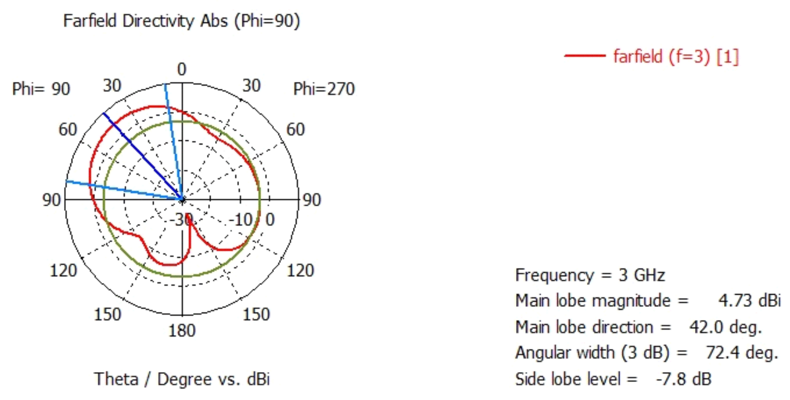
Though the area is away from the antenna, it is considered effective, as the radiation intensity is still high there.

The field, which is nearer to the antenna, is called as **near-field**. It has an inductive effect and hence it is also known as **inductive field**, though it has some radiation components.

The field, which is far from the antenna, is called as **far-field**. It is also called as **radiation field**, as the radiation effect is high in this area.

Many of the antenna parameters along with the antenna directivity and the radiation pattern of the antenna are considered

in this region only.



Operating band	**Resonating frequency**	**S11**	**VSWR**
(3.38-3.47)GHZ	3.428GHZ	41.4dB	1.02

CHAPTER 6

CONCLUSION:

We can say that there are many aspects that affect the performance of the antenna such as dimensions, selection of the substrate, feed technique and also the Operating frequency can take their position in effecting the performance. , the microstrip patch antennas with rectangular-shaped metamaterial unit cells has an improved bandwidth and size reduction compared to the conventional microstrip patch antenna. In this paper we designed patch antenna operating at 3.428 GHz. After simulation, the obtained results are The operating band of antenna lies between (3.38- 3.47)GHz& the resonating frequency of microstrip patch antenna is 3.43 GHz. The proposed antenna exhibits resonant frequency at 3.428GHz with a return loss of -41.4dB & 1.02 VSWR

Future scope:

It is very important to consider input technology, impedance and substrate as key parameters. The correct position of the feed line end also affects the performance of the antenna. In the future**,** it may be possible to increase the gain using array antennas and other input techniques.

Antenna design innovations are now essential components of any wireless system because to the enormous development in demand for wireless communication and information transmission via smartphones and personal communications (PCS) devices.

Microstrip antennas are one type of antenna that can accommodate the majority of the needs of wireless systems. Both base stations and portable devices frequently make use of these antennas. The most active area of antenna research and development right now is microstrip antennas, which come in a range of designs.

Due to their many advantages, microstrip antennas are finding use in a growing number of wireless communication systems, including handheld mobile devices, satellite communication systems, and medicinal applications.

CHAPTER 7

REFERENCE:

https://core.ac.uk/download/pdf/12006839.pdf

http://www.antenna-theory.com/antennas/patches/patchhttp://www.antenna-theory.com/definitions/vswr-calculator.php

http://ieeexplore.ieee.org/document/4455895/