Bachelor of Science in Electronic and Telecommunication Engineering

Design and Performance Analysis of an UWB Micro-strip Patch Antenna for Breast Cancer Detection with Jeans Substrate.

Submitted by

Kazi Sami Ullah

T153004

Sudipta Kumar Nath

T153041

Supervised by:

Engr. Mohammed Jashim Uddin

Chairman & Assistant professor,

Dept. of ETE

International Islamic University Chittagong

Department of Electronic and Telecommunication Engineering

International Islamic University Chittagong

Kumira, Sitakunda, Chattogram - 4318

Academic Year: 2020

DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this thesis has been submitted elsewhere for the award of any degree or diploma.

_____

Kazi Sami Ullah

_____

Sudipta Kumar Nath

DEDICATION

This thesis work is dedicated to all of our honorable teachers and parents.

CERTIFICATE OF APPROVAL

This is to certify that **Kazi Sami Ullah** (T153004) and **Sudipta Kumar Nath** (T153041), are the students of the department of Electronic and Telecommunication Engineering, International Islamic University Chittagong had carried out the Thesis on **"Design and Performance Analysis of an UWB Micro-strip Patch Antenna for Breast Cancer Detection with Jeans Substrate''**successfully under my supervision and guidance.

_____

Supervisor
Engr. Mohammed JashimUddin
Assistant Professor and Chairman.
Department of Electronic and Telecommunication Engineering
International Islamic University Chittagong.

ACKNOWLEDGMENT

In the name of Allah, the Entirely Merciful, the Especially Merciful. All praises and glory are to Allah (SWT) for blessing us with opportunities abound and showering upon us His mercy and guidance all through the life. And may peace and blessings of Allah be upon Prophet Muhammad (PBUH), a guidance and inspiration to our lives. We express our sincere gratitude and indebtedness to our thesis supervisor **Engr. Mohammed Jashim Uddin**, for his initiative in this field of research, valuable guidance, encouragement throughout the time of research. We also express our thankfulness to him for providing us with best facilities in the department and his timely suggestions. We are also thankful to **Engr. Syed Zahidur Rashid**, Convener of our thesis for his dedication and sacrifice. We also express our sincere gratitude to our entire teacher for giving us the best effort throughout our entire academic years. And we remember our parents for their support in our life till now. And we also express gratitude our friends, well-wishers for their directly or indirectly involvement in the completion of this thesis work.

ABSTRACT

In this emerging technology of microwave in medical science, UWB wireless communication enables a very different way to antenna technology compared to narrow band antenna systems. It can also be usable in microwave imaging technology for breast cancer tumor detection. Our research presents the design and performance analysis of an UWB micro strip patch antenna. By using jeans cloth as substrate material the flexibility of the antenna structure has increased. The antenna bandwidth also increased for the dielectric properties of the substrate. 3.5 GHz to 20 GHz of operating frequency range is gained with minimum -35 dB return loss at 5.5GHz and -45dB at 14.04GHz. The total bandwidth obtained is 18.5 GHz which is comparatively high with an efficiency of around (75-80) % .The UWB and cloth material substrate makes it preferable for using in breast cancer detection equipment.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABRIVATIONS

MPA	Micro-strip patch antenna
MRI	Magnetic Resonance Imaging
RF	Radio Frequency
IRM	Interference Reflection Microscopy
MWI	Microwave Imaging
Hz	Hertz
E	Electric fields
H	Magnetic fields
VSWR	Voltage Standing Wave Ratio
HF	High Frequency
3D	Three Dimensional
EM	Electromagnetic
MWS	Microwave Studio
DS	Design studio
CAD	Computer-aided Design
CMI	Confocal Microwave Imaging
ISM	Industrial, Scientific and Medical
UWB	Ultra-Wideband
HFSS	High Frequency Simulation Software
SAR	Synthetic Aperture Radar
VNA	Vector Network Analyzer
CPW	Coplanar Waveguide
RHCP	Right-handed Circular Polarization
XPD	Cross-polarization Discrimination
FCC	Federal Communications Commission

LIST OF SYMBOLS

O	Gain
B	Bandwidth
E	Energy
ε	Permittivity
σ	Conductivity
μ	Permeability
η	Wave impedance
S_{11}	Return loss (Reflection coefficient in dB)
Γ	Reflection coefficient
Er	Constant of the substrate
Hs	Height of the substrate
W	Width of the patch
L	Length of the Patch
h	thickness
c	Speed if light
F	Frequency
f_0	Resonance Frequency
ε_{eff}	Effective Dielectric Constant
Leff	Effective length
ΔL	Length extension
R	Radius
Hz	Hertz
s	Second
Mb	Megabit
Gb	Gigabit
Nm	Nano-meter
μm	Micro-meter

CHAPTER 1

INTRODUCTION

1.1 Development in Biomedical Application

Cancer is the uncontrolled growth of irregular cells anywhere in a body and it is some models of fatal tumor that scatters unexpectedly to the relaxation of the human corpus. Every year, about one million human beings in the universe are determined with especial sorts of cancers. Statistics concealment that breast cancer is one of the most prevalent forms of tumors that have an effect on women's worldwide, in specific in developing countries. This kind of most cancer catches up with lung cancers which are used to top the listing worldwide with 1.6 million diagnostics and deaths in 2012. Since the latest scientific examination of breast cancer in 2008, instances of this type of most cancer are increasing by greater than 20%, with 14 percent of fatal cases. 1.7 million Females had been diagnosed with breast cancer in 2012.

This tumor is now figure out as the first motive of death among female recognized with cancer, with 5220 dying purposes [1]. In Bangladesh, breast cancer is the most recognized form of cancer. The early detection of cancer increments the probabilities of profitable medication and it will end result in the discount of the excessive range of deaths prompted by this disease. To obtain this, distinctive processes have been designed for breast most cancers detection. In this paper, some antenna models are investigated and optimization is complete cases to get the aspect antennas with the great elements. Biomedical engineering nowadays contains a noticeable place as implies of progressing medical diagnosis and medication.

Nowadays glucose observing, insulin pumps, deep brain recreations, and endoscopy are many cases of the curative fields which can take benefit remote checking framework and body inexorable are broadly investigated for people, within the applications like observing blood weight and temperature, following reliant people or lost pets, wirelessly transferring symptomatic data from an electronic device discovered within the human body for human care, safety and security, namely a pacemaker, to an external RF receiver.

Microwave frequencies extending from 300 MHz to 300 GHz are more noteworthy appealing and helpful for biomedical applications, specifically for biomedical imaging and therapy, as it presents the best spatial choice and profundity of entrance [2]. Additionally microwave frequencies are predominantly helpful for breast tumors identification because of the reality of the huge variety in electrical properties, for example, permittivity and conductivity of the standard breast tissue and malignant tissue.

An antenna is a particular transducer that changes over radio-frequency (RF) fields into rotating current or the other way around. A Transmitter is a lot of hardware used to deliver and communicate electromagnetic waves conveying messages or signals, particularly those of radio or TV. In the medication of malignant tumor, Hyperthermia can be induced by using microwaves energy in an effective way. For this purpose, the radiator used must be easy to handle light-weight and rough [3].

For distinguishing breast disease, Resonance Imaging (MRI) is every now and again utilized demonstrative instruments. Notwithstanding, X-beam mammography produces a generally high number of bogus negative judgments which is somewhere in the range of 10% and 30% and bogus positive conclusions is over 5%. In addition, this cycle utilizes radiation and requires awkward pressure of the breast during the test; which yields restricted accomplishment for patients with thick bosom tissue. Likewise, it is demonstrated that the ionization started from X-ray mammography has a few wellbeing risks, which is incomprehensibly includes the chance of turning solid tissue harmful.

The examinations in clinical sciences have given innumerable biomaterials that can perform, increment, or override the regular limit of a deficient organ by teaming up with the characteristic strategies. These materials show an indistinct class of biomedical utilitarian materials that potentially perform far reaching scope of normal deeds without the principal living tissue or organ, as such override the issues experienced with the blemished tissue or organ and support smooth working of the organ and the living animal. The regular makings demand in the clinical field for the bio decisions that may play out the living activities of generous organs has extended the energy of the researchers to build novel biomaterials. Thusly, the examination of

biomaterials has gotten basic for the material scientists and specialists to see more about biomaterials. [4]

1.2 Radiofrequency

Radiofrequency (RF) is a wavering pace of a pivoting voltage or of an attractive, electric, or electromagnetic field or mechanical system in the recurrence stretches out from around 20 kHz to around 300 GHz. This is around between the uttermost compasses of sound frequencies and the lower farthest reaches of infrared frequencies; these are the frequencies at which imperativeness from a swaying current can transmit off a conductor into space as radio waves. Different beginnings choose distinctive upper and lower limits for the frequency run [5]. Usually apparent from the specialized sessions and workshops given to biomedical imaging, sensors, and MRIs at the as of late held IEEE MTT-S Worldwide Microwave Symposium in Montreal. Besides, in spite of the challenges posed by FDA approvals and special application situations, many RF and microwave firms are finding victory serving medical markets.

1.3 Background

Bioengineering is the exercise of understanding problems within the lifestyle's sciences utilizing a constructing obtainment. To resolve clinical matters go returned thousands of years, format and production of therapeutic devices instruments designed specially. This incorporates prosthetic parts, intended to substitute lacking body parts. Mummies with wood figures have been seen in Egyptian burial places.

Within the late 1700s, Luigi Galvani's tests driven to the investigation of the connection between power and creature physiology. This was driven to the think about utilizing the electrical driving forces of the body as demonstrative signs of wellbeing, like in electro cardiology.

Galvani's student Alessandro Volta discovered the primary battery at the starting of the 18th century and it was around instantly prompted use of power to restorative cases. The discovery by Wilhelm Roentgen of x-rays within the 19th century led to use of electromagnetic radiation for symptomatic purposes. The twentieth century has prompted various marvelous disclosure and advancements, especially concerning the union of mechanical, electrical and substance building strategy into muddled logical

frameworks. Such structures included dialysis, the pacemaker and pacemaker, prosthetic gadgets that could answer, and the DNA looking at that underlies a variation of genetic technologies. As we advancement into the 21st century, bioengineering will continue to be an exuberant locale for high innovative discoveries and energizing new improvements which have the valuable to impressively upgrade the quality of life [6].

At the global level, 18 to 64 per cent of healthcare institutions or organizations are reported to have unsatisfactory Bio-Medical Waste Management (BMWM) facilities predictors involve absence of mindfulness, inadequate assets and modest removal techniques. Many countries lack documented government rules involved to Bio-Medical Waste Management. As the first country India who was implemented Bio-Medical Waste Management rules [7].

1.4 Motivation

In the start of the 2000s, for breast cancer disease identification had been suggested by the utilizations and use of Micro-strip Patch antenna [8]. In this filed, antenna apparatuses must be planned by thinking about the human body. The creators have created reproduction model of human body for breast cancer identification, and the model was entrenched by assessments [9].

Nowadays, X-ray mammography and Magnetic Resonance Imaging (MRI) are the important imaging process for detection and assessment of breast cancer. In any case, there are some own restrictions for those process, e.g. excessive proportion of miss detection, detrimental because of ionizing radiations, high price and long procedure. Hence, these problems are inflicting the researchers to elaborate any other method for breast most cancers detection.

Microwave primarily based imaging approach makes use of the distinction in dielectric properties in ordinary and malignant breast tissues. By deciphering the reflected signs, it is attractive to investigate the measurement and tumor area in the breast. There are two significant microwave imaging strategies, microwave tomography [10] and incredibly huge band radar-based methodology [11]. The Microwave tomography oversees chat disseminating burden in which response from

reflected and communicated waves is reliable to recoup the dielectric property profile of the measures breast.

The early identification of malignant growth builds the potential outcomes of fruitful treatment [12], which will bring about the decrease of the inordinate number of passing's brought about by utilizing this ailment. To obtain this, specific procedures have been designed for breast most cancers detection. Among these approaches, we can cite mammography, MWI, IRM, etc. The microwave imaging (MWI) is some other promising strategy that we are focusing on in this study [13]. It permits for the distinction between cancerous and benign tissues in terms of their dielectric properties [14].

1.5 Objectives

The whole thesis work was based on minding the following objectives:

- To design a simple micro-strip patch antenna for working within 3-20GHz.
- To analyze already existing antenna designs which are used for breast cancer detection.
- To enhance our initial antenna performance in comparison with the already existing designs.
- To tune different elements of the planned antenna for optimal performance.
- To simulate the antenna on the human breast phantom designed to simulate human breast.
- To calculate the results and comparing with already existing result.

1.6 Antenna Basics

Antenna apparatuses are much more than fundamental devices associated with each radio. The voltage from a transmitter goes into a radio which is converted by the transducers. Additionally, they pick radio signals out of the air and for improvement in a recipient, it is converted them into a voltage.

Frequently allowed and cleared out for the final diminutive in a plan, receiving wires are in any case basic for building up and keeping up a solid radio association. They may appear to be unpredictable and enigmatic to most engineers, especially EEs

working with distant applications for the essential time not to determine that they come in evidently relentless assortment of sizes and shapes. Regardless, a brief review of the essentials can help mollify any plan or design worries. Now we get directly down to the investigation of antennas and antenna Fundamentals.

1.6.1 Frequency

Within the most common sense, a case happens per unit of time which is characterized of frequency. In physics and chemistry, the term frequency is frequently connected to waves, counting light, sound, and radio. Frequency is the occasions a point on a wave passes a table reference point in one second. The period or term of time of a cycle of a wave is the corresponding of frequency. Hertz is the SI unit for frequency, which is equal to the older unit cycles per moment (CPS). Frequency is additionally known as cycles per moment or secular frequency. The frequency is basically the quantity of complete cycles the wave finishes in a single second that implies 200 cycles for each second is composed 200 Hz [15].

1.6.2 Radiation Pattern

The antenna radiation pattern example could be a proportion of its capacity or radiation isolating concerning a particular kind of directions.

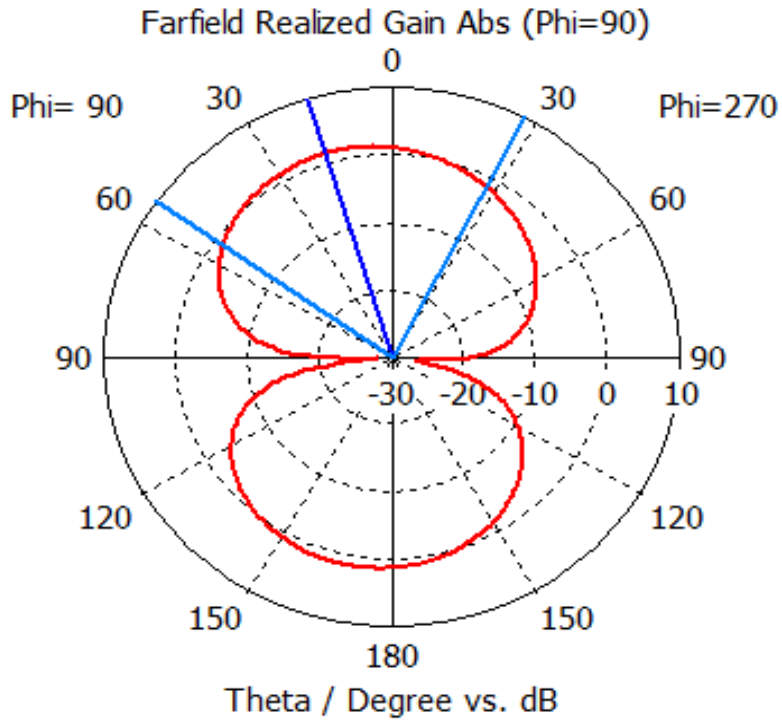

Figure 1.1: Radiation pattern of Micro-strip Patch Antenna [16].

To radiate in a spherically symmetrical pattern, we generally consider round directions as the ideal antenna is assumed. In a radiation greatest along one particular direction, antenna in practice is not omni-directional, as in figure 1.1 . For example, wherein the most absurd radiation happens along the axis of the antenna in case of dipole antenna which is may be a main side antenna. As a component of the heading endlessly from the antenna, the variety of the power emanated by an antenna which is describe the characteristics of a radiation. In the antenna's far field, this power variety as an element of the arrival angle is situated [17].

1.6.3 Polarization

When planning and raising radio antennas, the most important and fundamental term is antenna polarization. A few antennas are vertically energized, others antenna types, but then other antenna types have various models of polarization. A visual representation of polarization is shown in figure 1.2.

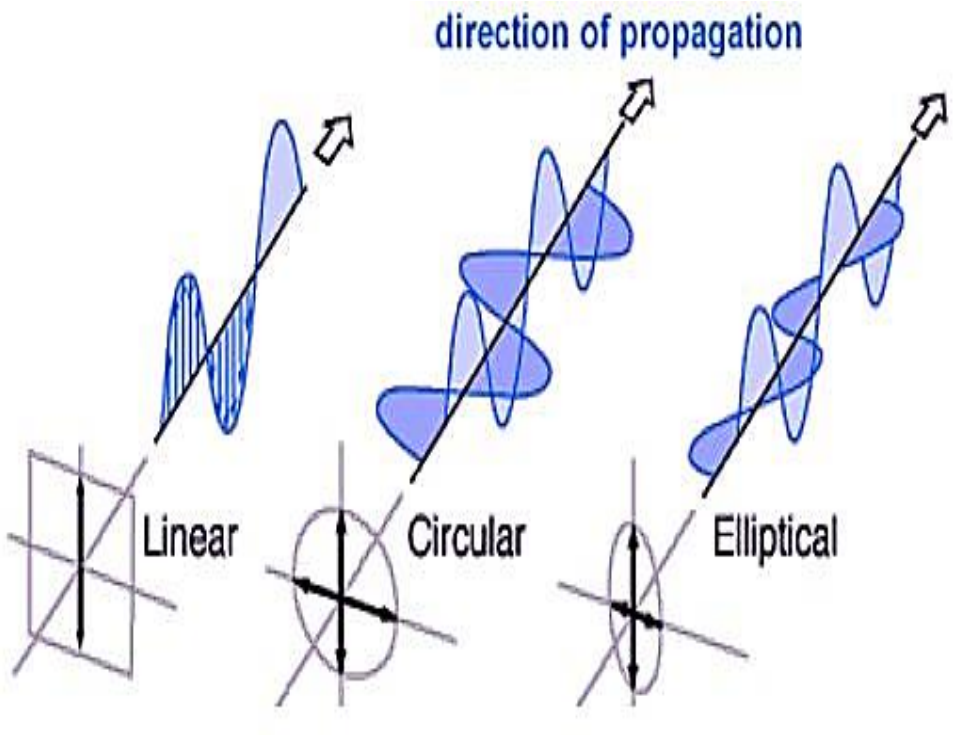

Figure 1.2: Polarization Linear, Circular, Elliptical [18].

When planning an antenna, choosing a specific type of antenna, it is critical to comprehend what direction it should be polarized. Radio antennas with a specific polarization won't be powerful getting electromagnetic wave signals with an alternate

polarization. All things considered, numerous remote and cell phone frameworks may depend on the way that there are probably going to be numerous reflections between the transmitter and the receiver and these will in general imply that a sign will have a specific polarization when it arrives at the beneficiary. Be that as it may, the polarization of the antenna is as yet significant. For the electromagnetic wave the polarization is enough the plane in which the electric wave vibrates. This is noteworthy when taking a gander at receiving antennas in light of the fact that they are fragile to polarization, and commonly simply get or communicate a sign with a particular polarization. It is very easy to originate the polarization for most antennas. As the components of the antenna, it is just in similar plane. In this way, a vertical antenna for example one with vertical components will get vertically spellbound signals best and correspondingly an even antenna will get on a level plane captivated signs. The plane in which the electric field shifts is otherwise called the polarization plane. The fundamental patch secured so far is straightly spellbound since the electric field shifts just a single way [19].

This polarization can be anything among vertical and horizontal relying upon the direction of the patch. To send and get antennas must have a comparable polarization for ideal structure execution. The patch portrayed above yields level polarization and when rotated by 90°, the current streams in the vertical plane and the antenna are by and by vertically captivated. And clearly they ought to be in precisely the same plane to give the optimum signal as per the polarization of the antenna set in free space is significant.

1.6.3 Field Region

At the point when a more noteworthy frequency current streams in a radio antenna, it delivers a high frequency electromagnetic field inside the encompassing space. The point by point structure of this field is typically extremely intricate and decidedly relies upon the antenna shape. Near to the antenna, but in some simple academic cases, there's exceptionally small we can say almost the electric and magnetic areas without including complex numerical calculations. But the great news is that, as we move absent from the antenna, the field tends to see like spherical waves. And the greater the distance is, the better the resemblance with spherical waves. The fields encompassing of an antenna is separated into 3 guideline districts:

- Reactive Near Field
- Radiating Near Field or Fresnel Region
- Far Field or Fraunhofer Region

The far field region is the most noteworthy, as this chooses the reception apparatus' radiation pattern. Furthermore, reception apparatuses are used to impart remotely from significant distances, so this is the region of action for most radio antennas [20].

1.6.3.1 Far Field Region

The far-field is the area far from the radio wire, as you may likewise presume. In this region, the radiation pattern doesn't trade shape with separation. Furthermore, this region is administered through the technique for transmitted fields, with the E-fields and H-fields symmetrical to each extraordinary and the engendering with plane waves [20].In various cases, it is nonsensical or endless to make radio wire plan estimations on a customary far-field go; the separation to the emanating far field might be too long, it might be illogical to move the antenna from its workplace to an antenna run, or the necessary aggregate of example data may require also much time on a far-field tangents..

For these and different reasons, it is often appealing or important to choose far-field antenna designs from estimations made inside the emanating close field district; three essential methods for fulfilling this have demonstrated to be effective. Within the first strategy, the opening stage and sufficiency distributions are inspected by a filtering field probe, and after that, the deliberate conveyances are changed into the far-field.

1.6.3.2 Reactive Near Field Region

In this locale, the fields are predominately responsive fields, which mean the E-fields and H-fields are out of stage by 90 degrees to each other; audit that for engendering or transmitting fields, the fields are symmetrical for instance Perpendicular yet are in stage [21].

It has an inductive effect and along these lines it is generally called inductive field, anyway it has some radiation sections.

1.6.3.3 Radiating Near Field Region

In this area, the reactive fields are not ruling; the transmitting fields begin to rise. Notwithstanding, in contrast to the Far Field district, here the state of the radiation test may withal shift altogether with separation [20].

1.6.4 Directivity

The essential element of an antenna is directivity which is a ratio of how directional the radiation sample from an antenna is. An antenna that radiates similarly every which way would have effectively zero directionality, and the directivity of this sort of antenna would be 1 or 0 dB. Directivity of an antenna is described as the proportion of the radiation power in a provided guidance from the antenna to the radiation power found the middle value of over all directions. The average radiation intensity is identically tantamount to the consummate power radiated by the antenna divided by 4π. Moreover, if the direction isn't carefully shown; the direction of maximum radiation intensity is implicatively insinuated. Directivity is a measurement of the concentration radiation in a direction while gain imitates the power transmitted in the main beam. An example of directivity graph is shown in figure 1.3.

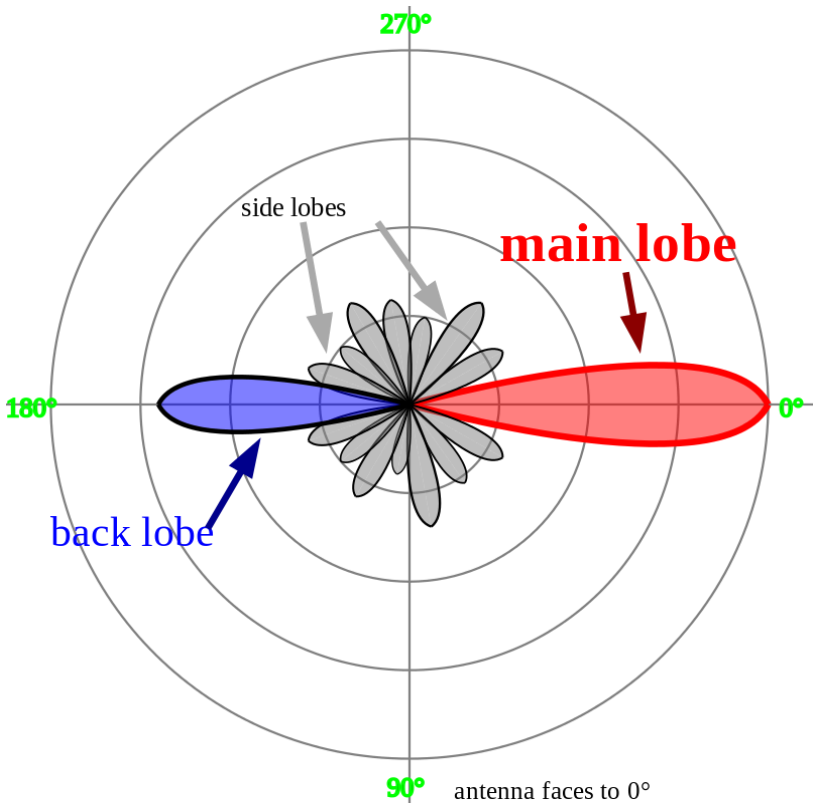

Figure 1.3: Diagram showing of Directivity [22].

1.6.5 Antenna Efficiency

Another important parameter of an antenna is efficiency which is an extent of the power created to the antenna relative with the power emanated from the antenna. A greater efficiency antenna has the vast majority of the quality present at the antennas enter radiated away. In the case of antennas with a low efficiency, most of the strength is absorbed as loss in the antenna or reflected off due to an impedance mismatch. The antenna efficiency or radiation efficiency can be composed as the proportion between the radiated power and the antenna input power. Being a ratio, antenna effectively is a number somewhere in the range of zero and 1[23]. Therefore, antenna efficiency is as a rule cited in expressions of a rate; for instance, an efficiency of 0.5 is equivalent to half. Antenna efficiency is additionally regularly quoted in decibels dB; an efficiency of 0.1 is 10% or - 10 dB, and a proficiency of 0.5 or half is - 3dB.

1.6.6 Antenna Gain

The term Antenna Gain characterizes how much power is communicated toward top radiation to that of an isotropic source. Antenna gain is more prominent than directivity in an antenna's determination sheet since it considers the best possible losses that happen.

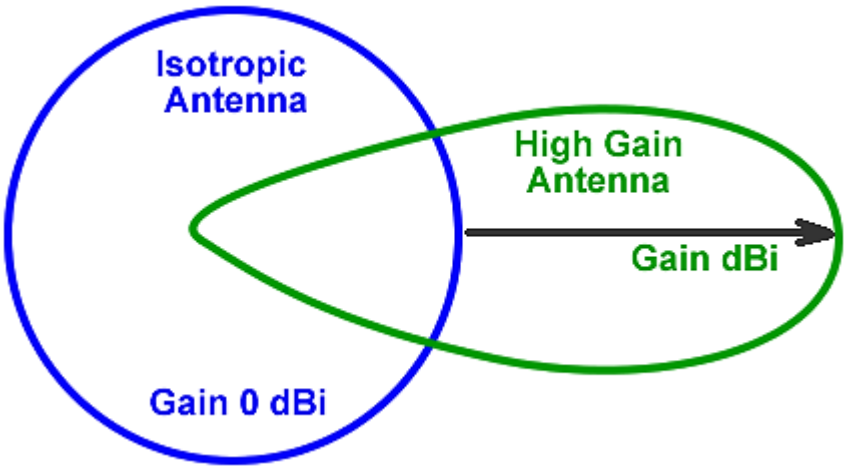

Figure 1.4: Diagram showing of antenna gain [24].

A transmitting antenna with an increase of 3 dB limit that the power got a long way from the antenna will be 3 dB more noteworthy than what might be gotten from a lossless isotropic antenna with a similar info power. Note that a lossless antenna

would be an antenna with n antennas effectiveness of 0 dB or 100%. Correspondingly, an antenna with an addition of 3 dB in a specific way would secure 3 dB additional powers than a lossless isotropic antenna. An example of antenna gain schematic is shown in figure 1.4.

1.6.7 Impedance

Impedance relates the voltage to the current at the contribution to the antenna. The real aspect of the antenna impedance speaks to power that is either emanated away or ingested inside the antenna. The fanciful segment of the impedance speaks to power that is put away in the close to field of the antenna. This is non-emanated power. An antenna with real input impedance is supposed to be full. Note that the impedance of an antenna will change with frequency [25]. A radio antenna takes after some other kind of RF load or signal source. It has a load or source impedance.

So as to get the ideal exhibition, the antenna feeder must be coordinated to antenna to guarantee the most extreme power move. Likewise, it significant to comprehend the feed impedance of any antenna with the better performance that as well as can be expected be gotten. This impedance is also known as the antenna feed impedance. It is confounded impedance and it is made up from a couple of constituents: opposition, capacitance and inductance.

1.6.8 Bandwidth

Another vital antenna parameter is bandwidth. The bandwidth of an antenna is represented by if it is able to operate within the parameters required for that specific application. But sometimes impedance may be an issue, in others; it may be gain or bandwidth. In this way, there are a few ways in which the performance of an antenna bandwidth can be judged.

In most cases, the antenna is worked around the resonant point. This suggests there's as it was a restricted bandwidth over which a RF antennas configuration can work proficiently. Aside from this the levels of reactance ascend to levels which will be also more noteworthy for reasonable activity. Different qualities of the antenna may too be disabled away from the middle working frequency. The antenna can appropriately transmit or obtain energy by bandwidth which is defines the range of frequencies over. Frequently, it is a one kind of discovering elements used to choose

an antenna. For example, some antenna model has thin bandwidth capacities and can't be utilized for wideband activity. The bandwidth capacity of an antenna alludes to the level of frequencies over which the antenna fulfills a specific parameter determination.

The parameters normally determined are gain, radiation pattern, the VSWR, and so on. Most usually, the VSWR is picked as the bandwidth for bandwidth contemplations and this bandwidth is known as the impedance bandwidth. The lower and upper frequencies changing in accordance with the ideal VSWR set the frequency band over which the antenna meets the VSWR assurance.

1.6.9 VSWR

Voltage Standing Wave Ratio (VSWR) is likewise alluded to as Standing Wave Ratio (SWR). VSWR is a component of the reflection coefficient, which portrays the force reflected from the antenna. For a radio transmitter or collector, to create capacity to a antenna, the impedance of the radio and transmission line should be appropriately coordinated to the antenna's impedance. The parameter VSWR is an estimate that mathematically portrays how appropriately the antenna is impedance matched to the radio or transmission line [26].

Standing waves are a fundamental thing taking a gander at feeders or transmission lines, and the standing wave extent or even more customarily the voltage standing wave extent, VSWR is as an assessment of the scope of standing waves on a feeder. Standing waves insinuates control that is unaccepted by the load and reflected back along the transmission line or feeder.

1.6.10 Return Loss

An antenna Return Loss is a figure that exhibits the degree of antenna appearing at the getting wire input that are excused as an extent against those that are recognized. It is resolved in decibels dB relative with a short out or 100% excusal.

Consider the antenna being used in impart mode. The radio waves from the transmitter are directed by methods for a transmission line to the data ribs of the gathering device feed. At all waveguide convergences there is a mechanical screw up, the size of which will choose the size of the significant electrical tangle.

In this way, an extent of the radio waves will be reflected down the transmission line from the reception apparatus input spine association. The rest of proceed into the feed framework. Anyway any blemishes inside the feed framework will again make limited quantities of the episode radio waves be reflected back again towards the info spine.

At last, the radio waves will rise up out of the feed opening to be emanated onto the allegorical reflector, preceding being coordinated into the climate towards their expected objective. Once more, a little level of the radio waves will be reflected back from the reflector into the feed framework and back towards the info rib. [26]

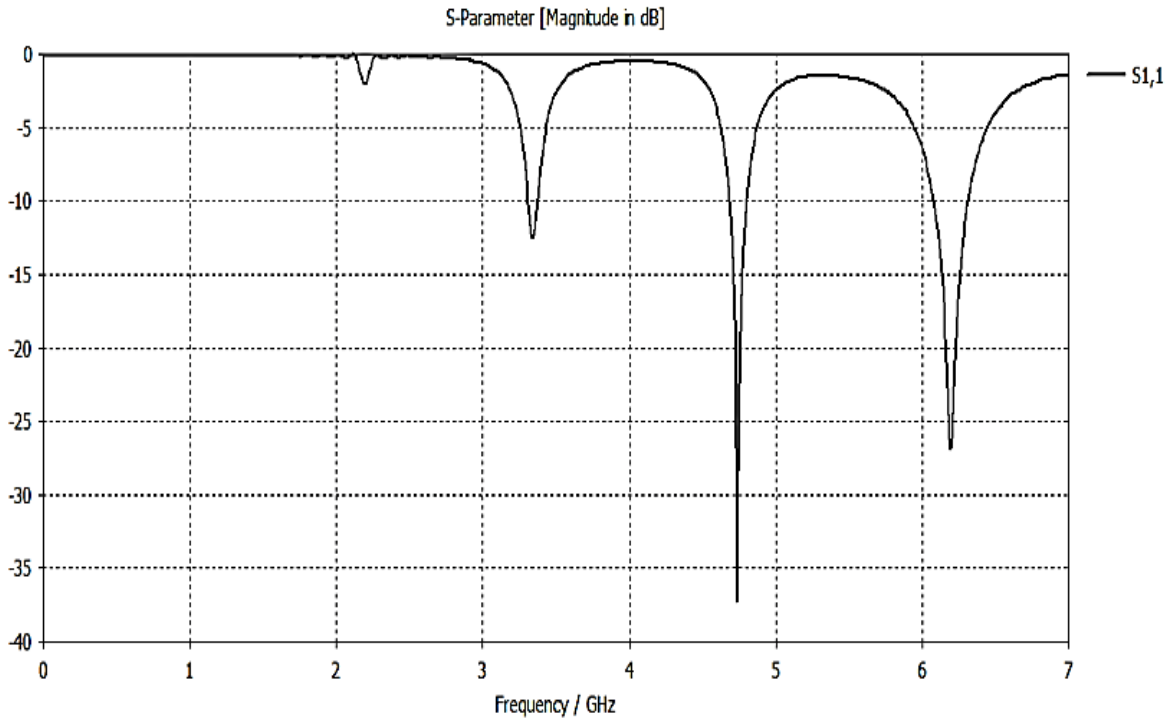

Figure 1.5: Return loss graph of antenna [27].

1.7 Micro-strip Patch Antenna

Micro-strip antenna is the familiar models of imprinted antenna. This antenna plays a very significant role in present wireless communication systems. In this thesis, we talk about micro-strip antenna, their polarization and radiation pattern, applications and upcoming trends. Micro-strip patch antennas have gotten the famous of antenna creators on account of their adaptability and having the upsides of planar profile, simplicity of manufacture, similarity with incorporated circuit innovation, and

comparability with a molded surface. This kind of antenna is commonly lightweight and encased in white or dark plastic to make it unnoticeable to the spectator. The plastic packaging shields the get together from harm and furthermore makes it simple to mount. A fix radio wire is anything but difficult to make and can be redone and planned without quite a bit of an exertion. It is commonly made utilizing similar materials and strategies for plan printed circuit sheets on a dielectric material. A visual case of micro-strip patch antenna is demonstrated is figure 1.6.

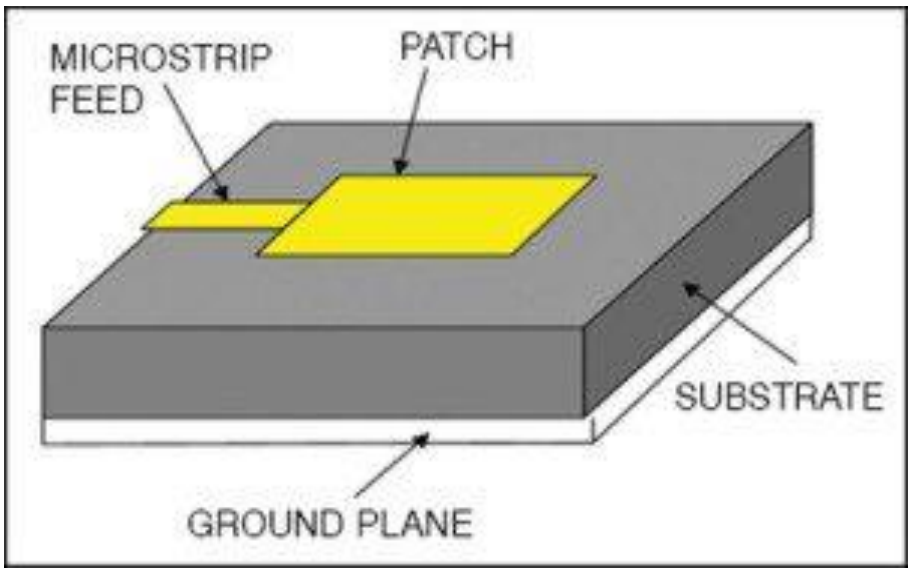

Figure 1.6: Physical geometry of micro-strip antenna [28].

1.7.1 Medical Applications of Micro-strip Patch Antenna

In the treatment of compromising tumors, microwave energy should be the best technique for provoking hyperthermia. The radiator to be used consequently should be light-weight, helpful to regulate, and extreme. Only a fixed radiator fulfills these necessities. The basic plans of small scale strip radiators for inducing hyperthermia relied upon printed dipoles and annular rings that were moved toward S-band 2-4 GHz. Later on, the arrangement relied upon an indirect scaled down strip hover at L-band 1-2 GHz. Two coupled small scale strip lines with a versatile parcel are used to measure temperature inside the human body. For instance, on the off chance that the Antenna has a recurrence 27 MHZ external side the body, at that point it won't give a comparative rate inward side of the body. Additionally, in the event that we find such reception apparatuses inside the body, they may have parts of variable recurrence and this recurrence likewise alterable. That implies such reception apparatuses are

ordinarily named as reverberating receiving wires that don't have a consistent recurrence level inside and outside the human body.

1.7.2 Micro-strip Patch Antenna Feeding Techniques

There are two kinds of feeding techniques. One being contacting and the other is non-contacting. The connecting type feeding has two parts, Coaxial probe and micro-strip line. And non-connecting feeding also has two parts, proximity coupled and aperture coupled.

1.7.3 Coaxial or Probe Feed

In this taking care of cycle, inward conductor of coaxial link is associated with the miniature strip fix of a radio wire and outside one is associated with ground plane. Normally, the feed networks are disengaged from the miniature strip fix, yet in this instrument, it is not normal for that deceptive radiation minimization, simple creation and effective taking care of are the advantages of coaxial taking care of cycle. The coaxial test feed is as appeared in figure 1.7.

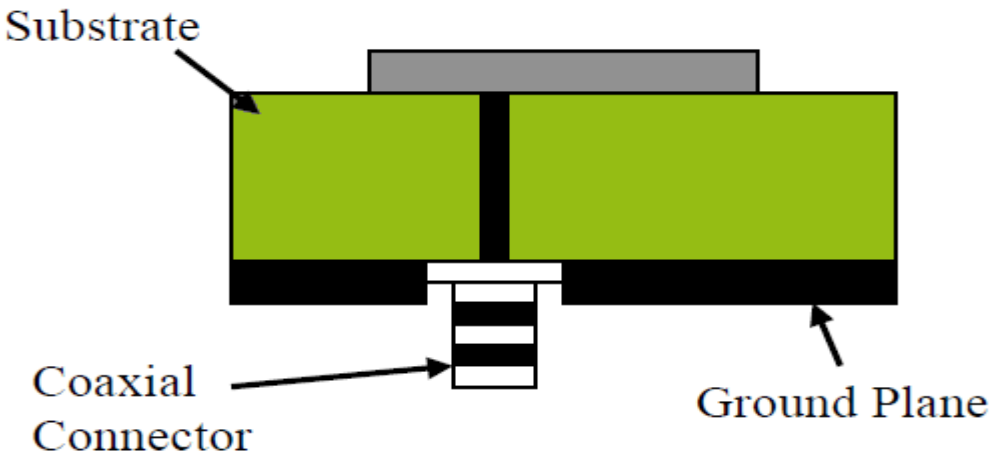

Figure 1.7: Coaxial or probe feed [29].

1.7.4 Micro-strip Line Feed

It is a feeding procedure, where the miniature strip fix is straightforwardly associated with the directing micro strip feed line. The components of the feed line are not quite

the same as miniature strip fix. It is anything but difficult to create and coordinate. The micro strip line feed is as appeared in figure 1.8.

Circuit organizers pick transmission-line progresses reliant on different segments, including foreseen high-repeat execution and effortlessness of utilization. In spite of the way that transmission-line choices fuse some all the more intriguing groupings, for instance, coplanar-waveguide (CPW) advancement, the decision much of the time decreases to either miniature strip or strip line. Seeing the differentiations between the two headways can help ensure about the best other option.

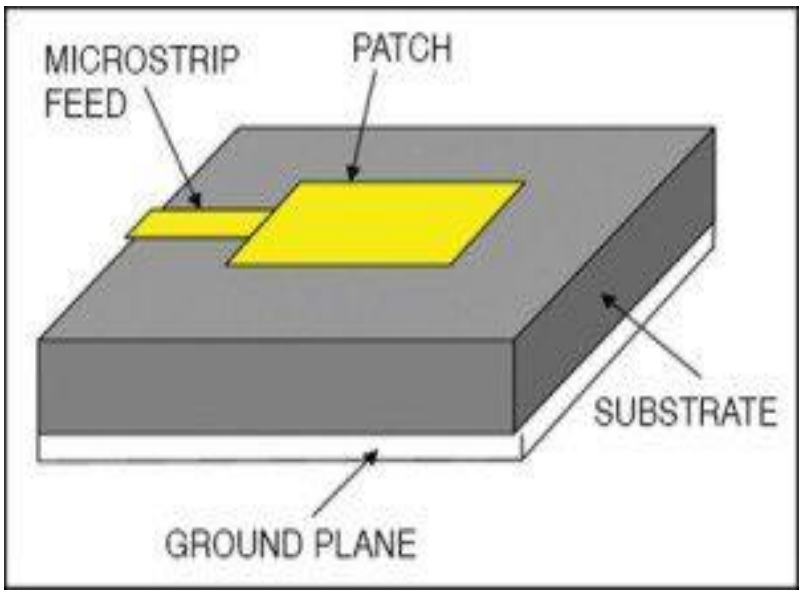

Figure 1.8: Micro-strip line feed [28]

1.7.5 Aperture Coupled Feed

There are two substrates of this feed, which are distinct from each other and are isolated through a ground plane.

In this process, the micro-strip patch is connected with feed line through a slot in the ground plane. Minimization in interference and pure polarization are the benefits of aperture coupled feeding process. In figure 1.9, showing the aperture coupled feed.

The aperture coupled technique exhibits reduced transmission line radiation and enhanced antenna radiation and co- to cross-pol performance relative to micro-strip and probe fed configurations. Researchers have focused on analytical methods and

design improvements without identifying parametric tradeoffs or design methods. Hence, this paper presents theoretically and parametrically identified critical antenna dimensions and performance effects, and a design procedure to convert desired performance requirements into operational prototypes.

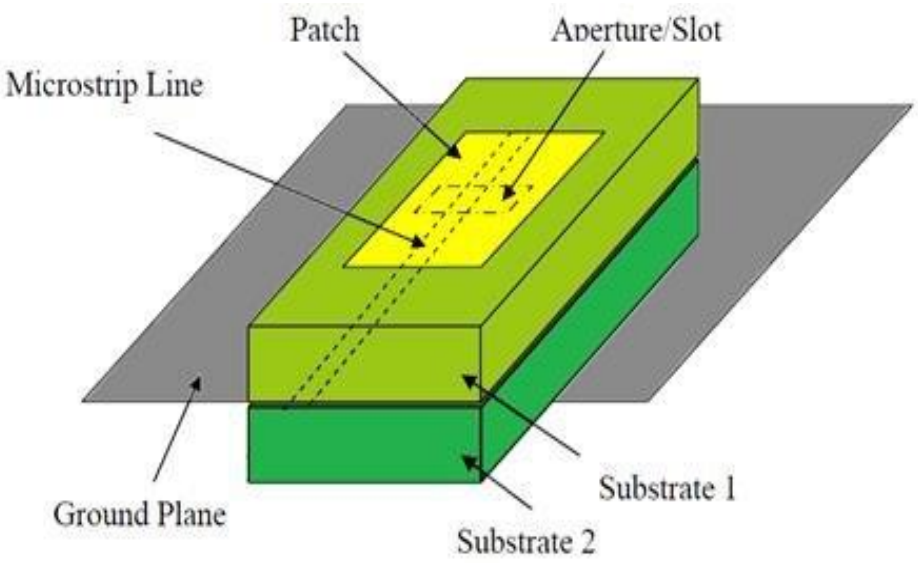

Figure 1.9: Aperture coupled feed [30].

1.7.6 Proximity Coupled Feed

In this feeding process, the fabrication is little bit complex comparatively. There are two dielectric substrates which are used in this method. The micro-strip patch is placed at the higher surface of the upper dielectric substrate and the feed line is there between two substrates. It gives easiest bandwidth and ignores spurious radiation. Also, it can give dual and circular polarizations, wide bandwidth, dual frequency operation, flexibility in feeding line, beam scanning omnidirectional patterning. The structure of the micro-strip patch also matters to get the different outputs [31]. The proximity feed microstrip antenna (PMA) fed via a gap enables switching of the polarization with a simple operation of opening or shorting the end of the feed. However, since the PMA is coupled electromagnetically with the feed line printed on the same surface as the antenna, the effect of the feed line on the antenna characteristics is expected. In figure 1.10, showing the proximity coupled feed-

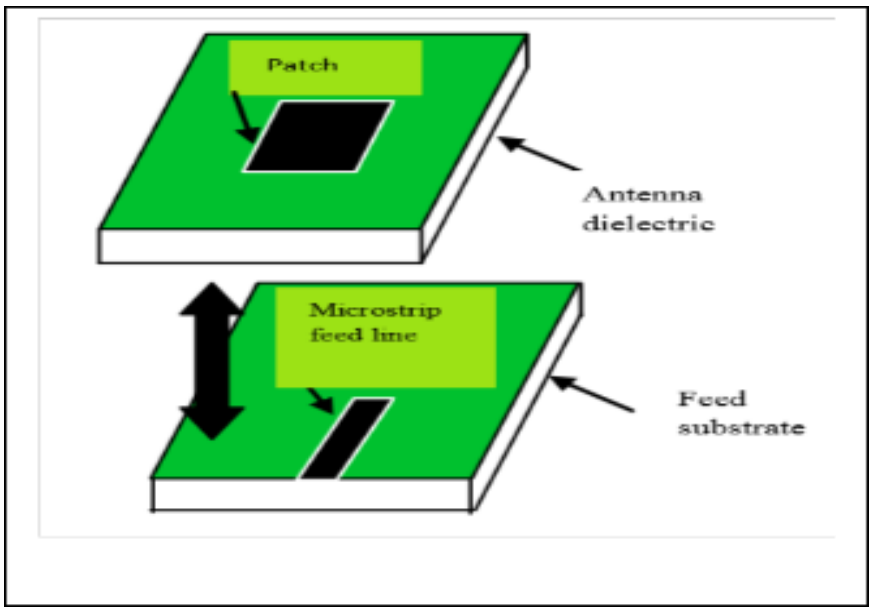

Figure 1.10: Proximity coupled feed [31]

1.7.7 Benefit of Micro-strip Patch Antenna

- Lite weight and less volume
- Planar configuration
- Low manufacturing cost
- Linear and circular polarization both are supported
- Simply operated with microwave integrated circuit
- Capable of multiband operation
- Precisely vigorous when mounted on inflexible surface.

1.7.8 Disadvantages of Micro-strip Patch Antenna

- The artificial radiation entire in many micro-strip emerged antennas like micro-strip patch antenna, micro-strip slot antenna and printed dipole antenna.
- It gives less efficiency because of dielectric losses and conductor losses.
- It gives lesser gain.
- It has greater level of cross polarization radiation.
- It gives lesser power handling ability.
- It has congenitally lesser impedance bandwidth.
- The micro-strip antenna shape radiates from feeds and another point.

CHAPTER 2

LITERATURE RIVIEW

2.1 Literature Review

In this work, a micro-strip patch antenna is intended for wearable microwave breast imaging. The framework for the repeatable one-dimensional array is less perplexing for fundamental tumor detection. Also, it could be reused for multi-layer design which gets the point of a smaller, cost-effectives and precision imaging framework. Because of the proposed antenna is for wearable application, the electric spacer wishes to be actualized as one layer of the proposed antenna which ought to augment the arrival of vitality to the human tissue.

The basic purpose of this exploration is to plan and investigation a UWB antenna for breast cancer detection, and to construct a breast image by applying a Confocal Microwave Imaging (CMI) count that gives high decision picture with satisfied suppression of commotion. This is critical to see the most diminutive component of the tumor with the tiniest antenna estimations. The proposed antenna exhibit gets these targets. The microwave imaging (MWI) is another promising approach that we are focusing on in this study [32]. It allows for the distinction between cancerous and benign tissues in terms of their dielectric properties. This approach has a low cost and offers the possibility to detect the tumor in its early stage compared to many other approaches.

The guideline of the MWI comprises of utilizing a transmitter microwave signal to discharge signal internal the breast and beneficiaries to recognize those radiated signals after they connect with the breast. In the presence of a tumor, for the most part it has bigger dielectric properties [1].

Then the other tissues of the breast, the amount of signal energy scattered by way of the tumor is greater than the one scattered through the fabrics of a normal breast with no tumor. The general exhibition and points of interest of micro-strip patch antennas, especially low weight, low profile, and minimal effort, make them the ideal contender for correspondence engineers. We present the plan of micro-strip patch antenna for microwave imaging; Efficiency and gain of the antennas are adjusted by changing the thickness of the substrate. It is acquired that the more dielectric substrate thickness,

the more would be gain yet it is just up to some point. This is a direct result of an unsavory effect called surface wave excitation because of expanding thickness of dielectric substrate. Surface wave decreases the antenna efficiency and agitate the radiation pattern.

2.2 Methodology

Methodology is the deliberate, hypothetical examination of the techniques applied to a field of study. It contains the hypothetical examination of the collection of methodologies and standards identified with a part of information. Commonly, it includes thoughts like worldview, hypothetical model, stages and quantitative or subjective methods. A technique doesn't begin to deliver arrangements it is along these lines, not indistinguishable as a way. Rather, procedure ology a system a strategy offers the hypothetical supporting for understanding that technique, set of methodologies, or best practices is applied to a chose case, for example, to figure a chose outcome.

1. Topic Selection: The capacity to build up a decent proposal subject is a significant ability. Choosing a decent point for postulation may not be simple. It must be limited and centered enough to be fascinating, yet wide enough to discover sufficient data. My selected topic for this thesis is "Design and Performance analysis of an UWB Micro-strip Patch Antenna for Breast Cancer Detection with jeans substrate". So before selecting this topic, main focus points were-

- what my final goal should look like,
- What is brainstorm for ideas?
- Will this topic be enabled to understand the literature?
- Is it flexible to work?

2. Survey: Survey means studies of the design and simulation of antenna from other antenna and associated survey data collection techniques and methods for improving the results. Main aims for survey were to collect, gather and associate vital papers which were related to this thesis.

3. Literature Review: A literature review is a book of an insightful paper, which incorporates the current information including meaningful discoveries, just as

hypothetical and methodological commitments to a specific subject. A literature review has following targets-

- It observe the literature in decided field of study,
- It analyses the information and evidence in that literature into a summary.
- It critically analysis the information accumulated by determining gaps in present knowledge. For this thesis, a lot of literatures were reviewed which were likely breast cancer detection using micro-strip patch antenna.

4. In this thesis, the objective is the most essential topic for carrying any thesis. To ascertaining the possibility of carrying the study is done by this objective. In general, thesis objectives describe what we expect to achieve by a subject of title. There are four strategic objectives are here to achieving goal from thesis-

- To define areas where thesis evidence could make the most difference.
- To assure that optimally the existing thesis evidence is used.
- To discover a new thesis to help to program planning and appraisement.
- To collaborate in making knowledge about strong quality level. The main objectives for this thesis has following targets-
    - To analyze the design of antenna using CST microwave studio.
    - To compare the performance of antenna's parameters with respect to reference papers.
    - To analyze and achieve the result of simulation.

5. Structure and design: One of the most important methodologies was designing shape of elements. These structures were designed according to their personal theoretic concepts.

6. Output from transmitter: The output from transmitter was properly measured by simulating the transmitter side elements.

7. **Antenna Design:** We design antenna using antenna parameters to detect the cancer tissues.

8. System simulation and results: After using these parameters good performance is measured from the system. The simulation is carried out for different S11 and other parameters.

9. Conclusion: In this paper, a microwave imaging system with an antenna array in the top of a breast phantom has been designed with CST for early breast cancer detection. The results indicate a good impedance matching. An antenna patch in Industrial, Scientific and Medical (ISM) band used to be optimized to biomedical purposes with at 5.7GHz resonance frequency. The created reproduction and the results show that the affectability of tumor identification increments. For future work, huge exploration will be directed to settle the most precise and instructive recreated pictures with Nano-radio wire cluster geography identification. Most clinicians would without a doubt rather have photographs that obviously call attention to the presence of malignant growth than examining nonnutritive element portrayal, so genuine picture reproduction is vital in making methodology direct for clinicians.

2.3 Paper Review

In this section, the works by other researchers that are related to this thesis "Designing Micro-strip Patch Antenna for Breast Detection with jeans substrate" will be reviewed, which is vital element to successful research to the biomedical application with the existing antenna hence, for the design and simulation of an antenna with better performance and easy fabrication.

1. Research paper on, "Design and Analysis of a Micro-strip Antenna Array for Biomedical Applications." [1]

In this research, some antenna models are researched and optimizations are acted so as to get the best antenna with the best parameters. At that point, an entire annular array is planned and experimented. Additionally, some significant elements of the detection system, for example, reflection coefficient, mutual coupling and E-field appropriation are examined. Those parameters demonstrate that the detection system can be claimed. An imaging process for breast tumour composed of a rectangular patch antenna. In this paper, its band is varying from 2.44 GHz to 2.46 GHz and the VSWR is less than 2dB at 2.45GHz.

2. Research paper on, "A Novel Antenna Array Design for Breast Cancer Detection." [2]

In this paper, a Multi-Ring Slots Ultra-Wide Band (MRS-UWB) fix radio wire is arranged, repeated and made for bosom disease location. The outcomes of the made receiving antenna are used to set up the reproduction results. The results addressed in the paper suggest that our proposed reception apparatus plan with CMI computation is a likely chance to amass a gadget that can distinguish bosom tumor even of a 1mm size with significant standard. To the extent we might know, this is the most diminutive size of the perceived tumor with the tiniest size of receiving antenna available. We furthermore plan radio wire exhibit containing eighteen receiving antenna components that can be used in a gadget to perceive bosom tumor at its starting stage. The future stretching of this work is to plan and production an all-out arrangement that can be used for bosom disease location. Additionally, the usage of this radio wire show in other wearable gadgets for malignant growth discovery in various bits of the human body will be a charming and hailing research issue.

3. Research paper on, "4 x 4 Pentagonal Patch Array Antenna for Breast Cancer Detection." [5]

   A pentagonal fix antenna utilizing a FR-4 substrate was proposed. The deliberate and determined recurrence ascribes of S-boundaries of 4 x 4 exhibit receiving antenna coordinate well. Appropriateness of 3-D imaging for bosom malignant growth identification utilizing confocal imaging calculation will be examined later on. A pentagonal fix reception apparatus utilizing a FR-4 substrate and 4 x 4 clusters are proposed by the creators to set up the necessity with planar shape.

4. Research paper on, "Assembly Conformal Antenna Array for Wearable Microwave Breast Imaging Application." [6]

   In this examination, a novel gathering of the conformal reception apparatus cluster for microwave bosom imaging (MWI) is proposed. A couple of 6-component hemispherical antenna clusters is proposed utilizing a lift creator planned flimsy film UWB reception apparatus incorporated into the dielectric spacer. A solitary 6 component exhibit considers identification of the tumor utilizing an unpleasant rendition of the mono-static radar-based strategy. In the reproduction work, a down to earth voxel-based phantom is suggested and sent out from a MRI-checked human bosom.

5. Research paper on, “Circular Antenna Array Design for Breast Cancer Detection” [8]

   In this exploration, an industrial scientific and medical bands (ISM) relative investigation of five miniature strip fix radio wires for microwave imaging at 2.45GHz recurrence, a decision of one receiving antenna is made for a reception apparatus cluster controlled by reception apparatus for a microwave bosom imaging framework, each rudimentary masterminded in a round arrangement, so as that each radio wire component can be straightforwardly looked to the bosom apparition for better tumor identification. This decision was made by putting every reception apparatus on the Breast skin to examine electric field, attractive fields and flow thickness in the sound tissue of the bosom photon planned and mimicked in Ansoft High Frequency Simulation Software (HFSS).

6. Research paper on, “Flexible Sixteen Monopole Antenna Array for Microwave Breast Cancer Detection” [9]

   In this examination, an adaptable, impermeable monopole receiving antenna on a 100μmKapton polyimide is planned, utilizing a huge recurrence structure test system (HFSS), to be in associating with organic bosom tissues over the 2-5GHz recurrence extend. The radio wire boundaries are improved to accomplish a superior impedance coordinate over the necessary recurrence run. The planned radio wire size is 18mmx18mm. Further, an adaptable conformal 4x4 super wideband antenna exhibit, in an all-out structure like that of a bra, was worked for a radar-based breast disease identification framework.

7. Research paper on, “Hexagonal Micro-strip Antenna Simulation for Breast Cancer Detection.” [10]

   In this examination, the plan and recreation of a hexagonal micro strip patch antenna close by a breast phantom reenactment. The antenna is reproduced by proposing a hexagon opening in the point of convergence of the fix an impedance transfer speed just about 5 GHz is gotten. The presented antenna has been arranged and reenacted effectively. Recreation cycle of planned reception apparatus is finished using HFSS programming. The procured results with this

antenna make it a proper reception apparatus for UWB frameworks and similar applications.

8. Research paper on, “Investigation on Simulation based Specific Absorption Rate in Ultra-Wideband Antenna for Breast Cancer Detection.” [11]

   In this examination, breast model is planned with 60 mm span and it insinuates three layers, for instance, skin layer, greasy tissue layer and glandular tissue layer. Here the hurtful tumor is proposed in glandular tissue layer with various sizes and unmistakable zone. Here the UWB receiving antenna is used to recognize the tumor reliant on the SAR. The breast model is mimicked without tumor using a MOSUMMA receiving antenna. The separation among radio wire and bosom model is 10 mm. The most extraordinary typical SAR1g assessment of bosom model is 37.959W/kg and 6.5007 W/kg independently. The overall permittivity of tumor is tremendous when it is differentiated and skin, greasy tissue and glandular tissue layers. Since to its permittivity SAR1g assessment of tumor is high when it is differentiated and various layers .While proposing tumor with relative permittivity (r) of 50 and conductivity of 4 S/m in various sizes and different areas in glandular tissue layer in the bosom model, greasy tissue and glandular tissue layers are changed, at each layer, yet additionally for whole bosom model. For example Tumor is presented with 4 mm in glandular tissue layer arranged at (0, 0, and 45) mm co-ordinate, the neighborhood and normal SAR1g estimation of whole bosom model is 4027.2W/kg and 175.93 W/Kg individually. From this it is reasonable to distinguish the tumor in the bosom model when the nearby and normal SAR1g estimation of whole bosom model is above 37.959W/Kg and 6.5007 W/kg individually in practically all reasons.

9. Research paper on, “Micro-strip Antennas for Direct Human Skin Placement for Biomedical Applications” [12]

   In this exploration, a cycle to diminishing the effect of sign reflection from the breast skin by setting the antenna in-contact with the breast skin. In the revealed cycle, the skin is insinuated a layer of the receiving antenna substrate, and the effect of having the reception apparatus in interface with the skin is incorporated the antenna plan. By then, the arrangement considers setting the antenna on the breast skin. This reductions the sign scattering from the skin and more conveyed

signal is lit on the tumor and extending the tumor distinguishing proof affectability. Plan and reenactment in Ansoft High Frequency Simulation Software (HFSS) is conceded. The recreation results present the current thickness in the breast skin is substantially less while the current thickness in the tumor is a lot higher when the reception apparatus is set straightforwardly on the bosom skin, contrasted with when the receiving antenna is set away from the skin.

10. Research paper on, "Micro-strip Back-Cavity Hilbert Fractal Antenna for Experimental Detection of Breast Tumors." [13]

    In this examination, a scaled down micro strip back cavity Hilbert Fractal Antenna expressly planned for bosom threatening development acknowledgment. This reception apparatus is used to inspect on the opportunity of recognizing the presence of breast tumors by really assessing the move of the receiving antenna resonation recurrence. In the first place, generations are performed on a multi-layer bosom model; by then the proposed approach was applied for in vivo assessments on two interesting patients resolved to have bosom dangerous development, followed by ex vivo portrayal of the electrical properties of extricated tumors. The arrangement of a Back-cavity HFA for microwave disclosure of bosom tumors was presented. The recreation results show that the receiving antenna response is affected similarly as repeat and return adversity when it's inserted on the risky model diverged from the sound one. The Measurement show was applied on 2 particular patients resolved to have bosom danger. Assessment results show significant differences appeared differently in relation to reenacted ones, this part is explained by the way that the theoretical model don't address unequivocally enough the authentic constitution of the bosom, expressly the inhomogeneous arrangement of the glandular territory.

11. Research paper on, "An Integrated Microwave Imaging Radar with Planar Antennas for Breast Cancer Detection." [14]

    In this exploration, the framework plan of the essential radar module custom fitted for clinical imaging applications reliant on a planned handset. The organized circuit, completed in 65-nm CMOS advancement, is companioned by two expressly arranged wideband fix receiving antenna for coordinated transmission and social occasion. The presented fused circuit can be genuinely connected with

the reception apparatus to perform monocratic or biostatic assessments, avoiding the usage of a many-sided trading organization, and feasibly replacing the VNA in the assessment game plan. The coordinated handset can create than 3 octaves from 2 to 16GHz and to assemble the signs reflected by the bosom with a ground-breaking range in excess of 100 db. Because of the handset 14-GHz data transmission and high unique range, and to a 23 cm 15 cm manufactured reception apparatus cluster, the radar framework can distinguish tumors with a goal of 3 mm inside the body, adequate to determine even the littler tumors.

12. Research paper on, "UWB High Gain Antenna Array for SAR Based Breast Cancer Detection System" [15]

    In this examination, the execution of super wideband, high increase, and directional miniature strip antenna cluster show for breast malignancy detection framework. Meta-material cells are used for reception apparatus gain improvement reason. Penetrability and permittivity of meta-material unit cell are refined everywhere on the working transmission capacity. Considering the meta-material cell execution its calculation is adjusted to develop the reception apparatus gain at ultra wide band (UWB) inconsistent force divider is utilized to take care of the proposed four components radio wire exhibit dependent on Chebyshev excitation measure. The proposed radio wire has sensible 3 dB pillar width (3dBBW) and increase of 17.7 degrees and 14.5 dB at 4.12 GHz, individually. The working bandwidth (BW) extends from 5.6 GHz to 10.9 GHz. The proposed reception apparatus is manufactured, estimated, and great arrangement is acquired among reenacted and estimated results. Mimicked explicit assimilation rate SAR is acquired and explored for bosom apparition where a little tumor is set.

13. Research paper on, "Wearable Micro-strip Patch Ultra-Wide Band Antenna for Breast Cancer Detection."[17]

    In this examination, Omni-directional miniature strip UWB radio wire with extended data transfer capacity design to be used in bosom malignant growth recognition. The antenna considers a round emanating patch dealt with by inset dealing with strategy. Certain downsizing methods are used, for instance, partial ground plane for increase of bandwidth to get our desired result. Subtleties of

radio wire plan and reenactment results, for instance, return misfortune and radiation design are inspected in this paper. The last reception apparatus structure suggests extraordinary UWB characteristics and has beaten the transfer speed necessities. Proposed receiving antenna has the upsides of wide data transmission, conservative size and minimal effort, great Omni directional radiation designs for utilizing in microwave imaging applications. The greatest estimated gain for the manufactured radio wire is around 6.1dBi with a normal productivity above 88% all through the data transfer capacity. In this paper in new minimized UWB radio wire configuration has been allowed. The working data transfer capacity of reception apparatus at any rate useable return loss of 10 dB accomplished was 2.01 GHz to 16.78 GHz. This receiving antenna has the advantages of wide transmission capacity, reduced size, negligible exertion and incredible Omni-directional radiation plans with fitting increment of 9dBi with a normal productivity above 86% all through the transfer speed considered as insinuated for microwave imaging application for bosom malignancy identification.

14. Research paper on, “Design and Analysis of Circular Patch Micro-Strip UWB Antenna for Breast cancer Detection.”[32]

    In this examination, Omni-directional miniature strip UWB reception apparatus with expanded data transmission configuration to be utilized in bosom malignant growth location. The antenna considers a roundabout emanating patch took care of by inset taking care of procedure. Certain scaling down strategies, for example, fractional ground plane used for expansion of data transfer capacity so as to get our aim. Subtleties of antenna plan and reenactment results, for example, return misfortune and radiation designs are talked about in this paper. The last antenna structure allows great UWB qualities and has outperformed the transfer speed necessities. Proposed radio wire has the upsides of wide data transmission, minimal size and ease, great Omni directional radiation designs for utilizing in microwave imaging applications. The most extreme estimated gain for the manufactured antenna is around 6.1dBi with a normal effectiveness above 88% all through the data transfer capacity. In this paper in new smaller antenna configuration has been conceded. The working data transfer capacity of antenna at any rate useable return loss of 10 dB accomplished was 2.01 GHz to 16.78 GHz. This radio wire has the benefits of wide transfer speed, smaller size, ease and great

Omni-directional radiation designs with reasonable addition of 9dBi with a normal productivity above 86% all through the data transmission considered as alluded for microwave imaging application for bosom malignant growth discovery.

15. Research paper on, “Design and development of implantable CPW fed monopole L-Slot antenna at 2.45 GHz ISM band for biomedical Applications.”[33]

    In this exploration, discoverable Coplanar Waveguide (CPW) took care of monopole opening antenna for mechanical logical and clinical (ISM) band biomedical uses of measurement 25mm×16mm×0.5mm at ISM band from2.4 – 2.48 GHz and short separation correspondence band which is Electronic Communications Committee endorsed the recurrence band 688 MHz . The reception apparatus is arranged on human tissues like skin, fat, muscle, etc. Additionally, it is made practical for implantation by introducing it on alumina earthenware substrate. This Implantable CPW dealt with monopole space antenna are effectively used in implantable biomedical components on account of the advantages, for instance, versatility in plan, similarity, size, prosperity and low force use.

16. Research paper on, “Design and Development of Single Layer Micro-Strip Patch Antenna for Breast Cancer Detection.”[34]

    In this examination, another space reception apparatus developed for breast malignant growth identification framework. The segments of the space, feed and ground have been picked so the reception apparatuses works in a perfect world, with the opening in interface with an organizing medium that has electrical things like that of regular bosom tissue. Make sense of this paper is as indicated by the going with; the newly arranged single layer hole coupled miniature strip fix gathering contraption is presented close by an opening dealt with, twofold layer stacked fix antenna which was as of late planned for a comparative application. The introduction of the two antennas is examined. A solitary layer miniature strip fix antenna proposed for use in of bosom disease recognition framework has been presented and diverged from a twofold layer fix radio wire which was as of late planned for a comparable application. Return misfortune assessments show that two reception apparatuses have expected transmission capacity for use in an ISM band (2.4 – 2.48 GHz) discovery framework and incredible comprehension has

been found between reenacted results for both tight opening and wide-space radio wire. Due to greater radiation model and directivity of single layer pitch antenna the figuring and electrical things of bosom disease can be assessed correctly for rapidly analysis.

17. Research paper on, "Capacitive Loaded Circularly Polarized Implantable Patch Antenna for ISM Band Biomedical Applications."[35]

In this examination, using the capacitive stacking on the radiator Differentiated and the fundamental geology of the proposed antenna, the supposed square fix reception apparatus with a center square space, the proposed procedure has the advantage of good size reduction and incredible polarization goodness. The impression of the planned radio wire is 10x10x1.27 mm. The mimicked impedance, center point extent, and radiation configuration are analyzed and contemplated in two proliferation models: cubic skin spirit and Gustav voxel human body. The effect of different body ghost is discussed to assess the affectability of the planned radio wire. The effect of coaxial connection is moreover inspected. There are two normal approaches to manage address the biocompatibility issue for useful applications is represented as well. The duplicated and assessed impedance transfer speed in cubic skin ghost is 7.7% and 10.2%, exclusively. The introduction of the correspondence interface between the installed CP reception apparatus and the external radio wires is also presented. A reflection coefficient of under 10 dB and the AR data transfer capacity that is secured from 2.44 to 2.48 GHz (1.63%) for pivotal proportion (AR) 3dB.The simulated outcomes imply that the bringing down in the middle frequency can compare to an antenna size decrease of about 72% by utilizing the suggested plan instead of the ordinary implantable CP micro-strip patch plan at a fixed working frequency. The peak gain is 22dBi at 2.45 GHz which were simulated. The principle polarization of this arranged antenna is correct given right-handed circular polarization (RHCP) with cross-polarization segregation (XPD) 22 dB at the primary radiation bearing.

18. Research paper on, "Ultrasound-guided microwave imaging of breast cancer: Tissue phantom and pilot clinical experiments." [36]

    In this exploration, a multimodality approach for high-resolution microwave imaging, where microwave picture generation is on a very basic level guided by

ultrasound imaging. The united imaging thought is indicated using tissue apparition assessments obtained from a 16x15 transmitter/recipient microwave imaging framework and a changed B-mode ultrasound framework. With the count of the target and establishment known from the before ultrasound, viable dielectric property pictures are recovered using a restricted element-based proliferation estimation. We show that a goal as meager as 1.2 mm in estimation can be imaged with the multimodality approach, while it is hard to recognize such a small-size object using microwave imaging alone. The pilot clinical examinations on two cases suggest that bosom tumors can be altogether more accurately recognized by the multimodality strategies.

19. Research paper on, “A modified Bow-Tie Antenna for Microwave Imaging Applications.” [25]

In this research, a newly designed, compact bow-tie antenna was constructed and created. The outcomes show that the created antenna gives a return loss of - 24dB at 5.8GHz and is in better agreement with the simulation results. The reenactment results additionally show that by changing the elements of the antennas, the resounding qualities can be improved.

20. Research paper on, “Effect of Lesion Morphology on Microwave Signature in 2-D Ultra-Wideband Breast Imaging.” [26]

In this paper, the possibility of perceiving obliging and hazardous masses by methods for abusing the morphology-subordinate common and ridiculous proportions of their microwave backscatter reaction in ultra wideband bosom disease identification. The estimated edge profiles of 2-D bosom masses are created by strategy for changing the standard round rings reliant on upon the irregularity of their peripheries. Furthermore, the single-and multilayer sore models are used to speak to an undeniable mass spot watched by methods for a sharp change to establishment, and a clouded mass periphery showing a consistent advancement to establishment, separately. In like manner, the tangled normal resonances (CNRs) of the backscatter microwave imprint can be gotten from the late-time target reaction and reveal decisively profitable information. The partial succession CLEAN calculation is proposed to assess the injuries' protract stretches and find the late-time reactions. At last, it is demonstrated

through mathematical models that the territories of predominant CNRs depend on the injury morphologies, where 2-D computational breast apparitions with single and more than one sore are researched. The experiment is of serviceable use for separation among amiable and dangerous injuries, where the previous by and large has a superior characterized, more smaller structure rather than the last mentioned.

21. Research paper on, "Breast Tumor Detection System Based on a Compact UWB Antenna Design." [40]

In his paper, a novel breast model technique dependent on a UWB antenna for finding a tumor malignancy. The antenna with normal size of 36 mm×21 mm×1.7 mm is portrayed include a super wideband of 120% and frequency range of three GHz-12 GHz for the FCC band. The planned antenna uncovers right impedance coordinating, unnecessary addition and Omni-directional radiation designs. The estimation results are acquainted with exhibit the exhibitions of the planned antenna. This antenna has been applied in an arranged framework model with dielectric properties of a human bosom proficient to watch strange items. The measurement and limitation directions of the tumor are read in component for satisfied tumor location. The directions of the comparing most extreme estimation of SAR are perceived so as to absolutely watch select location of tumor inner side of the breast. The outcomes display that the confinement of the tumor can be distinguished with inordinate exactness which exhibits the presentation of the planned antennas and the whole techniques.

22. Research paper on, "Small planar monopole UWB wearable antenna with low SAR." [39]

    In this paper, using a UWB jeans antenna and appraise the protection levels through showing the estimated. Explicit Absorption Rate (SAR). Easy cast of the plan was pointed so as to manufacture the antenna with fewer blunders. A rectangular patch situated at 32×34 mm2 jeans substrate with incomplete ground as per supposed design. Recreated and estimated S11 boundary for the antenna at free space is accounted for in this paper. Emulated radiation designs are furthermore defined in this paper. To created model of human arm analyzed by the general presentation of the antenna. In order that, the antenna set at 5, 10, 15 and 20 mm a long way from the phantom, assessment of SAR has added ascertaining 10g SAR.

2.4 Summary

Several researchers were done on designing micro-strip patch antenna for biomedical applications and bandwidth including 2 GHz, 6 GHz, 14 GHz and others. From the current researchers it is clear that the bandwidth 2 GHz to 15 GHz band is the most potential and important candidate for biomedical applications as many researchers have been performed encompassing this band of frequency. A microwave imaging method with a pair of antennas in 2 other side of a breast phantom has been designed with CST for early breast cancer detection. The results indicate a good impedance matching. An antenna patch in Industrial, Scientific and Medical (ISM) band was by 5.5GHz resonance frequency to biomedical applications.

2.6 Thesis Outline

This thesis work has been arranged into five chapters. Every contents of every chapter are shortly discussed under.

This thesis is based on biomedical application of microwave engineering. That's why chapter 1 is consists of the background of biomedical and the motivation for this thesis, objectives of this thesis. Brief discussion of Micro-strip Patch Antenna and the history of biomedical have been studied in this chapter. After carrying the literature review regarding this thesis.

Work has been already discussed in this chapter. In this chapter literature review of related field work has been carried out along with designing an antenna, imaging. Understanding the parameters is important to find out the actual research and its goal and hence the parameters are studied in this chapter.

System model used in this thesis has been studied in chapter 3. In this chapter, the brief discussion of the software we used has done and our proposed design has been discussed thoroughly. CST Microwave Studio is very powerful tool for design an antenna and in this chapter about this software has been briefly discussed. We used CST Microwave Studio software to carry out our simulation and results are prepared using CST Microwave Studio. Results are discussed in chapter 4.

Finally, for our thesis work has been completed in the conclusion and future work section in chapter 5.

CHAPTER 3

SYSTEM MODEL

3.1 Research Design

The structured that has been fashioned to find solutions to the research questions is defined as research design. The design of a research work outlines the research resources such as research questions, dependent and independent variables, experimental design and where applicable, data collection techniques and a statistical trial plan.

Research design for this research:

- Study on antenna requirements for biomedical.
- Select bandwidth.
- Study literature on micro-strip patch antenna and other existing antennas.
- Study procedure of micro-strip antenna design.
- Study antenna design procedure in CST Microwave Studio.
- Calculate necessary parameters to design antenna.
- Find out best substrate material.
- Find out best substrate height.
- Find out best feeding technique.
- Implement the procedure.

3.2 Software

CST MICROWAVE STUDIO is one of the most famous tools. It is utilizing for high recurrence components with 3D EM reenactment. CST MWS gives the brisk and legitimate cycle of high recurrence (HF) units like radio wires, channels, couplers, planar and multi-layer developments and SI and EMC impacts. Particularly easy to use, CST MWS rapidly gives you knowledge into the EM conduct of your more noteworthy recurrence plans. For 3D EM, CST creates all out innovation. Clients of our product program are given acceptable adaptability in handling an enormous application go through the assortment of open solver techniques. Besides, the lead module, the generally open Time Domain solver and the Frequency Domain solver, CST MWS inclines toward likewise solver modules for extraordinary applications.

Channels for the import of specific CAD documents and the extraction of SPICE boundaries augment plan prospects and spare time. Furthermore, CST MWS can be embedded in various industry standard work measures through the CST STUDIO SUITE UI. CST MICROWAVE STUDIO is seen by a growing number of planners as an endeavor standard progression instrument [26].

CST Studio Suite lean towards programmed advancement schedules for electromagnetic frameworks and gadgets. CST Studio Suite models can be characterized with respect to their numerical estimations or material properties. This enables Users to analyze the activity of a gadget as its properties change. Clients can glance through the ideal plan boundaries to get a given effect or satisfy a specific goal. They can in like manner adjust material substances to fit determined information. CST Studio Suite contains diverse customized progression counts, both neighborhood and internationally. Nearby streamlining agents give quick union yet hazard uniting to a neighborhood least instead of the general great arrangement. Likewise, worldwide enhancers find the entire issue space anyway routinely require more figuring's. Elite registering cycles can be used to quicken proliferation and smoothing out for complex framework, or issues with colossal amounts of elements. The show of worldwide enhancers in certain can be altogether advanced with the usage of circulated preparing [19].

3.2.1 Minimum System requirements for CST MICROWAVE STUDIO

EM simulations can be named elite processing assignments. This implies PCs utilized for CST applications must meet high prerequisites as far as CPU, RAM, and graphical determinations so as to accomplish ideal execution. Adequate force gracefully and cooling must likewise be guaranteed for the workstation or server. We emphatically suggest purchasing a total bundle from a brand-name maker, for example DELL, HP, or IBM, and that the picked equipment meets the accompanying prerequisites.

- **Processor:** Intel Core 3 , AMD Ryzen 3
- **Memory (RAM) :** 16 Gb
- **Graphics Card:** 100% OpenGL compatible graphics card.
- **Storage :** 30GB of free disk space
- **Operating System:** Supported 64-bit operating system. Windows 7/8.1/10, RHE Linus 6.x/7.x/8.x.

3.2.2 CST Microwave Studio Solver List

CST Microawave Studio has Multiple Electromagnetic (EM) simulation solver procedures which use strategies, for example, the Finite Element Method (FEM) the Finite Integration Technique (FIT), and the Transmission Line Matrix Method (TLM). These speak to the most remarkable universally useful solvers for high frequency simulation assignments. Extra solvers for master high frequency applications, for example, electrically huge or profoundly full structures supplement the broadly useful solvers.

CST Microwave Studio involves FEM solvers devoted to static and low frequency applications, for example, electromechanical parts, transformers or sensors. Close by these are frequency strategies accessible for charged molecule elements, hardware, and multiphysics issues.

CST Studio Suite Solver are:

1. High Frequency Solvers: High Frequency Solvers are divided into Seven Sub-Solvers.

    - Time Domain: This solver registers the progression of fields through time at discrete regions and at discrete time tests, which is incredibly compelling for most high-repeat applications and can get the entire broadband repeat lead of the reproduced contraption from a solitary count.

    - Frequency Domain: This solver utilizes the finite element method (FEM) with front line tetrahedral cross segment to clarify Maxwell's conditions in the repeat space. While an old style repeat space amusement would be resolved repeat by-repeat, CST uses two broadband procedures, one for all around valuable and one diminished solicitation for high-Q structures.

- Eigenmode: Used to compute the frequencies and relating electromagnetic field plans when no excitation is applied. Mishaps with the notion of a repeat free complex permittivity or reluctivity are open. If waveguide ports are used, essentialness may leave the contraption through those terminals.

- Integral Equation: The fundamental condition solver discretizes as far as possible using the Multilevel Fast Multipole Method (MLFMM) which applies for the remarkable eagerness of electrically enormous models.

- Asymptotic: An asymptotic figuring is an examination in the repeat territory subject to an alleged beam following strategy, ordinarily used for dispersing or radio wire circumstance for electrically incredibly colossal zones.

2.Low Frequency Solvers: Low Frequency Solvers are divided into two Sub- Solvers.

- Low Frequency – Frequency Domain (LF-FD): A 3D solver for mimicking the time-harmoni lead in low recurrence frameworks that is important for reproductions of curls utilized for remote force move.

- Low Frequency – Time Domain (LF-TD): A 3D solver for mimicking the transient lead in low recurrence frameworks which fuse vortex streams, non-straight effects and development. Resistive-capacitive effects may in like manner be illustrated.

3. Static Solvers: Static Solvers are divided into three Sub-Solvers.

- Electrostatic: A 3D solver used for simulating static electric fields.

- Magnetostatic: A 3D solver used for simulating static magnetic fields.

- Stationary Current: A 3D solver for simulating the flow of DC currents through a device, especially with lossy components.

4. Multiphysics Solvers: Multiphysics Solvers are divided into four Sub-Solvers.

- Steady State Thermal: Figures the fixed temperature dispersion of a framework. Warmth sources can incorporate electric and attractive fields, flows, molecule impacts, human bio-heat, and other pre-characterized sources.

- Transient Thermal: Computes how a framework warms after some time. Warmth sources can incorporate electric and attractive fields, flows, molecule impacts, human bio-heat, and other pre-characterized sources.

- Conjugate Heat Transfer: Joins warm and liquid elements reenactment strategies, and can calculate the warming of a contraption while taking convection and fan cooling into thought.

- Mechanical: Offers linear and non-linear methods for calculating the displacement and deformation of structures.

5. Particle Dynamics Solvers: Particle Dynamics Solvers are divided into three Sub-Solvers.

   - Particle-in-Cell: its a flexible, self-predictable reproduction technique fused for molecule following that ascertains both molecule direction and electromagnetic fields in the time-area, considering the space charge impacts and common coupling between the two.

   - Particle Tracking: A 3D solver for simulating particle trajectories through electromagnetic fields.

   - Wakefield: A solver that calculates the fields around a particle beam and the wakefields produced through interactions with discontinuities.

6. PCB Solvers: PCB Solvers are divided into one Sub-Solvers.

   PCBs & Packages: A tool for signal integrity (SI), power integrity (PI), and electromagnetic compatibility (EMC) analysis on printed circuit boards (PCB).

7. Cable Solvers: Cable Solvers are divided into one Sub-Solvers.

   Cable Suite: It is dedicated to the 3D analysis of signal integrity (SI), radiated emission (RE), conducted emission (CE), and electromagnetic susceptibility (EMS) of complex cable structures in electrically large systems.

8. Circuits and Systems: Circuits & Systems are divided into Two Sub-Solvers.

   - Schematic: Easy-to-use and powerful schematic design tool to simulate systems & circuits.

- Assembly: Layout used to integrate complex structures for synthesis and optimization.

9. Enhancements and Addons: Enhancements and Addons are divided into Three Sub-Solvers.

- Design Study & Optimization: Fully-integrated parametric study and optimization tools are built into every design module.

- Hardware Acceleration: Included in the base value, influence boundless centers in your one/two-attachment workstation. Extra equipment quickening agent tokens can be bought for GPU(s), quad-attachment frameworks, and group processing.

3.3 Design procedure

Step 1: Firstly, micro-strip patch antenna (MPA) is intended to work in 5 GHz, depend on the fundamental conditions of planning MPA which is called condition based antenna.
Step 2: Secondly, different diameter of the central circular patch is simulated to find out best one based on biomedical requirement.
Step 4: Different sized triangles (T) is simulated for further enhancement.
Step 5: Best substrate material, best substrate height and best feeding technique used to design 5 GHz and 15 GHz antenna.
Step 6: Save the structure and simulate the developed antenna,
Step 7: Save the result if antenna follow the criteria.
Step 8: Optimize the developed Micro-strip patch antenna for better performance.
Step 9: Save the structure and simulate the developed antenna.
Step 10: Save the result if antenna follow the criteria.
Step 11: Compare the result with existing antennas.

Flow diagram of the Research work shown in figure 3.1

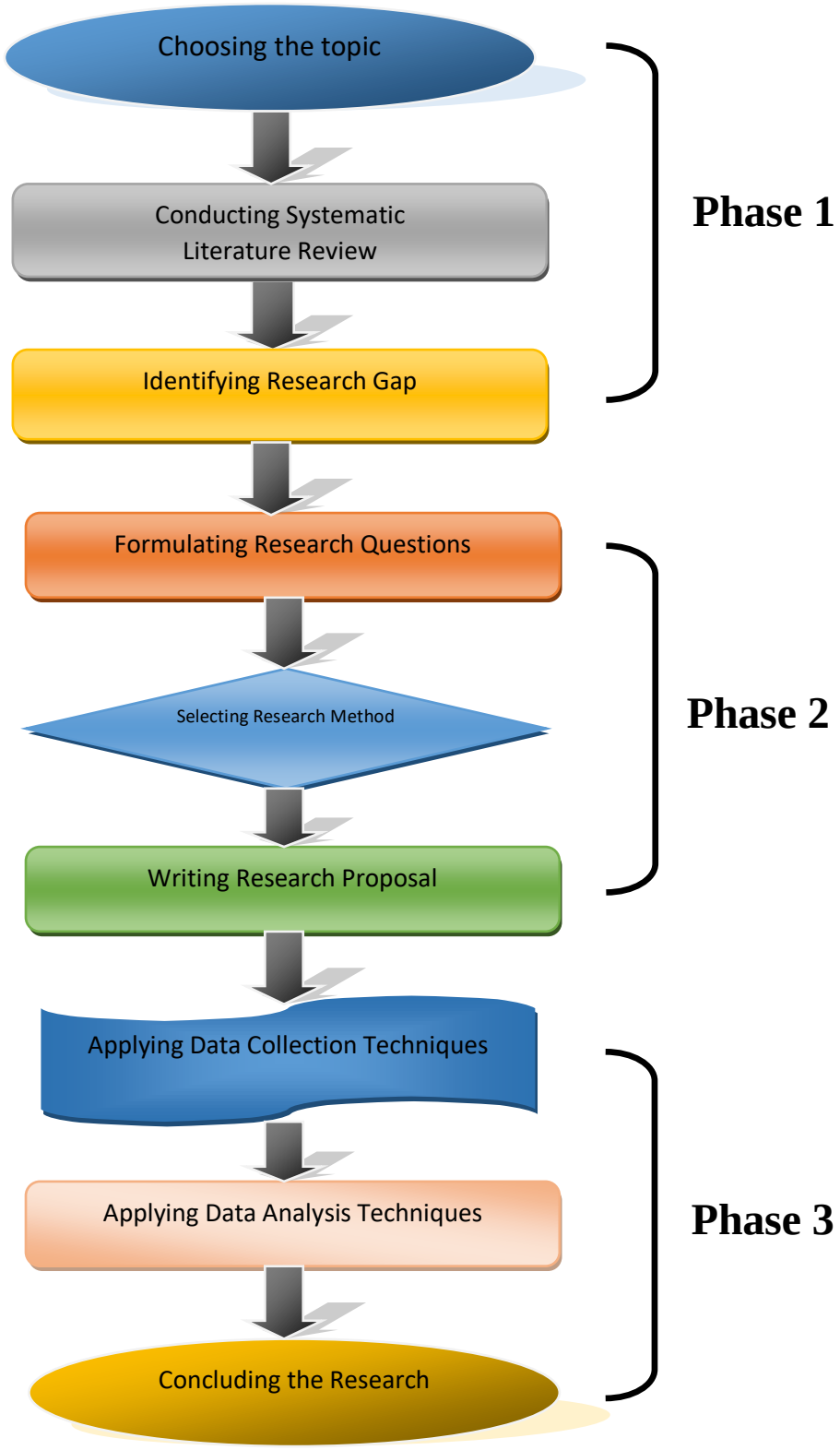

Figure 3.1:Flow Diagram of the Research work.

3.3.1 Antenna Substrates

The initial step of designing antenna is to pick a suited substrate of appropriate thickness. Dielectrics are used to improve electrical and mechanical stability. They are used to decrease the size of the antenna and help to generate displacement current which in turns produces time various magnetic field by Ampere's Law. The time varying magnetic field can in turn in produces time varying electric field by Faraday's Law and a propagating electromagnetic field is prepared. Moreover, flexible electronics is becoming an appealing candidate for the next generation of consumer electronics due to light weight, low cost of manufacturing, ease of fabrication, and the availability of inexpensive flexible substrates (i.e., papers, textiles, and plastics) [2]. Flexible electronic systems also incorporate flexible antennas to provide additional room for system trade-off space and design flexibility.

The proposed antenna comprises of a substrate made of jeans and a metallic radiator. This examination has required inspecting the properties of the form utilized for substrate. A trial was done to decide the permittivity and loss tangent of the form. The average value of the dielectric constant and loss tangent found to be 1.76 and 0.078 respectively. The comparative data of different dielectric materials are shown in Table 3.1.

TABLE 3.1: LIST OF SUBSTRATES.

Dielectric Name	Dielectric Element
FR4	4.4
RT Duroid-6002	2.94
RO4730	3
Rogers RO 3200	3.02
Rogers RT Duroid-5880	2.2
Rogers RT Duroid-5870	2.33
Foam	1
Jeans	1.76

3.3.2 Antenna Design by equation

The part of this antenna design methodology is divided into various segments. The first one is designing the antenna radiating patch, this section generally comprises with estimating the length and width of the patch. For designing this antenna radiating

patch is required some sub-parameter which are the dielectric constant of the substrate, height of the substrate and the resonance frequency of the antenna. The second one is the feeding technique has been designed. There are basically two feeding technique used to design this antenna, the one is inset fed and the other is quarter wave transformer feeding technique. And ultimately, the quarter wave transformer feeding method have selected as the feeding technique.

3.3.3 Radiating Patch calculation

Step 1: Estimation of the Width (W) –

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}} \quad \ldots\ldots (1)$$

Step 2: This calculation represents the Effective Dielectric Constant which is depend on the height, dielectric constant of the dielectric and the estimated width of the patch antenna.

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}} \quad \ldots\ldots (2)$$

Step 3: Calculation of the Effective length

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} \quad \ldots\ldots (3)$$

Step 4: Calculation of the length extension ΔL

$$\Delta L = 0.412h\frac{(\varepsilon_{eff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad \ldots\ldots (4)$$

Step 5: Calculation of actual length of the patch

$$L = L_{eff} - 2\Delta L \quad \ldots\ldots (5)$$

Where the following parameters are used

f_0 = Resonance Frequency

W = effective radiated power

L = Length of the Patch

h = thickness

ε_r = relative Permittivity of the dielectric substrate

c = Speed of light: 3 x 10^8

3.4 Antenna Design

The antenna is designed by CST microwave studio. The ground has been slotted for better directivity. The main patch is inspired from the mentioned antenna in reference paper [11]. An additional circular patch is added in the middle circular slot of the antenna and the ground has L shaped slots.

Another additional feature added is the triangular neck between the patch and the feed line which provides more well distributed current flow. The length of the ground is taken as less than half of the total length of the dielectric for better gain as shown in figure 3.3. A full-length ground plane is not effective for directivity in this case. The gap between the outer circle of the slot and the inner patch is varied so different bandwidth range can be observed. The front and back perspective on the antenna are appeared in figure 3.2 and 3.3.

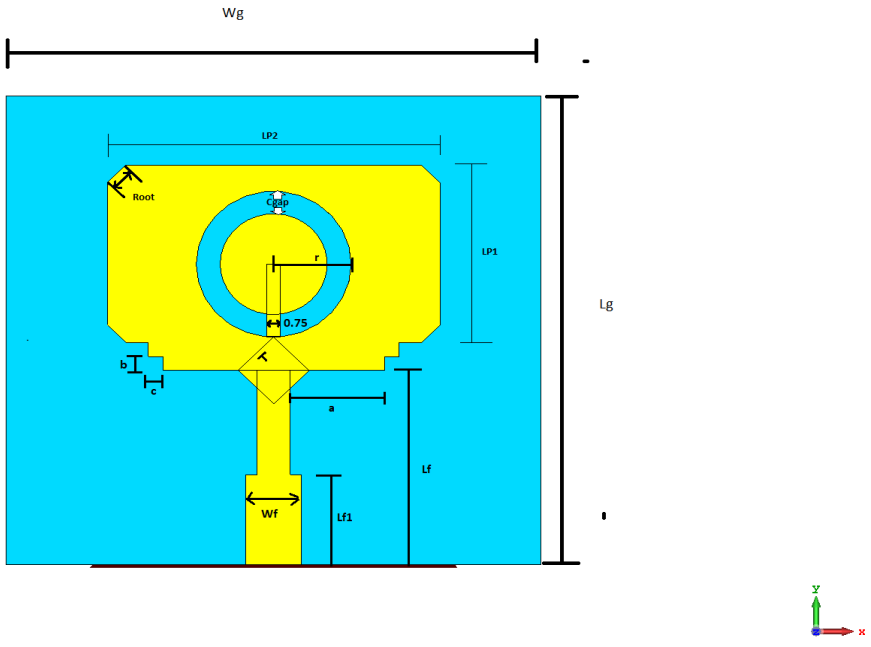

Figure 3.2: Top view of proposed antenna.

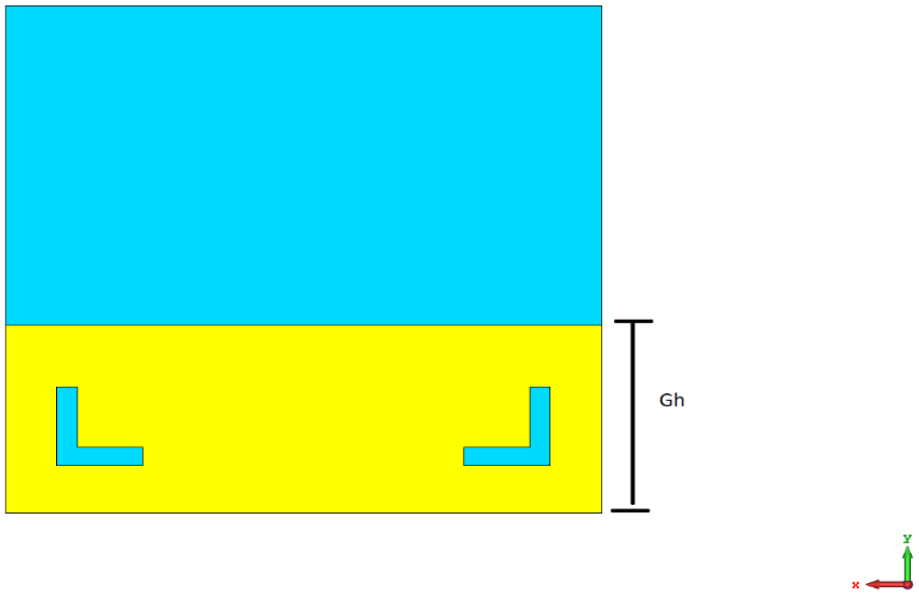

Figure 3.3: Bottom view of proposed antenna.

The physical dimensions of the antenna are mentioned in Table 3.2. All the measurements are in millimeter.

TABLE 3.2: ANTENNA DIMENSIONS.

Dimension	Value(mm)
Wg	27
lp1	15.2
lp2	7.4
lg	29
r	4.2
a	3.7
b	0.8
c	2
Wf	3
lf	11.2
lf1	5.2

CHAPTER 4

SIMULATION RESULTS AND DISCUSSIONS

In this chapter, after completing simulation of the designed antenna, the results are presented.

4.1 Simulation result of the antenna

The outcome examination and conversation that is appeared in this segment is chiefly shown on two antenna design elements and this segment is composed by two sections. This examination was performed by observing four outcome parameters. The last antenna elements are chosen by watching antenna result parameters and the last antenna designed with those plan parameters.

4.1.1 Result analysis on different Circle gap

The gap between the circular cut out on the patch and the circular patch inside that cutout is varied to analyze the effect of the size of the inner circle.

The results show that the best S11 value found for the antenna is -36.96db at 5.08GHz for Cgap 0.2mm. And the other peak is -45.5db at 14.04GHz for Cgap1.4mm.

This size circle has similar S11 value of -35.5 at 5.5 GHz. To benefit from both peaks the 1.4mm size for C gap is much optimal to use.

4.2 S11 graph

In general, the foremost normally cited parameter with regard to antennas is S11. S11 illustrates what quantity power is mirrored from the antenna and thus which is called as the reflection constant. If S11 is 0 dB, then all the ability is mirrored from the antenna and zilch is radiated. If S11 is -10 dB, this means that if three dB of power is distributed to the antenna, -7 dB is that the mirrored power. The rest of the possibility was granted by or distributed to the antenna.

This granted power is either radiated or absorbed as losses inside the antenna. Since the unit of antennas area usually designed to be low loss, normally the bulk of the ability generated to the antenna is radiated. The S11 parameter simulation result of our antenna is given in figure 4.1. As it is, the lowest S11 values are found in around

5 GHz and 15 GHz. The different graph for different Cgap is plotted in the same graph.

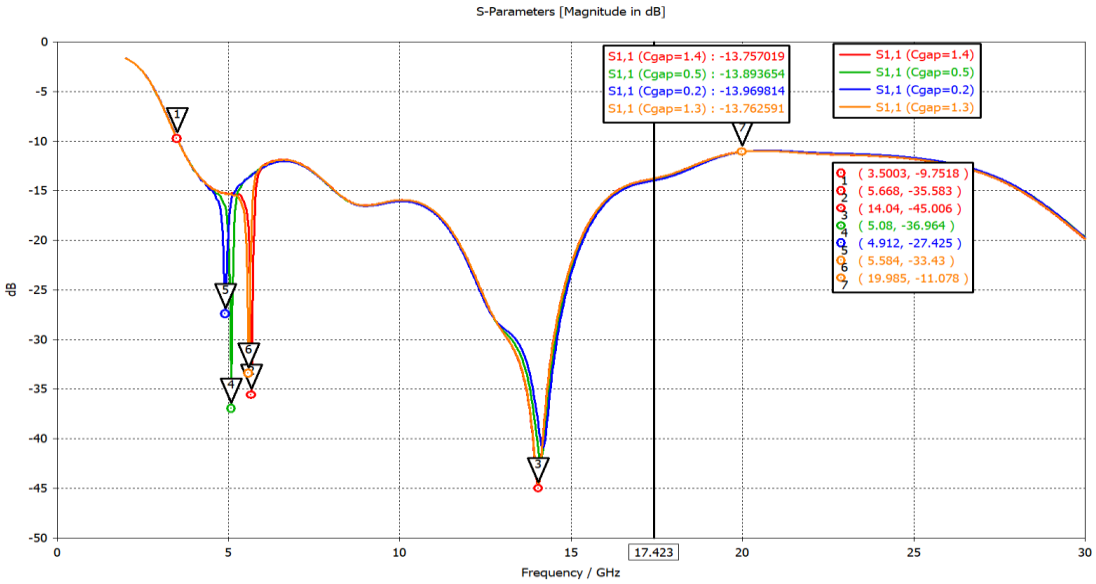

Figure 4.1:S11 graph.

4.3 VSWR graph

The another elements of antenna is VSWR which is measure that numerically composes however well in the radio or conductor, the antenna is impedance matched and it's connected to that elements.

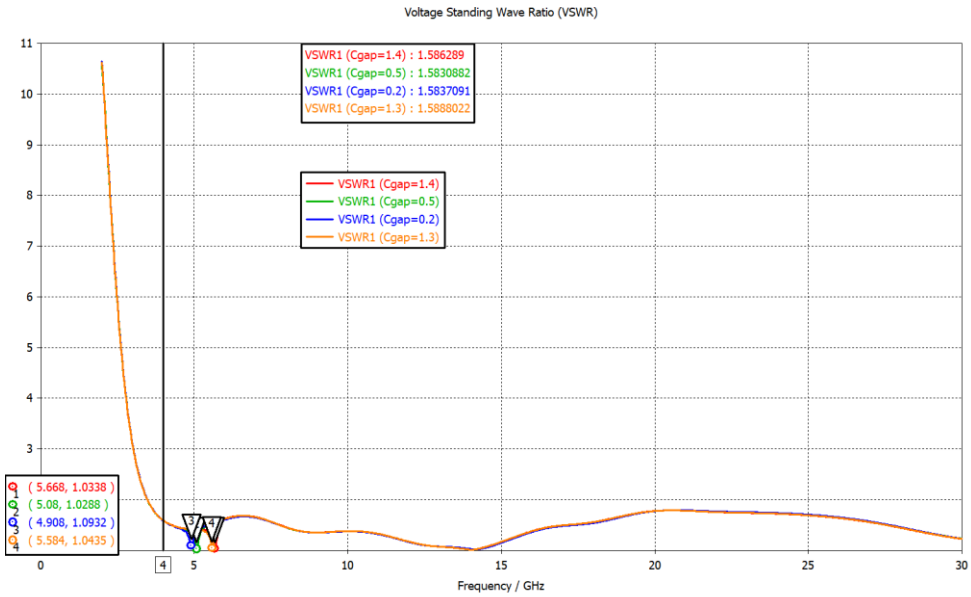

Figure 4.2: VSWR graph

VSWR stands for Voltage stationary wave magnitude relation and is additionally noted as stationary wave magnitude relation (SWR). VSWR may be a performance of the reflection constant that constructs the ability mirrored from the antenna. The simulation results of the VSWR are shown in figure 4.2. The VSWR value is zero or nearly zero conjointly around 5 GHz and 15 GHz. It means that the antenna has no standing wave at these frequencies therefore these square measures the approximate frequencies that the antenna works best.

4.3 Efficiency

Another parameter of antenna is antenna efficiency which is power provided to the antenna and the proportion of power radiated by the antenna. The capability of an antenna is regularly assessed in an anechoic chamber where an antenna is dealt with some power and the nature of the radiated electromagnetic field in the incorporating space is assessed.

An ideal antenna is an antenna with 100% efficiency i.e., so it communicates all the force took care of to it. Yet, in reality, a decent antenna transmits just 50 to 60% of the force provided the simulation results of our antenna efficiency in figure 4.3 the efficiency is comparatively higher around 4-5 GHz and the maximum efficiency is achieved at 4GHz for all variable dimensions.

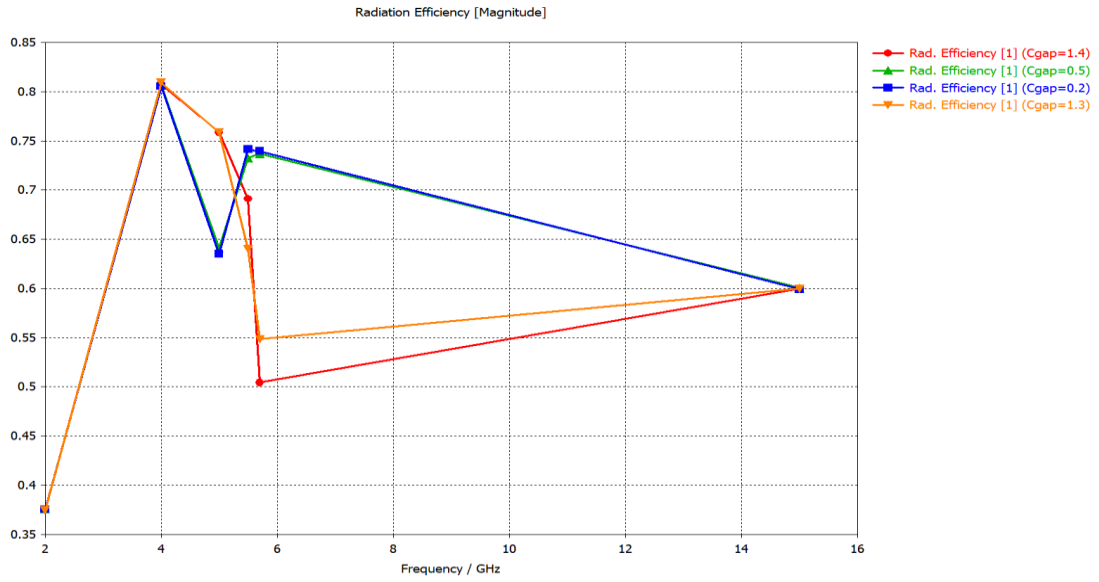

Figure 4.3: Efficiency.

4.4 Gain over frequency Gain over frequency

Though the antenna is designed to work better in certain frequencies, the gain of this antenna varies across the whole range of frequency. At around 4 GHz, the gain is around 2 dBi bit as frequency increases, the gain also increases. Figure 4.4 showing the simulation result of gain over frequency.

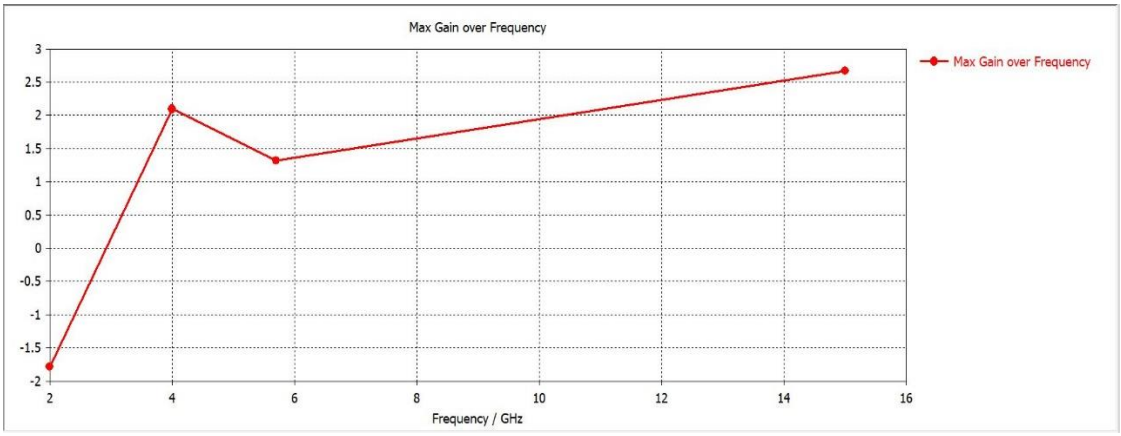

Figure 4.4: Gain over frequency (in dBi).

4.5 Radiation pattern

Radiation is that the term which is defines to the outflow or reception of wave front at the antenna, determining its quality. In an outline, the sketch attracted to shown to the radiation of the related angle antenna is its radiation pattern. One will essentially see the function associate angle directivity of an antenna by having a look at its radiation pattern.

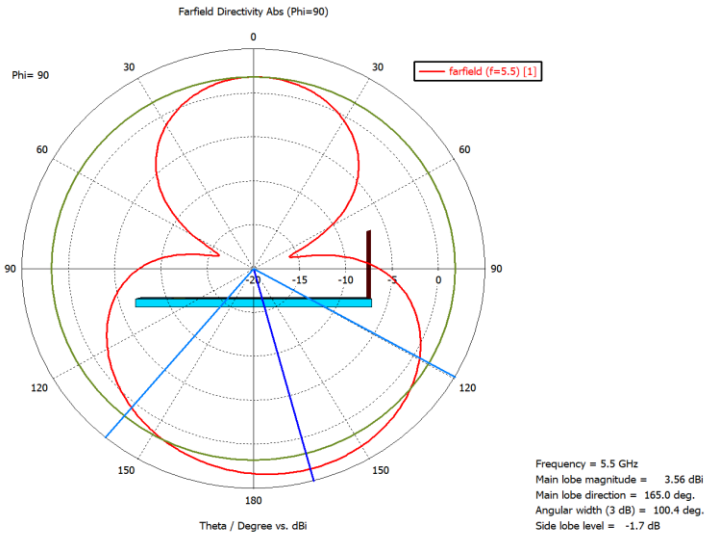

Figure 4.5: Radiation pattern

The radiation pattern simulation result of the proposed antenna for 5.5 GHz is shown in figure 4.5. As shown in the diagram, the main lobe directivity of the antenna is 3.56 dBi for 5.5 GHz. The directivity varies from different operating frequencies as shown is figure 4.4. but the best results are found around 4-6GHz.

4.6 Comparison table

The comparison among similar research works with the proposed work is given in Table 4.1.

TABLE 4.1 : A COMPARATIVE VIEW OF ANTENNA RESULTS.

Raf.	Frequency (GHz)	Size (mm)	Material	S11	Efficiency	Bandwidth (GHz)	Gain
[39]	2.8 – 11.6	32X34	jeans	-35 dB at 9.5 GHz	65%		
[11]	3 - 15	27X29X1.6	FR-4	-22db at 4.5Ghz to -21 dB at 8.2 dB		12	
[40]	3–12	35X20X1.6	FR-4	-32 dB		9.1	
[5]	2.2		FR-4				
[6]	3.2 - 5.7					2.5	4.86dBi
[41]	2.45			-26 dB		0.2	4.2dB
[8]	2.45	37.26X28.82		21.23 dB-15.50 dB-17.59 dB-27.81		0.05	
[9]	2-5	18X18		-24 dB			
[10]	5			-10dB-7dB		0.048	
[42]	2.45			-24dB		0.05	
[44]	2 – 16			-48dB		14	36dB
[15]	3.6-10			-40dB		8	4.5dB
[17]	1.6-11.2	70 X 60		-32dB	93%	2.7	6.17dBi
Proposed Antenna	3.5-20	27X29X1.6	jeans	-35dB at 5.5GHz and-45 dB at 14.04 GHz	80%	16.5	3.601dBi at 5.5GHz and 4.891dBi at 14.04GHz

CHAPTER 5

CONCLUSION

This paper presents a flexible UWB antenna for using in locating a tumor inside human breast instead of conventional imaging or detection technique. The antenna performs reasonably well in cases of radiation pattern return loss, VSWR and gain. The flexibility and availability factor of the antenna could play an important role in medical implementation. In this thesis work, micro-strip patch antennas are designed and simulated successfully at both frequency of operation 5.5GHz and 14.5GHz. The proposed antenna works at 3.5 GHz and 20GHz band with return loss under- 10dB. The simulated antenna's VSWR is near 1 at the pick frequency 5.5 GHz and 14.5GHz. For this antenna, the bandwidth is around 18.5 GHz and gain is 3.6dBi at 5.6GHz and 5 GHz at 14GHz which is nearly better than the current antennas found in the literature review in terms of size.

5.1 Future Work

Biomedical application of microwave antenna is a central topic in the development of telecommunication, microwave engineering , healthcare and biomedical technologies. Increasing healthcare quality, in addition to the continuous miniaturization of sensors and the advancement in wearable electronics, embedded software, digital signal processing and biomedical technologies, has led to a new era of biomedical devices and increases possibility of continuous monitoring, diagnostic and/or treatment of many diseases. There is a huge opportunity of development in biomedical applications of microwave antenna. The proposed antenna is comparatively good as literatures reviewed but the results parameters can be more refined by further experimentations.

At the current state, the radiation efficacy has room for improvement which is not much consistent over the frequency spectrum. The antenna is yet to be tested in real or simulation equivalent of human body. It will open another way to fine tune its performance on human body.

REFERENCES

1. "Design of planar antenna using micro strip feed for biomedical applications," International Journal of communication and computer Technologies, vol. 5, no. 2, 2019.

2. M. A. Khan and M. A. U. Haq, "A novel antenna array design for breast cancer detection," 2016 IEEE Industrial Electronics and Applications Conference (IEACon), 2016.

3. P. Chauhan, S. Dey, S. Dhar, and J. M. Rathod, "Early Breast Cancer Detection Using Flexible MicrostripAntenn."

4. G. M. Raghavendra, K. Varaprasad, and T. Jayaramudu, "Biomaterials: Design, Development and Biomedical Applications," Nanotechnology ApplicationsforTissueEngineering,23-Jan-2015.[Online].Available: https://www.sciencedirect.com/science/article/pii/B9780323328890000029. [Accessed: 20-Sep-2020]

5. T. Hirano and T. Kikkawa, "4 × 4 Pentagonal patch array antenna for breast cancer detection," 2016 IEEE Conference on Antenna Measurements & Applications (CAMA), 2016.

6. F. Wang, "Assembly conformal antenna array for wearable microwave breast imaging application" Loughborough Antennas & Propagation Conference (LAPC 2017), 2017.

7. INCLEN Program Evaluation Network (IPEN) study group, New Delhi, India, "Bio-medical waste management: situational analysis & predictors of performances in 25 districts across 20 Indian States," The Indian journal of medical research, Jan-2014. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3994730/. [Accessed: 20-Sep-2020].

8. K. Ouerghi, N. Fadlallah, A. Smida, R. Ghayoula, J. Fattahi, and N. Boulejfen, "Circular antenna array design for breast cancer detection," 2017 Sensors Networks Smart and Emerging Technologies (SENSET), 2017.

9. H. Bahrami, E. Porter, A. Santorelli, B. Gosselin, M. Popovic, and L. A. Rusch, “Flexible sixteen monopole antenna array for microwave breast cancer detection,” 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2014.

10. A. Kahwaji, H. Arshad, S. Sahran, A. G. Garba, and R. I. Hussain, “Hexagonal micro-strip antenna simulation for breast cancer detection,” 2016 International Conference on Industrial Informatics and Computer Systems (CIICS), 2016.

11. S. Subramanian, B. Sundarambal, and D. Nirmal, “Investigation on Simulation-Based Specific Absorption Rate in Ultra-Wideband Antenna for Breast Cancer Detection,” IEEE Sensors Journal, vol. 18, no. 24, pp. 10002–10009, 2018.

12. M. A. J. R. a. K. V. SudhirShrestha, "PIERS Proceedings, Cambridge, USA," Microstrip Antennas for Direct Human Skin Placement for Biomedical Applications, July 5–8, 2010.

13. Z. Katbay, S. Sadek, M. Le Roy, R. Lababidi, A. Perennec and P. Dupré, "Microstrip back-cavity Hilbert Fractal Antenna for experimental detection of breast tumors," 2016 IEEE Middle East Conference on Antennas and Propagation (MECAP), Beirut, 2016, pp. 1-4, doi: 10.1109/MECAP.2016.7790092.

14. M. Bassi, M. Caruso, M. S. Khan, A. Bevilacqua, A. Capobianco and A. Neviani, "An Integrated Microwave Imaging Radar with Planar Antennas for Breast Cancer Detection," in IEEE Transactions on Microwave Theory and Techniques, vol. 61, no. 5, pp. 2108-2118, May 2013, doi: 10.1109/TMTT.2013.2247052.

15. M. B. Tayel, T. G. Abouelnaga, and A. F. Desouky, “UWB high gain antenna array for SAR based breast cancer detection system,” 2018 5th International Conference on Electrical and Electronic Engineering (ICEEE), 2018.

16. R. Çalışkan, S. S. Gültekin, D. Uzer, and Ö. Dündar, “A Microstrip Patch Antenna Design for Breast Cancer Detection,” Procedia - Social and Behavioral Sciences, 26-Jul-2015. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1877042815038975. [Accessed: 18-Feb-2020].

17. F. Alsharif and C. Kurnaz, “Wearable Microstrip Patch Ultra Wide Band Antenna for Breast Cancer Detection” 2018 41st International Conference on Telecommunications and Signal Processing (TSP), 2018.

18. J. Sankar, “Antenna Polarisation,” Electronics For You, 02-Jun-2017. [Online]. Available: https://www.electronicsforu.com/resources/learn-electronics/antenna-polarisation. [Accessed: 20-Sep-2020].

19. krn5, “Automatic optimization: CST Studio Suite,” Automatic optimization | CST Studio Suite. [Online]. Available: https://www.3ds.com/products-services/simulia/products/cst-studio-suite/optimization/. [Accessed: 20-Sep-2020].

20. S. A. Kumar and T. Shanmuganantham, “Design and development of implantable CPW fed monopole L-Slot antenna at 2.45 GHz ISM band for biomedical applications,” International Journal of RF Technologies, vol. 7, no. 4, pp. 201–208, 2016.

21. “Design and Development of Single Layer Micro-strip Patch ...” [Online]. Available:https://www.researchgate.net/publication/262142101_Design_and_Development_of_Single_Layer_Microstrip_Patch_Antenna_for_Breast_Cancer_Detection. [Accessed: 18-Feb-2020].

22. “Directivity,” Wikipedia, 07-Jun-2020. [Online]. Available: https://en.wikipedia.org/wiki/Directivity#/media/File:Sidelobes_en.svg. [Accessed: 20-Sep-2020]

23. C. Liu, Y.-X.Guo, and S. Xiao, “Capacitively Loaded Circularly Polarized Implantable Patch Antenna for ISM Band Biomedical Applications,” IEEE Transactions on Antennas and Propagation, vol. 62, no. 5, pp. 2407–2417, 2014.

24. T. Samuels, Antenna Factor and Gain Calculations.[Online]. Available: https://www.ahsystems.com/EMC-formulas-equations/Antenna-Factor-Gain-calculation.php. [Accessed: 20-Sep-2020].

25. E. Rufus, Z. C. Alex, and P. Chaitanya, “A modified Bow-Tie Antenna for Microwave Imaging Applications: Semantic Scholar,” undefined, 01-Jan-1970. [Online]. Available: https://www.semanticscholar.org/paper/A-modified-Bow-Tie-

Antenna-for-Microwave-Imaging-Rufus Alex/f8d79616180c7ce3ebfaa0b318ac290628405145. [Accessed: 19-Feb-2020].

26. Y. Chen, E. Gunawan, K. S. Low, S.-C. Wang, C. B. Soh, and T. Putti, "Effect of Lesion Morphology on Microwave Signature in 2-D Ultra-Wideband Breast Imaging," IEEE Transactions on Biomedical Engineering, vol. 55, no. 8, pp. 2011–2021, 2008.

27. S. Hassan, K. Mahmood, U. Farooq, Burhan-Ud-Din, and M. Munir, "U Patch Antenna using Variable Substrates for Wireless Communication Systems," International Journal of Advanced Computer Science and Applications, vol. 7, no. 12, 2016.

28. DESIGN TRI-BAND SINGLE AND DUAL PATCH ARRAY ANTENNA WITH BAND SUPPRESSION - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Microstrip-line-feed-with-rectangular-patch-antenna_fig5_276353525 [accessed 22 Sep, 2020]

29. Design and Fabrication of Printed Fractal Slot Antennas for Dual-band Communication Applications - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Figure-26-Coaxial-probe-feed-27_fig5_271530182 [accessed 22 Sep, 2020]

30. Design and Fabrication of Printed Fractal Slot Antennas for Dual-band Communication Applications - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Figure-27-Aperture-coupled-feed-27_fig6_271530182 [accessed 22 Sep, 2020]

31. Indrasen Singh and Dr. V.S. Tripathi, "Micro strip Patch Antenna and its Applications: a Survey", Int. J. Comp. Tech. Appl., Vol 2 (5), 1595-1599.

32. P. Bevelacqua, Radiation Pattern. [Online]. Available: http://www.antenna-theory.com/basics/radpattern.php. [Accessed: 05-Jan-2020].

33. Choudhary, Heena, RomikaChoudhary, and Ashish Vats. "Design and Analysis of Circular Patch Micro-Strip UWB Antenna for Breast cancer Detection."International Journal of Innovative Research in Science, Engineering and Technology 4, no. 12 (2015).

33. S. A. Kumar and T. Shanmuganantham, “Design and development of implantable CPW fed monopole L-Slot antenna at 2.45 GHz ISM band for biomedical applications,” International Journal of RF Technologies, vol. 7, no. 4, pp. 201–208, 2016.

34. Mahalakshmi, N., and Vijay Jeyakumar. "Design and development of single layer micro-strip patch antenna for breast cancer detection." Bonfring International Journal of Research in Communication Engineering 2.Special Issue Special Issue on System Design and Information Processing (2012): 14-18.

35. C. Liu, Y. Guo and S. Xiao, "Capacitively Loaded Circularly Polarized Implantable Patch Antenna for ISM Band Biomedical Applications," in IEEE Transactions on Antennas and Propagation, vol. 62, no. 5, pp. 2407-2417, May 2014, doi: 10.1109/TAP.2014.2307341.

36. H. Jiang, C. Li, D. Pearlstone, and L. L. Fajardo, “Ultrasound-guided microwave imaging of breast cancer: Tissue phantom and pilot clinical experiments,” Medical Physics, vol. 32, no. 8, pp. 2528–2535, 2005.

37. Authors: CST Computer Simulation Technology AG, swMATH. [Online]. Available: https://www.swmath.org/software/15733. [Accessed: 15-Feb-2020].

38. CST Studio Suite Recommended Hardware. [Online]. Available: https://www.3ds.com/support/hardware-and-software/simulia-system-information/cst-studio-suite/cst-studio-suite/. [Accessed: 19-Sep-2020].

39. W. A. M. A. Ashwal and K. N. Ramli, “Small planar monopole UWB wearable antenna with low SAR,” 2014 Ieee Region 10 Symposium, 2014.

40. I. Amdaouch, O. Aghzout, A. Naghar, A. V. Alejos, and F. J. Falcone, “Breast Tumor Detection System Based On A Compact UWB Antenna Design,” Progress In Electromagnetic Research M, vol. 64, pp. 123–133, 2018.

41. K. Ouerghi, A. Smida, R. Ghayoula and N. Boulejfen, "Design and analysis of a micro-strip antenna array for biomedical applications," 2017 International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), Fez, 2017, pp. 1-5, doi: 10.1109/ATSIP.2017.8075589.

42. Shrestha, Sudhir, MangilalAgarwal, Joshua Reid, and KodyVarahramyan. "Microstrip antennas for direct human skin placement for biomedical applications."PIERS Proceedings, Cambridge, USA (2010).

43. Z. Katbay, S. Sadek, M. L. Roy, R. Lababidi, A. Perennec, and P.-F.Dupre, “Microstrip back-cavity Hilbert Fractal Antenna for experimental detection of breast tumors,” 2016 IEEE Middle East Conference on Antennas and Propagation

Thesis Group 13

by Md Jashim Uddin

Submission date: 07-Oct-2020 08:45PM (UTC+0300)
Submission ID: 1408208345
File name: group_13_thesis_book_plag_check.pdf (1.39M)
Word count: 13777
Character count: 74503

Thesis Group 13

ORIGINALITY REPORT

31%	15%	15%	15%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	caelynx.com Internet Source	3%
2	www.scribd.com Internet Source	1%
3	M. Arif Khan, M. Aziz ul Haq. "A novel antenna array design for breast cancer detection", 2016 IEEE Industrial Electronics and Applications Conference (IEACon), 2016 Publication	1%
4	Submitted to Higher Education Commission Pakistan Student Paper	1%
5	Suresh Subramanian, B. Sundarambal, D. Nirmal. "Investigation on Simulation-Based Specific Absorption Rate in Ultra-Wideband Antenna for Breast Cancer Detection", IEEE Sensors Journal, 2018 Publication	1%
6	Changrong Liu, Yong-Xin Guo, Shaoqiu Xiao. "Capacitively Loaded Circularly Polarized	1%

	Implantable Patch Antenna for ISM Band Biomedical Applications", IEEE Transactions on Antennas and Propagation, 2014 Publication	
7	insights.ovid.com Internet Source	1 %
8	www.ijser.org Internet Source	1 %
9	K. Ouerghi, N. Fadlallah, A. Smida, R. Ghayoula, J. Fattahi, N. Boulejfen. "Circular antenna array design for breast cancer detection", 2017 Sensors Networks Smart and Emerging Technologies (SENSET), 2017 Publication	1 %
10	ee.ump.edu.my Internet Source	1 %
11	Submitted to Universiti Teknologi MARA Student Paper	1 %
12	Submitted to University Tun Hussein Onn Malaysia Student Paper	1 %
13	ethw.org Internet Source	1 %
14	mafiadoc.com Internet Source	1 %

15	Yifan Chen, E. Gunawan, Kay Soon Low, Shih-Chang Wang, Cheong Boon Soh, T.C. Putti. "Effect of Lesion Morphology on Microwave Signature in 2-D Ultra-Wideband Breast Imaging", IEEE Transactions on Biomedical Engineering, 2008 Publication	1 %
16	Z. Katbay, S. Sadek, M. Le Roy, R. Lababidi, A. Perennec, Pierre-Francois Dupre. "Microstrip back-cavity Hilbert Fractal Antenna for experimental detection of breast tumors", 2016 IEEE Middle East Conference on Antennas and Propagation (MECAP), 2016 Publication	1 %
17	Submitted to Karunya University Student Paper	1 %
18	Md Mohiuddin Soliman, Mohammad Lutful Hakim, Mohammed Jashim Uddin, Muhammad Mostafa Amir Faisal, Atikur Rahaman. "Optimization of Design Parameters of Microstrip Patch Antenna at 28 GHz and 38 GHz for 5G Applications", 2019 IEEE International Conference on Telecommunications and Photonics (ICTP), 2019 Publication	1 %
	Submitted to Universiti Teknologi Malaysia	

19	Student Paper	<1%
20	Submitted to Engineers Australia Student Paper	<1%
21	www.everythingrf.com Internet Source	<1%
22	Submitted to Madan Mohan Malaviya University of Technology Student Paper	<1%
23	content.iospress.com Internet Source	<1%
24	www.3ds.com Internet Source	<1%
25	F. Wang. "Assembly conformal antenna array for wearable microwave breast imaging application", Loughborough Antennas & Propagation Conference (LAPC 2017), 2017 Publication	<1%
26	Suresh Subramanian, B. Sundarambal, D. Nirmal. "Investigation on Simulation based Specific Absorption Rate in Ultra-Wideband Antenna for Breast Cancer Detection", IEEE Sensors Journal, 2018 Publication	<1%
27	Mazhar Basyouni Tayel, Tamer Gaber	

	Abouelnaga, Asmaa Fereg Desouky. "UWB high gain antenna array for SAR based breast cancer detection system", 2018 5th International Conference on Electrical and Electronic Engineering (ICEEE), 2018 Publication	<1%
28	Bassi, Matteo, Michele Caruso, Muhammad Saeed Khan, Andrea Bevilacqua, Antonio-Daniele Capobianco, and Andrea Neviani. "An Integrated Microwave Imaging Radar With Planar Antennas for Breast Cancer Detection", IEEE Transactions on Microwave Theory and Techniques, 2013. Publication	<1%
29	Takuichi Hirano, Takamaro Kikkawa. "4 × 4 Pentagonal patch array antenna for breast cancer detection", 2016 IEEE Conference on Antenna Measurements & Applications (CAMA), 2016 Publication	<1%
30	digital-library.theiet.org Internet Source	<1%
31	Submitted to Middle East College of Information Technology Student Paper	<1%
32	Submitted to Manipal University Student Paper	<1%

33	www.mdpi.com Internet Source	<1%
34	Submitted to De Montfort University Student Paper	<1%
35	Submitted to Jamia Milia Islamia University Student Paper	<1%
36	/paperInfo.asp?oid=6508106 Student Paper	<1%
37	Submitted to Chittagong University of Engineering and Technology Student Paper	<1%
38	Kaur, Gurveer, Amandeep Kaur, Gurpreet Kaur Toor, Balwinder S. Dhaliwal, and Shyam Sundar Pattnaik. "Antennas for biomedical applications", Biomedical Engineering Letters, 2015. Publication	<1%
39	Submitted to Liberty Union High School District Student Paper	<1%
40	Submitted to Krop High School Student Paper	<1%
41	www.irjet.net Internet Source	<1%
42	Submitted to University of Western Sydney Student Paper	<1%

43	Bhuvidha Singh Tomar, Sumit Bharadwaj, Punit Gupta. "Designing A Microstrip Square Patch Antenna", 2019 Fifth International Conference on Image Information Processing (ICIIP), 2019 Publication	<1%
44	Submitted to Australian Harbour International College Student Paper	<1%
45	"Implementation of Compact Ultra wide Band Antenna Design for Breast Cancer Tumor detection", International Journal of Recent Technology and Engineering, 2019 Publication	<1%
46	linknovate.com Internet Source	<1%
47	www.icmr.nic.in Internet Source	<1%
48	Submitted to Cebu Technological University Student Paper	<1%
49	Submitted to University of Basrah Student Paper	<1%
50	publikasi.mercubuana.ac.id Internet Source	<1%
51	link.springer.com Internet Source	<1%

52	Submitted to Universiti Malaysia Perlis Student Paper	<1%
53	Submitted to The University of the South Pacific Student Paper	<1%
54	Submitted to University of Northumbria at Newcastle Student Paper	<1%
55	Submitted to Florida Virtual School Student Paper	<1%
56	eprints.uthm.edu.my Internet Source	<1%
57	"Emerging Trends in Computing and Expert Technology", Springer Science and Business Media LLC, 2020 Publication	<1%
58	Yusnita Rahayu, M. F. Hilmi, Huriatul Masdar. "A Novel Design Rectangular UWB Antenna Array for Microwave Breast Tumor Detection", 2019 16th International Conference on Quality in Research (QIR): International Symposium on Electrical and Computer Engineering, 2019 Publication	<1%
59	Submitted to Punjab Technical University Student Paper	<1%
60	www.mysciencework.com Internet Source	

		<1%
61	Submitted to College of Engineering & Technology Bhubaneswar Student Paper	<1%
62	ieeexplore.ieee.org Internet Source	<1%
63	Submitted to University of Pune Student Paper	<1%
64	Submitted to Chulalongkorn University Student Paper	<1%
65	Submitted to Sim University Student Paper	<1%
66	Submitted to University of Bradford Student Paper	<1%
67	Osama W. Ata. "Explicit Design Methodology of Microstrip Antenna for Breast Tissue Tumor Detection", International Journal on Communications Antenna and Propagation (IRECAP), 2017 Publication	<1%
68	Submitted to Auston Institute of Management and Technology Student Paper	<1%
	Submitted to Istanbul Aydin University	

69	Student Paper	<1%
70	byjus.com Internet Source	<1%
71	www.ebookee.org Internet Source	<1%
72	takuichi.net Internet Source	<1%
73	ijireeice.com Internet Source	<1%
74	"Microstrip Patch Antenna Design for Early Breast Cancer Detection", International Journal of Recent Technology and Engineering, 2020 Publication	<1%
75	www.elamigos-games.com Internet Source	<1%
76	Antora Hossain, Md. Kamal Hosain. "Design and Simulation of a Compact Bow-tie Antenna for Cancer Detection and Treatment", 2019 4th International Conference on Electrical Information and Communication Technology (EICT), 2019 Publication	<1%
77	G. Geetharamani, T. Aathmanesan. "Metamaterial inspired THz antenna for breast	<1%

	cancer detection", SN Applied Sciences, 2019 Publication	
78	slideplayer.com Internet Source	<1%
79	Submitted to Lovely Professional University Student Paper	<1%
80	Maged A. Aldhaeebi, Khawla Alzoubi, Thamer S. Almoneef, Saeed M. Bamatraf, Hussein Attia, Omar M. Ramahi. "Review of Microwaves Techniques for Breast Cancer Detection", Sensors, 2020 Publication	<1%
81	enggate.net Internet Source	<1%
82	digitalcommons.njit.edu Internet Source	<1%
83	M Azman Zakariya, M. Izzat Shahidi, Lingeshgugan Sanmugan, Gunawan Witjaksono et al. "The Development of Dual Band DRA Hybrid Antenna", 2018 International Conference on Intelligent and Advanced System (ICIAS), 2018 Publication	<1%
84	Merbin John, M. Ayyappan, B. Manoj, Stephen Rodrigues. "Bandwidth enhancement of microstrip patch antenna for 5.8GHz by	<1%

optimized feed offset", 2016 International Conference on Communication and Signal Processing (ICCSP), 2016
Publication

85	Submitted to The University of Manchester Student Paper	<1%
86	paduaresearch.cab.unipd.it Internet Source	<1%
87	Swetha Amit, S. P. Oshin. "Design, implementation and performance analysis of a high gain UWB slot wearable antenna with human phantom for medical application", 2017 IEEE International Conference on Antenna Innovations & Modern Technologies for Ground, Aircraft and Satellite Applications (iAIM), 2017 Publication	<1%
88	"Information and Communication Technology for Sustainable Development", Springer Science and Business Media LLC, 2018 Publication	<1%
89	Al ashwal, Wadhah A. M., and Khairun Nidzam Ramli. "Small planar monopole UWB wearable antenna with low SAR", 2014 IEEE REGION 10 SYMPOSIUM, 2014. Publication	<1%
90	Kumar, S. Ashok, T. Shanmuganantham, J. Navin Sankar, and Anandha Saravanan.	<1%

"Design of implantable CPW fed l-slot antenna for biomedical applications", 2015 1st International Conference on Telematics and Future Generation Networks (TAFGEN), 2015.
Publication

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		