BACHELOR OF SCIENCE IN

ELECTRONIC AND TELECOMMUNICATION ENGINEERING

Microstrip patch antenna design and simulation for detection of breast cancer.

Submitted by

Abdul Hamid Ridoy

T181034

Supervised by

Engr. Md. Razu Ahmed

Professor and Chairman

Department of CCE

International Islamic University Chittagong

Department of Electronic and Telecommunication Engineering

International Islamic University Chittagong

Kumira, Sitakunda, Chittagong – 4314

12th November, 2022

CANDIDATE DECLARATION

I, hereby certify that the work given here was my original creation and was not submitted concurrently as a candidate for any degree. The conclusion of this thesis is entirely dependent on my own work.

Professor Engr. Md. Razu Ahmed of Computer and Communication Engineering, International Islamic University Chittagong ,Under his direction, I completed this thesis.

…………………………….

Abdul Hamid Ridoy

ID-T181034

RECOMMENDATION

Abdul Hamid Ridoy, bearing ID: **T181034** who is students at International Islamic University Chittagong (IIUC) in the Department of Electronic and Telecommunications Engineering, have successfully completed his thesis on " Microstrip patch antenna design and simulation for detection of breast cancer." under my supervision and direction. This is to certify that his work has been accepted as satisfactory in partial fulfillment of the requirements for the degree.

Engr. Md. Razu Ahmed
Professor and Chairman
Department of CCE, IIUC

ACKNOWLEDGMENT

In the name of Allah, the Most Forgiving, the Most Merciful. All praise and glory belongs to Allah (SWT), who has provided me with a wealth of chances and showered me with His kindness and guidance throughout life. and may peace and blessings of Allah be upon Prophet Muhammad (pbuh), a guidance and inspiration to our lives.Any form of thesis requires the involvement of several people to be completed successfully. To prepare this thesis report, I also received assistance from a variety of sources. Now, there is a small effort being made to express my sincere gratitude to those kind people. I really deeply appreciate everything that our excellent academic supervisor has done **Engr. Md. Razu Ahmed,**Professor of Department of Computer and Communications Engineering, International Islamic University Chittagong. This thesis would not have been as successful without his patient direction and knowledgeable recommendations. His observation and direction shaped this thesis to be completed successfully at every stage. I am also thankful to **Dr. Saif Hannan**, for his guidance and technical help. Lastly but not least, I would like to express our sincere gratitude to all of our teachers for their unending support and assistance. I am incredibly lucky to have kind people like them by my side.

Abdul Hamid Ridoy

DECLARATION

The study in this thesis, submitted for the degree of Bachelor of Science was undertaken at the Department of Electronic and Telecommunication Engineering, International Islamic University Chittagong, under the supervision of Engr Md. Razu Ahmed, Professor, Department of CCE, IIUC.

Information quoted from any source has been properly acknowledged by mentioning the author's reference at appropriate place. The prerequisites for the Bachelor of Science in Electronic and Telecommunication Engineering degree are partially satisfied by the thesis work that is submitted.

ABSTRACT

This thesis is titled Microstrip patch antenna design and simulation for detection of breast cancer. The most prevalent and potentially fatal disease among women is breast cancer. So it's critical to find cancerous tissue early in the diagnosing process. Most conventional methods for finding breast cancer, unfortunately, have some drawbacks. Thus, methods for microwave imaging (MWI) is created. The MWI method is quite thought-provoking and hopeful. In this book, we have try to implement the technique. We try to design a Rectangular patch antenna for the detection of tumor. The substrate we used was fr4 [FR stand for "Flame Retardant." 4 means fiber glass epoxy] (lossy) which dielectric constant was 4.3. In this thesis I also design a breast phantom via Computer Simulation Technology Microwave Studio (CST-MWS) with and without tumor. The size of tumor was 5 mm. set the antenna was simulated and the return loss, the VSWR, Surface Current, SAR value have been changed -19.265db, 1.2443, 36.8166A/m,0.637174 to -18.874,1.257.37.01,0.67539 . Which shows that propose antenna can detect tumor.

TABLE OF CONTENTS

Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS

Hz	Hertz
KHz	Kilo Hertz
MHz	Mega Hertz
GHz	Giga Hertz
mm	Millimeter
cm	Centimeter
m	meter
ε	Relative permittivity
L	Length
W	Width
C	Speed of light
ε_r	Dielectric Constant
dB	Decibels
Q	Quality Factor
λ	Lambda
Ω	Ohm

LIST OF ABBERVIATION

IEEE	Institute of Electrical and Electronic Engineers
MPA	Microstrip Patch Antenna
CST	Computer Simulator Technology
VSWR	Voltage Standing Wave Ratio
RL	Return Loss
BSE	Breast self-examination
CBE	Clinical breast examination
BU	Breast ultrasound
CT	Computerized tomography
MRI	Magnetic resonance imaging
PET	Positron emission tomography
MI	Microwave imaging
MWI	Microwave imaging system
RF	Radio-frequency
UWB	Ultra-wide-band
ISM	Industrial, Scientific, and Medical (ISM)
MBI	Microwave Breast Imaging
RMPA	Rectangular microstrip patch antenna
MICS	Medical Implant Communication Service
MUSIC	Multiple Signal Classification
LSTM	Long Short-Term Memory
MI	Microwave Imaging
PMI	Passive Microwave Imaging
CMPA	Circular microstrip patch antenna
RCS	Radar cross section
SAR	Specific Absorption Rate
EM	Electromagnetic

Chapter 1

INTRODUCTION

1.1 Breast Cancer

An uncontrolled growth of breast cells is breast cancer. Learning how any cancer might develop will help us better recognize breast cancer. Mutations, or aberrant changes, in the genes in charge of controlling cell development and maintaining their health, are what cause cancer. The nucleus of every cell serves as its "control room" and houses the genes. In a typical state, healthy new cells replace aging ones when they die out in our bodies through an organized process of cell proliferation. However, over time, mutations in a cell can "turn on" some genes and "turn off" others. That altered cell gains the capacity to divide indefinitely and randomly, giving rise to more identical cells and developing a tumor.

The two types of tumors are benign (not harmful to health) and malignant (has the potential to be dangerous). Because they develop slowly, have cells that resemble normal tissue, do not invade surrounding tissues, or spread to other parts of the body, benign tumors are not regarded as cancerous. Cancerous tumors are malignant tumors. Malignant cells eventually have the potential to invade other organs of the body if they are not contained.

A genetic abnormality (a "fault" in the genetic sequence) is always the real cause of breast cancer. However, only 5-10% of cancers are due to an abnormality inherited from your mother or father. Instead, 85–90% most breast cancers are brought on by genetic abnormalities brought on by aging and the general "wear and tear" of life [1].

1.2 Breast Cancer Situation In Bangladesh

Breast cancer incidence in Bangladesh was actually nearly 22.5 per 100000 females. Women in Bangladesh between the ages of 15 and 44 have been shown to have the highest prevalence rate (19.3 per 100,000) of breast cancer. At Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2013 to June 2014, a cross-sectional study was created to evaluate the knowledge, attitude, and practices of community-dwelling women in Bangladesh regarding breast cancer. All female participants who were attending the BSMMU outpatient department and were above 20 years old and had at least a JSC were purposefully chosen until the sample size reached 500[2].

1.3 Breast Cancer Detection Techniques

For the early identification of breast cancer, the cancer imaging method is essential or decisive. Breast self-examination (BSE), clinical breast examination (CBE), breast ultrasound, computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), mammography, and other breast screening procedures are some of the cancer imaging modalities currently in use. Although these methods are still in use, they nonetheless have certain drawbacks. PET is ineffective for identifying initial tumors. The gold standard for breast screening is mammography, although it is useless for younger women and those with thick breasts. X-rays damage human body cells and tissues, and MRIs' use of magnetic radiation results in subpar imaging of superficial soft tissues[7],[8]. Ionizing radiations are used during mammography, and the imaging is slower and nonportable.

1.3.1 Magnetic Resonance Imaging (MRI)

Breast MRI is the medical term for a test that uses magnetic resonance imaging (MRI) to look for abnormalities in the breasts, including breast cancer. In a breast MRI, your breast is depicted in several different pictures. Computer-generated detailed images are produced by combining breast MRI scans. Following a cancerous tissue sample from a biopsy, a breast MRI is typically done. Your doctor's assessment of the disease's severity can be made via a breast MRI. For some patients, breast MRI may be combined with mammography as a screening method to find breast cancer. Women who have a high risk of developing breast cancer, a significant family history of the disease, or genetic alterations linked to the disease are included in this[31].

Time-consuming and leading to blurry images, MRI imaging procedures. Patients have to go through the same imaging procedure multiple times due to misinterpreted MRI images. It's possible that MRI results will prevent patients from needless surgery, but there is also a risk that they will lead to unnecessary mastectomy or excision of extra tissue[32].

1.3.2 Breast Ultrasound

Medical professionals can use ultrasound imaging, a noninvasive procedure, to detect and treat a variety of illnesses. Both are painless and safe. Using sound waves, it creates images of the interior of the body. Also known as sonography, ultrasound imaging. Gel is applied directly to the skin together with a tiny probe known as a transducer. By way of the gel and into the body, high-frequency sound waves are transmitted from the probe. Sound waves that reflect back are captured by the probe. These sound waves are used by the computer to produce an image. Radiation isn't used during ultrasound tests (x-rays). It is possible to see the interior organs' shape and motion with ultrasonography since it takes real-time pictures. A blood vessel's blood flow can be seen in the photographs. There are no documented negative effects of standard diagnostic ultrasonography on people.An extra procedure, such as a follow-up ultrasound, aspiration, or biopsy, may result from the interpretation of a breast ultrasound examination. Many of the spots that were assumed to be concerning end up being non-cancerous (false positives)[33].

1.3.3 Breast Self-Examination (BSE)

Breast self-examination (BSE) is a regular examination that need to be done at the same time each month to check physically for any lumps or other changes. It involves both viewing and feeling, two significant components. To be able to see any changes right away, women should use this strategy to learn what is typical for them. Despite the fact that research has shown that breast self-examination is ineffective at reducing breast cancer mortality and that the vast majority of changes discovered during breast self-examination are not cancerous, it may still be the only option available to women in many developing nations. Women should be encouraged to be aware of what constitutes a normal breast and to spot changes in their breast size, shape, skin, and nipples as soon as possible by self-examination on a monthly or bimonthly basis. When women bathe, the majority of breast lumps are discovered.

According to W.H.O, mass screening by breast self-examination and physical examinations of the breast should not be encouraged by National Cancer Control Programs.Programs should instead promote breast cancer awareness and early detecti on by providing clinical breast examinations to women aged 40 to 69 who are visiting primary health care facilities or hospitals for other reasons[34].

1.3.4 Positron Emission Tomography (PET)

The metabolic or biochemical activity of your tissues and organs can be determined with the aid of a positron emission tomography (PET) scan, a type of imaging test.

Using a radioactive substance known as a "tracer," the PET scan can detect both healthy and unhealthy metabolic activity. Before a sickness manifests on other imaging tests, such as computerized tomography (CT) and magnetic resonance imaging, a PET scan can frequently detect the aberrant metabolism of the tracer in disorders (MRI). If the body's chemical balances are off, PET scanning may produce inaccurate results. In particular, changed blood sugar or blood insulin levels might negatively impact the test results of diabetic individuals or people who have eaten within a few hours of the examination[35].

1.3.5 Computerized Tomography (CT)

The term “computed tomography,” or CT, refers to a computerized x-ray imaging procedure in which a narrow beam of x-rays is aimed at a patient and quickly rotated around the body, producing signals that are processed by the machine’s computer to generate cross-sectional images, or “slices.” These slices are called tomographic images and can give a clinician more detailed information than conventional x-rays. Once a number of successive slices are collected by the machine’s computer, they can be digitally “stacked” together to form a three-dimensional (3D) image of the patient that allows for easier identification of basic structures as well as possible tumors or abnormalities[36]. CT scans can diagnose possibly life-threatening conditions such as hemorrhage, blood clots, or cancer. An early diagnosis of these conditions could potentially be lifesaving. However, CT scans use x-rays, and all x-rays produce ionizing radiation. Ionizing radiation has the potential to cause biological effects in living tissue.

1.4 Fundamentals of Antennas

The antenna is just a special type of transducer that converts RF (radio-frequency) fields into electrical energy or the other way around. There seem to be two fundamental kinds: the transmitting antenna, which receives electrical energy from the apparatus and generates radio-frequency field, and the receiving antenna, which absorbs RF energy and supplies alternate current to it. The microstrip patch antenna, which is implemented in wireless applications, is the most most used type of antenna. Only microwave frequencies often make sense for microstrip patch antennas.

1.4.1 Antennas Frequency

As an usual sense, frequency refers to how frequently an event occurs during a given time period. Frequency refers essentially the number of times an event occurs over a specified period of time. According to the common definition, "Frequency" is the amount of times a signal occurs within a specified period of time (one second). Every "T" seconds, or time frame, a periodic signal repeats itself. The frequency of a periodic signal is just the inverse of the time period (T). Frequency diagram is displayed in Figures 1.1 and 1.2. Frequency is a concept used in engineering to describe the rate of oscillatory and vibratory events, such as radio waves, audio signals (sound), mechanical vibrations, and light. German physicist Heinrich Hertz gave the SI (International System) unit of frequency its name: the hertz (Hz). An event or signal repeats once per second according to the unit of hertz.

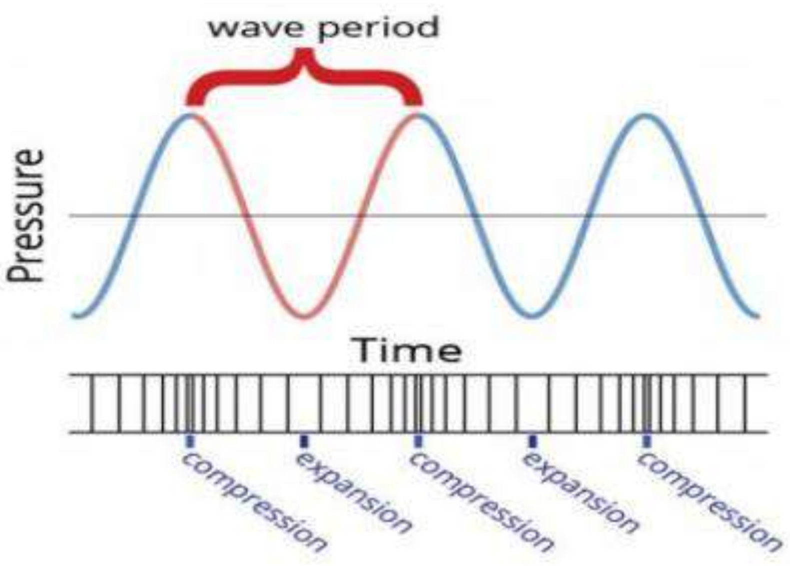

Figure1.1 Diagram of frequency

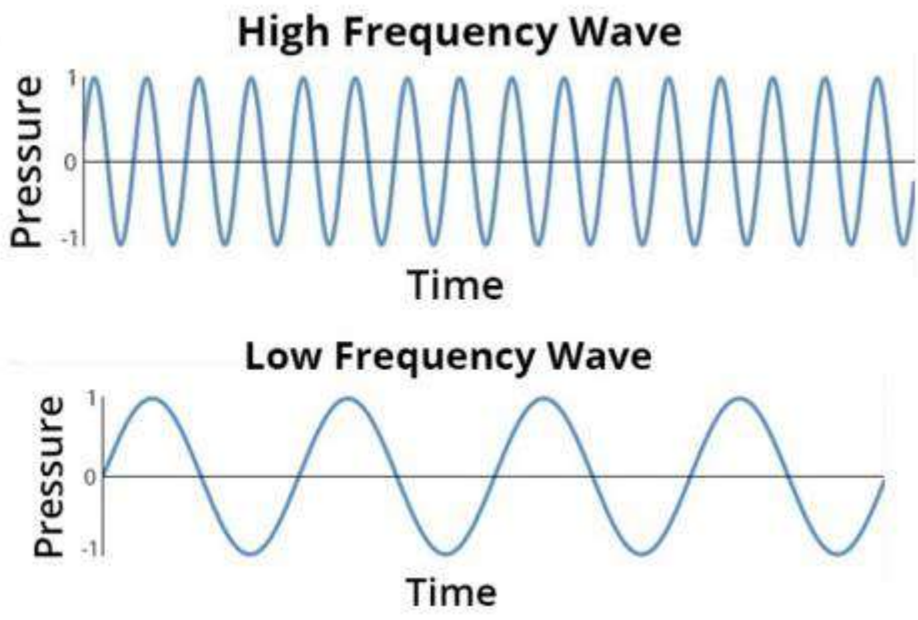

Figure 1.2 Diagram of high and Low frequency

1.4.2 Antenna's Bandwidth

In communication systems, bandwidth refers to the capacity of a wired or wireless communications system link to transmit the greatest amount of data feasible through a computer network or internet connection in a predefined amount of time, often one second. A device's bandwidth is the frequency range over which it can successfully transmit or receive energy. In many cases, bandwidth is among the most crucial variables used to select a antenna. Because of their extremely constrained bandwidths, a number of antenna types, for instance, cannot function in wideband mode. Figure 1.3 displays a bandwidth diagram.

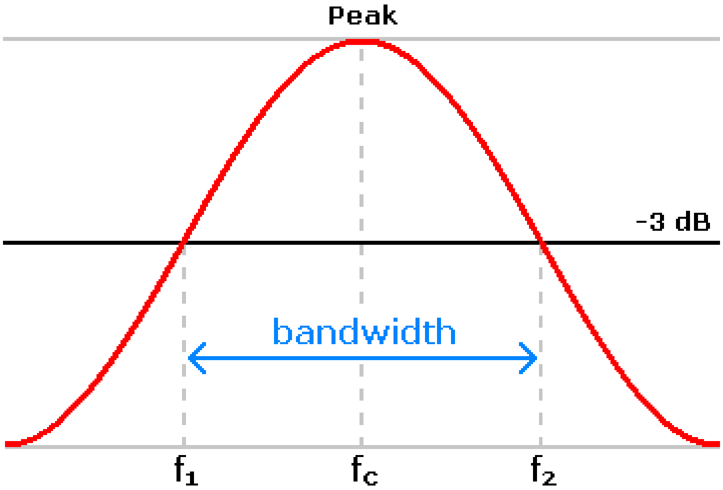

Figure 1.3 Diagram of the Bandwidth

1.4.3 Antenna's Input Impedance

Input impedance is the quantity that describes how much voltage to current is present at an antenna's input port. It is a significant antenna characteristic that expresses the antenna's resonance. The input impedance is divided into real and imaginary components. The actual component of the input impedance represents power that is released away or absorbe by antenna. The imaginary portion of the input impedance known as reflected powers serves as a representation of the power that is stored in the antenna's near field. An antenna that has zero imaginary impedance and actual input impedance are told to be resonant. The length and dimensions of antenna affect its input impedance. Impedance is symbolized by the symbol Z, which bears a real part that includes the radiation resistance and ohmic losses of the antenna, Rrad and Rohmic, respectively [3].

1.4.4 Antenna's Impedance Matching

The usual definition states that "Impedance matching" occurs when the approximated values of the impedances of a transmitter and receiver are equal or when they are opposite. Impedance matching is important for wireless communication between the circuitry and the antenna. According to the principle of maximum power transfer, When the impedances of the antenna, transmission line, and electronics are in harmony, the antenna and the receiver or transmitter may transfer the most power. When an antenna is "tuned" or "matched," the electronics and antenna are impedance matched all throughout the range of frequencies. VSWR is a measurement of the match's quality, and bandwidth is the range of frequencies when the VSWR is such that the antenna impedance is close to 50 Ohms. a mechanism that generates superior results at a certain, constrained range of frequencies is said to be resonant. Such resonant devices include antennas, whose output is improved if the impedance is matched. Impedance matching is necessary, as indicated beneath

- Maybe the impedance of the feedline and the source are the same, the power from the source will be capably transmitted towards the feedline.
- The feedline and antenna impedances match, feedline's power will be efficiently transmitted to the antenna.
- Input impedance of the receiver amplifier circuit must equal the output impedance of the antenna used as an receiver.
- The transmission line impedance and the input impedance of the antenna for a transmitter should match[4].

1.4.5 Antenna's Directivity and Gain

Directivity is capacity of an antenna to radiating energies in a certain direction when transmitting, to better receive energy from a specific direction when receiving. And gain is typically described as the ratio of the power generated by the antenna from the far-field source of the antenna's beam axis to the power generated by fictitious lossless isotropic antenna which is just as sensitive to signals from all directions. This two concepts, directivity and gain, are related. In comparison to a spotlight, a light bulb the phenomenon of enhanced directivity helps to explain this relationship. In comparison to a 100-watt light bulb, a spotlight will produce more light in some directions while producing less light in others. The light bulb is claimed to have a lesser amount of "directivity" than a spotlight. The spotlight was analogous to a high-directivity antennas. Gain is the directivity useful importance. Gain is mathematically the same to the product of efficiency and directivity. The efficiency of a antenna is a new parameter () that is included in the relationship between gain and directivity [5]. Gain and Directivity are shown in Figure 1.4.

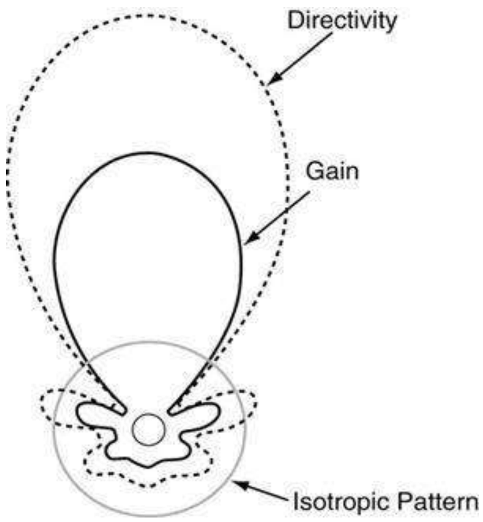

Figure 1.4 Concept of Directivity and Gain

1.4.6 Antenna's Radiation pattern

Radiation pattern, also known as antenna pattern or far field pattern, in the field of antenna design corresponding to how the radio waves' power changes with angle when they leave the antenna. Relative strength of the emitted at a fixed distance, the field from the antenna is referred to such as the radiation pattern. Because it also represents the antenna's receive capabilities, the radiation pattern can also be referred to as a "reception pattern." The situation remains challenging to portray the 3D radiation pattern in a way that is relevant despite the fact that the radiation pattern is 3D. Radiation patterns are displayed in Figure 1.5. A three-dimensional radiation pattern takes a long time to measure. A two-dimensional radiation pattern is frequently created by measuring a slice of a three-dimensional radiation pattern which display on a screen or piece of paper is simple. The formats used to depict these pattern measurements are rectangular or polar [6].

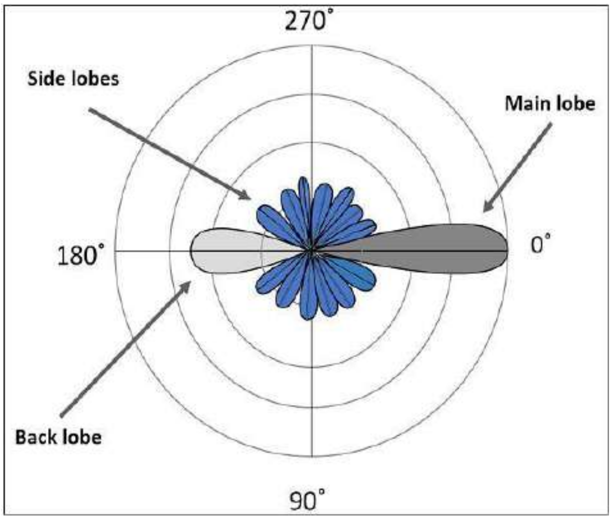

Figure 1.5 Radiation Pattern of Antenna

1.4.7 Voltage Standing Wave Ratio (VSWR)

The efficiency with which radio frequency powers are transported from a power source, by a transmission line, and into the load is gauged by VSWR (Voltage Standing Wave Ratio). In other words, the standing wave ratio, which is a measurement of the ratio between the wave's greatest and minimum power (SWR). The voltage ratio of the incident voltage to the reflected voltage is known as VSWR.VSWR for an antenna are each time a positive and real value. When the VSWR is decreased, the antenna receives more power and is better suited to the transmission line. The VSWR has to be at least 1.. This is the optimal situation because no electricity is reflected from the antenna [6]. Figure 1.6 depicts the VSWR.

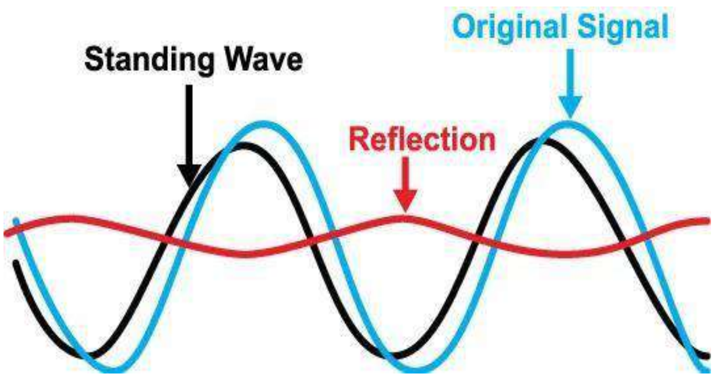

Figure 1.6 Antenna's VSWR

1.4.8 Antenna's Return Loss (RL)

An antenna's return loss is a measurement of the proportion of radio waves that enter the antenna's input that are rejected as opposed to those that are accepted. As relation to a short circuit, RL are measured in decibels (dB) (100 percent rejection). Another term for the misalliance between the feedline and the antenna is return loss (RL). The algorithmic ratio determines the difference between the power delivered into the antenna from the transmission line and the power reflected by the antenna, and it is measured in dB. Antenna's RL and VSWR are directly connected. Reality, S11 is a antenna parameter that is most frequently cited. S11 is merely the return loss in reality RL. If S11 = 0 dB than nothing are emitted and all powers are reflected from the antenna. If S11 is equal to -6 dB, then power reflected are equal to -3 dB if 3 dB of power is applied into antenna. A RL or S11 of -9.5 dB or below corresponds to the allowable If VSWR of two or less.The In this work, an RL of -10 dB is acceptable reliability [3]..

1.4.9 Antenna's Polarization

The antenna's polarization is determined by the electric field of the wave it generates. The magnitude and phase of the electric field have a direct influence on how polarized the antenna is. If the electric field's components have identical magnitudes and phases, the antenna is said to be linearly polarized. If the phases diverge by 90 degrees but the magnitudes are equivalent, the antenna is said to be circularly polarized. In order for two linearly polarized antennas to communicate, their projected electric fields must match. The ability to communicate with a circularly polarized antenna is shared by all linear antennas, regardless of their orientation. Each polarization type has a benefit; whereas A circular antenna is orientation sensitive but a linear antenna is not because all of the power is directed in one direction rather than being shared across the two components. The tag antenna should preferably be circularly polarized so that it may be read from any orientation, and the reader antenna can either be circular or linear depending on the application [5].Three different polarization types are shown in Figure

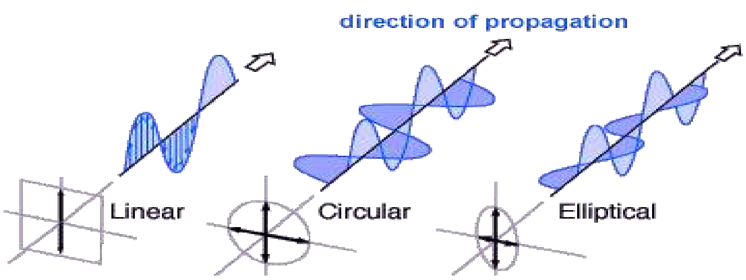

Figure1.7 Polarization : Linear,Circular,Eliptical [8].

1.5 A Microstrip Antenna

According to Figure 1.8, a ground plane and a radiating patch are attached to one side of a dielectric substrate to form a microstrip patch antenna.Which patch can take any form and is typically constructed on materials like copper or gold(conductive). Usually , the feed lines and radiating patch are photo etched onto the dielectric substrate. The patch is often square, rectangular, circular, triangular, or elliptical in shape to facilitate examination and performance prediction. $\lambda 0$ is the free-space wavelength $0.3333\lambda 0 < L < 0.5\lambda 0$. Patch will selected near thin such that $t \ll \lambda 0$ (where t is the patch thickness). The height h of the dielectric substrate is usually $0.003\lambda 0 \leq h \leq 0.05\lambda 0$. The dielectric constant of the substrate (εr) is typically in the range $2.2 \leq \varepsilon r \leq 12$.

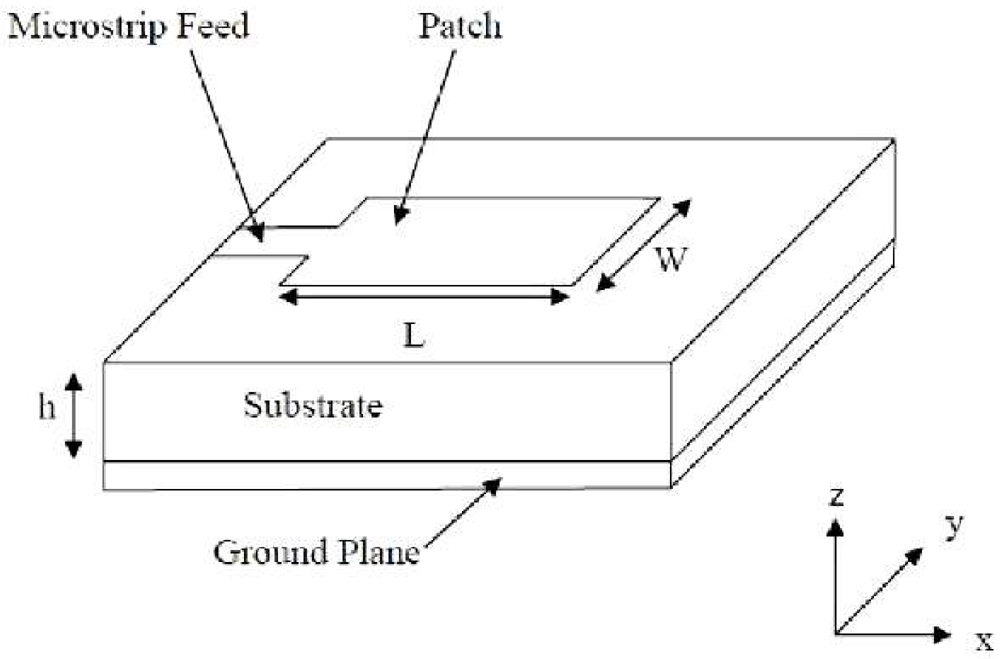

Figure 1.8 Concept of a Microstrip Patch Antenna[6]

1.5.1 Microstrip antenna Feed Techniques

Different type microstrip antenna feed techniques are given below,

- Microstrip Line Feed
- Coaxial / Probe Feed
- Aperture Coupled Feed
- Proximity Coupled Feed

- **Microstrip Line Feed**

In this type of feeding a microstrip transmission line is etched directly to the edge of patch which remains the total structure in same plane. Figure 1.9 shows microstrip feed line.

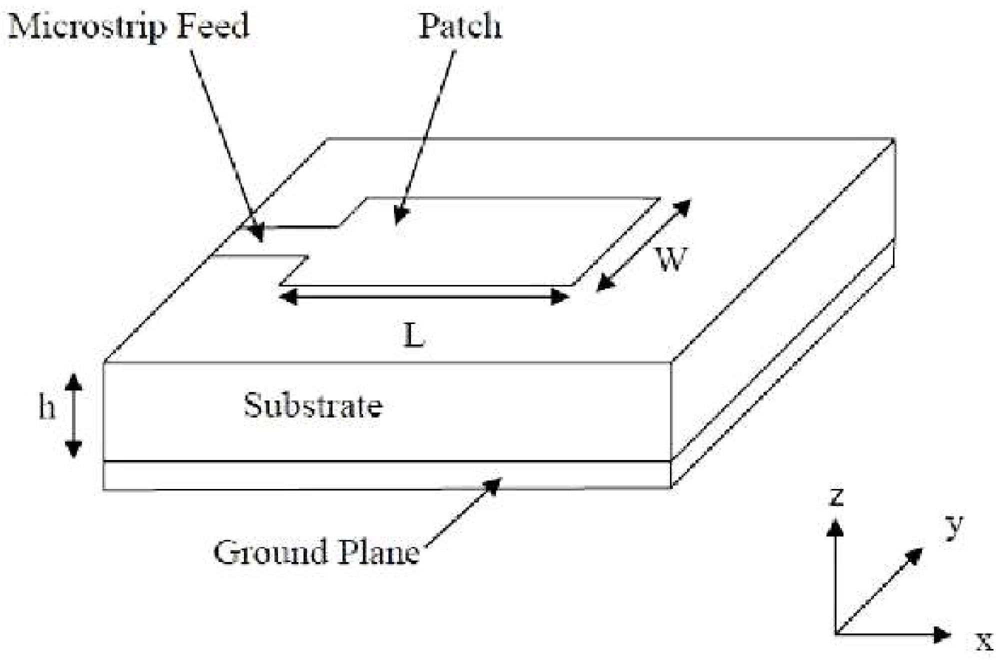

Figure 1.9 Microstrip Line Feeding [6].

- **Coaxial or Probe feeding**

The inner conductor of coaxial connector is passing through the substrate and is solderedto the radiating patch, while the outer conductor is connected to the ground plane. Coaxialfeeding shown in figure 1.10.

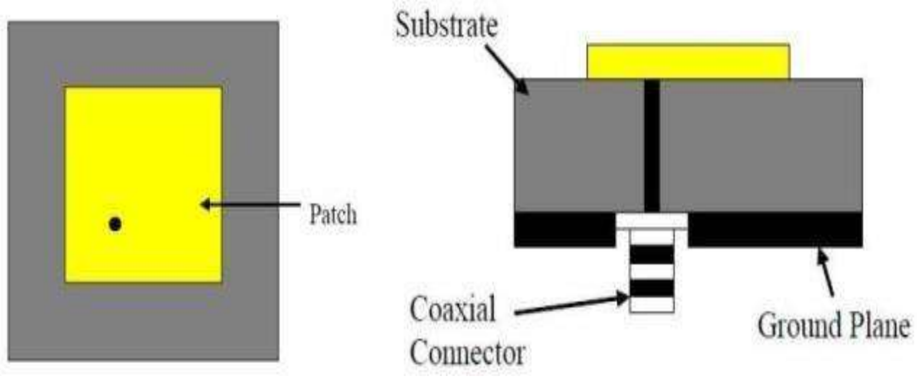

Figure 1.10 Coaxial / Probe feeding [6].

- **Aperture Coupled Feed**

In this type of feed, the aperture coupling consists of two substrates separated by a ground plane. The ground plane is separated the radiating patch and microstrip line which locate at the bottom of lower substrate. The coupling is achieved through an electrically small aperture or slot cut in the ground plane. Figure 1.11 shows aperture-coupled feed

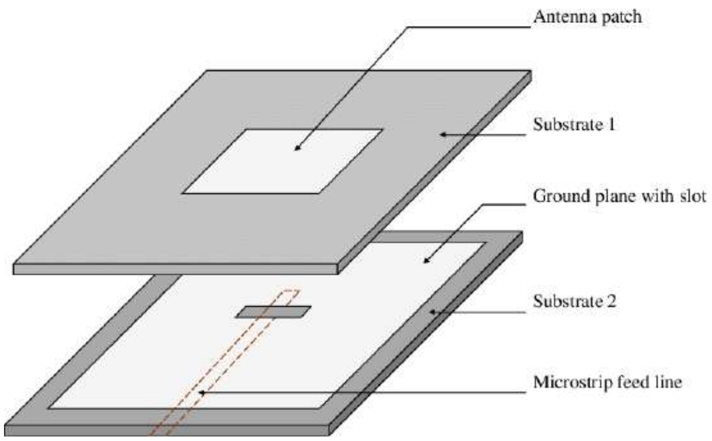

Figure 1.11 Aperture-Coupled Feed [6].

- **Proximity Coupled Feed**

It's also called Electromagnetically Coupled ECMSA. It's also consisting of two substrates. The microstrip feed line is locating between two substrates and the radiating patch is located in the top of upper substrate.

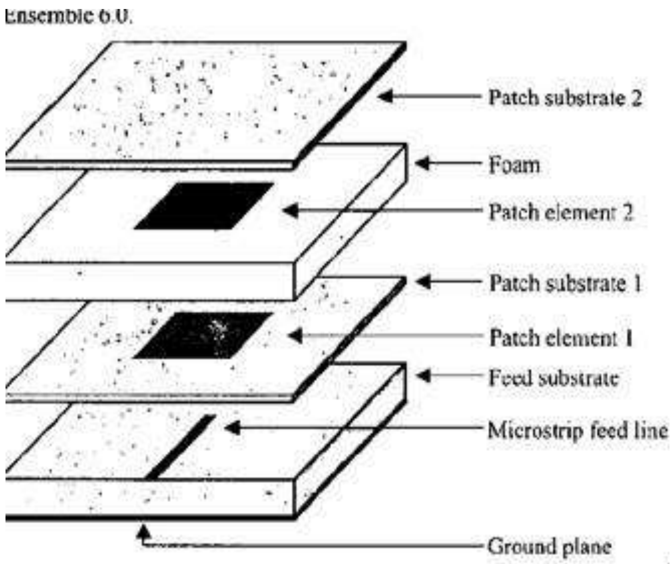

Figure 1.12 Proximity-Coupled Feed [6].

1.5.2 Benefits and Drawbacks of Microstrip Antenna

Microstrip patch antennas are used in wireless applications more frequently than ever before because of their low-profile design. As a result, they are quite well-matched with fixed antennas in portable without wire devices like cell phones and pagers. In order to be thin and conformal, the telemetry and communication antennas on missiles are frequently microstrip patch antennas.

Below are a few benefits of the microstrip antenna:

- Microstrip antennas are compact and light-weight.
- They can be produced in huge quantities since they can be made inexpensively.
- They can readily be made conformal to the host surface due to their low profile planar design.
- Supports both circular and linear polarization
- Microstrip antennas and microwave integrated circuits can be easily integrated (MICs).
- They can operate on two and three frequencies.
- When installed on hard surfaces, they are mechanically durable.

Below are a few disadvantages of the micro-strip antenna:

- The bandwidth of a microstrip antenna is limited.
- They are not very effective.
- They have little gain.
- They experience irradiation from feeds and junctions that is unnecessary.
- A fire radiator with a poor end, excluding tapered slot antennas
- They have a limited ability to handle electricity.
- Surface wave entrainment

Microstrip patch antennas have an antenna quality factor that is quite high (Q). A high Q results in a limited bandwidth and poor efficiency since Q stands for the antenna's associated losses. This can be reduced by growing the dielectric substrate's thickness. A surface wave absorbs an increasing portion of the source's overall power output.

Since this surface wave contribution finally scatters at the dielectric bends and degrades characteristics, it might be considered an undesired power loss [5].

1.6 Design Tool

This section contains information on the design tool's characteristics.

1.6.1 CST Microwave Studio (CST MWS)

The leading Softwre for the 3D electromagnetic high frequency structures simulation is CST MICROWAVE STUDIO (CST MWS). There user can quickly besides accurately analyze high frequency components,Like antennas, filters, couplers, planar and multi-layer structures, as well as SI and EMC effects, using CST MWS. Both Time Domain and Frequency Domain solvers are present in the software. By using filters to import certain CAD files and extract SPICE parameters, design possibilities are increased and time is saved.For electromagnetic design and analysis, CST provides precise, effective computational solutions.

1.7 Motivation

Breast cancer treatment is generally extremely successful, especially if the illness is found early. Breast cancer is commonly treated with a combination of surgical removal, radiation therapy, and medication in order to target the microscopic cancer that has spread from the breast tumor through the blood. By halting the development and progression of cancer, such treatment can also save lives. Breast cancer, which affected 2.3 million women in the world in 2020, claimed the lives of 685 000 people. By the end of 2020, 7.8 million women had been diagnosed with breast cancer, making it the most prevalent cancer in the world. Worldwide, this causes more lost disability-adjusted life years (DALYs) for women than any other type of cancer. Every country in the globe experiences breast cancer in women after puberty at any age. Use of imaging techniques like X-rays, mammograms, ultrasounds, tomography, and MRI to find breast cancer. These procedures can be expensive, and the radiation they use can hurt a patient's body. These procedures are time-consuming and risk providing inaccurate information. For this reason, we'd like to suggest an antenna for spotting breast cancer at an early stage.

Chapter 2

LITERATURE REVIEW

2.1 Review of Paper

Other researchers' works that are connected to this thesis are presented in this section "Design & Simulation of Microstrip Patch Antenna for Identifying Breast Cancer" will be studied, which is a crucial part of a successful study for design and simulating a microstrip patch antenna for detecting breast cancer.

1. Research paper on , "Miniature planar ultra-wide-band microstrip antenna for breast cancer detection"

   In this research, a miniature planar UWB microstrip antenna that can be applied to the breast surface to look for any potential cancerous growths. At 6 GHz, the antenna is in resonance. According to the results of the simulation, when the antenna is in touch with the breast surface, the sensitivity of tumor detection rises. The current densities inside the tumor are also around eight times larger when the antenna is in touch with the breast than when it is situated 5 cm or 15 cm breast, according to simulation results [10]
2. Research paper on , "Microwave imaging system for early detection of breast cancer"

   On this research, For the purpose of early breast cancer detection, a microwave imaging system was created. Based on the dielectric characteristics of actual woman's breasts, a human-like breast model with a target inside of it was created. The microwave signal was produced using a spherical patch antenna. CST software was thus employed for both design and simulation. Reconstructing a picture from planar scanning was the basic yet effective strategy used in this investigation. The inverse fast fourier transform was being used to translate the frequency domain data into the time domain. As the desired information was kept and the undesired noise was diminished, subtraction and windowing procedures were successful in improving image quality. The obtained planar image displayed the location of tumor successfully [11].
3. Research Paper on, "Design and analysis of a microstrip antenna array for biomedical applications"

This study uses CST and Ansoft HFSS to design a microwave imaging system with an antenna array on top of a breast phantom for early breast cancer diagnosis. The outcomes show an excellent impedance match. An antenna patch in the Industrial, Scientific, and Medical (ISM) band was tuned to the resonance frequency of 2.45GHz for biomedical purposes. The constructed simulation and the reported findings demonstrate that, in contrast to when the antenna array is positioned at a greater distance, the sensitivity of tumor identification increases when the array is Omm far from the top of the breast. According to the simulation's findings, the current density within the tumor is roughly twice as high as it is when the antenna array is located distant from the breast. Also, as the distance of a breast-patch antenna array decreases, the value of the E Field drops [12].

4. Research paper on, "Circular antenna array design for breast cancer detection"

   The antenna under study in this work is designed to be used in a scanning system for microwave breast cancer detection using an antenna array. The suggested antenna design is different from this system in a number of respects. In order to select the ideal microstrip patch antenna for use in microwave breast imaging systems to detect malignant tissues forming in women's breasts, a comparison study of five microstrip patch antennas was first conducted. With the existence of a malignant tumor in the breast, this study has convinced us to choose an antenna that will guarantee a reduction in the electric fields, magnetic fields, and current density inside healthy tissue. To have improved imaging for detecting tumors, they have developed a simplified antenna array. Second, compared to previous imaging techniques, the simulation results of the antenna array indicate a strong impedance matching with low mutual coupling and a high radiation pattern, leading us to believe that this array is effective and simple to construct for the Microwave Breast Imaging (MBI). The antenna had a respectable gain and a nice directed radiation pattern [13].

5. Research paper on, "Comparative analysis of different types of breast cancer cell detection antennas"

   Despite the fact that no one can offer superior efficacy in every section, it is not possible to compare these antennas in this paper from every angle. So, they contrast a few antennas for finding breast cancer cells. These antennas were all created using the Ansoft HFSS program. Future researchers will benefit from this paper's easy access to the summary and clear understanding of breast cancer detection antennas[14].

6. Research on, “Wearable Microstrip Patch Ultra Wide Band Antenna for Breast Cancer Detection”

   In this study, a wearable microstrip UWB antenna used for microwave imaging to find breast cancer early was examined. A simple 3D breast structure is used to replicate the antenna construction that operates between 1.6 GHz and 11.2 GHz. By altering the top and bottom planes of the microstrip, several antenna topologies are evaluated. Various substrate materials are also tested to determine the optimal return loss parameter to support wearability. Additionally, this proposed antenna's base is made entirely of cotton, which can hold onto water as needed. The execution was altered in order to be accepted for future development. The developed antenna has the advantages of UWB, modest size, low cost, strong directional radiation patterns, acceptable gain of 6.17 dBi, and total efficiency above 93%. It is also wearable and works in a variety of bending situations. As a result, when compared to other literary works, this work achieves higher results[15].

7. Research on, “On-Body Circular Patch Antenna for Breast Cancer Detection”

   This study simulated and designed a circular microstrip patch antenna for the ISM band. The antenna is preferable to the rest of the methods due to its small size and simple accessibility of on-body construction. To analyze the outcomes, two different kinds of breast phantoms were made. Different simulated results with and without tumors were seen. These findings allowed it to be determined whether or not there were any malignant tumors present. The presence of a tumor caused the resonance frequency for the first type of phantom model to alter from 2.876 GHz to 2.885 GHz. Additionally, a shift in the reflection coefficient (S11) value from 12.73 dB to 12.47 dB was noted. For the second type of breast phantom, the change was mostly seen in the reflection coefficient, which went from a value of 8.49 dB to an 8.43 dB change, indicating the presence of a malignant tumor in the breast phantom that was constructed. The values for directivity, radiation efficiency, and total efficiency were 6.776 dBi, 8.009 dB, and 8.496 dB, respectively. The maximum SAR measured in the simulated environment was 0.0603 W/kg. The antenna could identify cancerous tumors in the virtually produced breast phantoms, it was concluded from all the findings [16].

8. Research on, "Breast Cancer Detection & Tumor Localization Using Four Flexible Microstrip Patch Antennas"

   This study shows, The absence of a portable medical equipment that may help women identify any abnormal changes in their breasts at an early stage on their own and a lack of knowledge make breast cancer one of the most concerning health conditions that is spreading quickly around the world. This work focuses on the development of a portable medical device with a 1.5 GHz operating frequency employing 4 microstrip patch antennas that were developed using the meander line approach to reduce size. The technology can be used to locate potential tumor locations deep into the breast using uniform changes in the antennas' reflection coefficient data [17].

9. Research on, "An Off-Diagonal Feed Elliptical Patch Antenna With Ring Shaped Slot in Ground Plane for Microwave Imaging of Breast"

   Using the HFSS simulator, researchers created a model for this study's cancer diagnosis of a breast tumor. The simulated findings demonstrate that the maximum volume current density and maximum electric field for the breast model with tumor are greater than those for the breast model without tumor, even if there is less variance in the resonating frequency. It is also demonstrated that the near E-field result for breast with a tumor is greater than that for breast with no tumor for all values of theta. These findings offer a useful method for finding breast tumors. As a result of these findings, we may conclude that the planned antenna configuration is a viable option for an active microwave imaging system and transceiver. However, despite having positive simulation findings. Testing the antenna for such a disease is highly challenging because diverse human phantoms are produced in laboratories like jells or liquids, breast skin, normal tissues, and malignant tissue models [18].

10. Research on, "Inward Fractal Dual Band High Gain Compact Antenna"

    This research presents a unique antenna design for tumor detection or health monitoring at the medically acceptable frequency of 2.45 GHz. An efficient use of the antenna is enabled by a high gain obtained. The antenna is a strong candidate for inclusion in a phase shifted array for medical usage due to its small size of 4 × 4 cm 2, third design, and fourth design, particularly since a bandwidth of around 0.5 GHz is assured at 2.45 GHz. Additionally, an HPBW bigger than 90 degrees is obtained, making it ideal for targeting medical applications that focus on detection. Due to the unique radiation pattern form, the 5 x 5 antenna design is also used for IMT applications at 1.4 GHz and breast cancer detection at 3.2 GHz. Measured and the simulation result are comparatively showing good consistency[19].

11. Research on, "Elliptical Shape CPW Antenna for Breast Cancer Detection Applications"

    This suggested antenna offers a large 9.1 GHz bandwidth that is appropriate for breast cancer detection applications. This document details the proposed antenna's design methodology and procedure, as well as its fabrication and testing, simulation and measurement of the results, and a model for performance analysis. The computed and observed results demonstrate an omnidirectional radiation pattern and a bandwidth of 3.9 - 14 GHz (112.85%), with a peak gain of 3.8 dB at 9.5 GHz. The suggested antenna is small in size, incredibly adaptable, and provides features that are suited for imaging systems for breast cancer diagnosis. The depth of penetration can be increased by using this antenna in an array configuration [20].

12. Research on, "Electric and Magnetic Fields for the Proposed Microstrip Antenna with DGS for Breast Cancer Detection"

    Four different patch antenna designs are put forth in this study. It demonstrates that among all designs, Design 4 (with DGS suggested) exhibits good directivity and gain, Efield and H-field with and without the presence of tumor. It provides the results of high magnetic and electric fields of 7186A/m, 35.8A/m (without tumor) and 7083V/m, 35.5A/m, respectively. Design 4 is found to be the most suited in comparison to other suggested antennas and will be employed as the front-end of MIS when the mutual coupling of Design 4 is also determined [21].

13. Research on "Ultra-wide-band Flexible Antenna for Breast Cancer Detection"

    That is a flexible antenna design for a non-invasive and susceptible way to detect breast cancer in its early stages, lowering the likelihood that women would die from breast cancer. Thin-film exploitation AnsysHFSS16.2 software was used to design and implement the versatile antenna on a Rogers RT/duraid

5880(tm) substrate. The proposed structure will work on the basis of a UWB characteristic offering an average necessary bandwidth of roughly 3.5 GHz to 14 GHz with a medium frequency of 8 GHz. an antenna created using a multi-layer breast model for women. The results of this flexible antenna show that the intended antenna has an uninterrupted Ultra-wide-band characteristic. A promising The reduced size of 16 x 16 mm results in the planned antenna's full dimension. Additionally, a four-layer phantom tissue model of a woman's breast was used to create the antenna. This demonstrates the proposed antenna's suitability as a component of a microwave diagnostic procedure meter for the early detection of breast cancer in women[37].

14. Research on "A Compact UWB Antenna Design for Breast Cancer detection" A novel, compact UWB antenna design has been introduced in this study. The impact of the different antenna parameters on the resonance characteristic and bandwidth were discussed. The antenna operated between 3.5 GHz and 8 GHz with a minimum feasible return loss of 10 dB. In this antenna They used the substrate FR4 epoxy. The rectangular patch is used to avoid complex structure and make a profile. To excite the antenna micro-strip feed line is used. They used IR to fabricate the antenna. So the antenna is very compact. Thus the antenna is analyzed and designed. Results from the measurements indicate a good degree of consistency with the simulated one. The antenna had an effective directed radiation pattern and an acceptable gain of 8 dBi over the majority of the UWB that is thought to be best for imaging applications[38].
15. Research on "A Microstrip Patch Antenna Design for Breast Cancer Detection" This study examines inset fed rectangular microstrip antenna configurations to give microwave imaging in an effort to detect breast cancer early. Basic 3D breast structures are used to replicate the antenna structure operating at 2.45 GHz. Modifying the ground plane and slotting on a microstrip patch allows for the evaluation of various antenna configurations. In conclusion, for the fourth antenna structure, the electric field, magnetic field, and current density values in the situation of the breast structure with tumor are 137.36 V/m, 0.786 A/m, and 54.946 A/m2, respectively, while the values in the situation of the breast structure without tumor are 170.38 V/m, 0.84634 A/m, and 68.15 A/m2, respectively. It can be said that this work obtains better results when compared to works in literature. Depending on simulation results and graphical

observation, the fourth antenna structure provides the best detection for breast cancer [39].

2.2 Summary

Several research were done by the researcher on designing the microstrip patch antenna for breast cancer detection. There has been a conceptual model for finding a breast tumor implanted within the tissue. It has been demonstrated that it is possible to find cancers in the female breast by a adapted RMPA is constructed at the ISM band. Different simulated results with and without tumors were seen. Objectives

- To design a microstrip patch antenna for ISM band (2.4-2.48 GHz) and simulate it without any breast phantom.
- To design a microstrip patch antenna for ISM band (2.4-2.48GHz) and simulate it with the breast phantom without tumor.
- To design a microstrip patch antenna for ISM band (2.4-2.48GHz) and simulate it with the breast phantom with tumor.
- To detect the cancer as accurate as possible optimize it for better result.
- To compare with the proposed antenna with existing antenna.

Chapter 3

METODOLOGY

3.1 Methodology

Methodology is the methodical, theoretical assessment of the research-related techniques used. It comprises a theoretical investigation of the collection of practices and beliefs connected to a field of knowledge. It typically includes ideas like standards, theoretical models, phases, and quantitative or qualitative research procedures [21]. A sequence of tasks or processes is referred to as methodology. The methodologies utilized in a specific research project, as well as practices that are often applied across a field of study or industry, may be referred to by this name. A methodology, on the other hand, does not aim to provide solutions; as a result, it is not the same as a method. A methodology, on the other hand, compacts with the theoretic support for comprehending how approach,combination of procedures can be accurate to a specific instance.

3.2 Research Design

Design is characterized, the framework established to address the research concerns. A research program's design identifies the research tools, including the study topic, independent and depenend variables, design of experiment , and, if necessary, data collecting procedures and a plan on arithmetic analysis.

The research design was as follows:

- Research into the use of microstrip patch antennas in the detection of breast cancer.
- Researching the ISM antenna frequency band.
- Investigate Related Literature Regarding Microstrip Patch Antenna.
- Study published papers on tumor detection methods.
- Research the process being used construct MPA.
- Acquiring knowledge of CST Microwave Studio for simulation and analysis.
- Calculate the parameters required to design an antenna.
- Planning and simulating the proposed antenna.
- Examining the findings and comparing them to the literature review.
- Put the procedure into action.

3.3 Pilot Study

Prior to carrying out a full-scale research project, any of the following: a pilot research, initiative, test, or experiment has been carried out so as preliminary small-scale research to determine efficiency, hostile, time, cost, occurrences, besides increase the study project. It is carried out before the anticipated study. Typically, pilot studies are carried out according to the study's original plans. While it cannot completely exclude systemic miscalculations or unanticipated issues, it significantly decreases the number of errors that cause time and effort to be wasted at the primary research study.

To purpose of the pilot study is

- Toward classify important variables and decide how to functionalize each one.
- To create or assess the efficiency of research tools also methodologies
- To assess statistical factors for future research.
- To test the methodology and/or technique for the research.

3.4 Software

A potent tool for the 3D electromagnetic simulation of high frequency components is called Computer Simulation Technology Microwave Studio (CST MWS). High frequency (HF) devices such filters, couplers, antennas, single and multi-layer structures, as well as SI and EMC effects, can be quickly and precisely analysed using CST MWS.

CST MWS is the top choice in industry-leading research and development departments because of its unmatched performance. CST MWS, which is incredibly user-friendly, instantly provides the user with a glimpse into the EM behavior of high frequency designs [22].

3.5 Procedure of design

- **Step 1:** First, based on the fundamental equations for constructing MPA, a single microstrip patch antenna (MPA) is developed to work at 2.44 GHz.
- **Step 2:** Next, check the antenna's return loss and VSWR.
- **Step 3:** Save the results if the antenna corresponds to the requirements.
- **Step 4:** In this stage, we design the breast phantom on CST in accordance with the literature review, which states we are required to design the breast

phantom.

- **Step 5**: At this step, We created a second breast phantom with a tumor.
- **Step 6**: Keep the structure and simulate the designed antenna in step six.
- **Step 7:** If the antenna match the requirements.
- **Step 8:** Optimize the efficiency of the designed Microstrip patch antenna.
- **Step 9 :** Compare the results with existing antennas.

3.6 Antenna geometry and designed parameters

3.6.1 Antenna Substrate

The selection of an acceptable dielectric substrate with the proper thickness is the first stage in creating an antenna. To increase mechanical and electrical stability, employ dielectric materials. They are employed to make the antenna smaller and aid in creating displacement current, which, according to Ampere's Law, produces a magnetic field that varies over time. By applying Faraday's law, this time-varying magnetic field can create a time-varying electric field, which in turn creates a propagating electromagnetic field. A substrate can improve an antenna's capacity to radiate in this way. FR4 is a class of printed circuit board base material made from a flame retardant epoxy resin and glass fabric composite. FR stands for flame retardant and meets the requirements of UL94V-0. FR4 has good adhesion to copper foil and has minimal water absorption, making it very suitable for standard applications. FR4 is either used as a copper-coated material for 1 and 2-layer PCBs or is used for multilayer PCBs as a Prepreg and core[41].

TABLE 3.1: LIST OF SUBSTRATES

Dielectric Name	Dielectric constant
Fr4 (lossy)	4.3

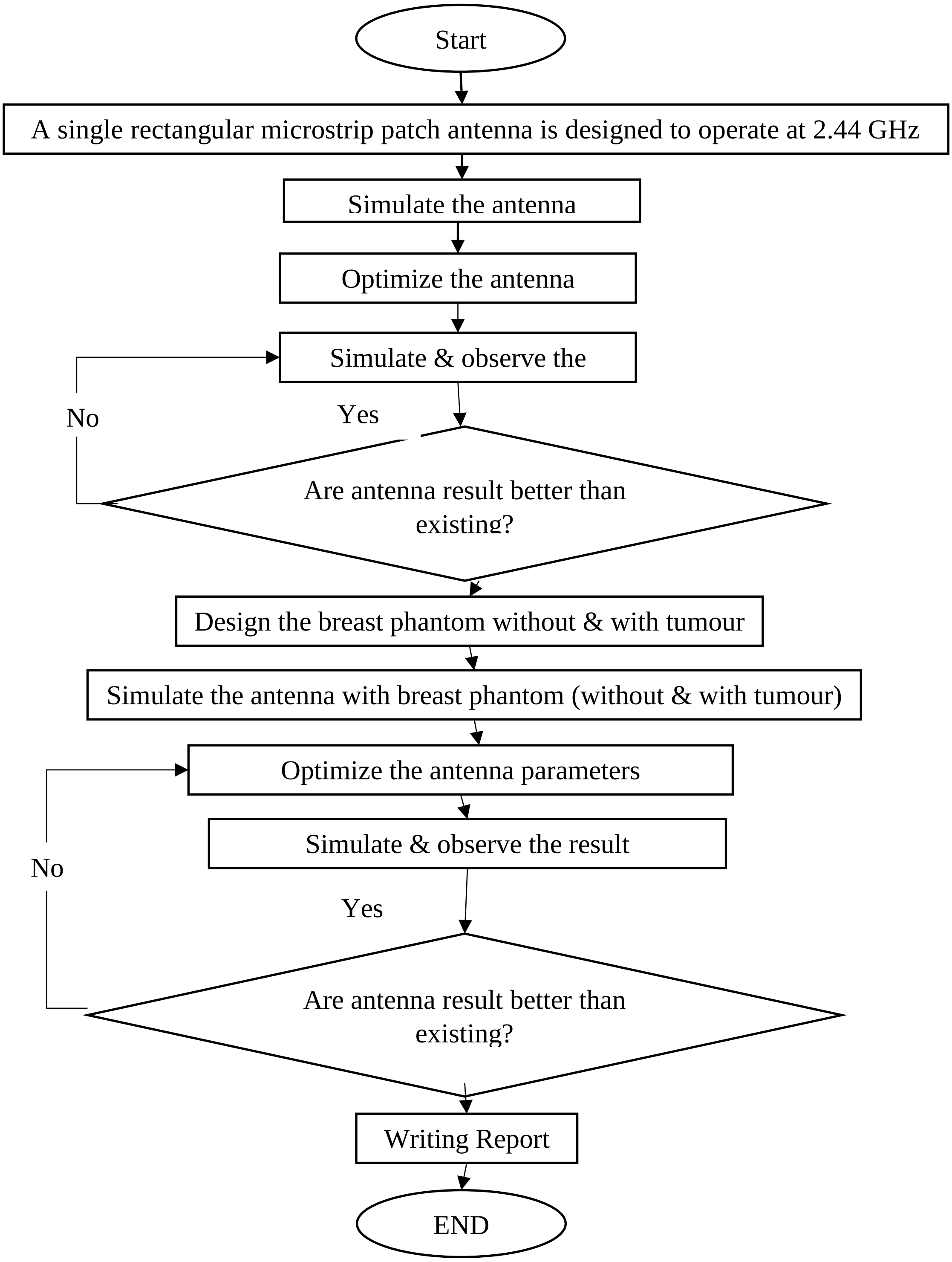

FIGURE NO 3.1 Flow Diagram of the Research work

3.6.2 Antenna Design Equation

- The patch width (Wp) and patch length (Lp) were found using the following formulas[23]:

  $$w = \frac{c}{2f_0\sqrt{\frac{\epsilon r+1}{2}}} \ldots\ldots(1)$$

  Where,

  c is the velocity of light in free space.

  fr is the resonant frequency of operation.

  $\in r$ is the dielectric constant of substrate.

- For determine the actual length L, two parameters such as effective dielectric constant and extension of length have to be calculated. Firstly, the effective dielectric constant is calculated using below equation (2).

  $$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1 + 12\, h/Wp]^{\frac{-1}{2}} \ldots\ldots(2)$$

  Here,

  ε_{eff} is the effective dielectric constant

  h is the thickness of the substrate

  W_p the width of patch

- The actual length L_p is determining by below equation (3).

  $$Lp = \frac{C}{2f_0\sqrt{\varepsilon_{eff}}} - 2\Delta L \ldots\ldots(3)$$

  where

  f_0 is the operating frequency.

- Extension of length is determining is using below equation (4)

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

  Here,

  ΔL is the extended incremental length of the patch

- The ground plane width (Ws) and the ground plane length (Ls) were found using the following formulas:

  Ws=6h+Wp……………………………………………………………(5)

  Ls=6h+Lp…………………………………………………………...(6)

- The inset-feed point distance (Is) was found using the following the equation:

$$Is=\frac{Lp}{\pi}\cos^{-1}\left[\sqrt{\frac{Z_0}{R_{in}}}\right]\ldots\ldots(7)$$

Where,

z_0 is the characteristic impedance

R_{in} is the input resistance

3.7 Antenna design and Parameter

As mentioned above, research has been done on antenna design , including substrate elements, substrate height, and feeding technique, to specify the antenna design. The antenna's geometry is displayed in the part after that, according to each parameter.

3.7.1 Design of the Microstrip Patch Antenna

Aground plane, a metallic patch, a dielectric substrate, and a feeding component make up a basic MPA [23].For this design we used FR4 (lossy) substrate and copper as the ground of the patch. The other parameter are mention below

Table 3.2 Rectangular Microstrip Patch Antenna Dimensions.

Designed Parameter	Dimension (mm)
Operating Frequency	2.44Ghz
Ground Plane Length(ls)	38.6
Ground Plane width(ws)	43.6
Length of patch(lp)	28.35
Width of patch(wp)	35.5
Height of substrate(hs)	1.6
Width of feedline(wf)	3
Feedline insertion(ls)	6
Ground Thickness	0.035

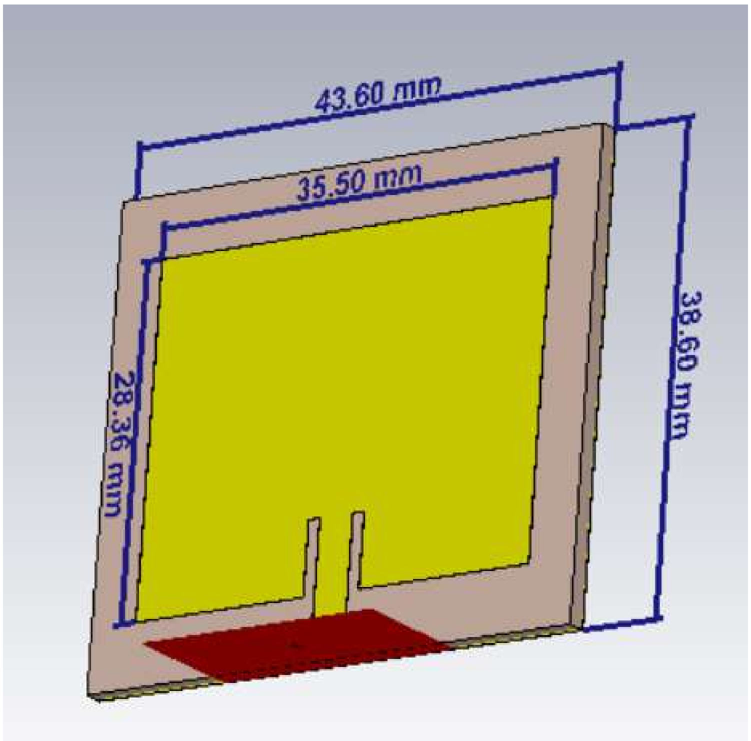

Figure no 3.2 The proposed Antenna

3.7.2 Design of Breast phantom

For the purpose of the simulation a breast is needed to design in this part.A human breast has multiple layer of Fat, tissue, skin. Each of those layer has their individual Permittivity, Electrical conductance, density, heat capacity, hermal conductance. The half-sphere shape of the model was used in its creation. Those parameter are mention below:

Table 3.3 Breast Phantom Model Electrical Properties Of Different Tissues WithTumor[24]

Tissue	Permittivity F/m	Electrical Conductance S/m	Density kg/m3	Heat Capacity j/kg/C	Thermal Conductance W/m/C
Skin	36.7	2.34	1109	3391	0.37
Fat(Adipose Tissue)	4.84	0.262	911	2348	0.21
Glandular Tissue	50	3.46	1041	2960	0.33
Tumor	54.9	4	1058		1.1

Table 3.4 Breast phantom model size

Tissues	Outer radius
Skin	40
Fat	36
Glandular	32
Tumor	5

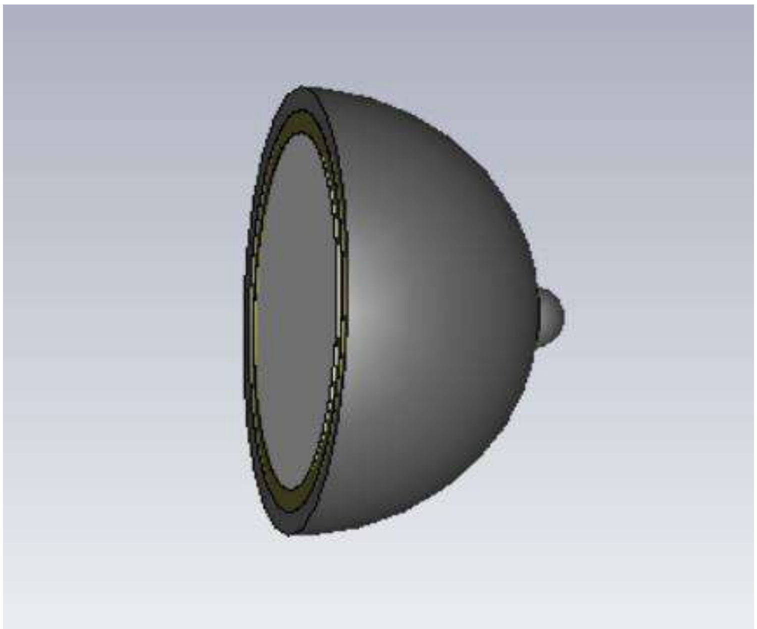

Figure 3.3 Breast phantom

3.7.3 The breast model with the Antenna

- **Without the presence of the Tumor**

  The layers depicted in the figure same to the breast phantom model. The phantom models' skin, adipose, and glandular tissue characteristics are also the same.

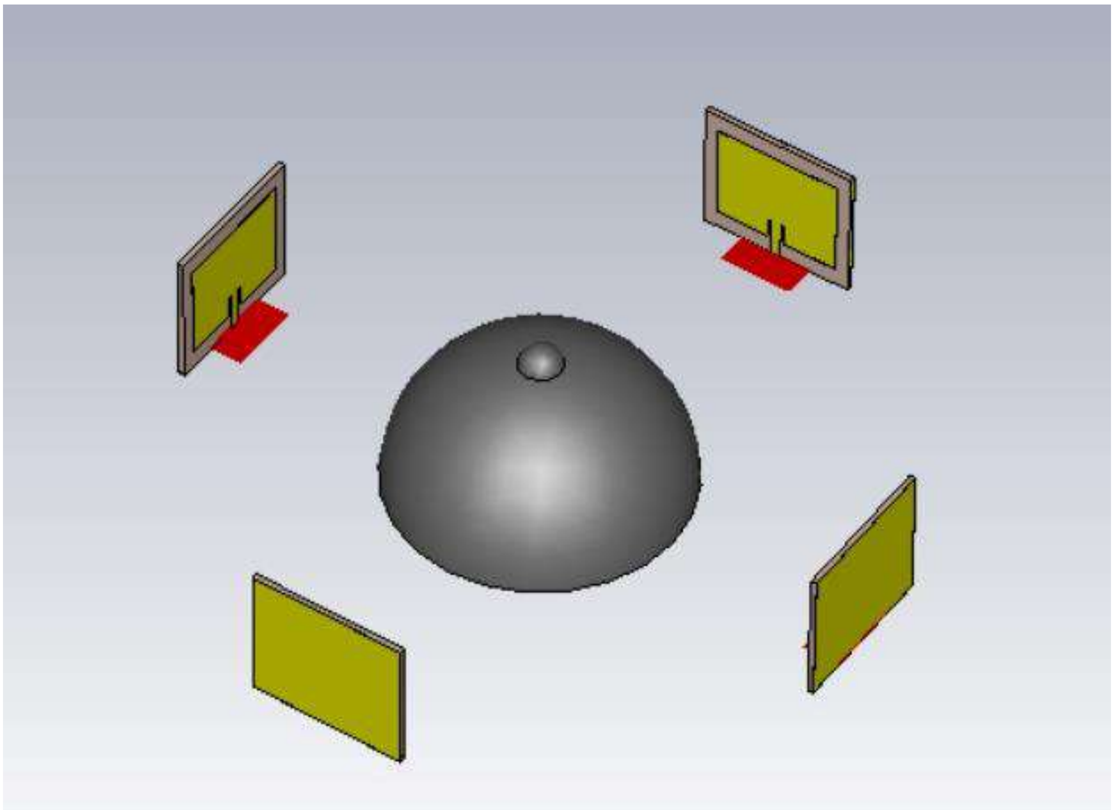

Figure 3.4 The proposed structure with breast phantom, without tumor

- **With the presence of the Tumor**

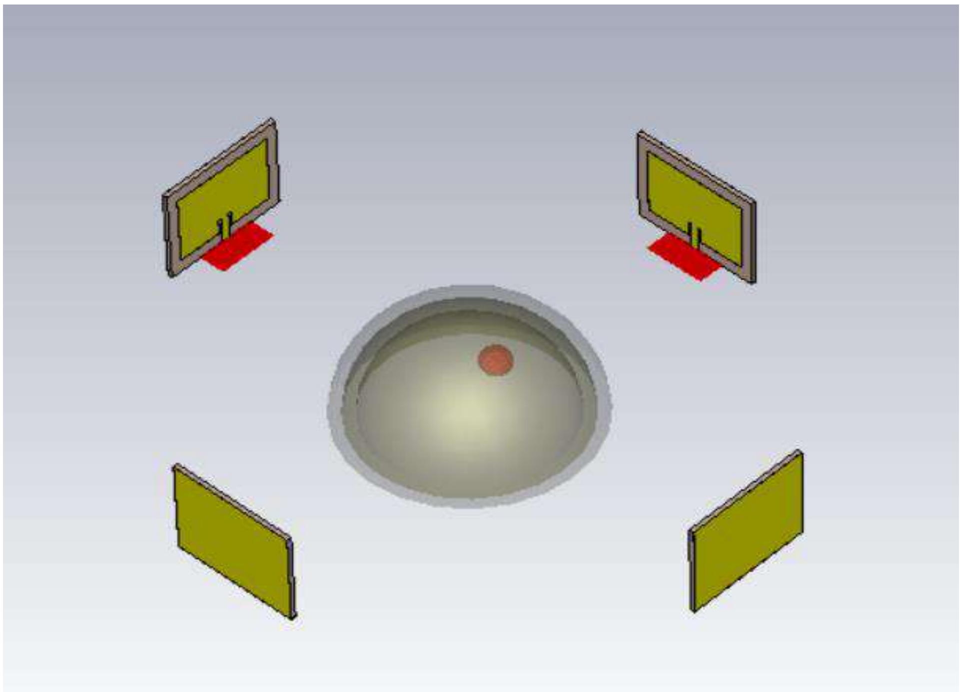

Figure 3.5 The proposed structure with breast phantom, with a tumor

Chapter 4

SIMULATIONS AND RESULT ANALYSIS

The results that were obtained after simulating the intended antenna are presented and discussed in this chapter.

4.1 Specific Absorption Rate (SAR)

A radio frequency (RF) electromagnetic field exposes a human body to energy, which is then absorbed per unit mass at a rate known as the specific absorption rate (SAR). It can also be used to describe the way that tissue absorbs energy from other sources, including ultrasound. It is measured in watts per kilogram (W/kg) and is referred to as the power absorbed per mass of tissue.

Typically, SAR is averaged across the entire body or over a limited sample volume (typically 1 g or 10 g of tissue). The referenced value is then the maximum level found in the bodily component under consideration relative to the specified volume or mass[40].

SAR for electromagnetic energy can be calculated from the electric field within the tissue as:

$$\mathrm{SAR} = \frac{1}{V}\int_{\mathrm{sample}} \frac{\sigma(\mathbf{r})|\mathbf{E}(\mathbf{r})|^2}{\rho(\mathbf{r})} d\mathbf{r}$$

where

σ is the sample electrical conductivity

E is the RMS electric field

ρ is the sample density

V is the volume of the sample

SAR measures exposure to fields between 100 kHz and 10 GHz (known as radio waves).It is commonly used to measure power absorbed from mobile phones and during MRI scans. The value will depend heavily on the geometry of the part of the body that is exposed to the RF energy, and on the exact location and geometry of the RF source. Thus tests must be made with each specific source, such as a mobile phone model, and at the intended position of use[40].

4.2 Simulation Results

This section is divided into three parts and the result analysis and discussion are mainly based on three simulated antenna design. This analysis was carried out by keeping an eye on a few outcome parameters. This article discusses the final antenna design and its simulation.

4.2.1 Results analysis on the proposed antenna

Antennas should be able to operate in the ISM band, which has a frequency range between 2.4 and 2.48 GHz, for medical diagnosis and treatment. The radio spectrum's ISM radio bands are portions set aside for uses other than telecommunications in the industrial, scientific, and medical (ISM) fields[25].Here we have designed an antenna which operate at the ISM radio band. The S-parameters represent the input-output relationships between ports or terminals. The amount of power an antenna reflects is measured by the reflection coefficient, also referred to as S11[24].The S11 of proposed antenna is -36.043 dB at 2.44 Ghz frequency shown in the figure 4.1.

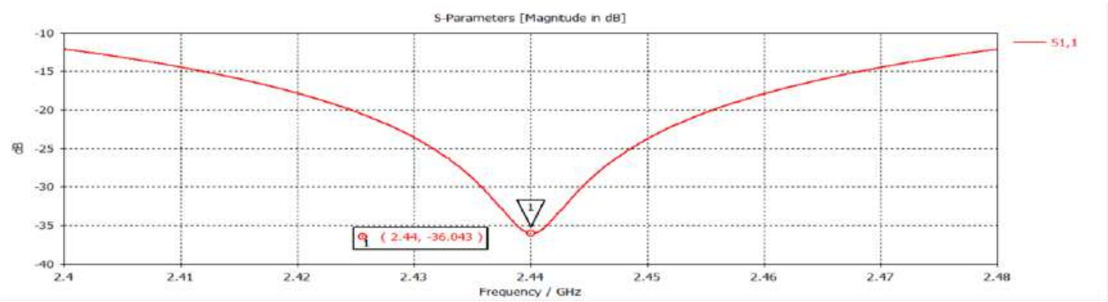

Figure 4.1 S11 parameters of the proposed Antenna.

The efficiency with which radio-frequency power is transported from a power source, through a transmission line, and into a load is gauged by the VSWR (Voltage Standing Wave Ratio).In figure 4.2 the VSWR is 1.0321.

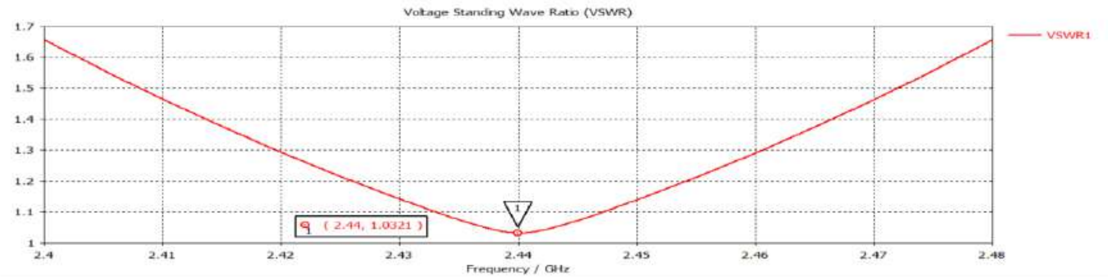

Figure 4.2 VSWR of proposed antenna

Directivity is the capacity of an antenna to radiate energy in a certain direction when transmitting or to better receive energy from a specific direction when receiving. And gain is typically described as the ratio of the power generated by the antenna from a far-field source on the antenna's beam axis to the power generated by a fictitious lossless isotropic antenna that is equally sensitive to signals from all directions.

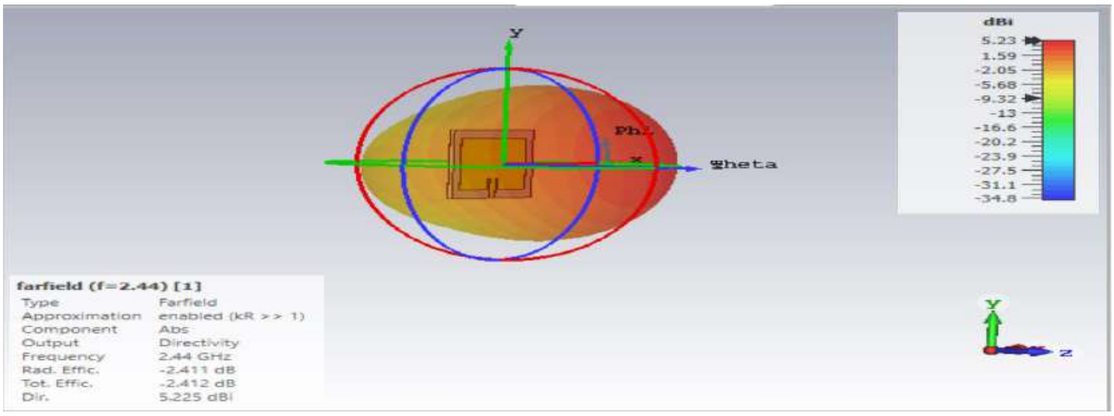

Figure 4.3 Directivity of the antenna(5.225dBi)

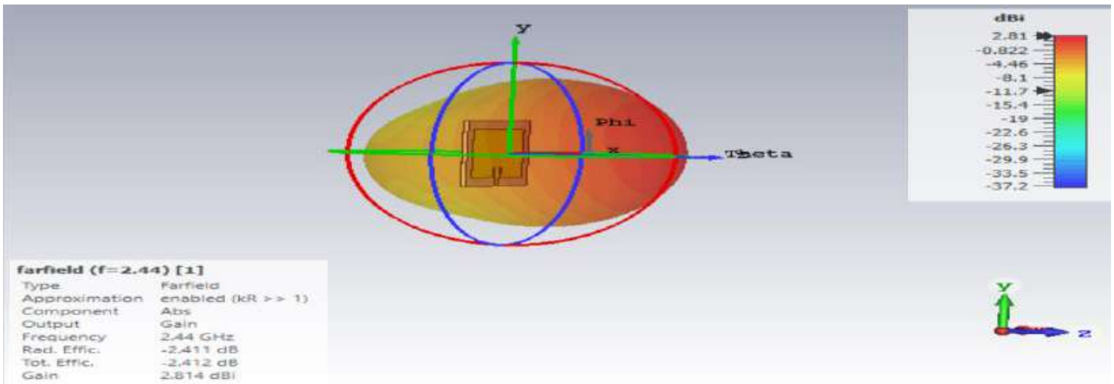

Figure 4.4 Gain of the Antenna(2.814dBi)

Table 4.1 Result of the antenna

Antenna Parameter **Resonance Frequency(2.4144Ghz)**	**Results/Outputs**
Return Loss(S1,1)	-36.043 dB
VSWR	1.0321
Directivity	5.225dBi
Gain	2.814dBi

- **Result analysis of Antenna with breast phantom(No tumor)**

In this process the main fact is the differences in the electric field will be obtained in the form of scattering parameters and the presence of the tumor cell will be detected.Here in figure 4.5 and 4.6 the S11 and VSWR is represented respectively.

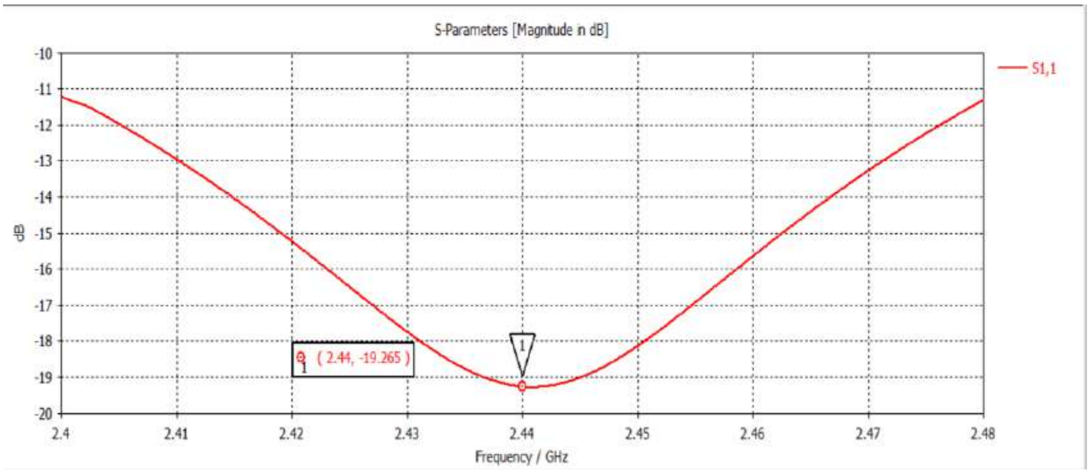

Figure 4.5 S11 parameters of the antenna with breast without tumor

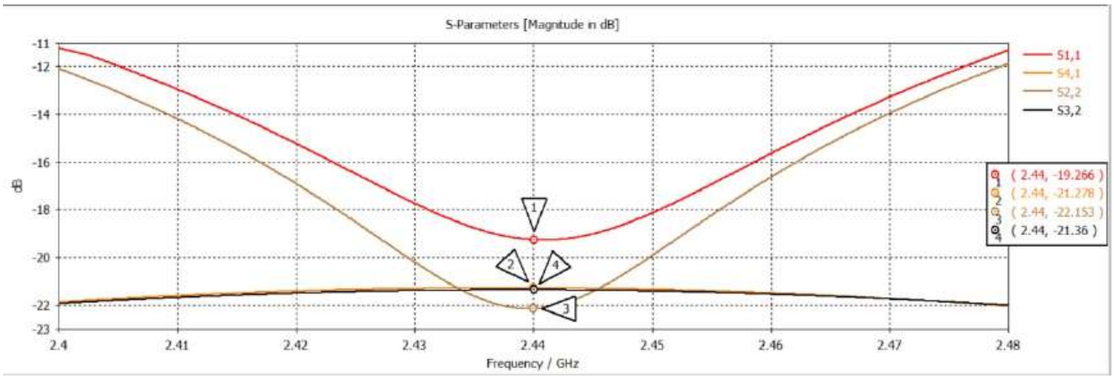

Figure 4.6 S11,S41,S22,S32 parameters of the antenna with breast without tumor

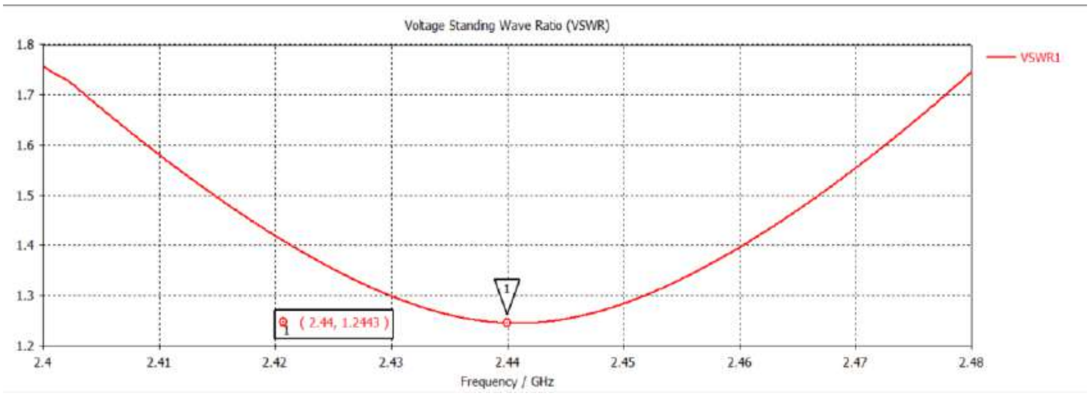

Figure 4.7 VSWR of the antenna with breast without tumor

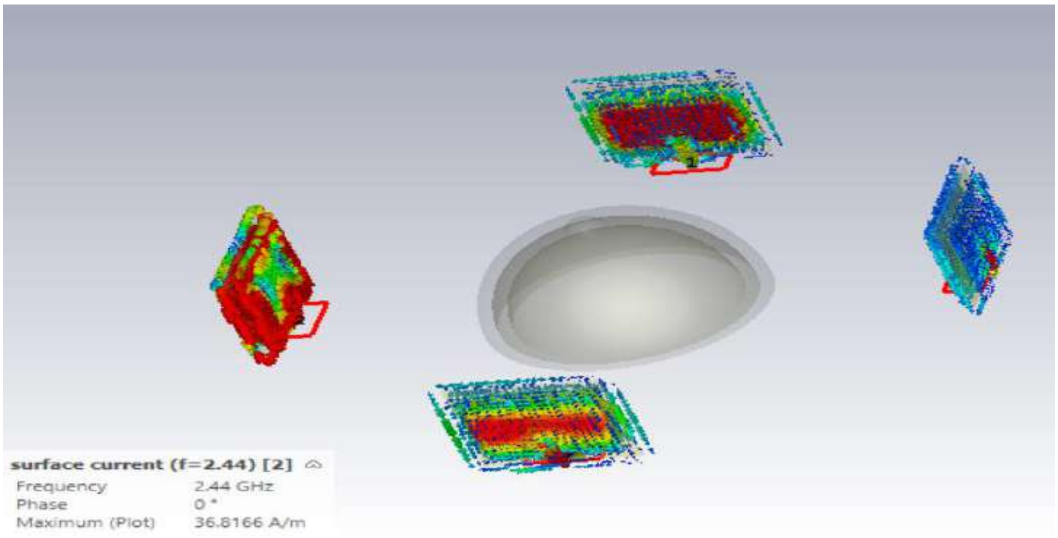

Figure 4.8 The Surface Current at 2.44 (GHz) is 36.8166(A/m), without tumor

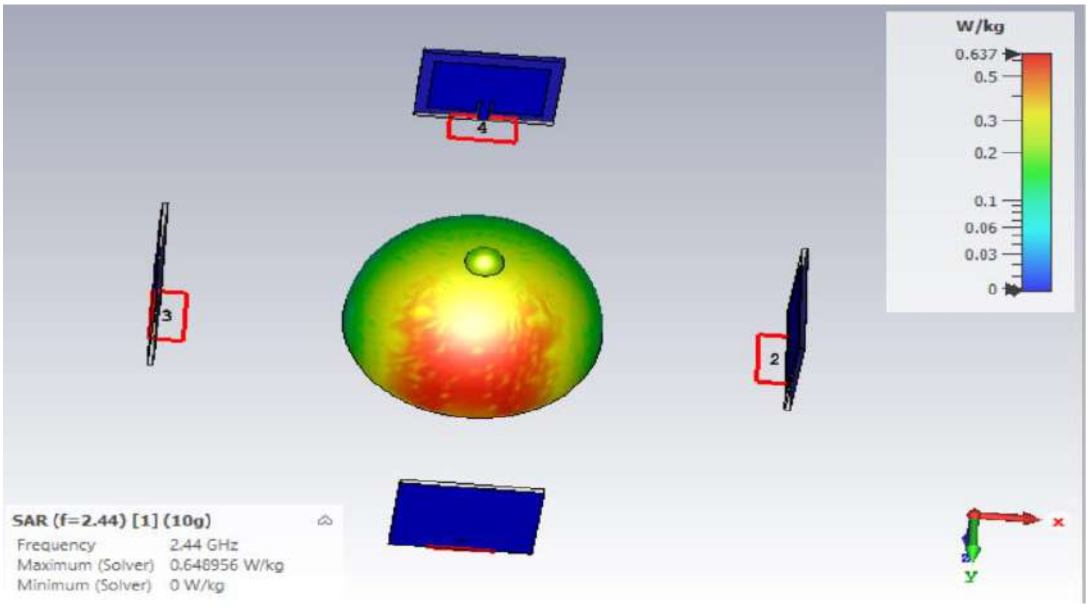

Figure 4.9 The SAR value at 2.44 (GHz) is 0.637174 (W/kg) for 10g, without tumor

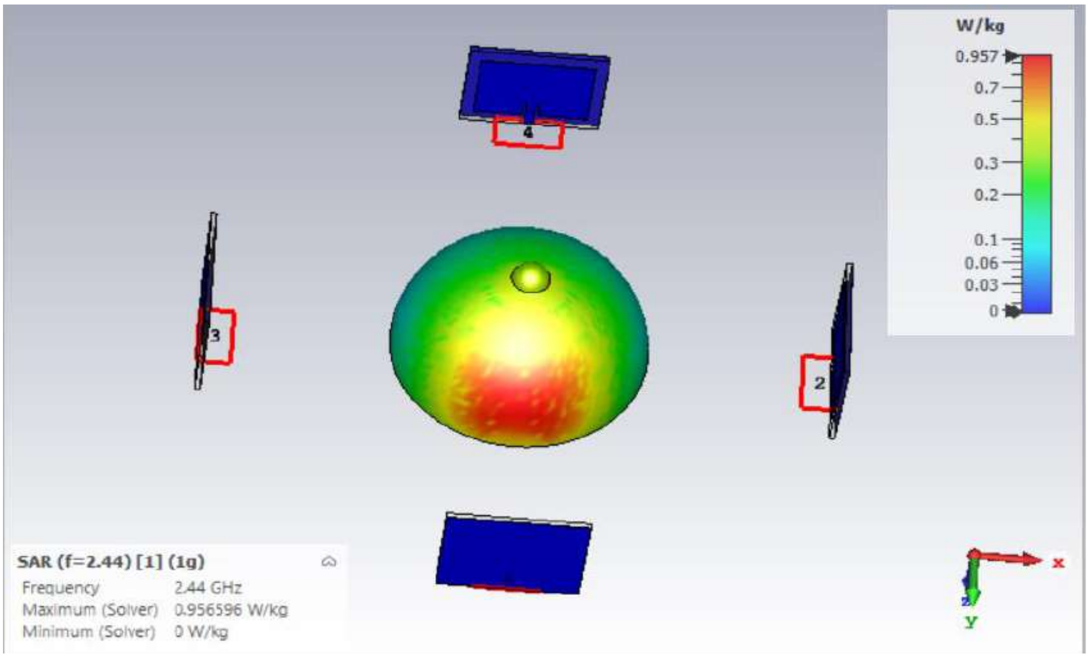

Figure 4.10 The SAR value at 2.44 (GHz) is 0.956588 (W/kg) for 1g, without tumor

- **Result analysis of Antenna with breast phantom(With tumor)**

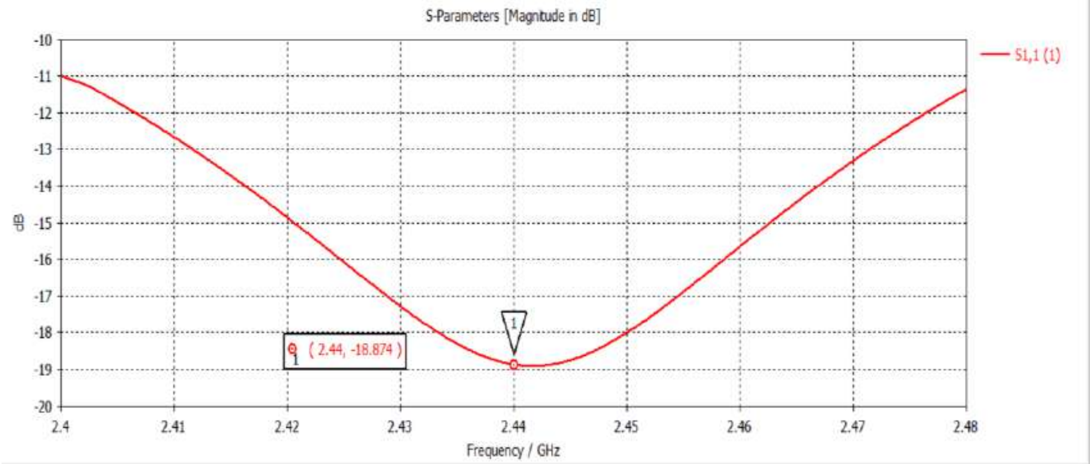

Figure 4.11 S11 parameters of the antenna with breast with tumor

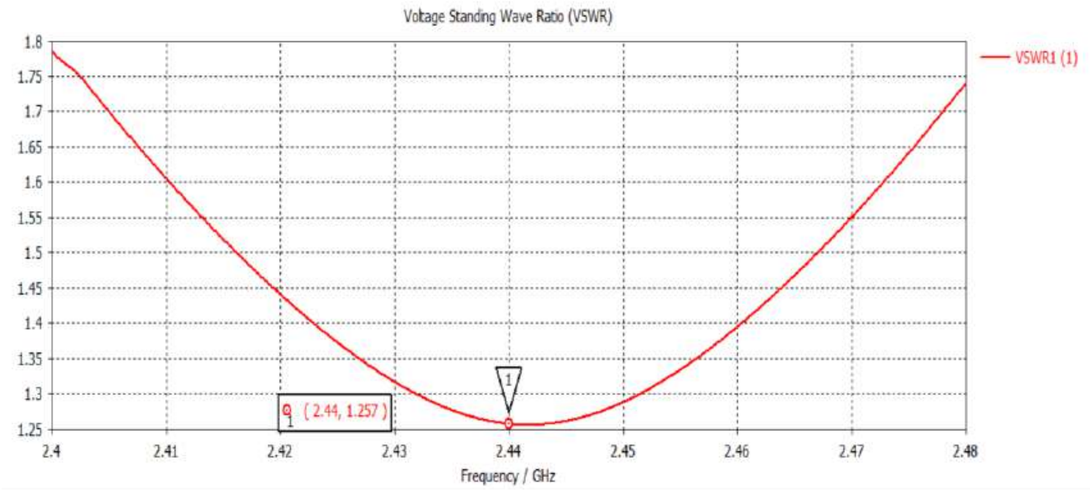

Figure 4.12 VSWR of the antenna with breast with tumor

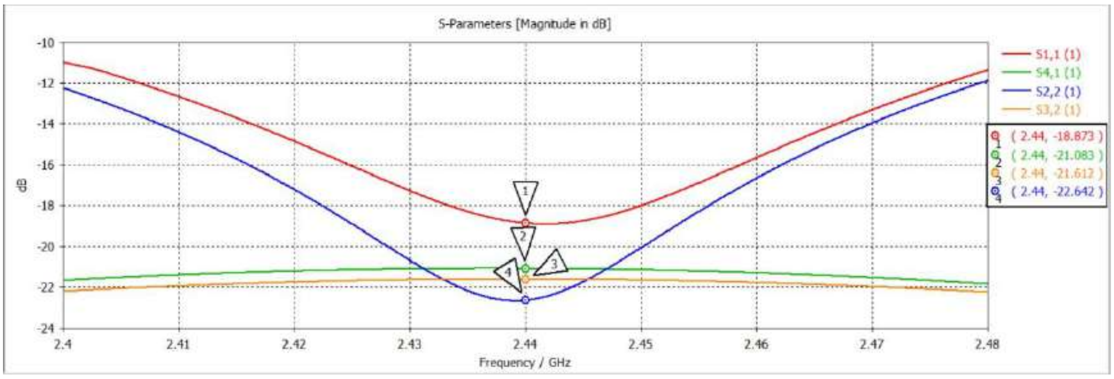

Figure 4.13 S11,S41,S22,S32 parameters of the antenna with breast with tumor

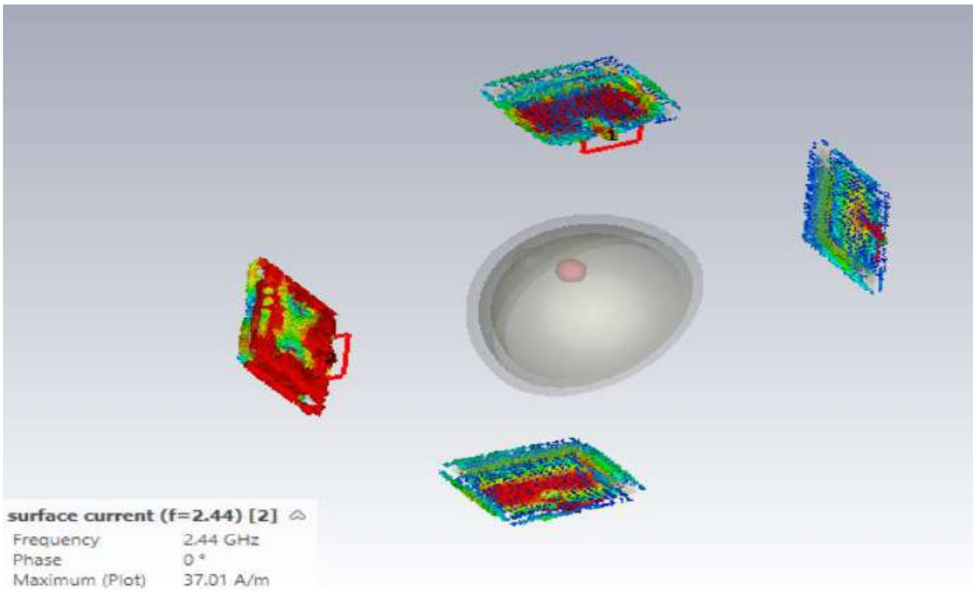

Figure 4.14 The Surface Current at 2.44 (GHz) is 37.01 (A/m), with tumor

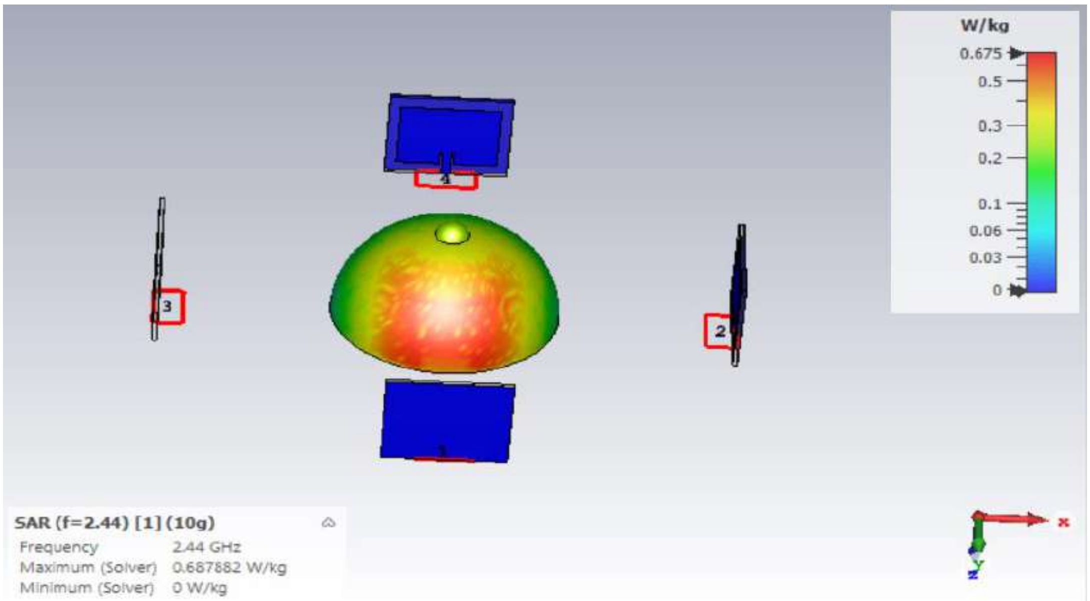

Figure 4.15 The SAR value at 2.44 (GHz) is 0.67539 (W/kg) for 10g, with tumor

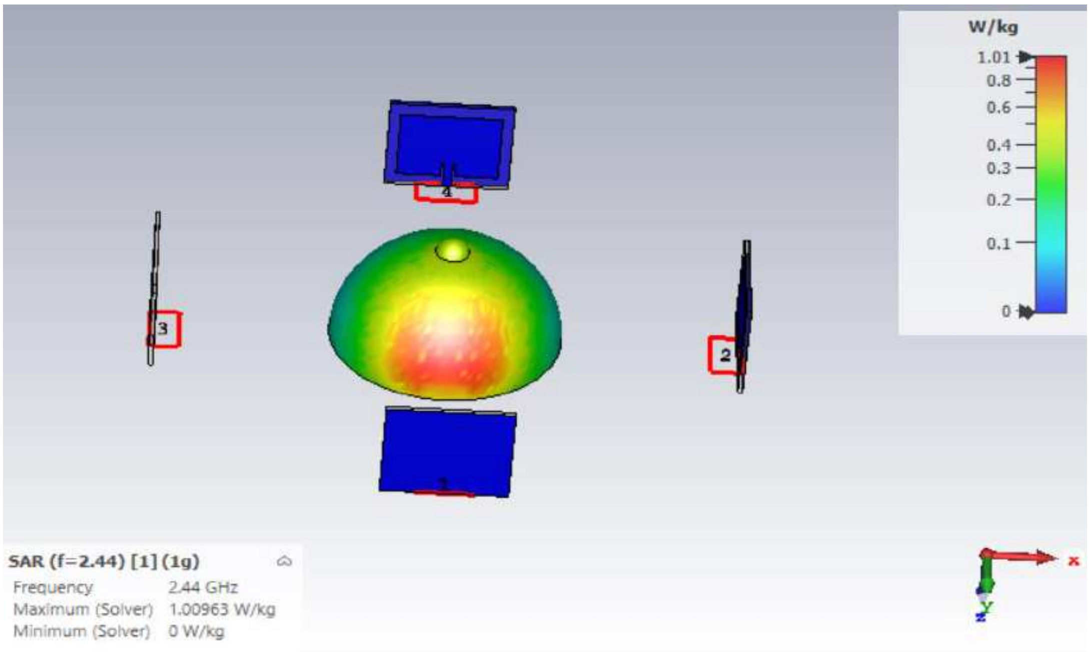

Figure 4.16 The SAR value at 2.44 1.00962 (GHz) is (W/kg) for 1g, with tumor

Table 4.2 Result Comparison Between Without Tumor & With Tumor

Parameter Name	**Without Tumor**	**With Tumor**
Return Loss ,S11(dB)	-19.265db	-18.874
S41,S22,S32 parameters(dB)	-21.278,-22.153,-21.360	-21.830,-21.612,-22.642
VSWR	1.2443	1.257
Surface Current(A/m)	36.8166	37.01
SAR(For 10g)(W/kg)	0.637174	0.67539
SAR(For 1g) (W/kg)	0.956588	1.00962

The Table is shows the difference between the antenna results parameter. At first glance we can see the S11 of the antenna Without tumor is -19.265 and with tumor its change to -18.874. It is discovered that the reflection coefficient increases slightly as the tumor appears. On the other hands the VSWR is increased in the presence of tumor from 1.2443 to 1.257.The surface current also rises up as 36.8166 to 37.01 A/m in the presence of tumor. Now, comes to the SAR value. The SAR value for 10g increases 0.637174 to 0.67539 in the presence of a tumor. As well as in the presence of a tumor the SAR value for 1g also increases 0.956588 to 1.00962.In this process the main fact is the differences of scattering parameters and the presence of the tumor cell will be detected.

Comparison with the existing Antennas.

Tables 4.3 below provide comparisons of the proposed work with earlier work.

Reference	**Reflection Co-efficient**		**SAR**	
	Without tumor	With tumor	Without tumor	With Tumor
[44]	-40.260902db	-39.904223db	-	0.720336(for 1g)
[45]	-22.40dB	-	1.2w/kg(for 1g)	1.4w/kg(for 1g)
[46]	-8.4932765	-8.4294207	-	0.0603w/kg
Proposed	-19.265db	-18.874db	0.956588	1.00962

Despite its small size, our suggested antenna is completely compatible and complies with Specific Absorption Rate (SAR) requirements to prevent dangerous heating of biological tissues. It exhibits minimized return loss as well as a relatively low SAR value when compared to other antennas. The antenna is more suitable for biomedical applications the lower the SAR value.

Chapter 5

CONCLUSION

Primary goal of this work was to design a microstrip patch antenna in accordance with the specifications for tumor detection. The motivation of this work was that the antenna design at present time works with the specific requirement of cancer cell detection.

5.1 Achievements

There has been a conceptual model for finding a breast tumor implanted within the tissue. It has been demonstrated that it is possible to find cancers in the female breast by employing the microwave imaging technology and a modified RMPA that is developed at the ISM band. The embedded tumor was represented as a sphere in accordance with the relative dielectric characteristics of tissue, whilst the breast was modeled as a sphere. The findings demonstrate that the optimized antenna is more effective than other designs that are already on the market at detecting breast cancers.

5.2 Limitation

Microstrip patch antenna is popular for its low cost, small structure, lightness and availability properties. But a particular antenna cannot offer all the features simultaneously. Every antenna has some parameters limitations. [13] So all the parameter's result of our desired antenna doesn't seems good, some of them had drawback also.

5.3 Future Work Field

There is a possible chance of defining two antenna as a transmitter and two antenna as a receiver. Which will give more data for the imaging.

By using VNA (Vector Network Analyzer) that has a frequency range from 100 kHz to 20 GHz and the number of test ports 2 or 4 ports to test component specifications.it has versatile options such that time domain, eye diagram, mixer measurements, and more [43]. The antenna is connected to VNA to gather the dispersing signal. Connect the transmitted, received signals to the ports of VNA and connect the output to PC using the USB cable.

The frequency-domain data comes from VNA were preprocessed prior to imaging signal by MATLAB using DMAS (Double stage delay multiply and sum) algorithm.

DMAS has high quality images (higher contrast, lower side lobes, and higher resolution), and use in medical imaging [42].

REFERENCES

[1] [Online] Available at: https://www.breastcancer.org/facts-statistics?gclid=CjwKCAjwp9qZBhBkEiwAsYFsbydEVHXgP-Qey_vjlKGb8NL57ma5NPQlirQHjTSWrdmPQcv7GqH-SBoC-d4QAvD_BwE

[2] Begum SA, Mahmud T, Rahman T, Zannat J, Khatun F, Nahar K, Towhida M, Joarder M, Harun A, Sharmin F,” Knowledge, Attitude and Practice of Bangladeshi Women towards Breast Cancer: A Cross Sectional Study.” Mymensingh medical journal : MMJ vol. 28,1 (2019): 96-104.

[3] M. M. M. Ali and A. Sebak, "Directive antennas for future 5G mobile wireless communications," 2017 32th General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS), Montreal, QC, 2017, pp. 1-4.

[4] W. Hong; K. Baek; Y. Lee; Y. Kim; S. Ko, "Study and prototyping of practically large-scale mmWave antenna systems for 5G cellular devices," in IEEE Communication Magazine, 2014.

[5] H. Jaafar, M. T. Ali, S. Subahri, A. L. Yusof and M. K. M. Salleh, "Improving gain performance by using air substrate at 5.8GHz," 2012 International Conference on Computer and Communication Engineering (ICCCE), Kuala Lumpur, 2012, pp. 95-98.

[6] https://www.researchgate.net/figure/Microstrip-Patch-Antenna-12_fig9_292508017

[7] C. Saunders, L. Wylie, Vineeta Singh and Anita Bourke “New diagnostic techniques for breast cancer detection,”FUTURE ONCOLOGY, vol. 4, no.4, pp. 501–513, 2008.

[8] P. Jaglan, R. Dass, and M. Duhan, “Breast Cancer Detection Techniques: Issues and Challenges,” J. Inst. Eng. Ser. B, vol. 100, no. 4, pp. 379–386, 2019.

[9] Manjot Kaur, Sonia Goyal,” Microstrip Patch Antenna Design for Early Breast Cancer Detection,”in International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020.

[10] R. Karli, H. Ammor, R. M. Shubair, M. I. AlHajri, R. Alkurd and A. Hakam, "Miniature planar ultra-wide-band microstrip antenna for breast cancer detection," 2016 16th Mediterranean Microwave Symposium (MMS), 2016, pp. 1-4.

[11] F. M. Eltigani, M. A. A. Yahya and M. E. Osman, "Microwave imaging system for early detection of breast cancer," 2017 International Conference on Communication, Control, Computing and Electronics Engineering (ICCCCEE) , pp. 1-5 2017.

[11] K. Ouerghi, A. Smida, R. Ghayoula and N. Boulejfen, "Design and analysis of a microstrip antenna array for biomedical applications," 2017 International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), 2017, pp. 1-5.

[12] 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, pp. 1-4.

[13] M. M. A. Faisal, M. J. Uddin, M. W. Ullah, M. I. Kamrul, K. M. Haque and E. Rahman, "Comparative analysis of different types of breast cancer cell detection antennas," 2017 International Conference on Inventive Computing and Informatics (ICICI), 2017, pp. 927-930.
[14] 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, pp. 1-5
[15] A. Aziz, D. Ahmad, T. A. Shila, S. Rana, R. R. Hasan and M. A. Rahman, "On-Body Circular Patch Antenna for Breast Cancer Detection," 2019 IEEE International Electromagnetics and Antenna Conference (IEMANTENNA), 2019, pp. 029-034
[16] M. M. U. Rashid, A. Rahman, L. C. Paul, J. Rafa, B. Podder and A. K. Sarkar, "Breast Cancer Detection & Tumor Localization Using Four Flexible Microstrip Patch Antennas," 2019 International Conference on Computer, Communication, Chemical, Materials and Electronic Engineering (IC4ME2), 2019, pp. 1-6
[17] S. Shekhawat, V. Sharma, P. K. Jain, B. R. Sharma, V. K. Saxena and D. Bhatnagar, "An Off-Diagonal Feed Elliptical Patch Antenna With Ring Shaped Slot in Ground Plane for Microwave Imaging of Breast," 2019 IEEE Indian Conference on Antennas and Propogation (InCAP), 2019, pp. 1-4
[18] M. Madi, M. Moussa and K. Y. Kabalan, "Inward Fractal Dual Band High Gain Compact Antenna," 2019 International Conference on High Performance Computing & Simulation (HPCS), 2019, pp. 595-599,
[19] P. K. Rao and R. Mishra, "Elliptical Shape CPW Antenna for Breast Cancer Detection Applications," 2020 International Conference on Electrical and Electronics Engineering (ICE3), 2020, pp. 489-494,
[20] M. N. Truna et al., "Electric and Magnetic Fields for the Proposed Microstrip Antenna with DGS for Breast Cancer Detection," 2020 13th International UNIMAS Engineering Conference (EnCon), 2020, pp. 1-4,
[21] M. Ikram, Y. Wang, M. S. Sharawi and A. Abbosh, "A novel connected PIFA array with MIMO configuration for 5G mobile applications," 2018 Australian Microwave Symposium (AMS), Brisbane, QLD, 2018, pp. 19-20.
[22] Z. U. Khan, Q. H. Abbasi, A. Belenguer, T. H. Loh and A. Alomainy, "Empty Substrate Integrated Waveguide Slot Antenna Array for 5G Applications," 2018 IEEE MTT-S International Microwave Workshop Series on 5G Hardware and System Technologies (IMWS-5G), Dublin, 2018, pp. 1-3.
[23] C. A. Balanis, Antenna theory: analysis and design. John wiley & sons, 2016.
[24] I. Jahan and A. Kabir, "Microstrip Patch Antenna for Breast Cancer Detection," 2021 5th International Conference on Electrical Information and Communication Technology (EICT), 2021, pp. 1-6
[25] R. Karli, H. Ammor, R. Shubair, M. Alhajri and A. Hakam, "Miniature Planar Ultra-Wide-Band Microstrip Patch Antenna for Breast Cancer Detection", The 2016 IEEE 16th European Miditerrean Microwave Symposium (IEEE MMS'2016), 2016.
[26] R. Çalışkan, S. S. Gültekin, D. Uzer, and Ö. Dündar, "A microstrip patch antenna design for breast cancer detection," Procedia-Social Behav. Sci., vol. 195, pp. 2905–2911, 2015.
[27] K. Ouerghi, N. Fadlallah, A. Smida, R. Ghayoula, J. Fattahi, and N. Boulejfen, "Circular antenna array design for breast cancer detection," in 2017 Sensors Networks Smart and Emerging Technologies (SENSET), pp. 1–4, 2017.

[28] H. K. Gupta, R. Sharma, and V. V. Thakre, “Breast cancer detection by T-shaped slotted planner antenna,” Ind. J. Sci. Technol, vol. 10, no. 8, pp. 974–6846, 2017.

[29] M. Elsaadi, H. Muhmed, M. Abd Alraheem, H. Miftah, and O. Salah, “Square Patch Antenna for Breast Cancer Diagnosis at 2.45 GHz,” Circuits Syst., vol. 10, no. 04, p. 45, 2019.

[30] S. Shekhawat, V. Sharma, P. K. Jain, B. R. Sharma, V. K. Saxena and D. Bhatnagar, "An Off-Diagonal Feed Elliptical Patch Antenna With Ring Shaped Slot in Ground Plane for Microwave Imaging of Breast," 2019 IEEE Indian Conference on Antennas and Propogation (InCAP), 2019, pp. 1-4,

[31] [Online] Available at: https://www.mayoclinic.org/tests-procedures/breast-mri/about/pac-20384809#:~:text=A%20breast%20MRI%20usually%20is,breast%20cancer%20in%20some%20people.

[32] M. S. Islam, N. Kaabouch and W. C. Hu, "A survey of medical imaging techniques used for breast cancer detection," IEEE International Conference on Electro-Information Technology , EIT 2013, 2013, pp. 1-5

[33] [Online] Available at: https://www.radiologyinfo.org/en/info/breastus

[34] [Online] Available at: https://screening.iarc.fr/breastselfexamination.php

[35] [Online] Available at: https://www.mayoclinic.org/tests-procedures/pet-scan/about/pac-20385078

[36] [Online] Available at: https://www.nibib.nih.gov/science-education/science-topics/computed-tomography-ct

[37] P. K. Rao and R. Mishra, "Ultra-wide-band Flexible Antenna for Breast Cancer Detection," 2019 IEEE 5th International Conference for Convergence in Technology (I2CT), 2019, pp. 1-4.

[38] Adnan, Shahid, Raed A. Abd-Alhameed, Chan H. See, H. I. Hraga, Issa TE Elfergani, and Dawei Zhou. "A compact UWB antenna design for breast cancer detection." PIERS online 6, no. 2 (2010): 129-132.

[39] Çalışkan, R., Gültekin, S.S., Uzer, D. and Dündar, Ö., 2015. A microstrip patch antenna design for breast cancer detection. Procedia-Social and Behavioral Sciences, 195, pp.2905-2911.

[40] [Online] Available at: https://en.wikipedia.org/wiki/Specific_absorption_rate

[41] [Online] Available at: https://www.multi-circuit-boards.eu/en/glossary/FR4_Material.html#:~:text=FR4%20is%20a%20class%20of,very%20suitable%20for%20standard%20applications.

[42] Mozaffarzadeh M, Mahloojifar A, Orooji M, Adabi S, Nasiriavanaki M. Double stage delay multiply and sum beamforming algorithm: Application to linear-array photoacoustic imaging. IEEE Transactions on Biomedical Engineering, 2017e.

[43] data sheet[Online] Available at: https://scdn.rohde schwarz.com/ur/pws/dl_downloads/dl_common_l

ibrary/dl_brochures_and_datasheets/pd f_1/service_support_30/ZNB_dat-sw_en_5214- 5384-22_v0900_96dp.pdf.

[44] I. Jahan and A. Kabir, "Microstrip Patch Antenna for Breast Cancer Detection," 2021 5th International Conference on Electrical Information and Communication Technology (EICT), 2021, pp. 1-6

[45] Ajnadkar, P., Amin, M., Kanchan, P., Barapatre, V. and Rathod, K., 2021. Early Detection of Breast Cancer Using Microstrip Patch Antenna. Available at SSRN 3868048.

[46] A. Aziz, D. Ahmad, T. A. Shila, S. Rana, R. R. Hasan and M. A. Rahman, "On-Body Circular Patch Antenna for Breast Cancer Detection," 2019 IEEE International Electromagnetics and Antenna Conference (IEMANTENNA), 2019, pp. 029-034.

Plagiarisms check of the attached file.

External Inbox ×

Ishtiak Ahmed <t181002@ugrad.iiuc.ac.bd>
to turnitin@iiuc.ac.bd

One attachment • Scanned by Gmail

THESIS BOOK Fin...

IIUC Central Library <turnitin@iiuc.ac.bd>
to Jahangir, me

On Tue, Oct 11, 2022 at 12:40 PM Ishtiak Ahmed <t181002@ugrad.iiuc.ac.bd> wrote:

One attachment • Scanned by Gmail

THESIS BOOK Final updated

THESIS BOOK Fin...

Reply | Reply all | Forward

BACHELOR OF SCIENCE IN

ELECTRONIC AND TELECOMMUNICATION ENGINEERING

Design & Simulation of Microstrip Patch Antenna for Identifying Breast Cancer.

Submitted by

Ishtiak Ahmed

T181002

Abdul Hamid Ridoy

T181034

Supervised by

Engr. Md. Razu Ahmed

Professor and Chairman

Department of CCE, IIUC

Department of Electronic and Telecommunication Engineering

International Islamic University Chittagong

Kumira, Sitakunda, Chittagong – 4314

THESIS BOOK Final updated

ORIGINALITY REPORT

28%	18%	13%	13%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.iiuc.ac.bd:8080 Internet Source	6%
2	Donia N. Elsherif, Mostafa Y. Makkey. "Early Detection of Breast Cancer using Microstrip Patch Antenna", 2021 International Conference on Electronic Engineering (ICEEM), 2021 Publication	2%
3	Submitted to Dr. S. P. Mukherjee International Institute of Information Technology (IIIT-NR) Student Paper	2%
4	Ishrat Jahan, Ahasan Kabir. "Microstrip Patch Antenna for Breast Cancer Detection", 2021 5th International Conference on Electrical Information and Communication Technology (EICT), 2021 Publication	1%
5	Submitted to Meerut Institute of Engineering & Technology Student Paper	1%

www.ijrte.org