

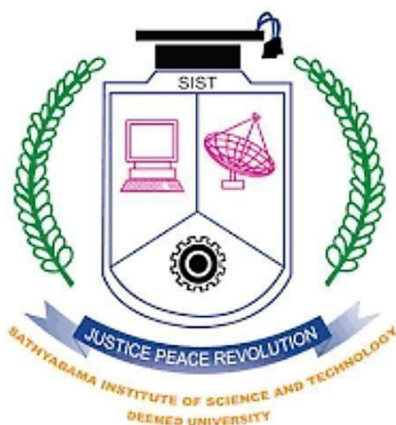
ANALYSIS & IMPLEMENTATION OF MICROSTRIP PATCH ANTENNA FOR BREAST CANCER TUMOR DETECTION

A Project Report Phase – II

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering Degree in Electronics and Communication Engineering

by

SIVASAKTHI S (39130433)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A” by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI-600119**

APRIL - 2023



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of SIVASAKTHI S (39130433) who carried out the project entitled " ANALYSIS & IMPLEMENTATION OF MICROSTRIP PATCH ANTENNA FOR BREAST CANCER TUMOR DETECTION" under my supervision from November 2022 to April 2023.

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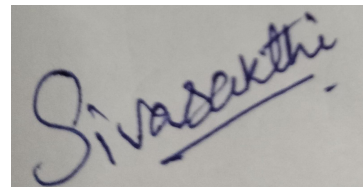
DECLARATION

I SIVASAKTHI S hereby declare that the Project Report entitled “ANALYSIS & IMPLEMENTATION OF MICROSTRIP PATCH ANTENNA FOR BREAST CANCER TUMOR DETECTION” done by me under the guidance of Dr.I.Rexiline Sheeba,M.E.,Ph.D.,is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE: 20.04.23

PLACE: Chennai

SIGNATURE OF CANDIDATE

A photograph of a handwritten signature in blue ink. The signature is written in a cursive style and reads "Sivasekthi". There is a horizontal line drawn under the name.

ACKNOWLEDGEMENT

I am pleased to acknowledge our sincere thanks to the Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

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ABSTRACT

Breast cancer is one of the most widespread invasive disease for women around the world. Now a days, more number of women are being affected every year by breast cancer. There are main techniques used for breast tumor detection mammography, Biopsy , Computer Aided Detection, Magnetic Resonance Imaging as these techniques have their limitations.To overcome this limitations to use micro strip antenna is a wearable, convenient, planar, easy-to-fabricate antenna with some attractive attributes and features, as well as some distinct limitations. The wearable antenna has wearable bending in 2D, which shows flexibility for wearable electronic devices. Antenna working in ISM band, is perfectly suitable for biomedical applications. As radiation patch provide antenna a wide working band 1.9-2.5GHz or 5.3-5.6GHz which is an ISM band used for wearable Biomedical Applications.In the proposed antenna silk substrate is chosen for implementation because of its low SAR (Specific Absorption Rate) and is placed on the breast to detect the breast cancer tumor. Microstrip Patch Antenna were considered and analyzed within and without cancer-affected areas. Since cancer cells are more water-content tissues, the gain and electrical conductivity performance were found to change. The analysis for antenna simulation will be done by convenient software (CST Studio suite or HFSS ansys Software). The simulated results will be tabulate and measure. The results of the fabricated will propose by using the network analyzer.

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CHAPTER - 1

INTRODUCTION

Cancer is a disease occurs due to the uncontrolled growth of abnormal cells that spread rapidly to the rest of body and damage healthy tissues. It started anywhere in the body usually forms a solid tumor. Breast cancer is one of the most widespread invasive diseases for women around the world. Nowadays, more number of women are being affected every year by breast cancer. Breast cancer can also lead to others serious complications in brain, lungs, liver ,bones and also cause death. It is necessary to ensure critical, proper and effective treatment, early detection of tumors that leads to breast cancer is of most importance. Globally it is known that Breast cancer is the main prevalent type of cancer in the world, and the earlier it's been detected the better. Presently, the most common way for the detection is X-ray imaging, which is called the X-ray mammography. However, due to the limits in the X-ray mammography, researchers started to search for a new advanced device that will aid in the early detection of the Breast cancer. For long time ago, microwaves were utilized for breast cancer detection, and the microwave imaging functions by using low power electromagnetic wave at microwave frequencies in order to illuminate the target, and then view its internal parts. Utilizing microwaves radiation into the breast in order to check and discover the existence of tumors, is a popular method and it can be divided into two approaches the tomography and the radar- based. The antenna is a device that is made out of a conductive , metallic material and has the purpose of transmitting and receiving electromagnative waves, usually radio waves is to communicate or signals. There are two Basic Types of Antenna : Transmitter antenna and Receiver antenna. The purpose of transmitting and receiving radio waves to communicate or broadcast information at the speed of light. In the first stage, tomography, one transmitter is used to radiate toward the breast, in the same time, around the breast several antennas are laid in order to receive scattered and diffracted waves. Based on the received data, some processes are done to get a 2-D or 3-D image of the breast.

The radar-based microwave imaging is another used method for breast cancer detection. This method requires a single ultra-wideband (UWB) antenna is used to transmit a short pulse to the breast and receive the scattered signal back, and the same thing is repeated in various locations around the breast. If the strength of the scattering was high, it will indicate that there is a tumor. In this method extra detailed information are provided compared to the tomography microwave imaging method. However, the UWB antennas should authorize resolution level, which causes some limitations. Thus, the major characteristics that must be taken into consideration are large fractional bandwidth, low side-lobes and low mutual coupling. In addition, to minimize the reflection between the free space and the breast surface, the metallic sensors must be placed in a matching medium that has almost the same permittivity of the breast tissue. However, in real life, the implementation of the matching medium around the patient's breast is hard. As we discussed above There are main techniques used for breast tumor detection mammography, Piopsy, Computer Aided Detection, Magnetic Resonance Imaging as these techniques have their limitations. To overcome this techniques limitations an alternative method is Micro strip Patch Antenna (MSPA).

These parameters are sometimes also Properties of Antenna or Characteristics of Antenna :

- Radiation Intensity
- Directivity and Gain
- Input Impedance
- Effective Length
- Bandwidth
- Effective Aperture
- Antenna Polarization
- Radiation Efficiency
- Antenna Radiation Patterization

1.1. PROBLEM STATEMENT

Cancer is one of the deadliest diseases especially when it goes malignant and start takes over the body and spreads to the other organs. It happens when a growth process of a cell goes wrong, and it have been hard to detect since ages despite the presence of the modern technologies. One of the worldwide commonly type of cancer is the breast cancer which harness the lives of a lot of women and that arises the need of finding solution, addressing this subject, start working on a cure and more important a way to detect the presence of it. Years of research proved that the most important element of curing cancer is to detect it on its early stages before it goes wild and spreads to more organs. For detecting this tumors many techniques have been proposed like mammography , MRI , and ultrasound , and those technologies has limitations for early detection mostly because of the poor contrast, which does not provide an early detection and therefore the late detection of the cancer reduces the probability of curing it. This research addresses the usage of a microwave imaging which proved to be promising detection technique , radar based techniques and usage of microwave in tomography have been used in cancer detection .

1.2. TYPES OF ANTENNAS

1.2.1.Wire antennas

- dipole, monopole, loop antenna, helix.
- Usually used in personal applications, automobiles, buildings, ships,aircrafts and spacecrafts.



Fig :1.2 : dipole antenna

1.2.2. Aperture Antennas

- Horn antennas, waveguide opening.
- Usually used in aircrafts and space crafts, because these antennas can be flush mounted.

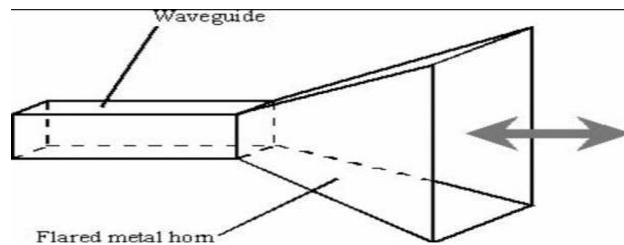


Fig:1.3 : Horn antenna

1.2.3. Reflector Antennas

- Parabolic, corner reflectors
- These are high gain antennas usually used in Radio astronomy, Microwave communication and Satellite Tracking.



Fig :1.4: Reflector antenna

1.2.4. Lens Antennas

- Convex plane, convex-convex, concave-convex and concave plane lenses.
- These antennas are usually used for very high frequency applications.

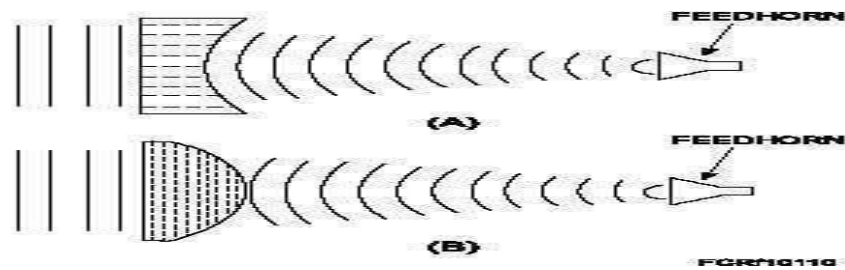


Fig:1.5: Lens antenna

1.2.5. Microstrip Antennas

Rectangular, Circular etc shaped metallic patch above a ground plane. Used in aircraft, spacecraft, satellites, cars, mobile phones etc.

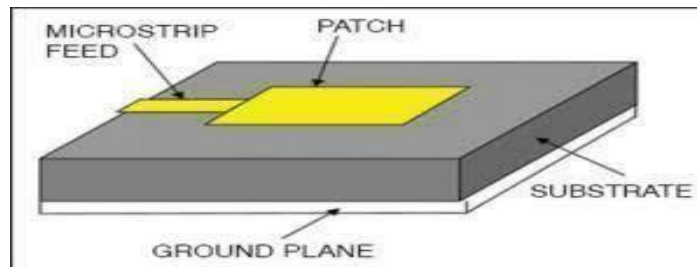


Fig:1.6: Microstrip antenna

1.2.6. Array Antennas

- Yagi-Uda antenna, Microstrip patch array, Aperture array, Slotted wave guide array.
- Used for high gain applications with added advantage such as controllable radiation.

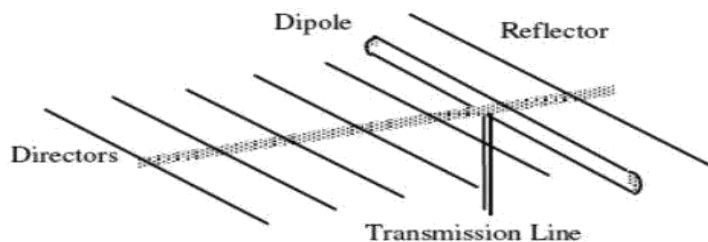


Fig:1.7: Yagi-uda antenn

1.3. ANTENNA PARAMETERS

1.3.1. Return Loss

The return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is fed into the antenna from the transmission line. The relationship between SWR and return loss is the following

$$SWR = 20 \log 1/SWR-1$$

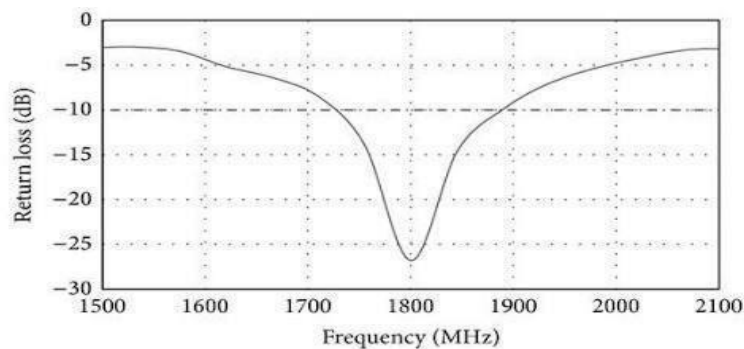


Fig:1.8: Example plot for return loss

1.3.2. Band Width

The bandwidth of an antenna refers to the range of frequencies over which the antenna can operate correctly. The antenna's bandwidth is the number of Hz for which the antenna will exhibit an SWR less than 2:1.

The bandwidth can also be described in terms of percentage of the center frequency of the band.

$$BW = 100 * \frac{F_H - F_L}{F_C} \quad (1.2)$$

Where

F_H - Highest frequency in the band

F_L is the lowest frequency

F_C is the center frequency

In this way, bandwidth is constant relative to frequency. If bandwidth was expressed in absolute units of frequency, it would be different depending upon the center frequency. Different types of antennas have different bandwidth limitations.

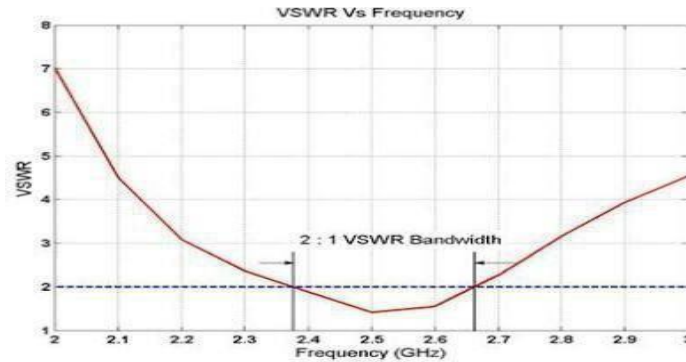


Fig:1.9: Example plot for band width

1.3.3. Directivity

Directivity is the ability of an antenna to focus energy in a particular direction when transmitting, or to receive energy better from a particular direction when receiving. In a static situation, it is possible to use the antenna directivity to concentrate the radiation beam in the wanted direction. However, in a dynamic system where the transceiver is not fixed, the antenna should radiate equally in all directions, and this is known as an omni-directional antenna.

Where, D = Directivity of Antenna

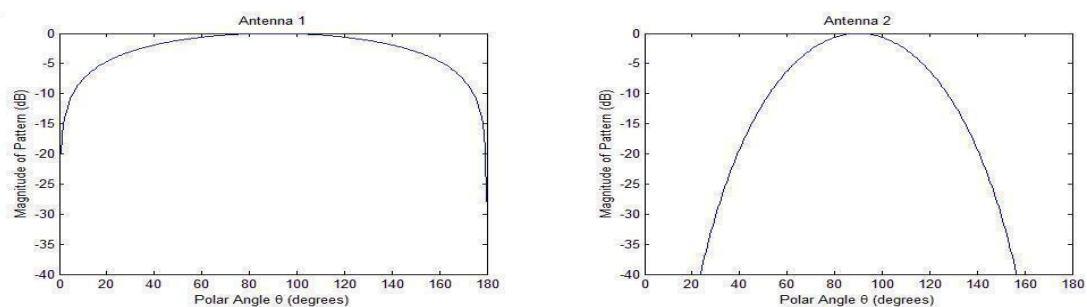


Fig:1.10: Example plots of radiation pattern of antennas with higher directivity

1.3.4. Gain

Gain is not a quantity which can be defined in terms of a physical quantity such as the Watt or the Ohm, but it is a dimensionless ratio. Gain is given in reference to a standard antenna. The two most common reference antennas are the isotropic antenna and the resonant half-wave dipole antenna. The isotropic antenna radiates equally well in all directions. Real isotropic antennas do not exist, but they provide useful and simple theoretical antenna patterns with which to compare real antennas. Any real antenna will radiate more energy in some directions than in others. Since it cannot create energy, the total power radiated is the same as an isotropic antenna, so in other directions it must radiate less energy. The gain of an antenna in a given direction is the amount of energy radiated in that direction compared to the energy an isotropic antenna would radiate in the same direction when driven with the same input power.

Usually we are only interested in the maximum gain, which is the gain in the direction in which the antenna is radiating most of the power. An antenna gain of 3 dB compared to an isotropic antenna would be written as 3 dB. The resonant half-wave dipole can be a useful standard for comparing to other antennas at one frequency or over a very narrow band of frequencies. To compare the dipole to an antenna over a range of frequencies requires a number of dipoles of different lengths. An antenna gain of 3 dB compared to a dipole antenna would be written as 3 dB.

The method of measuring gain by comparing the antenna under test against a known standard antenna, which has a calibrated gain, is technically known as a gain transfer technique. Another method for measuring gain is the 3 antennas method, where the transmitted and received power at the antenna terminals is measured between three arbitrary antennas at a known fixed distance.

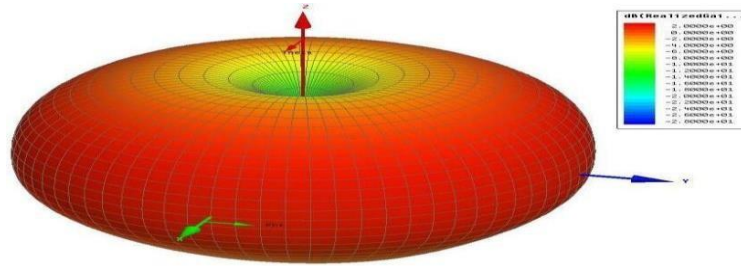


Fig:1.11: Example gain pattern of an antenna

1.3.5. Radiation Pattern

The radiation or antenna pattern describes the relative strength of the radiated field in various directions from the antenna, at a constant distance. The radiation pattern is a reception pattern as well, since it also describes the receiving properties of the antenna.

The radiation pattern is three-dimensional, but usually the measured radiation patterns are a two-dimensional slice of the three-dimensional pattern, in the horizontal or vertical planes. These pattern measurements are presented in either a rectangular or a polar format.

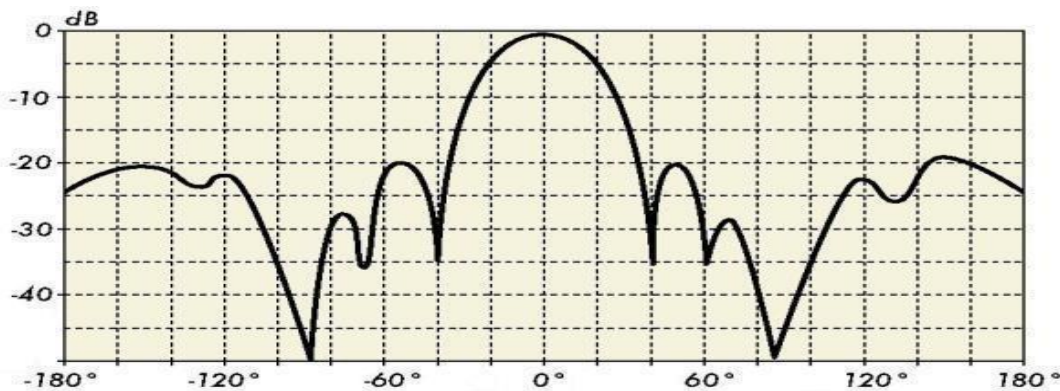


Fig:1.12: Example for rectangular plot representation of radiation pattern

Polar coordinate systems are used almost universally. In the polar coordinate graph, points are located by projection along a rotating axis (radius) to an intersection with one of several concentric circles.

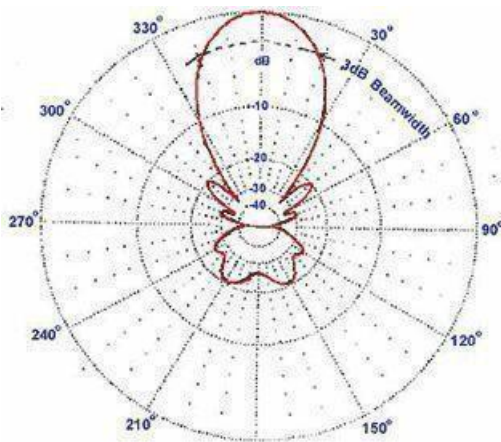


Fig:1.13: Example for polar plot representation of radiation pattern

1.3.6 Logarithmic

In the linear coordinate system, the concentric circles are equally spaced and are graduated. Such a grid may be used to prepare a linear plot of the power contained in the signal.

In the logarithmic polar coordinate system the concentric grid lines are spaced periodically according to the logarithm of the voltage in the signal. Different values may be used for the logarithmic constant of periodicity, and this choice will have an effect on the appearance of the plotted patterns.

1.3.7 Polarization

Polarization is defined as the orientation of the electric field of an electromagnetic wave. Polarization is in general described by an ellipse. Two special cases of elliptical polarization are linear polarization and circular polarization. The initial polarization of a radio wave is determined by the antenna.

In linear polarization the electric field vector stays in the same plane all the time but in circular polarization the electric field vector appears to be rotating with circular motion about the direction of propagation, making one full turn for each RF cycle. This rotation may be righthand or left hand. Choice of polarization is one of the design choices available to the RF system designer.

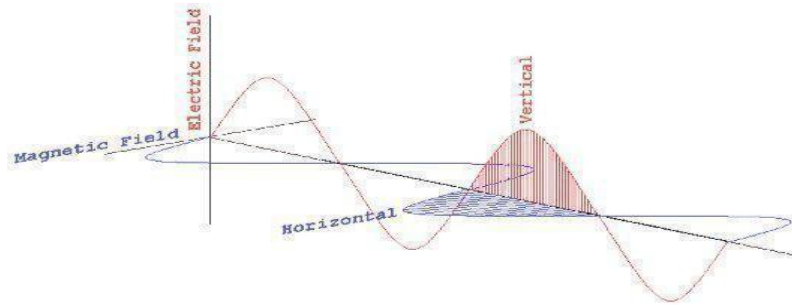


Fig:1.14: Example figure for polarization

1.3.8 Polarization Mismatch

In order to transfer maximum power between a transmit and a receive antenna, both antennas must have a same spatial orientation, the same polarization same polarization sense and the same axial ratio.

When the antennas are not aligned or do not have the same polarization, there will be a reduction in power transfer between the two antennas. This reduction in power transfer will reduce the overall system efficiency and performance.

When the transmitter and receiver antennas are both linearly polarized, physical antenna misalignment will result in a polarization mismatch loss.

1.4. STRUCTURE OF MICRO-STRIP PATCH ANTENNA

Microstrip Patch Antenna is a device has Different parts like Substrate, Ground , Patch , Feed line and Source. Metallic Patch placed on Dielectric Material and supported by ground plane. Radiating Patch and Feed Lines are placed by process of Photo – etching on Di- electric material. The ground plane is a conducting material which is Silver or copper, Aluminum etc...The Substrate has different shapes Rectangular, circular, square depends on applications.

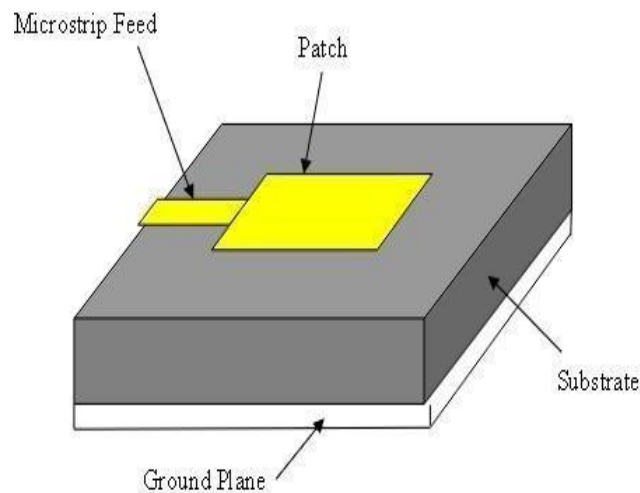


Fig 1.15 : Structure of Micro Strip Patch Antenna

Firstly, the ground plane which consists of a conductor. Secondly, the substrate part which includes the dielectric, and finally, a conductor that represents the metal patch. In the design of the antenna, the first two components (the ground plane and the substrate) are over each other. They both have the same exact size. An antenna is a device that is made out of a conductive, metallic material and has the purpose of transmitting and receiving electromagnetic waves, usually radio waves is to communicate or signal. Antenna has been implemented in the medical field in general and application of cancer more specifically. It has been used for diagnosis and treatment and sometimes only for information transmission, the Radio Frequency Identification (RFID) has been used in monitoring systems and medical implants, and microwave imaging so in general antennas can be used as communication and/or a treatment device. There are two Basic Types of Antenna : Transmitter antenna and Receiver antenna. The purpose of transmitting and receiving radio waves to communicate or broadcast information at the speed of light. However, the metal patch component has almost half the size of the other two components. The Rf energy is transmitted into space in the form of an electromagnetic field. As the travelling electromagnetic field arrives at the receiving antenna, a voltage is induced into the antenna.

Wireless technologies are implemented in the implantable antennas, in order to allow the doctors to monitor the patient's body all the time and recognize the changes that happen to the cells "including the mutation of cells into malignant tumors". Additively, there are some external antennas and other internal ones, and the shape of the antenna relies on its location. Antennas need power to work, and this power is provided to the antenna through a copper wire called the feeder. The feeder is linked to the first part of the antenna (the metal patch), which is conductor, thus current will flow and voltage will appear. Reaching to the middle point of the antenna, the voltage will approach zero, while at the end points the current will have zero value. Having a very small metal patch, will lead to having an open circuit, and thus the current will be zero.

1.5 MICRO -STRIP PATCH ANTENNA IN BREAST CANCER

The early detection of breast cancer can be done via the microwave imaging. Due to the micro-strip patch antenna's features such as small size, light weight, low profile, and low manufacturing cost, studies are done on the capability of micro-strip patch antenna in detecting the breast tumor. Therefore, micro-strip patch antenna became active and useful for the imaging, as it will aid in the early detection of the cancer and it will help to locate the suspicious lesion in the breast for a biopsy procedure. The technology of wearable devices is a technology of electronic and computer devices incorporated into clothes. It can be worn on in everyday life. Those devices can be watches, glasses, earring, caps and fabrics. Those devices are capable to do various tasks, it can work normally like a mobile phone and computer but also can work as a sensor or a tracker or even work as a scanning device. It is considered as a major step in the trend of pervasive computing where everybody can access information anywhere. In general, wearable devices have a very broad application. Before introducing it to the consumers those devices were used in military technology. Microstrip Patch Antenna is more flexible for Biomedical Applications Performance. antennas can be thought of as a "transducer" that converts radio waves into electrical currents and voltages and vice versa. More specifically, these are devices designed to radiate or receive electromagnetic energy efficiently in a prescribed manner.

1.5. APPLICATIONS OF MICROSTRIP PATCH ANTENNA

Micro-strip antennas recently are used in the medical field for the purpose of imaging, diagnosis, and treatment. In addition, the flexibility in the micro-strip antenna leads to the ability of contacting between the human body and the skin. MSPA these patches are capable to blend with - microwave circuits therefore very well suited for Biomedical Applications, Wireless Local Area Network Applications and Navigation Systems etc.

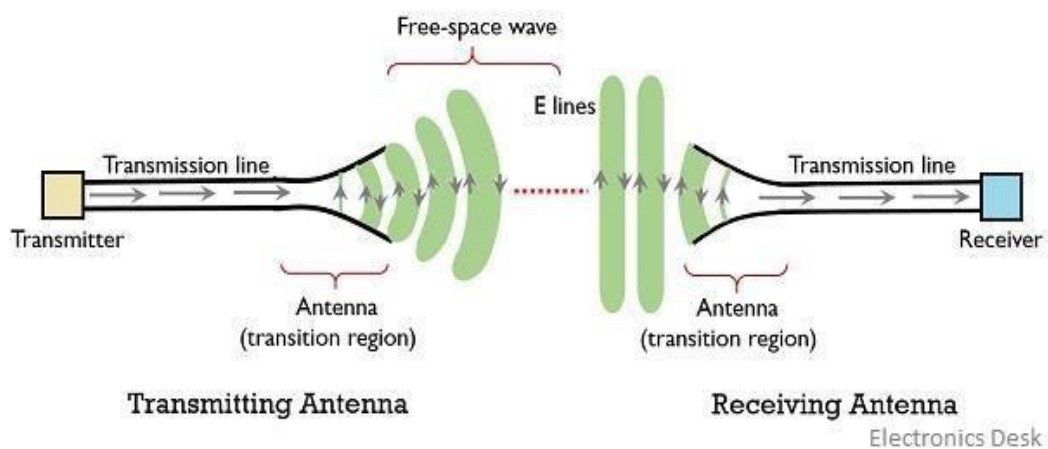


Fig 1.16 : Transmitting and Receiving Antenna.

The antenna is a device that transmits and receives signals in the shape of electromagnetic waves. It is also known as a transducer device as it can convert between electrical signals and electromagnetic energy to be able to be a transmitter and receiver at the same time. Figure 2.1 can explain the path of the transmission line from the transmitter to the receiver and shows that it connects between the wires which is the transmission line and the wireless which is the free space.

Antenna has been implemented in the medical field in general and application of cancer more specifically. It has been used for diagnosis and treatment and sometimes only for information transmission, the Radio Frequency Identification (RFID) has been used in monitoring systems and medical implants, and microwave imaging so in general antennas can be used as communication and/or a treatment device.

Nowadays, minimizing the antenna size and reducing the complexity is the major purpose of the antenna research. The study that tries to connect between human body and the electronic devices is known as the Wireless Body Area Networks (WBANSs), in this study a tiny nodes group that are equipped with a sensor, or a motion detector and a wireless device, which uses techniques similar to the ones used in wireless systems.

In the human body, it is known that the frequency of the microwave band increases therefore to ensure the safety of the human body from being affected by the radio waves a Specific Absorption Rate (SAR) usually used to test the in wireless devices. Flexible antennas with compact size, low impact on the human body and small SAR are always preferable in WBAN, communication patch antenna is used because of their small size and simple design and high gain, an obstacle in patch antenna is the huge back radiation.

1.6. ADVANDAGES OF MICRO STRIP PATCH ANTENNA

MSPA is very simple in construction using conventional micro strip fabrication technique. Can be easily obtained circular polarizations, frequency agility, Dual Characteristics , Feed line flexibility , Beam Scanning from these Patch Antenna. Low cost, Low weight , Compact Design, Low Mass, Good Gain and Low profile. It is Easily Integrated with Microwave Integrated Circuits. It support Both Linear as well as Circular Polarization. Rectangular , Triangular , Square is different shape of Microstrip Patches so Easily Etched. Capable of Dual and Triple Frequency Operations. Microstrip Patch Antenna is more flexible for Biomedical Applications Performance of MSPA these patches are capable to blend with microwave circuits therefore very well suited for Biomedical Applications, Wireless Local Area Network Applications and Navigation Systems etc..

This Chapter discussed about the Problem Statement of the Project , Types of Antenna , Antenna Parameters , Structure of Microstrip Patch Antenna , Microstrip Patch Antenna in Breast Cancer , Applications of Microstrip Patch Antenna and Advantages of Microstrip Patch Antenna.

CHAPTER -2

LITERATURE SURVEY

Literature Survey about Micro strip Patch Antenna for Breast Phantom Cancer Tumor Detection.

Dhrubo Ahmad ,et.al (2019) “ On-Body Circular Patch Antenna for Breast Cancer Detection “ IEMANTENNA International Electromagnetics and Antenna Conference 2019 Two different types of breast phantoms were created for analyzing whether there were any presence of cancerous tumors or not. First phantom S11 value changed from -12.73 db to -12.47 db , second phantom S11 value Changed from -8.49 to -8.43 db.All constraints of the planned antenna be simulated and measured result shows with the intention of highflying performance, high desirable S11, and supreme radiation pattern along with fair gain across the functioning band. Contrasting category of the design part to a variety of client needs to be evidence.

Yifan Chen IEEE Member , et.al (2021) “ Time of Arrival Data Fusion Method for Two-Dimensional Ultrawideband Breast Cancer Detection “ .A new microwave imaging method is given for breast tumor detection using an ultrawideband (UWB) imaging system. By combining the time of arrival (TOA) measurements from different sensors, the presence and location of small malignant lesions can be identified. At each sensor, the generalized sequence CLEAN (GS-CLEAN) algorithm is proposed to resolve the impulse response (IR) components into bins smaller than the duration of the sounding pulse. This novel deconvolution technique, working well with largely continuous image content, also solves an inverse problem to estimate the unknown tumors' morphological/dielectric properties and delay intervals. Subsequently, the TOA data fusion step is applied to obtain an estimate of the locations of dominant scattering sources such as cancerous tumors. We also apply the entropy-based approaches to collectively estimate the tumor morphological and electrical features based on the information acquired at various antenna elements.Preliminary two-dimensional (2-D) analysis and simulations demonstrate that the system developed is feasible to detect small breast malignant masses using this approach.

Donia N. Elsherif, et.al (2020) Early Detection of Breast Cancer using Microchip Patch Antenna Hence, early diagnosis is important to detect cancer tissue. But the common techniques used for breast cancer detection have limitations. So, microwave imaging (MWI) techniques were developed. MWI techniques are rather interesting and promising. In this paper, a rectangular microstrip patch antenna (RMPA) was designed and modified for breast cancer detection. And a breast phantom was modeled with tumor and without tumor using Computer Simulation Technology Microwave Studio (CST-MWS). Once the breast tumor is embedded within, the results showed that the current density, the magnetic field, the electric field, and the power loss density have been increased by 30 A/m² , 10 A/m, 1800 V/m, and 100000 W/m³ , respectively. These results show that the described RMPA is capable to detect the tumor in the breast with better characteristics than the other available designs in the literature.

Kaeli , et.al (2019) “ Miniature Planar Ultra — Wide — Band Microstrip Antenna for Breast Cancer Detection “IEEE Miniature planar UWB MSPA placed on breast skin to detect cancer tumor .Antenna resonates at 6 GHz. Breast placed compared with 5cm to 15cm. Abstract—This paper presents localization of tumor at 13 different positions deep inside a dense human breast using only 4 meander line microstrip patch antennas of operating frequency 1.5 GHz for the detection of breast cancer. This designed narrow band microstrip medical antenna can be used for application in medical field for breast cancer detection.

Vinoth Kumar ,et.al (2018) “ Design of Microstrip Patch Antenna to Detect Breast Cancer” ICTACT journal on Microelectronics April 2020 Rectangular MSPA designed, simulated, fabricated and validated the results S₁₁ value -18.91 dB .of frequency 2.4 GHz. The VSWR of a phantom without and with tumor are 1.11 and 1.45 respectively. The antenna is built to be low-profile, low-cost, simple to fabricate, and have good isolation. This antenna's vertical and horizontal lengths are 34 mm and 36 mm, respectively, at radio frequencies of 2-12 GHz. The CST modelling technique is used to build the truncated rectangular shape antenna. This novel deconvolution technique, working well with largely continuous image content, also solves an inverse problem to estimate the unknown tumors' morphological/dielectric properties and delay intervals.

Shanmuganantham, et.al (2018) proposed a Study and Design of SRR loaded ACS-Fed Multiband Koch star and Minkowski Curve Fractal-Patch Antenna. The antenna is printed on the Flame Retardant- grade 4 dielectric substrate of 12 mm x 20 mm by Relative-Permittivity of 4.4 with a thickness of 1.6 mm. To endorse multiband quality, mixture of fractal geometries is placed on the face side of the rectangular patch resonator, Split ring Meta material resonator is fixed back side of the FR4, outstanding to this the additional resonances be attained. The antenna scheme at Multi vends, layer at 2.55 GHz, 3.17 GHz on S band, 5.46 GHz, 6.51 GHz on C band with 10.37 GHz on X band covering WLAN IEEE802.11/ Radio Frequency Identification/ satellite/ microwave relay/ HYPER-LAN 2/ Radar band. All constraints of the planned antenna be simulated and measured result shows with the intention of highflying performance, high desirable S11, and supreme radiation pattern along with fair gain across the functioning band. Contrasting category of the design part to a variety of client needs to be evidence.

Huayan Jin,et.al (2017) proposed Researches on Circularly-Polarized SIW Cavity- Backed Filtennas Substrate integrated waveguide (SIW) cavity-backed structure, as a multi-mode resonator featuring low loss and low profile, is suitable for the implementation of circularly polarized(CP) antennas. By embedding CP patches into SIW cavities, radiation nulls can be generated by the modes of SIW cavity and the mixed electric and magnetic coupling between the patch and SIW cavity, simultaneously, to form filtering responses. By adopting these filtering mechanisms, three examples of SIW cavity-backed filtennas are proposed and studied. A wideband single-layer dual-CP SIW cavity-backed patch filtenna with an out-of-band rejection level over 13 dB is achieved. The radiation nulls are realized by the TE₁₁₀ mode of the SIW cavity and the mixed coupling between the patch and the cavity. Then modified perturbations are used in our second work to reduce the frequency of TE₂₂₀ mode of the SIW cavity to improve the high band side roll-off characteristics.

Wenlei Wang,et.al (2015) The dual-CP SIW cavity-backed filtenna is implemented by employing a corner-excited square SIW cavity operating at the degenerated TE₁₂₀/TE₂₁₀ modes. with the slot perturbation, these two SIW cavity modes can be split to generated CP radiation. By embedding a square CP patch, the AR bandwidth can be significantly improved. Using SIW cavity-backed patch antennas and the multi modes of the SIW cavities to achieve CP filtennas with wide bandwidth and good filtering

performance is an effective approach. A comparison of the proposed three filterennas with other published CP filterennas is given in Table I. As compared, Antenna I is a single-fed dual-CP filterenna, which has an edge in wideband, single-layer structure, and compact size. Antenna is a 2×2 CP filterenna array. As no extra filtering circuits are required, Antenna II features simple design with high antenna gain, wide operating band and good filtering performance.

Md Adasan Kabir et.al (2021) "Microstrip Patch Antenna for Breast Cancer Detection". 5th International Conference on Electrical Information and Communication Technology (EICT) 17-19 December 2021. Reflection coefficient of breast phantom model 1 from 17.50214 - 17.537977 bB for model 2 -40.260902 to -39.904223 dB. The reflection coefficients of the antennas demonstrates a very uniform pattern for localization of the tumors in CST Microwave Studio simulation environment. The result of this work can help to develop a portable medical device for breast cancer detection at home by analyzing the reflection coefficient data of the 4 antenna.

K.Sushmitha,et.al (2021) Design of Narrowband Truncated Rectangular Antenna for Breast Cancer Detection 2022 International Conference on Applied Artificial Intelligence and Computing (ICAAIC) This work describes a microstrip patch antenna as a truncated rectangular shape. The antenna is built to be low-profile, low-cost, simple to fabricate, and have good isolation. This antenna's vertical and horizontal lengths are 34 mm and 36 mm, respectively, at radio frequencies of 2-12 GHz. The CST modelling technique is used to build the truncated rectangular shape antenna. For the frequency range of 2 GHz to 12 GHz, the antenna resonate at 7 GHz, and the reflection coefficient is less than -28. This antenna's substrate is made of FR4 with 4.3 permittivity. The length of 18 mm and width 11 mm of a rectangular patch antenna were used to find different parameters such as the S parameter, Gain, Directivity. This designed narrow band microstrip medical antenna can be used for application in medical field for breast cancer detection.

Shih-Chang Wang et.al (2018) “ Time of Arrival Data Fusion Method for Two-Dimensional Ultrawide band Breast Cancer Detection” IEEE Transactions on Antennas and Propagation, 10 October 2007 Breast cancer detection using UWS imaging. GS-CLEAN algorithm to process received Signals at each sensors. This paper presents the design of microstrip antenna with defected ground structure (DGS) for the detection of breast tumor in microwave imaging system at operating frequency of 2.45GHz. Four types of microstrip patch antennas have been designed using microstrip feed inset with grounding patches at 2.45 GHz operating frequency using dielectric substrates.

Kho.J.Annie et.al (2019) Electric and Magnetic Fields for the Proposed Microstrip Antenna with DGS for Breast Cancer Detection. This paper presents the design of microstrip antenna with defected ground structure (DGS) for the detection of breast tumor in imaging system at operating frequency of 2.45GHz. Four types of microstrip patch antennas have been designed using microstrip feed inset with grounding patches at 2.45 GHz operating frequency using dielectric substrates, FR4 ($\epsilon_r = 4.4$ F/ m). The results are collected via the intensity of electric (E), magnetic fields (H) and current densities. The antenna is examined with a 3D breast model structure with specific dielectric value and conductivity. From the results, it shows that antenna with design structure, Design 4 produce a good intensities values of both E and H fields respectively with the presence of the tumour, and gives the value of 7083 V/m and 35.5 A/m while without the presence of tumour is 7186 V/m and 35.8 A/m compare to other proposed antennas.

Yusnita Rahaya, et.al (2019) “ Microstrip Antenna for Tumor Detection SAR Analysis “, 2021 IEEE 7th International Conference on Smart Instruments, Measurements and Applications (ICSIMA) Antenna parameter of S11 on 4x4 antenna array is -37.50 dB with working frequency 4.9 — 6.4 GHz. The value obtained from simulation results on head

-14.50 Db AT 2.44 GHz. Preliminary two-dimensional (2-D) analysis and simulations demonstrate that the system developed is feasible to detect small breast malignant masses using this approach. The antenna is built to be low-profile, low-cost, simple to fabricate, and have good isolation. This antenna's vertical and horizontal lengths are 34 mm and 36 mm, respectively, at radio frequencies of 2-12 GHz. The CST modelling technique is used to build the truncated rectangular shape antenna.

S.Bhavani et.al (2021) “ Wearable Microstrip Circular Patch Antenna for Breast Cancer Detection” 2021 International Symposium on Antennas and Propagation and USNC — URSI Radio Science Meeting. Circular MSPA has designed and fabricated with maximum SAR values for two sizes 50 and 60 mm. The antenna achieves enhanced bandwidth and good return loss. It design under FCC standards. Wearable jean is used as a substrate and more flexible for medical Applications

Md.Mamun Ur Rashid ,Ashiqur et.al (2019) Rahman Breast Cancer Detection & Tumor Localization using four Flexible Microstrip Patch Antenna International Conference on Computer , Communication , Chemical , Materials and Electronic Engineering (IC4ME2). Microwave imaging is explored as an imaging modality for early detection of breast cancer. When exposed to electromagnetic waves, the breast tumor has electrical properties that are substantially different from those of healthy breast tissue. This paper for the detection of breast cancer. We examine the ability to detect tumors by a UWB microstrip antenna operating at 6 GHz. Using a simple model in the form of a cone. This model consists of the breast skin, fat, and tumor tissues. The study is done according to several distances between the patch antenna and the model of the breast. Simulation and measured results are presented, namely, reflection coefficient, gain and radiation pattern of the antenna and the current density in the breast skin, fatty tissue and the tumor to give us a clear insight into the concept studied.

In this Chapter discussed about the Existing Projects Literature Survey of Microstrip Patch Antenna regarding The Breast Cancer Tumor Detection.

CHAPTER - 3

SOFTWARE

3.1.HFSS REQUIREMENTS

Two software found in this field one of them is the high frequency structure simulator (HFSS) is a 3D electromagnetic simulation software for the purpose of designing and simulating antennas or any other high frequency electronic. Researchers and engineering use the HFSS to design and simulate those electronics to build various communication systems, internet of things (IoT) products, digital devices, and other high-speed RF systems.

This software can give unparalleled performance and deep insight to all the 3D electromagnetic problems, providing a complete analysis of the electronics products with accuracy and reliability challenges by its automatic adaptive meshing technique and precise solvers.

A set of solvers to tackle electromagnetic problems starting from passive components to analyses with large-scale. The automatic adaptive mesh designed withing the software is reliable and make the design process easier by focusing only on the design rather than spending time finding the best mesh. Another software used for antenna design is the CST Studio Suite. Which is a high-performance 3D EM analysis software package for designing, analyzing, and optimizing electromagnetic (EM) components and systems.

Ansys Mechanical finite element analysis software is used to simulate computer models of structures, electronics, or machine components for analyzing the strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes. Ansys simulation gives engineers the ability to explore and predict how products will work — or won't work — in the real world. With industry-leading capabilities, Ansys enables our clients to rapidly innovate and easily validate their design ideas, empowering them to develop transformational products.

This software gives the engineers more flexibility in order to be able to analyze multiple components in an efficient and direct way. Because it can do multiple simulations, analyzation of performance and efficiency of antennas and other electromagnetics structures can be made software also the exposure of human body to the electromagnetic fields can be analyzed, which a great technology to be used to for easy simulation.

The CST MWS is based on FIT which finite integration technique. It gives the user the choice of using frequency domain approach, and the time domain approach. Hexahedral mesh type is used to have a transient analysis of the proposed structured antenna; the user has a full control over the mesh size in CST, which make it a good competitor for the HFSS. In this work, the CST Microwave studio will be used for designing and simulating the antenna.

3.1 ABOUT SOFTWARE

Ansys HFSS is a 3D electromagnetic (EM) simulation software for designing and simulating high-frequency electronic products such as antennas, antenna arrays, RF or microwave components, high-speed interconnects, filters, connectors, IC packages and printed circuit boards. Engineers worldwide use Ansys HFSS software to design high-frequency, high-speed electronics found in communications systems, advanced driver assistance systems (ADAS), satellites, and internet-of-things (IoT) products.

Ansys HFSS mainly used in,

- **Component-to-System EM Workflow**
- **Coupled EM System Solver**
- **Encrypted 3D Design Share**
- **Automatic Adaptive Meshing**

Ansys Mechanical finite element analysis software is used to simulate computer models of structures, electronics, or machine components for analyzing the strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes. Ansys simulation gives engineers the ability to explore and predict how products will work — or won't work — in the real world. With industry-leading capabilities, Ansys enables our clients to rapidly innovate and easily validate their design ideas, empowering them to develop transformational products.

Ansys Parametric Design Language (APDL) is a powerful structured scripting language used to interact with the Ansys Mechanical solver. PyAnsys is a family of Python packages that enable users to interact with Ansys products, including MAPDL, AEDT, and others, in an unprecedented manner. Ansys delivers the expertise, capabilities and tools to transform the design and production processes of industries ranging from automotive to energy to healthcare.

Ansys was founded in 1970 by John Swanson, who sold his interest in the company to venture capitalists in 1993. Ansys went public on NASDAQ in 1996. In the 2000s, the company acquired other engineering design companies, obtaining additional technology for fluid dynamics, electronics design, and physics analysis. Ansys became a component of the NASDAQ-100 index on December 23, 2019.

The idea for Ansys was first conceived by John Swanson while working at the Westinghouse Astronuclear Laboratory in the 1960s. At the time, engineers performed finite element analysis (FEA) by hand. Westinghouse rejected Swanson's idea to automate FEA by developing general purpose engineering software, so Swanson left the company in 1969 to develop the software on his own. He founded Ansys under the name Swanson Analysis Systems Inc. performed finite element analysis (FEA) by hand. Westinghouse rejected Swanson's idea to automate FEA by developing general purpose engineering software, so Swanson left the company in 1969 to develop the software on his own. He founded Ansys under the name Swanson Analysis Systems Inc. (SASI) the next year, working out of his farmhouse in

Pittsburgh. Swanson developed the initial Ansys software on punch-cards and used a mainframe computer that was rented by the hour. Westinghouse hired Swanson as a consultant, under the condition that any code he developed for Westinghouse could also be included in the Ansys product line. Westinghouse also became the first Ansys user.

Ansys develops and markets engineering simulation software for use across the product life cycle. Ansys Mechanical finite element analysis software is used to simulate computer models of structures, electronics, or machine components for analyzing the strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes. Ansys is used to determine how a product will function with different specifications, without building test products or conducting crash tests. For example, Ansys software may simulate how a bridge will hold up after years of traffic, how to best process salmon in a cannery to reduce waste, or how to design a slide that uses less material without sacrificing safety. Ansys Parametric Design Language (APDL) is a powerful structured scripting language used to interact with the Ansys Mechanical solver.

3.2. SYMMETRICAL ANTENNA ARRAY

The microwave radar antenna array based has a curved surface, which can be used for real 3D breast models. The Figure 3.8 shows geometry from a sideview with breast phantom, also the top view is shown in Figure 3.2.1. The analytical expression of equivalent permittivity for rain medium is presented by utilizing the system identification method to investigate the electromagnetic wave attenuation induced by rain. The obtained result shows that the permittivity is a function both of the frequency and the rain rate. The pulse broadening effects in rain are researched with the incoming permittivity.

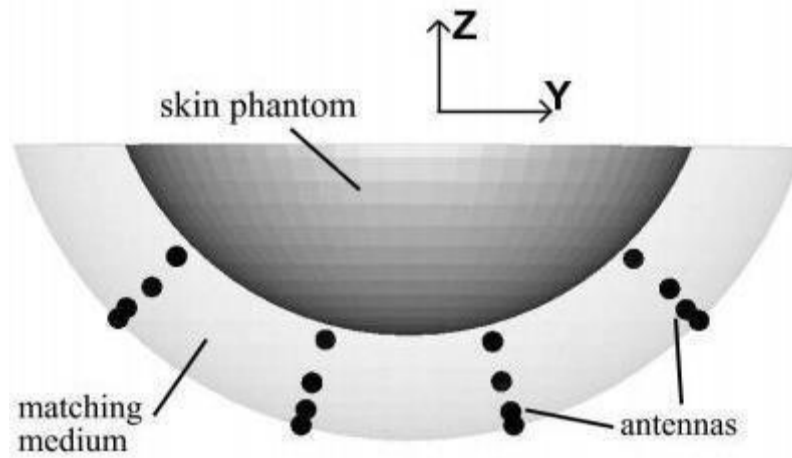


Fig :3.1 : The Sideview for Antenna Array Geometry with the Curved Spherical Skin Model

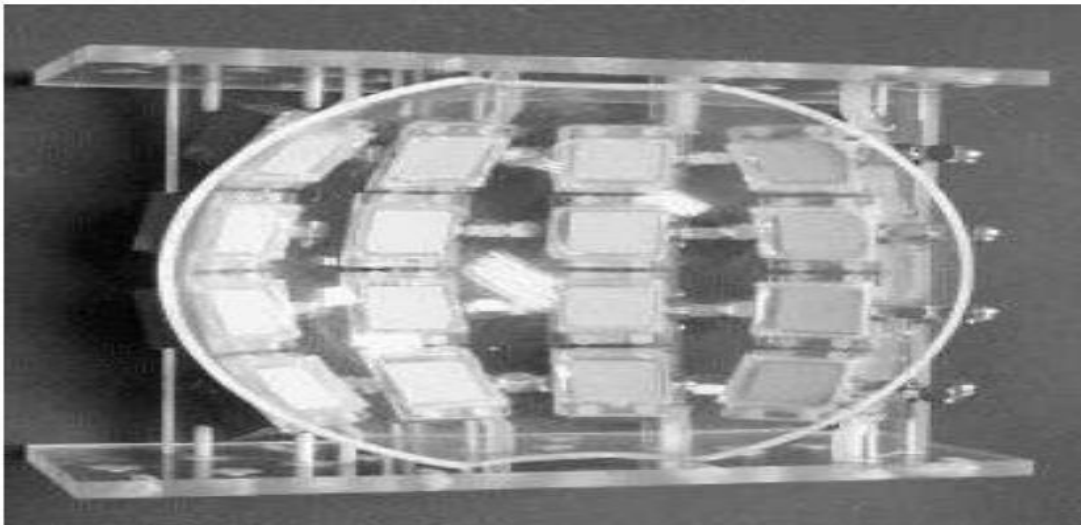


Fig :3.2 : The Top View of The Curved Spherical Skin Model with the Antenna Array .

Four antennas in four rows in the lower part (78 mm radius sphere). Which allow symmetrical array geometry. The phantom materials have electrical properties that demonstrate realistic curved breast with values of real breast.

Table 3.2 : Permittivity and Attenuation at Freq. of 6 Ghz.

	Breast fat/matching medium	Skin phantom	Tumor phantom
Permittivity	Close to 10	30	Close to 50
Attenuation	0.8 dB/cm	16 dB/cm	Close to 70

During their experiments, the array was filled with matching medium while in the right position the curved phantom takes place, attached to top of the antenna a tank to fill it with fat of the breast equivalent to the matching medium. The analytical expression of equivalent permittivity for rain medium is presented by utilizing the system identification method to investigate the electromagnetic wave attenuation induced by rain.

The obtained result shows that the permittivity is a function both of the frequency and the rain rate. The pulse broadening effects in rain are researched with the incoming permittivity. Simulations in millimeter waves band demonstrate that the increase of pulse broadening with that of rain rate and decrease with increase of operating frequency.

The steps before processing for the measured radar signal of the signal processing, first the tumor response will be taken from measured data, then equalization of tissue losses and the radial spread. Post-reception to obtain 3D image of the energy scattering, their algorithm depends on beam forming and classical delay.

3.3.THREE LAYERS OF BREAST

- Skin
- Fat
- Tissue

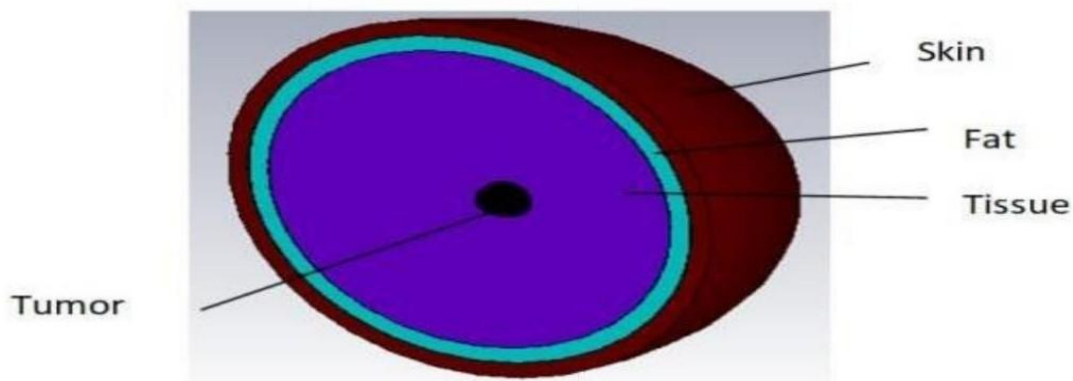


Fig 3.3 : Breast Layers

The phantom incorporates structures imaged in the female breast such as microcalcifications, fiber lesions, and tumors with different sizes. Moreover, the phantom was used to assess the sensitivity of lesion detection, depth resolution, and detectability thresholds with different imaging modalities.

The phantoms span the four American College of Radiology classes of breast density: (a) fatty, (b) scattered fibroglandular, (c) heterogeneously dense, and (d) extremely dense.

The phantom incorporates structures imaged in the female breast such as microcalcifications, fiber lesions, and tumors with different sizes. Moreover, the phantom was used to assess the sensitivity of lesion detection, depth resolution, and detectability thresholds with different imaging modalities.

3.4.3-D ANTENNA ARRAY DESIGN

At Duke University, they designed a 3D antenna array for the purpose of early cancer detection [44]. After measuring the performance of the antennas, the modeled scattered field information of the small tumor and the parameters, that were already known associated with the other components, they found that the screening of the tumor with the clinical microwave-imaging array is certainly possible. Since the previous experimental data with 3D imaging system with the successful inversion of phantoms demonstrate that, the inversion of their previously developed algorithm at Duke University is also possible. In addition, the only thing that will remain is finishing the implementation of the hardware system and design the prototype and start clinical trials.

Their major challenges were the assumption that the antenna will radiate in free space because that is what researchers usually assume when designing a fixed 3D array antenna. However, for designing an antenna for breast cancer detection radiation should be toward the tumor so it can copy the dielectric properties of the tumor. However, the breast cancer antenna should be designed to enhance in order to radiate directly into higher dielectric media. moreover, sampling resolution have to be considered, because the antenna gives the ability to know the characteristics of the field distribution within the imaging volume, that is going to be in order to remodel the dielectric properties of the area that it radiated in. therefore, it is better to increase the covered surface by increasing the number of antennas. Additionally, it is not preferable because increasing the number of antennas will cause an increasing of the coupling between them.

Additively, few negative effects of the mutual impedance on the performance of the antenna, such as the shifting effect on the resonant frequency, alter radiation pattern and reducing the matching performance. Furthermore, different impact due to those effects occurs on each antenna in the array due to their locations. Therefore, the design of the array must be done in a way that decrease the mutual coupling between the

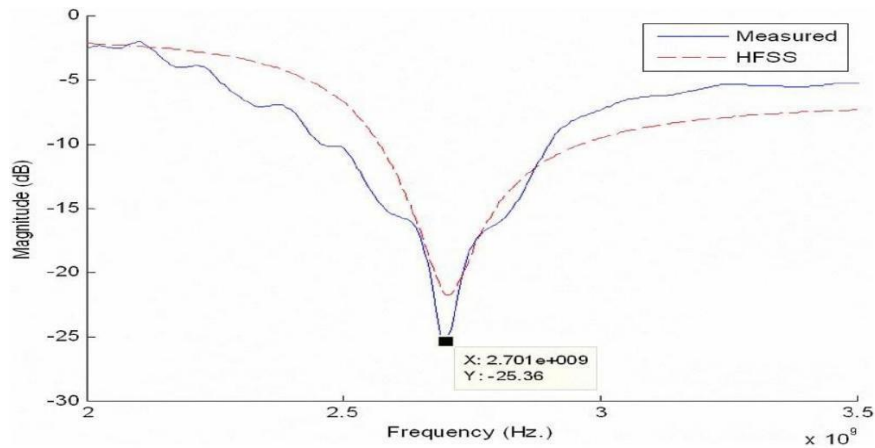


Fig :3.4 : Return Loss Comparison

Antennas and repeat the simulation and measurements to enhance and develop the design. They developed a tapered patch-imaging chamber for the client to use, the chamber is in the shape of a bra to make it easier as can be seen in Figure 3.4.1, and the chamber consists of six array of patch antenna and placed in a lossless dielectric material

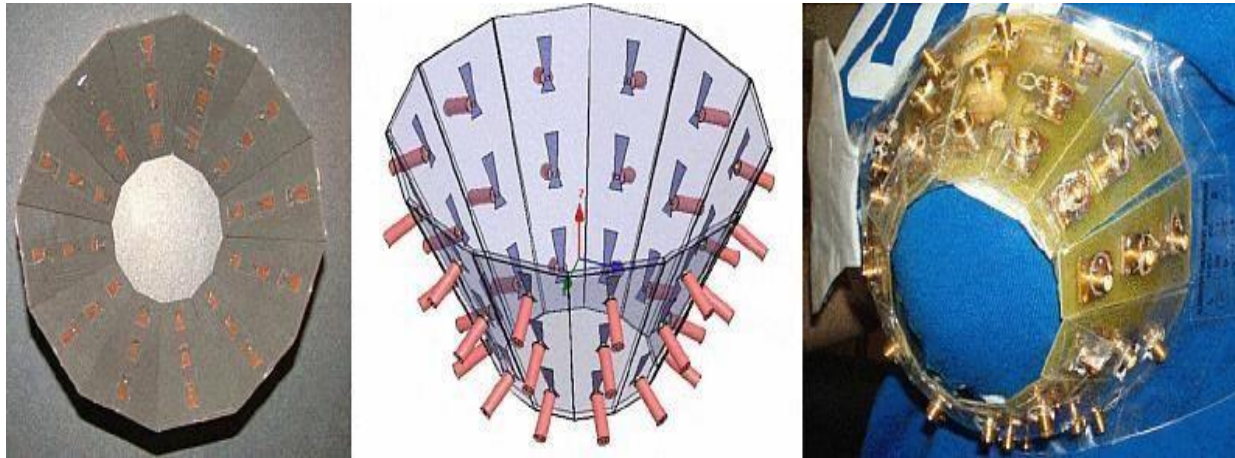


Fig :3.5: Imaging Chamber and The HFSS Model

Figure 3.4.2 illustrate the return loss for the simulation of the HFSS.

The simulation of the HFSS is similar to the real measurement for the operating antenna, which makes HFSS simulation software reliable.

Figure 3.4.3 shows the model of healthy breast and a breast with a tumor created depending on the dielectric properties for both; Figure 3.4 shows the antenna radiation.

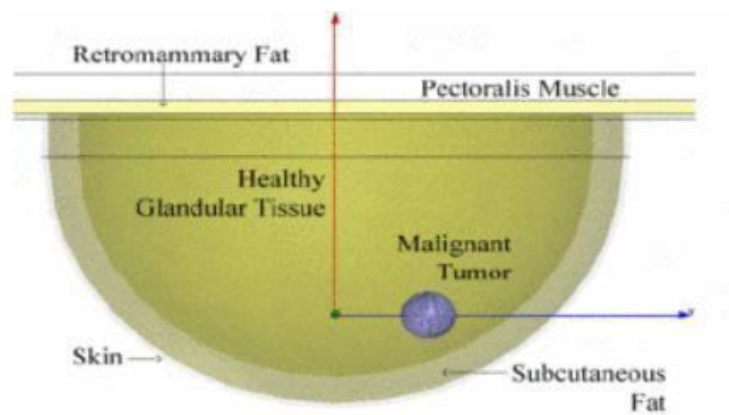


Fig :3.6 : Human Breast Model

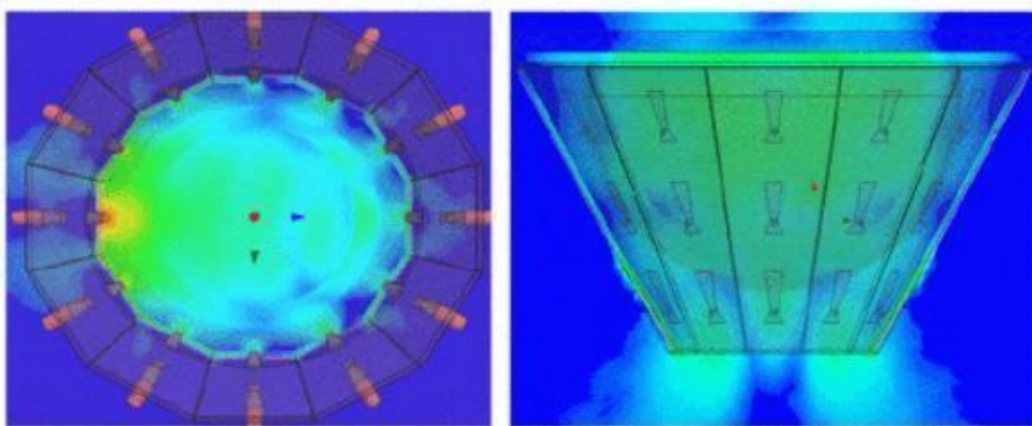


Fig :3.7: Antenna's Radiation in The Breast Model

3.5. FEEDING TECHNIQUES OF MICROSTRIP ANTENNA

The feeding techniques of microstrip patch antenna are of different types. The transfer of power to the patch antenna is done without any contacts by means of electromagnetic coupling. The techniques involved for feeding are coaxial probe feeding, feeding technique with microstrip line and aperture or proximity coupling.

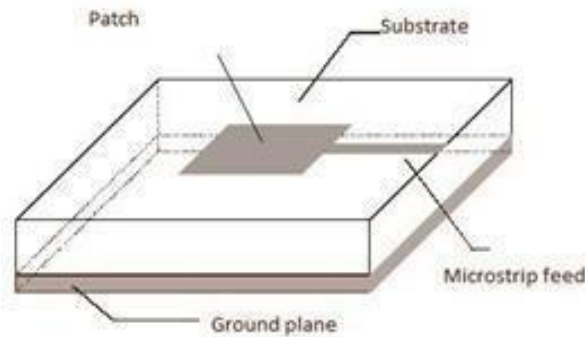


Fig :3.8 : Microstrip line

methods. The microstrip line feeding technique makes use of microstrip patch to which the conducting strip is connected directly to it. This technique has an advantage that the conducting element can be cut on same substrate. The conducting element width is less than the patch antenna as shown in figure 3.5.1.

In coaxial probe feeding technique, shown in figure 3.5.2 makes use of coaxial connector. The core of the coaxial connector is connected to the patch antenna and the other conductor of coaxial connector is connected to the ground of the patch antenna. This has major drawbacks that it is difficult to design. The proximity coupled feeding technique has the input feed is between two substrate and the patch element is placed above the substrate, as shown in fig 3.5.4.

Microstrip Line Feed: In this type, a conducting strip is connected directly to the edge of the Microstrip patch.. The patch is wider than the conducting strip. Thus the feed can be etched on the same substrate to provide a planar structure. Feeding methods can help control excess nutrient intake. Methods of feeding include free-choice feeding, time-restricted feeding, and food-restricted feeding. Free-choice feeding allows the pet to eat ad libitum, thereby increasing the risk for excess nutrient intake.

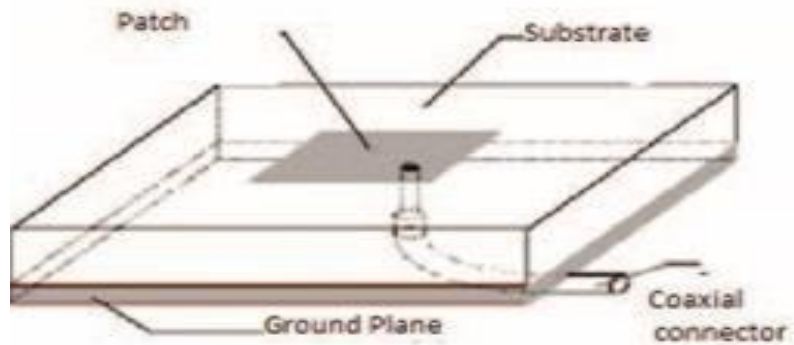


Fig :3.9: Coaxial probe feed

Design of Microstrip Rectangular Patch Antenna for Cancer Detection

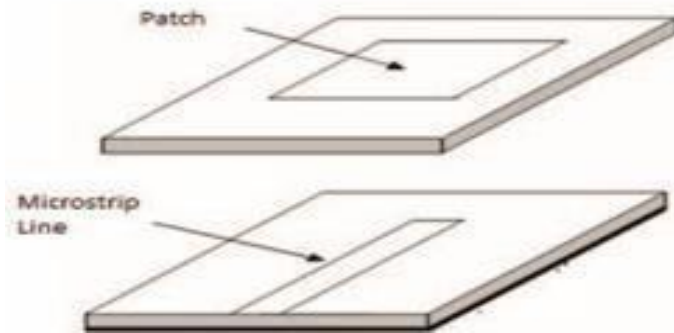


Fig :3.10: Proximity coupled feed

In aperture coupled feed, the radiating patch is kept between the microstrip feed line and the ground plane, which can be coupled using a slot. The slot is kept between the ground and the patch element. This changes are depends on length and width. This technique is used to improve the simulation result .

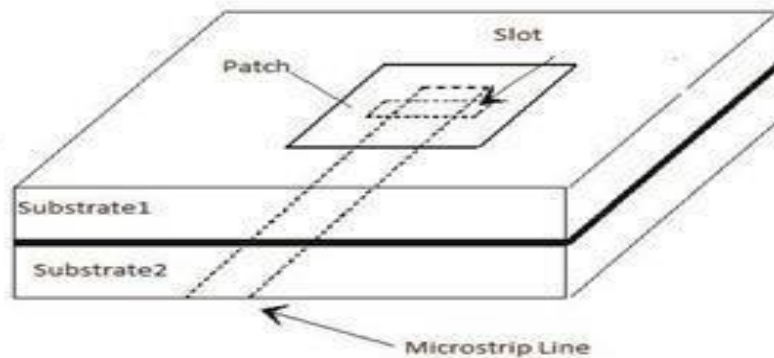


Fig :3.11 : Aperture coupled feed

Every HFSS simulation will involve, to some degree, all six of the above steps. While it is not necessary to follow these steps in exact order, it is good modeling practice to follow them in a consistent model-to-model manner.

3.5.1 Step One

The initial task in creating an HFSS model consists of the creation of the physical model that a user wishes to analyze. This model creation can be done within HFSS using the 3D modeler. The 3D modeler is fully parametric and will allow a user to create a structure that is variable with regard to geometric dimensions and material properties. A parametric structure, therefore, is very useful when final dimensions are not known or design is to be “tuned.” Alternatively, a user can import 3D structures from mechanical drawing packages, such as SolidWorks®, Pro/E® or AutoCAD®. However, imported structures do not retain any “history” of how they were created, so they will not be parameterizable upon import. If parameterization of the structure is desired, a user will need to manually modify the imported geometry so that parameterization is possible.

3.5.2 Step Two

The assignment of “boundaries” generally is done next. Boundaries are applied to specifically created 2D (sheet) objects or specific surfaces of 3D objects. Boundaries have a direct impact on the solutions that HFSS provides; therefore, users are encouraged to closely review the section on Boundaries in this document.

3.5.3 Step Three

After the boundaries have been assigned, the excitations (or ports) should be applied. As with boundaries, the excitations have a direct impact on the quality of the results that HFSS will yield for a given model. Because of this, users are again encouraged to closely review the section on excitations in this document. While the proper creation and use of excitations is important to obtaining the most accurate HFSS results, there are several convenient rules of thumb that a user can follow. These rules are described in the excitations section.

3.5.4 Step Four

Once boundaries and excitations have been created, the next step is to create a solution setup. During this step, a user will select a solution frequency, the desired convergence criteria, the maximum number of adaptive steps to perform, a frequency band over which solutions are desired, and what particular solution and frequency sweep methodology to use.

3.5.5 Step Five

When the initial four steps have been completed by an HFSS user, the model is now ready to be analyzed. The time required for an analysis is highly dependent upon the model geometry, the solution frequency, and available computer resources. A solution can take from a few seconds, to the time needed to get a coffee, to an overnight run. It is often beneficial to use the remote solve capability of HFSS to send a particular simulation run to another computer that is local to the user's site. This will free up the user's PC so it can be used to perform other work.

3.5.6 Step Six

Once the solution has finished, a user can post-process the results. Postprocessing of results can be as simple as examining the S-parameters of the device modelled or plotting the fields in and around the structure. Users can also examine the far fields created by an antenna. In essence, any field quantity or S, Y, Z parameter can be plotted in the post-processor. Additionally, if a parameterized model has been analyzed, families of curves can be created.

Solution Types

When using HFSS, a user must initially specify what type of solution HFSS needs to calculate. There are three types of solutions available:

1. Driven Modal
2. Driven Terminal
3. Eigen mode

The solution type can be selected by clicking on HFSS in the main menu bar, selecting Solution type, and selecting the desired type from the menu.

HFSS has three solution types. Traditionally, the Driven Modal solution type is used for most HFSS simulations, especially those that include passive, high-frequency structures such as microstrips, waveguides, and transmission lines.

For simulations that deal with Signal Integrity, the newest solution type, Driven Terminal Mode, is used. These simulations generally include models that have multi-conductor transmission lines.

The driven modal and driven terminal solution types are similar and rely on the same mathematical calculations when solving a given problem. The difference in the two solution types is in the types of results that are available to a user. Simulations that use the driven modal solution type yield S-matrix solutions that will be expressed in terms of the incident and reflected powers of waveguide modes.

The S-matrix that is given by the driven terminal type, however, is expressed in terms of terminal voltages and currents.

The eigen mode solver will provide results in terms of eigenmodes or resonances of a given structure. This solver will provide the frequency of the resonances as well as the fields at a particular resonance.

Boundaries in HFSS

Within the context of HFSS, boundaries exist for two main purposes:

1. To either create an open or a closed electromagnetic model or,
2. To simplify the electromagnetic or geometric complexity of the electromagnetic model.

Boundaries can be created either in open or a closed model.

A closed model simply represents a structure, or a solution volume, where no energy can escape except through an applied port. For an Eigenmode simulation, this could be a cavity resonator. For a driven modal or terminal solution, this could be a waveguide or some other fully enclosed structure.

An open model represents an electromagnetic model that allows electromagnetic energy to emanate or radiate away. Common examples would be an antenna, a PCB, or any structure that is not enclosed within a closed cavity.

While most HFSS simulations deal with models that are open, by default, HFSS initially assumes that any given model is closed. HFSS assumes all outer surfaces of the solution space are covered, or coated, by a perfect electric conductor boundary. In order to create an open model, a user will need to specify a boundary on the outer surfaces that will overwrite the default perfect electric conductor boundary.

The second reason why boundaries are used within HFSS is to decrease the geometric/electromagnetic complexity of a given structure or model. These boundaries should only be used internally to a model or possibly on a symmetry plane. They should be applied to specifically created 2D sheet objects or to specific surfaces of 3D objects. While boundaries can be very useful, a user should exercise caution when using them as they can create unintended results if applied incorrectly. Every HFSS model a user creates will use boundaries on the outer surfaces of the solution space. This is a direct result of the fact that a user must specify whether a given model is open or closed. As a result, any given HFSS model will always either have Conducting, Radiation, or Perfectly Matched Layer Boundary on all outer surfaces. Conducting boundaries are the perfect electric conductor, finite conductivity or impedance boundary.

Not every HFSS model, however, will use simplifying boundaries. When using boundaries to create simpler models, users should take care to not create a model that has unreasonable or inappropriate boundaries applied.

In this Chapter discussed about the Software Selection , Symmetrical Antenna Array , Three Layers of Breast , D - Antenna Array Design, Feeding Techniques of Microstrip Patch Antenna , General Steps in Microstrip Strip Patch Antenna Design.

CHAPTER - 4

METHODOLOGY

4.1 MOTIVATION

Many lives can be saved if tumours are detected in early stages, which can result in a chance for recovery. Many patients find it irritating to get regular check ups due to the fact that the majority of the monitoring systems are complicated, not available everywhere and not mobile. Further more, for medical field applications, micro-strip antennas are efficient and have flexible properties that are utilized in imaging, diagnosis and treatment. It is known that breast cancer is the most common type of cancer in the world, and the earlier its been detected the better. In the early stages of breast cancer, getting rid of from the tumours is much easier and more guaranteed.

4.2 AIM

The aim of our project is to Develop Micro strip Patch Wearable Antenna to help us to detect the breast cancer earlier with low cost, fast, and use the screen to show the tumor in early stage.

4.3. OBJECTIVES

- 2- How the antenna will help to detect the breast cancer.
- 3- Investigation of existing the antennas strategy for MICS and ISM bands.
- 4- Study a various alternatives for breast cancer detection using microwaveimaging.
- 5- Using the experiences in order to design a prototype for micro strip patchantenna array.
- 6- After getting an obtained data for real human tissues.
- 7- We are able to test the efficiencyof this result in the lab.

4.4. WEARABLE TECHNOLOGY

The technology of wearable devices is a technology of electronic and computer devices incorporated into clothes. It can be worn on in everyday life. Those devices can be watches, glasses, earring, caps and fabrics. Those devices are capable to do various tasks, it can work normally like a mobile phone and computer but also can work as a sensor or a tracker or even work as a scanning device. It is considered as a major step in the trend of pervasive computing where everybody can access information anywhere. In general, wearable devices have a very broad application. Before introducing, it the consumers those devices were used in military technology. Then, we see application in education, gaming, music, transportation fitness and health. The main task of such wearable devices is to incorporate the functions needed to be done in daily life.

4.5. WEARABLE ANTENNA DESIGN CHALLENGES

Limitation is to be found in any work, therefore it must be evaluated and analyzed to obtain the required outcomes. The lossy conducting materials found in the human body is one of the main reasons of these limitations which leads to the following challenges:

4.5.1. Size Limitations

The size limitations arise because of the relationship between the performance and the size of the antenna; therefore, the dielectric constant must be reduced to have a better performance and that is done by having the thickness of the substrate increased, therefore increasing the antenna size is important to have a larger bandwidth. computer but also can work as a sensor or a tracker or even work as a scanning device. It is considered as a major step in the trend of pervasive computing where everybody can access information anywhere. In general, wearable devices have a very broad application. Before introducing, it the consumers those devices were used in military technology.

4.5.2. Life of the Battery

Significant performance, speed and quality requires power therefore the battery will be consumed through time, moreover the size of the battery in some wearable antennas might cause a problem since it might affect the sensor performance, therefore, to create a system efficient to perform the required task, a larger battery will be needed to provide power to the small sensors.

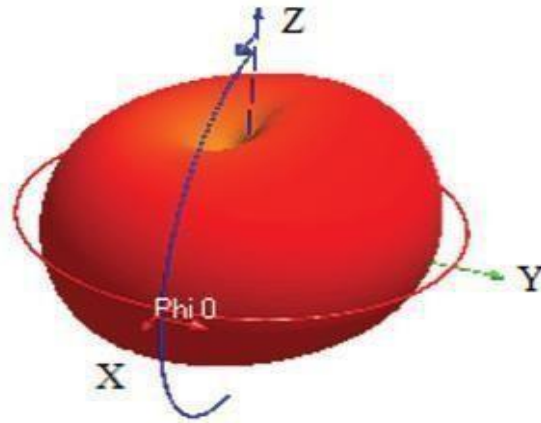


Fig: 4.1 : Radiation Pattern

4.5.3. Lossy Environment and Multipath Losses

In a multipath fading environment, the relative motion between the transmitter and receiver may also cause broadening of the power spectrum. Additionally, the wireless channel, or the over-the-air link between a transmitter and a receiver, is subject to interference from other users in the system. These multipaths are caused by mechanisms of reflection, diffraction, and scattering from buildings, structures, and other obstacles existing in the propagation environment. Multipath propagation is usually described by line of sight (LOS) path and non line of sight (NLOS) paths. Destructive interference causes fading; this may cause a radio signal to become too weak in certain areas to be received adequately. For this reason, this effect is also known as multipath interference or multipath distortion. Multipath interference occurs when an RF signal from a transmitter arrives at a receiver via two or more routes. Typically there is a direct path plus a number of indirect paths caused by reflections. Walls, people, set pieces, and other objects in a room can cause reflections indoor.

One of the human bodies characteristics is having a lossy conducting material, which will dissipate the energy, therefore when implementing the antenna in the body its behavior and the radiation pattern will be affected as illustrated in following.

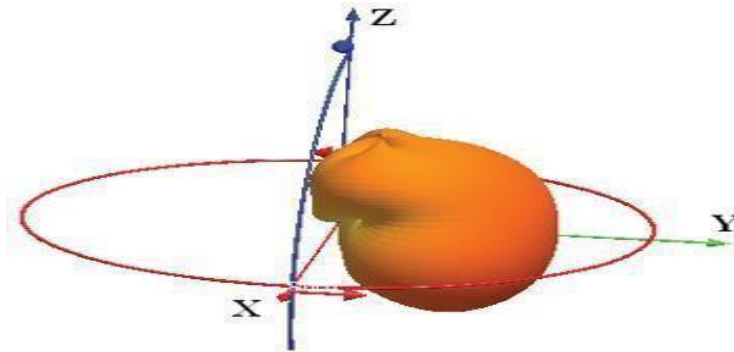


Fig : 4.2: Defected Radiation Pattern

The difference between the two figures is clear the Figure 2.2 shows a radiation pattern obtained by HFSS while the Figure 2.3 shows an antenna implemented in the skin tissue of a head model of a human.

4.6. EXISTING METHODOLOGY

A Micro Strip Patch Antenna was designed, measured , simulated , fabricated and validated with and without tumor .Experiments the Return loss , SAR Value (Specific Absorption Rate), VSWR (Voltage Standing Wave Ratio) , Gain , Directivity , results through Network Analyzer . A Micro Strip Patch Antenna was designed, measured , simulated , fabricated and validated with and without tumor . Antenna Frequency Between 10 to 25 GHz or 5.6 – 5.9 GHz. Experiments the Return loss , SAR Value (Specific Absorption Rate), VSWR (Voltage Standing Wave Ratio) , Gain , Directivity , results through Network Analyzer

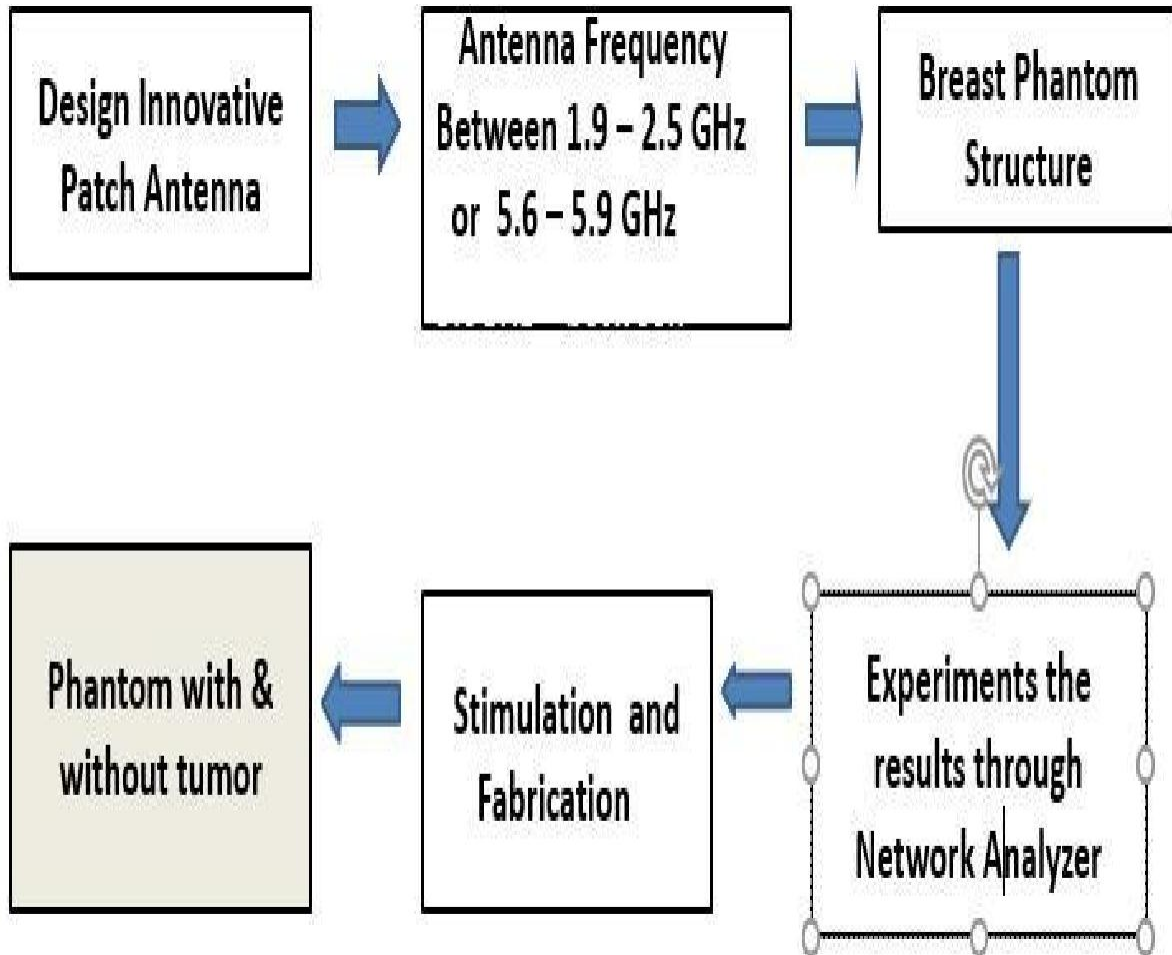


Fig 4.6 : Block Diagram of Existing Method

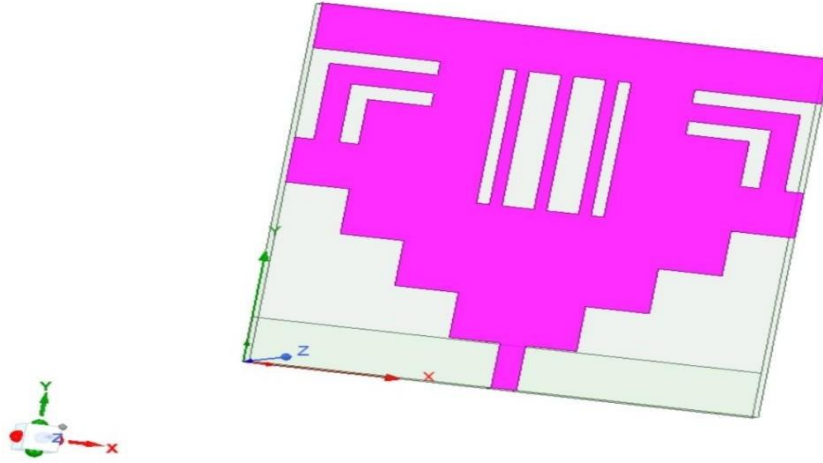
Antenna was designed, measured , simulated , fabricated and validated with and without tumor .Experiments the Return loss , SAR Value (Specific Absorption Rate) , VSWR (Voltage Standing Wave Ratio) , Gain , Directivity , results through Network Analyzer . A Micro Strip Patch Antenna was designed, measured , simulated , fabricated and validated with and without tumor . Antenna Frequency About 10 GHz. Experiments the Return loss , SAR Value (Specific Absorption Rate) , VSWR (Voltage Standing Wave Ratio) , Gain , Directivity , results through Network Analyzer.

In this Chapter discussed about the Motivation , Aim and Objective of the Project , Wearable Technology for Antenna , Wearable Antenna Design Challenges and Existing Methodology.

CHAPTER - 5

PROPOSED ANTENNA DESIGN MODEL

5.1.WITHOUT TUMOR PROPOSED DESIGN



**Fig 5.1 : Proposed Design in free space
(Without tumor)**

Resonant frequency, the effective length

$$L_{eff} = \frac{c}{2 \sqrt{\epsilon_{eff}}}$$

The width w of the radiating MSPA is computed using equation

$$W = \frac{c}{2 f_0 \sqrt{\frac{\epsilon_r + 1}{2}}}$$

where c is the velocity of light, ϵ_r is dielectric constant of the substrate and f_0 is the resonant frequency of antenna .

This is Proposed Design of Microstrip Patch Antenna without Tumor. Frequency of the Antenna is 2.45 GHz. Through this can find S Parameter Plot , Voltage Standing Wave Ratio Maximum unambiguous range , Front-to-back ratio , Gain Plot , Directivity Plot , S Parameter Chart etc...

5.2. WITHOUT TUMOR HFSS ANSYS

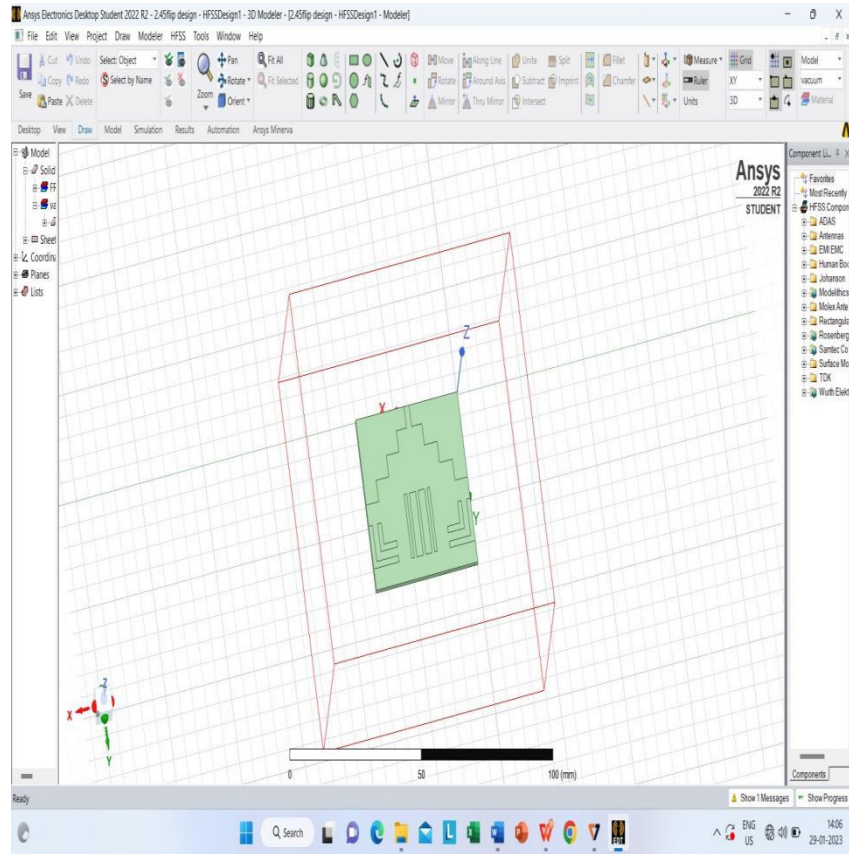


Fig 5.2 : WITHOUT TUMOR HFSS ANSYS

5.3 WORKING MECHANISM

5.2.1 S PPARAMETER PLOT

As shown in the Fig 5.3.1 The input-output relationship between ports (or terminals) in an electrical system is described by S-parameters. S_{12} , for instance, denotes the power transferred from Port 2 to Port 1 in the case of two ports (intelligently referred to as Port 1 and Port 2). Power was transported from Port 1 to Port 2 as shown by S_{21} . In a multi-port network, SNM typically denotes the power that was transmitted from Port M to Port N. Each location where we can

As shown in the Fig 5.3.1 The input-output relationship between ports (or terminals) in an electrical system is described by S-parameters. S12, for instance, denotes the power transferred from Port 2 to Port 1 in the case of two ports (intelligently referred to as Port 1 and Port 2). Power was transported from Port 1 to Port 2 as shown by S21. In a multi-port network, SNM typically denotes the power that was transmitted from Port M to Port N. Each location where we can deliver voltage and current can be considered a port. So, the radio terminals which supply power to the two antennas would be the two ports if we had a communication system with two radios (radio 1 and radio 2). S11 would then be the radio 1's reflected power attempt. The reflected power that radio 2 is attempting to send to antenna 2 is represented by S22. And S12 is the power that radio 2 transmits to radio 1 via antenna 1.

S-parameters are used to detail how energy can propagate through an electrical network. Scattering parameters are utilized to describe a complex network as a black box, analyzing the voltage and currents only at the input and output ports. S11 is the input port voltage reflection coefficient. S12 is the reverse voltage gain. S21 is the forward voltage gain. S22 is the output port voltage reflection coefficient.

The S-parameter matrix can be used to determine reflection coefficients and transmission gains from both sides of a two port network. Many electrical properties of networks of components (inductors, capacitors, resistors) may be expressed using S-parameters, such as gain, return loss, voltage standing wave ratio (VSWR), reflection coefficient and amplifier stability.

The expression used to calculate the Active S-Parameter is

$$(S_{11} \cdot a_1 + S_{12} \cdot a_2) / a_1$$

where ,

a1 is the complex excitation in volts incident on Port 1

a2 is the complex excitation in volts incident on Port 2.

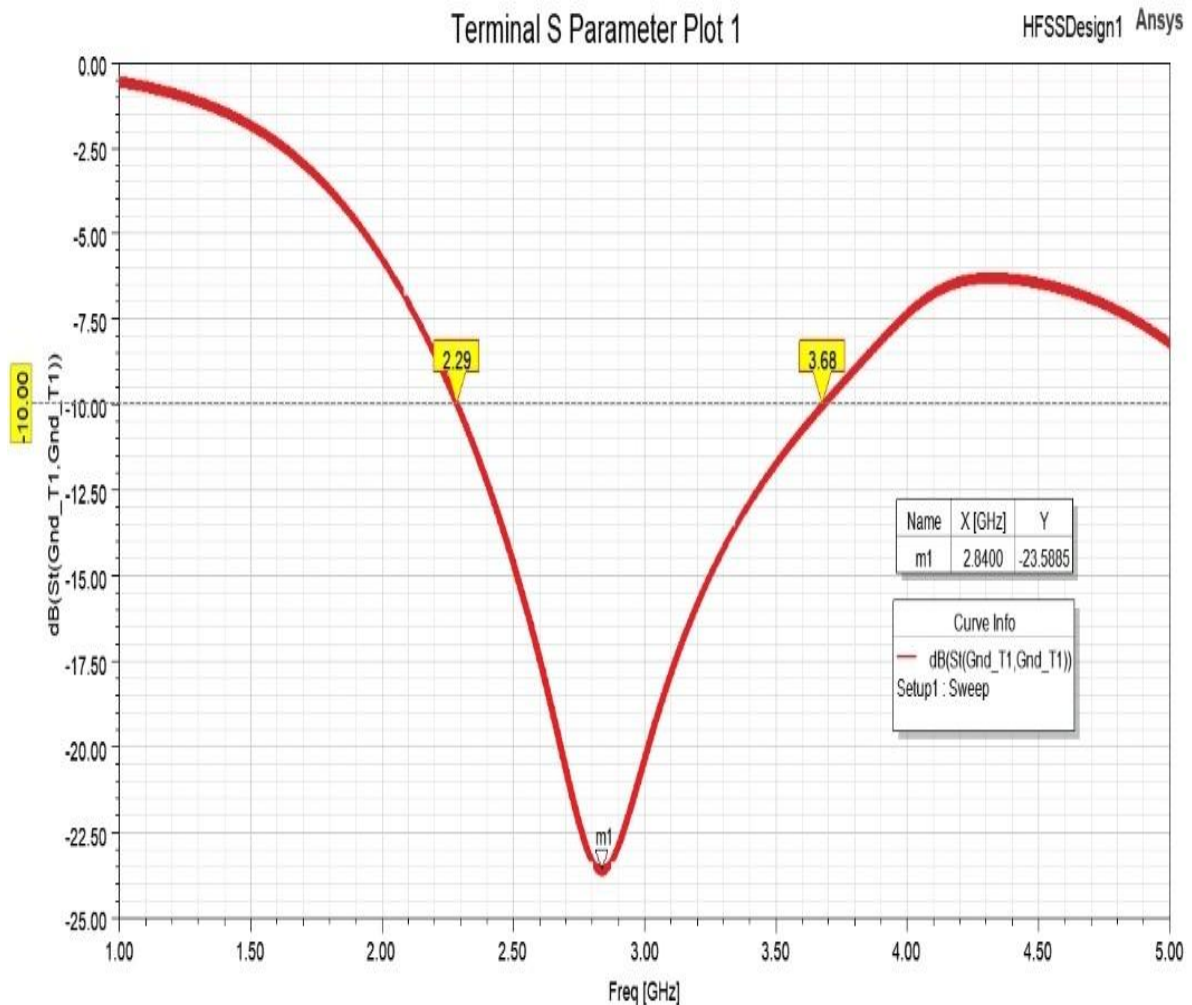


Fig 5.3 : S PPARAMETER PLOT

S-parameters describe the input-output relationship between ports (or terminals) in an electrical system. For instance, if we have 2 ports (intelligently called Port 1 and Port 2), then S12 represents the power transferred from Port 2 to Port 1. S21 represents the power transferred from Port 1 to Port 2. Remember that all signals that are received by the antenna is passed to the radio, and the radio needs to detect the LoRa signal out of the noise caused by all the other signals. So what we ideally want is an antenna that has a low S11 (**below -10dB**) around 868MHz, but a high (close to 0dB) at any other frequency

5.2.1. VSWR PLOT:

The impedance of the radio and transmission line must be properly matched to the impedance of the antenna for a radio (transmitter or receiver) to supply power to an antenna. The impedance matching performance of the antenna with respect to the radio or transmission line it is linked to is quantified by the VSWR parameter. As shown in the Fig 4.4.2 The Voltage Standing Wave Ratio, commonly known as Standing Wave Ratio, is the abbreviation for this measurement (SWR). The reflection coefficient, which specifies the power reflected from the antenna, is a function of VSWR. The VSWR is described by the following formula.

According to the definition of VSWR, the VSWR is the ratio of the line's maximum voltage to its minimum voltage. The sum of the voltage components from the forward power and the reflected power causes the voltage fluctuations. Many electrical properties of networks of components (inductors, capacitors, resistors) may be expressed using S-parameters, such as gain, return loss, voltage standing wave ratio (VSWR), reflection coefficient and amplifier stability.

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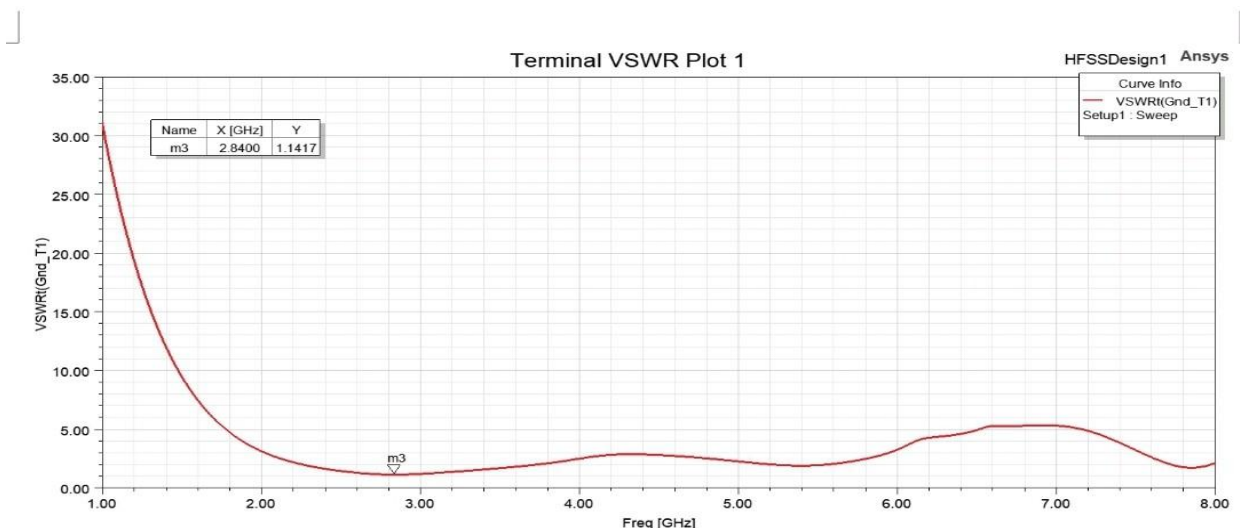


Fig 5.4 : VSWR PLOT

5.3.3 GAIN PLOT:

The ability of an antenna to focus the power that a transmitter provides to it in the direction of a target is measured as antenna gain. Antenna gain, which is sometimes represented by the sign G, is the antenna's ability to emit radiation at a higher intensity than a lossless, isotropic radiator using the same amount of power. An isotropic radiator would broadcast half as much effective power at a target as would an antenna with a gain of 2 (3 dB), which is

Equivalent to double the transmitter's output power in that direction. A ship's radar antenna will normally have a gain of 30 dB. (1000). The gain of an antenna in a given direction is defined as the ratio of the intensity, in a given direction, and the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically. This is called the absolute gain.

$$G_{dB} = 10 \log_{10} (4\pi\eta A/\lambda^2)$$

GdB is the antenna gain,

η is the efficiency,

A is the physical aperture area,

λ is the wavelength of the signal

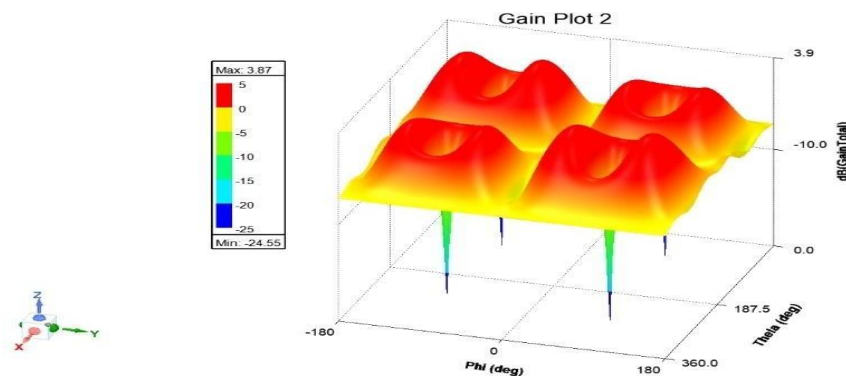


Fig :5.5: : GAIN PLOT

5.3.4. S PARAMETER CHART:

An electrical system's ports (or terminals) and their input-output relationships are described by S-parameters. For example, if there are two ports (intelligently referred to as Port 1 and Port 2), S12 stands for the electricity that was transferred from Port 2 to Port 1. Power moved from Port 1 to Port 2 is shown by the signal S21. The electricity that is transported from Port M to Port N in a multi-port network is typically represented as SNM. Any location where we can deliver current and voltage can be broadly referred to as a port. As a result, if a communication system has two radios (radios 1 and 2), the radio terminals which supply power to the two antennas would be the two ports. S11 would therefore be the radio 1's attempt to represent its power. S-parameters (also called S-matrix or scattering parameters) represent the linear characteristics of RF electronic circuits and components. From the S-parameter matrix, you can calculate characteristics of linear networks such as gain, loss, impedance, phase group delay, and voltage standing wave ratio. An S-Curve graph is a project management tool that allows tracking the progress of a project's aspect over time. It can track the project's cost, the hours labored, the man-hours, or any other relevant factor of the project. The S-Curve graph plots these resources versus time.

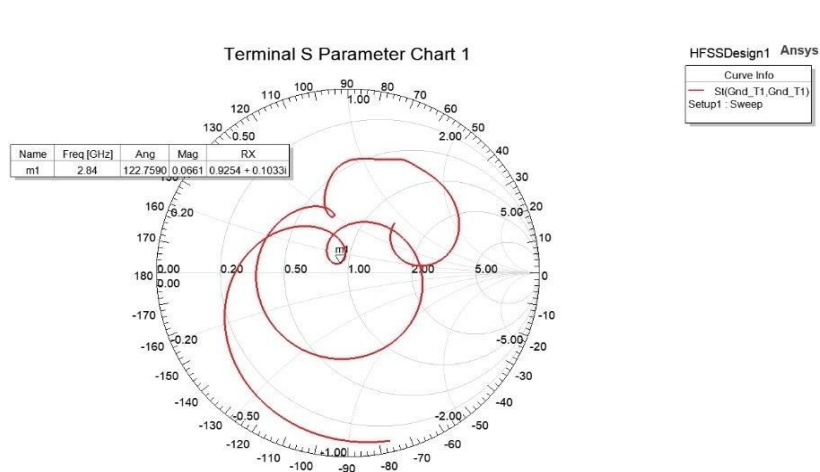


Fig :5.6: : S PARAMETER CHART

5.3.5. DIRECTIVITY PLOT:

A fundamental antenna parameter is directivity. It gauges how "directional" the radiation pattern is from an antenna. The directionality of an antenna that radiates evenly in all directions would be essentially zero, and its directivity would be 1. (or 0 Db). The only difference between a radiation pattern and a normalized radiation pattern is a scaling of the magnitudes so that the maximum value of the radiation pattern's magnitude is equal to 1. The directivity (D) formula is represented mathematically as follows:

$$D = \frac{1}{\frac{1}{4\pi} \int_0^{2\pi} \int_0^\pi |F(\theta, \phi)|^2 \sin \theta d\theta d\phi}$$

Although the denominator of this equation for directivity simply denotes the "average power emitted over all directions," the numerator of this equation for directivity is the greatest value of F. In order to determine the directivity of the antenna, this equation simply divides the peak amount of radiated power by its average.

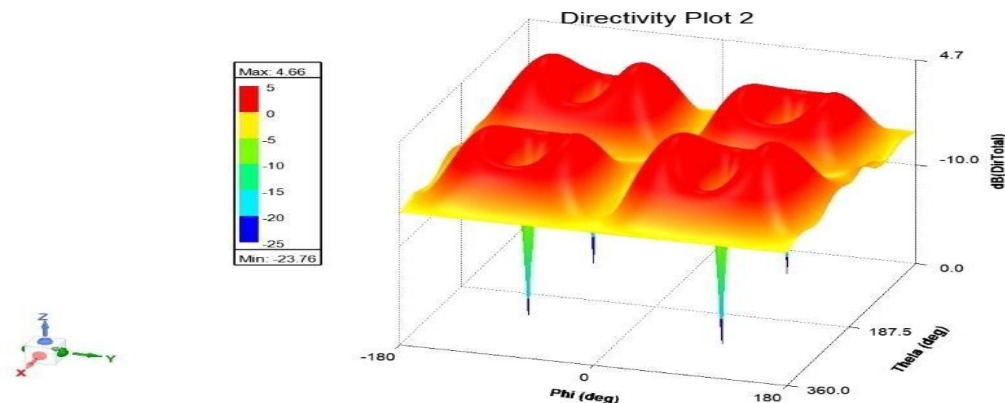


Fig : 5.7:DIRECTIVITY PLOT

5.3.6.FRONT TO BACK RATIO

The front-to-back ratio denotes the sensitivity of an antenna to radio waves in the region of 180 degrees plus or minus 40 degrees from the main beam direction - the area of space behind the antenna. It is defined in decibels (dB) relative to the peak of the main beam of the antenna. The ratio of power gain between the front and rear of a directional antenna. In point-to-point microwave antennas, a "high performance" antenna usually has a higher front to back ratio than other antennas. For example, an unshrouded 38 GHz microwave dish may have a front to back ratio of 64 dB, while the same size reflector equipped with a shroud would have a front to back ratio of 70 dB. Other factors affecting the front to back ratio of a parabolic microwave antenna include the material of the dish and the precision with which the reflector itself was formed.

In other electrical engineering the front to back ratio is a ratio of parameters used to characterize rectifiers or other devices, in which electric current, signal strength, resistance, or other parameters, in one direction is compared with that in the opposite direction.

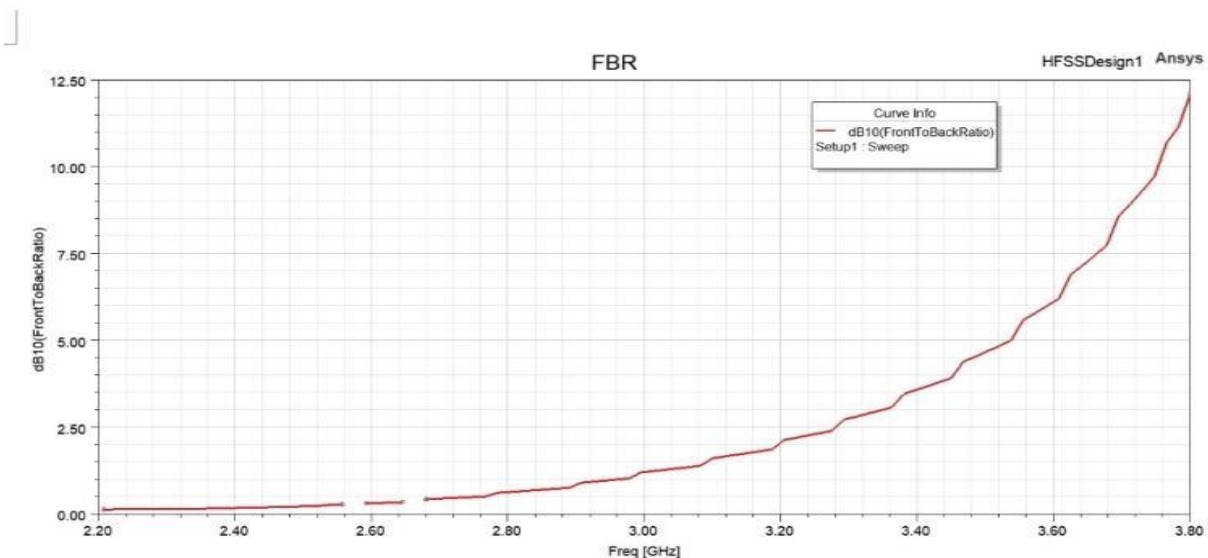


Fig: 5.8 : FRONT TO BACK RATIO

5.3.7.RADIATION PATTERN

In all forms of electromagnetic energy are referred to as the electromagnetic "spectrum." Radio waves and microwaves emitted by transmitting antennas are one form of electromagnetic energy. They are collectively referred to as "radiofrequency" or "RF" energy or radiation. They are commonly used for GPS applications, vehicles and emergency radio and have a higher gain in horizontal directions, Directional antennas primarily receive and transmit energy from one direction. Radio frequency (RF) is a measurement representing the oscillation rate of electromagnetic radiation spectrum, or electromagnetic radio waves, from frequencies ranging from 300 gigahertz (GHz) to as low as 9 kilohertz (kHz). Radio frequency devices use safe levels of low-frequency electromagnetic waves to generate heat. This heat penetrates deep into your skin's layers. There, it stimulates new skin cell production (regeneration). The treatment also stimulates the production of collagen and elastin. The radiation pattern or antenna pattern is the graphical representation of the radiation properties of the antenna as a function of space. That is, the antenna's pattern describes how the antenna radiates energy out into space (or how it receives energy).

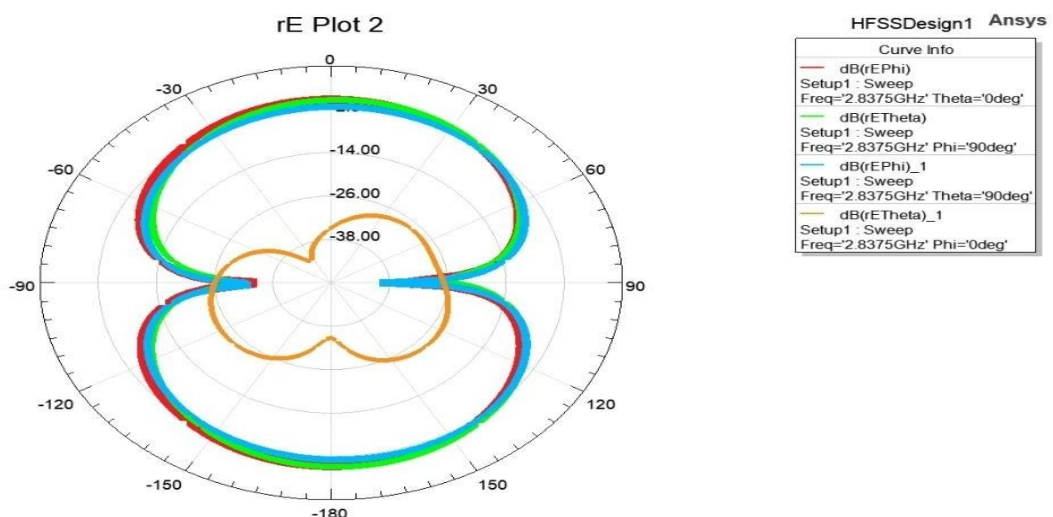


Fig :5.9 : RADIATION PATTERN

5.3.8. MAXIMUM UNAMBIGUOUS RANGE

The maximum unambiguous range ($R_{\max}$) is the longest range to which a transmitted pulse can travel out to and back again between consecutive transmitted pulses. In other words, $R_{\max}$ is the maximum distance radar energy can travel round trip between pulses and still produce reliable information.

The relationship between the PRF or their reciprocal value interpulse period T (PRT) and $R_{\max}$ determines the unambiguous range of the radar. Suppose the radar emits a pulse that strikes a target and returns to the radar in round trip time t :

If $t < T$ then the return signal arrives before the next pulse has been emitted.

If $t = T$ then the return signal arrives exactly when the next pulse has been emitted.

If $t > T$ then the return signal arrives after the next pulse has been emitted and there is an ambiguity, ie the radar cannot tell whether the return signal has come from the first or second pulse.

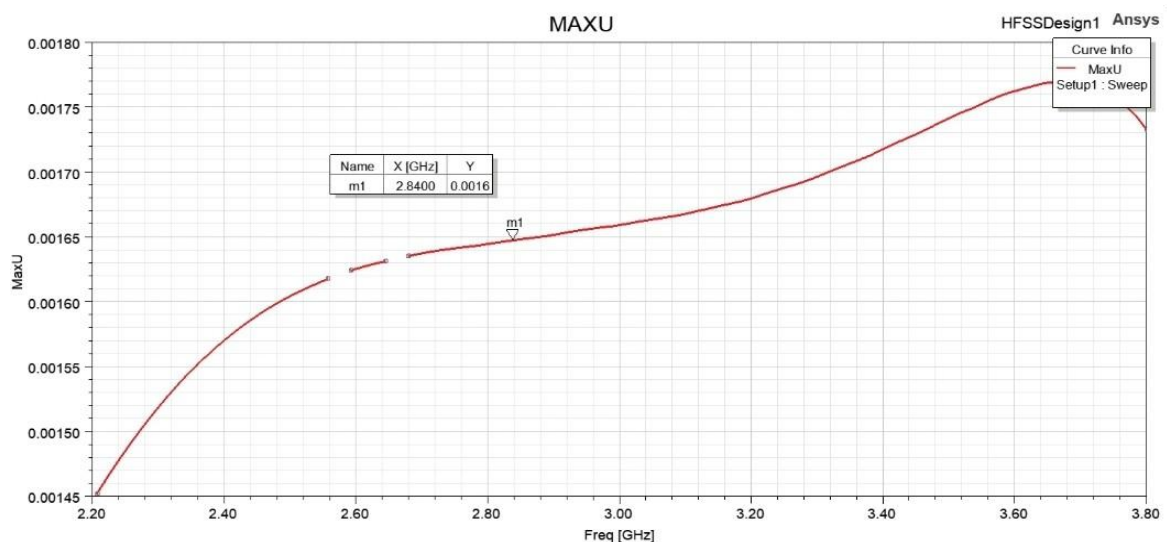


Fig :5.10 : MAXIMUM UNAMBIGUOUS RANGE

5.3. WITH TUMOR PROPOSED DESIGN

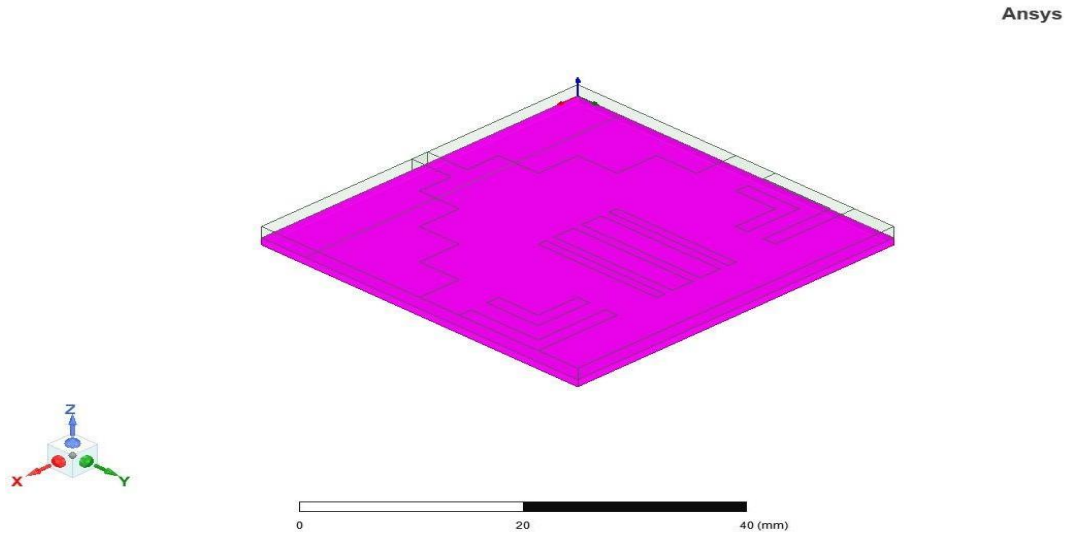


Fig : 5.11: WITH TUMOR PROPOSED DESIGN

The width w of the radiating MSPA is computed using equation

$$W = \frac{c}{2 f_0 \sqrt{\frac{\epsilon_r + 1}{2}}}$$

where c is the velocity of light, ϵ_r is dielectric constant of the substrate and f_0 is the resonant frequency of antenna .

Resonant frequency, the effective length

$$L_{eff} = \frac{c}{2 \sqrt{\epsilon_{eff}} f_0}$$

This is Proposed Design of Microstrip Patch Antenna with Tumor. Frequency of the Antenna is 2.45 GHz. Through this can find S Parameter Plot , Voltage Standing Wave Ratio Maximum unambiguous range , Front-to-back ratio , Gain Plot , Directivity Plot , S Parameter Chart etc...

5.5.WITH TUMOR S PARAMETER PLOT

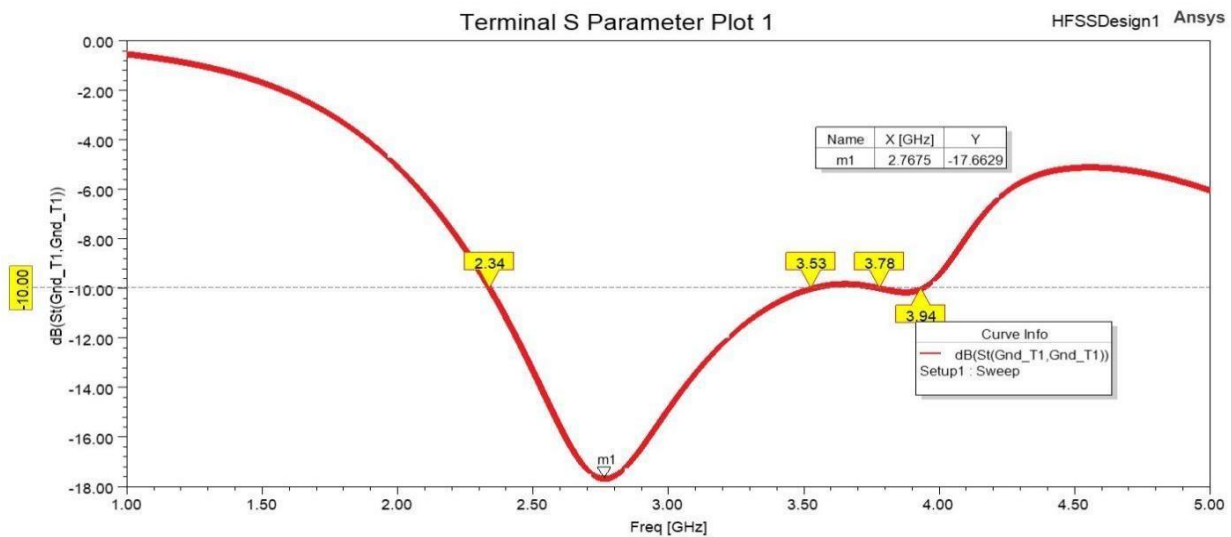


FIG : 5.12: S Terminal with tumor Plot

The input-output relationship between ports (or terminals) in an electrical system is described by S-parameters. S12, for instance, denotes the power transferred from Port 2 to Port 1 in the case of two ports (intelligently referred to as Port 1 and Port 2). Power was transported from Port 1 to Port 2 as shown by S21. In a multi-port network, SNM typically denotes the power that was transmitted from Port M to Port N. Each location where we can deliver voltage and current can be considered a port. So, the radio terminals which supply power to the two antennas would be the two ports if we had a communication system with two radios (radio 1 and radio 2). S11 would then be the radio 1's reflected power attempt. The reflected power that radio 2 is attempting to send to antenna 2 is represented by S22. And S12 is the power that radio 2 transmits to radio 1 via antenna 1.

The expression used to calculate the Active S-Parameter is $(S_{11} \cdot a_1 + S_{12} \cdot a_2) / a_1$

where ,

a_1 is the complex excitation in volts incident on Port 1

a_2 is the complex excitation in volts incident on Port 2

In this Chapter discussed about the Without Tumor Proposed Design , Without tumor Ansys Hfss Design , Working Mechanism , With Tumor Proposed Design and With Tumor S Parameter Plot.

CHAPTER - 6

RESULTS & CONCLUSION

6.1. FABRICATION WORK

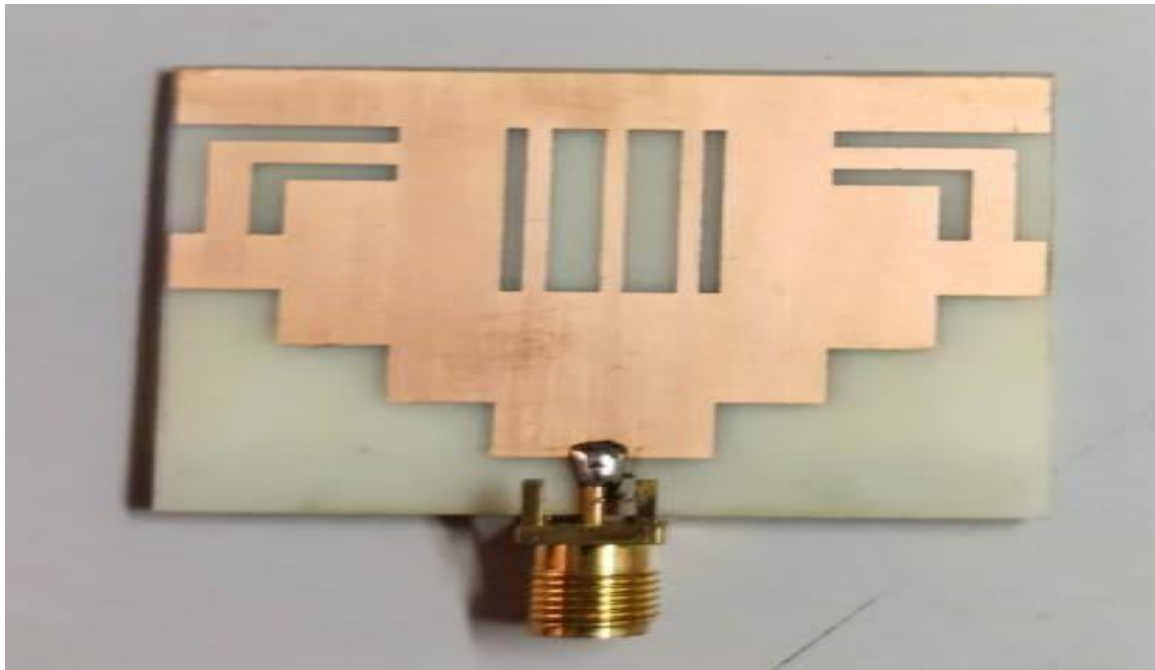


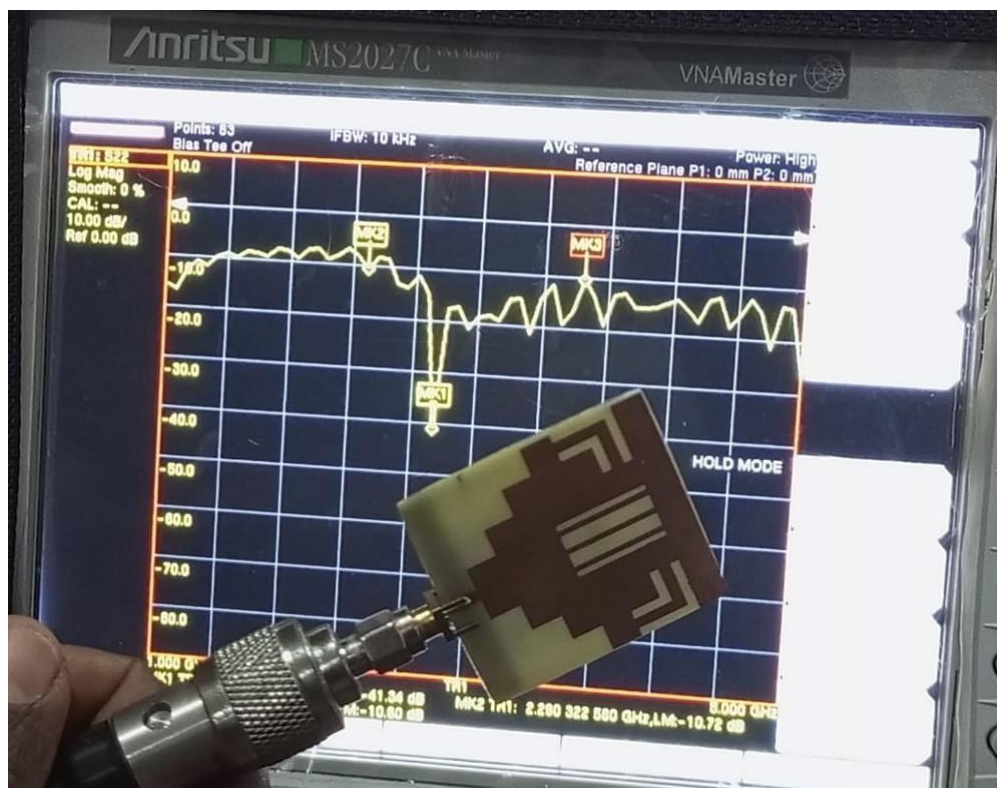
Fig : 6.1 FRONT SIDE FABRICATION WORK



FIG : 6.2: BACK SIDE FABRICATION WORK

6.2. SIMULATED RESULTS

S PARAMETER ANTENNA PARAMETER	SIMULATED VALUES
WITH TUMOR	Min :2.29 dB Max: 3.68.dB
WITHOUT TUMOR	Min: 2.37 dB Max: 3.94dB



6.3 NETWORK ANALYZER TESTING

6.2.COMPARISON OF WITH AND WITHOUT TUMOR DESIGN

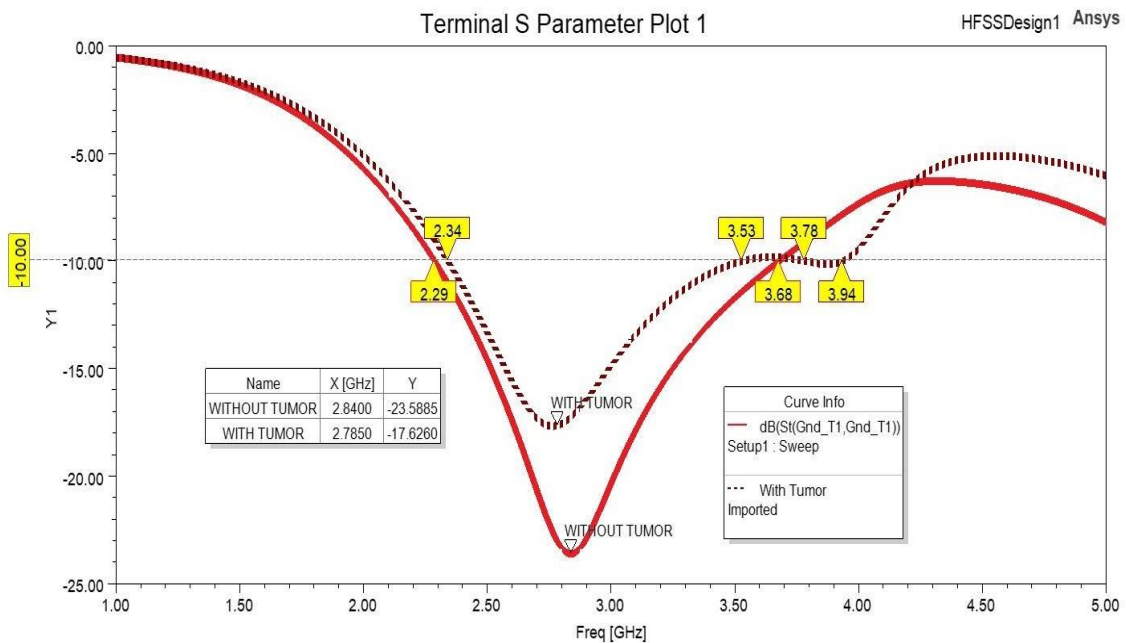


Fig : 6.4 COMPARISON OF WITH AND WITHOUT TUMOR DESIGN

The graph shows the difference between with and without Tumor Design. Without tumor x axis 2.8400 GHz , With tumor x axis 2.7850. Y axis without tumor -23.5885 , with tumor -17.6260.

This is Proposed Design graph of Microstrip Patch Antenna without and with Tumor. Frequency of the Antenna is 2.45 GHz. Through this can find S Parameter Plot , Voltage Standing Wave Ratio Maximum unambiguous range , Front-to-back ratio , Gain Plot , Directivity Plot , S Parameter Chart etc...

6.3. TESTING RESULTS OF FABRICATED ANTENNA

6.5: S11 - Parameter Plot

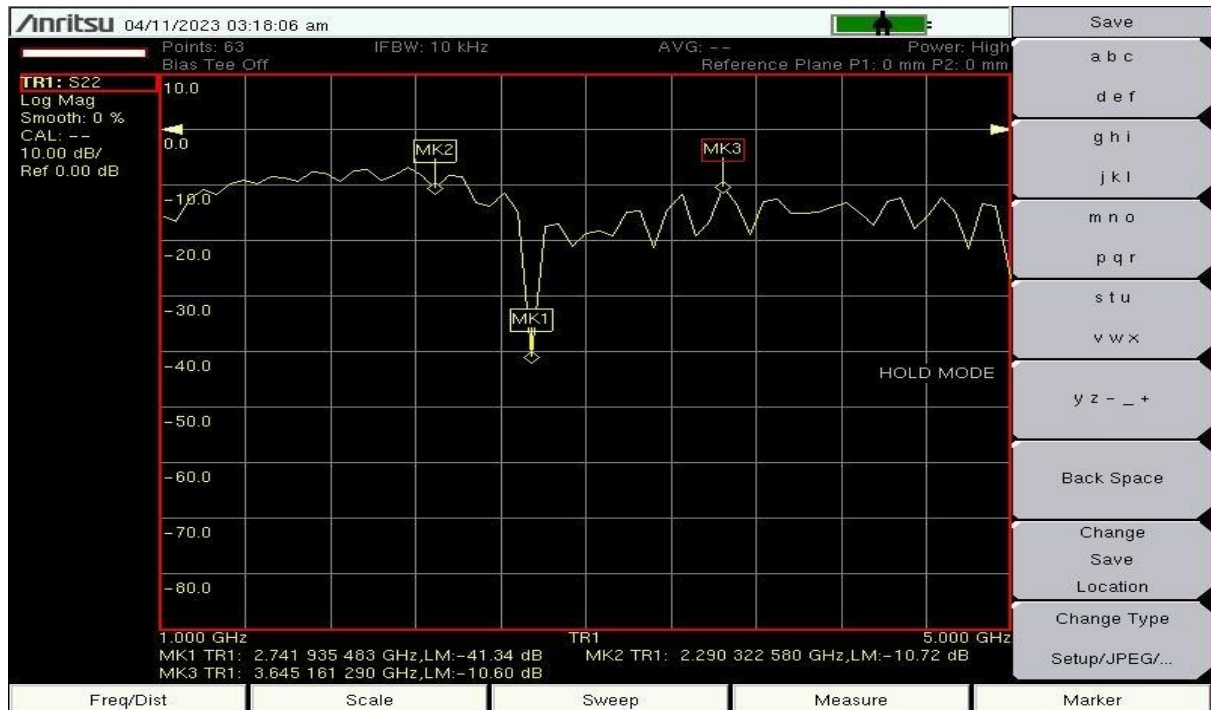


Fig 6.5: S11 - Parameter Plot

6.6 : VSWR PLOT

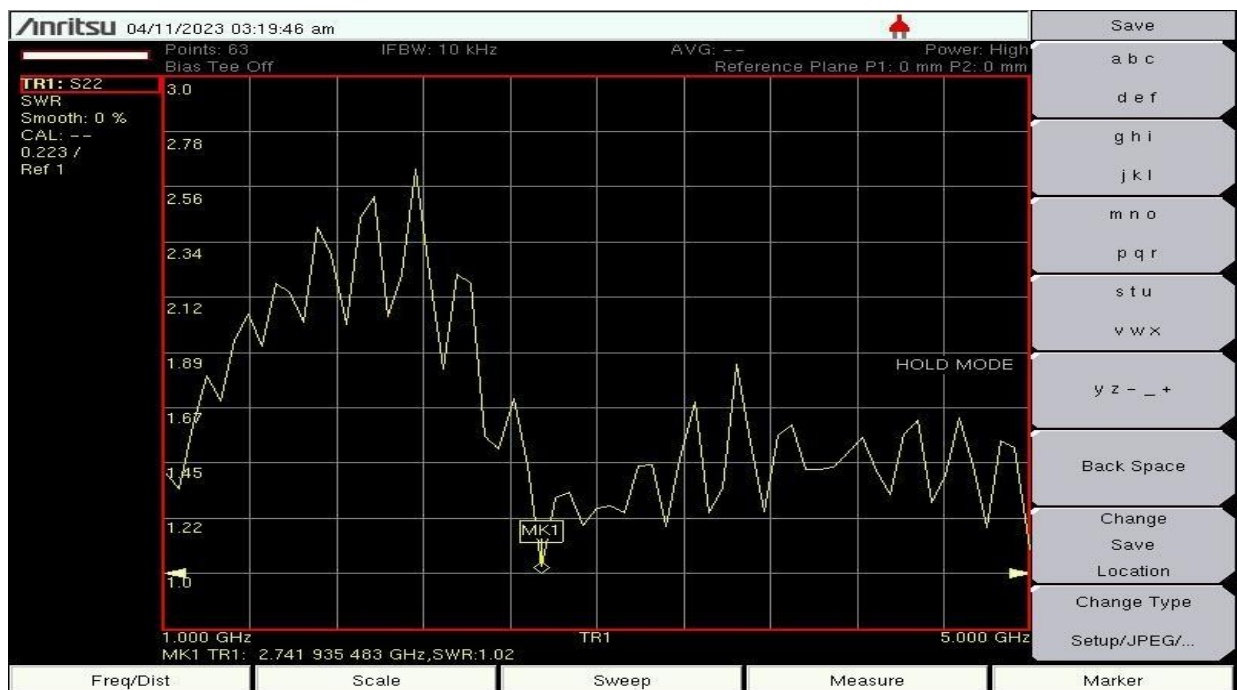


Fig 6.6 : VSWR PLOT

CHAPTER - 7

CONCLUSION

The overall working of antennas was understood. Design and Fabrication of Microstrip Patch Antenna for breast Cancer Tumor Detection was done by 2.45 GHz. Difference between With and Without Tumor was shown in S Parameter Plot Graph. The major parameters (such as V S W R , Return Loss curves, Radiation Patterns, Directivity and Beamwidth) that affect design and applications were studied and their implications understood. The patch antenna was simulated (using HFSS) and the desired level of optimization was obtained. It was concluded that the software results we obtained matched the theoretically predicted results. After the Fabrication of was checked by Network Analyzer.

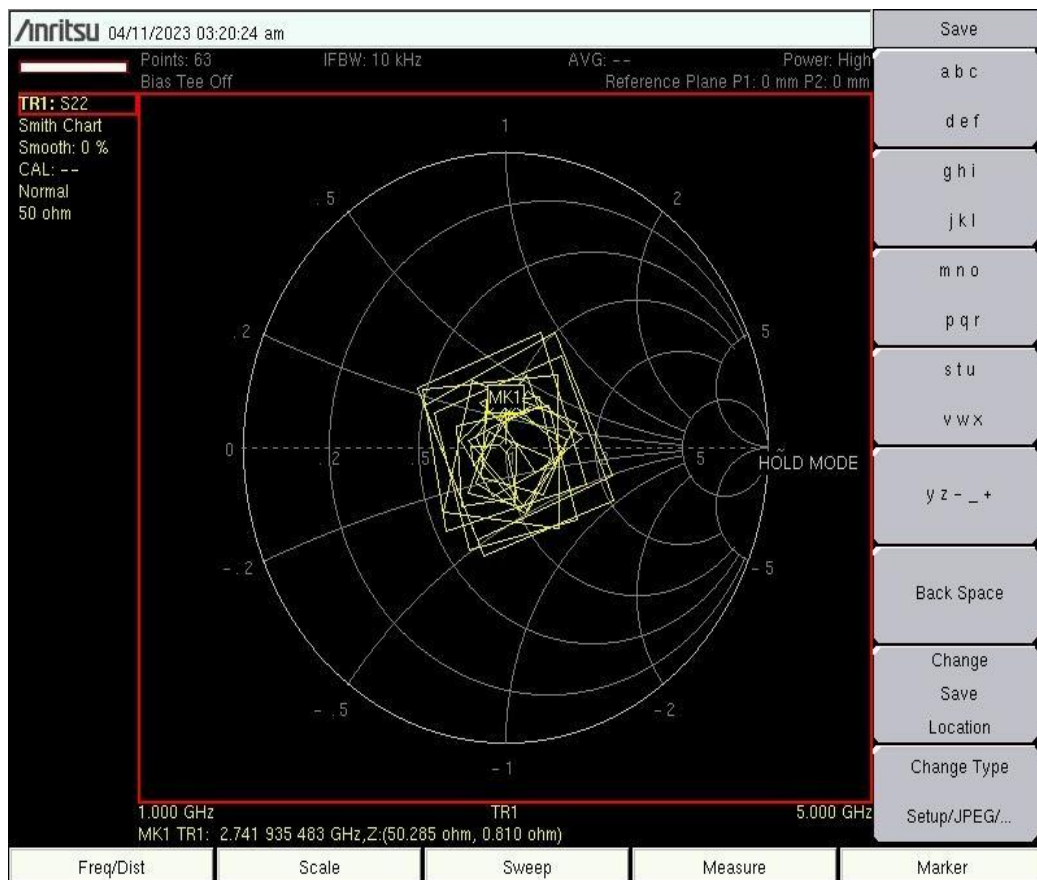


Fig : 7.1 SMITH CHART

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