Design and fabrication of Ultra-wideband antenna for microwave imaging

DISSERTATION-II

Submitted in partial fulfillment of
the Requirement for the award of the
Degree of

MASTER/BACHELOR OF
TECHNOLOGY IN
Electronics and Communication Engineering

By

Aditi Sharma (11617331)

Under the Guidance of
Gurpreet Kumar
Assistant Professor, L.P.U

School of Electronics and Electrical Engineering
Lovely Professional University
Phagwara, Punjab

December, 2017

CERTIFICATE

This is to certify that Aditi Sharma bearing Registration no. 11617331 have completed objective formulation/Base Paper implementation of the thesis titled, **“ ”** under my guidance and supervision. To the best of my knowledge, the present work is the result of his original investigation and study. No part of thesis has ever been submitted for any other degree at any university.

Gurpreet Kumar
Assistant Professor
School of Electronics and
Electrical Engineering
Lovely Professional University
Phagwara, Punjab
Date: 30-11-2017

ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude and appreciation to my guide Gurpreet Kumar**,** for his whole-hearted and invaluable guidance, inspiring discussions, encouragement, and support throughout my work. I found him always sincere in helping me even during his busiest hours of the day. His ardor and earnestness for studies are respected and will never be forgotten. Without his sustained and sincere effort, this report would not have taken this shape.

We are also indebted to all authors of the research papers and books referred to, which have helped us in carrying out the research work.

Aditi Sharma
11617331

DECLARATION

I, Aditi Sharma, student of M. Tech under Department of Electronics and Communication of Lovely Professional University, Punjab, hereby declare that all the information furnished in this Dissertation-I report is based on my own intensive research and is genuine.

This report does not, to the best of our knowledge, contain part of my work which has been submitted for the award of my degree either of this University or any other University without proper citation.

Aditi Sharma
Reg. no: 11617331

ABSTRACT

This thesis focuses on designing a planar antenna for microwave imaging using UWB antenna. Microwave imaging is one of the key researched areas in the field of communication. The microwave imaging modalities are used for cancer detection, SAR (Synthetic Aperture Radar), GPR (Ground Penetrating Radar) currently are not sufficient for society's need. The key feature in this field is to observe the microwaves frequencies for dielectric constant and conductivity between normal and malignant tissues in medical field, so experimentation of impedance matching and isolation control is important. In this thesis we will be designing and fabricating a compact planar microstrip antenna which will take into consideration all these parameters and will provide required characteristics for microwave imaging.

.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Table no. Page no.

CHAPTER 1

ANTENNA BASICS

1.1 INTRODUCTION

The 21st century is the era of science where there are numerous advancements in science and technology. Communication between different people all around the world is only possible due to the recent innovations in technology. The world is completely covered with electronic gadgets which are produced at a faster rate for communication to take place. The antenna becomes an important part of day to day life of an individual as it is the most important component for communication to take place which is found in every device which surrounds man from a simple mobile phone to the GPS satellites for tracking location. The very basic example of an antenna is on the Television where a good performance antenna can improve the broadcast reception. The antenna is a metallic device which acts as a transitional structure to radiate or receive radio frequency waves. The antenna can be categorized into two types:

Transmitting Antenna: It is present at the front end of the communication system to radiate the electromagnetic waves through the transmission line.

Receiving Antenna: It is the latter part of the communication system which is fed by an alternating current which in turn produces RF waves.

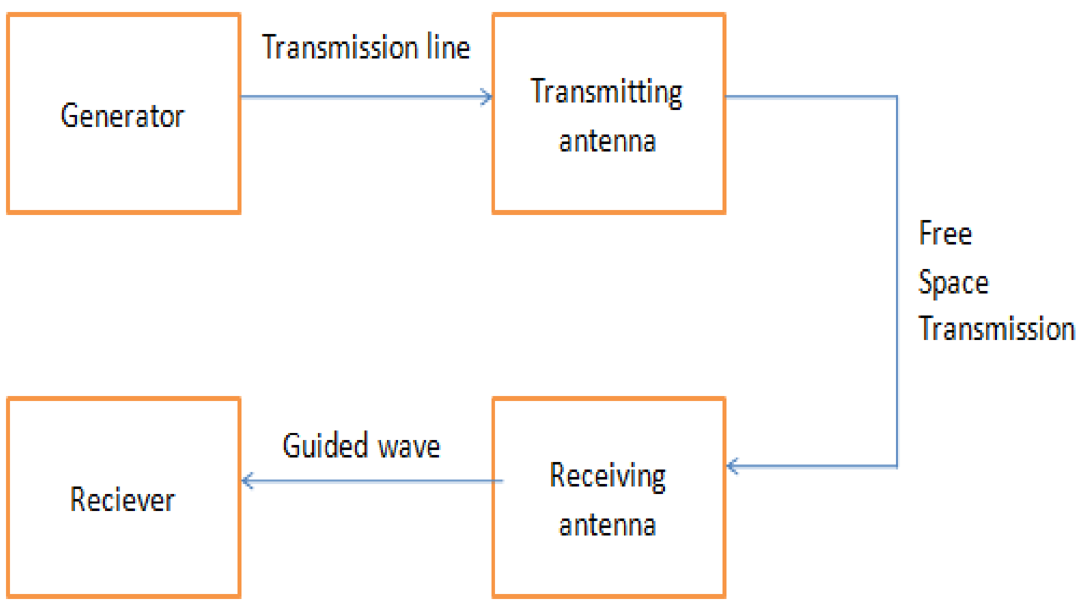


Fig. 1.1 Antenna as a transition device

1.2 TYPES OF ANTENNA

Antenna is categorized into different types depending on their characteristics and their usage. The following are the various types of antenna:

1.2.1 Wire Antenna

This is the most common type of antenna found almost everywhere in our day to day life ranging from the most common devices like mobile phones, automobiles to sophisticated devices like aircraft, spacecraft etc. Wire antennas can vary in shape. These can be helical, circular, rectangular, straight wire or loop-shaped. Most of the time circular shape of antenna is preferred due to its easy construction.

1.2.2 Aperture Antenna

Since with the advancements of technology there is demand for more sophisticated antenna with high frequency utilization, aperture antennas have gained a high importance. These antennas are widely used in applications related to aircraft and spacecraft due to their ability to be easily flush mounted onto the surfaces of aircraft or spacecraft. These can easily be protected from undesirable environmental conditions by coating them with dielectric material.

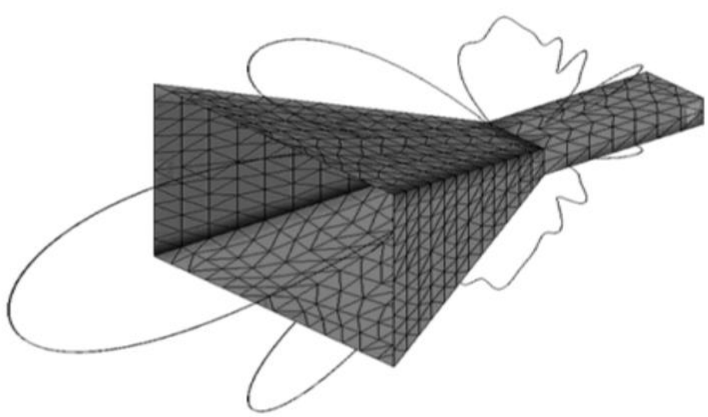


Fig. 1.2 Aperture antenna [8]

1.2.3 Microstrip Antenna

Microstrip antenna consist a patch of metal on a grounded substrate. The metallic patch of circular and rectangular configuration is most common. These antenna provide certain characteristics like low profile, inexpensive fabrication, robustness and exhibit versatility in terms of polarization, impedance and resonant frequency. This antenna is to find such a great importance in aircraft, spacecraft for providing high performance.

1.2.4 Array Antenna

Since single element in antenna is unable to achieve the desired radiation characteristics, so n number of elements are arranged electrically or geometrically to attain the required radiation characteristics. This is known as array antenna. Elements in an array are arranged in such a manner that each elements radiation either combine to give maximum radiation in particular direction or oppose each other to suppress the radiation in particular direction.

1.2.5 Reflector Antenna

As there were advances made in the technology and communication devices were driving importance, sophisticated antennas were required for long distance communication in order to communicate over longer distances in miles. These are referred to as parabolic reflector antenna. Since large distance needs to be covered so there is need of large diameter of about 305m. This leads to increase in dimensions of the antenna which are in turn needed for high gain for longer distance communication.

1.2.6 Lens Antenna

Basic purpose of a lens is to prevent the incident energy from spreading into undesired directions and focusing it into a narrow beam. This concept is used in Lens Antenna, whereby adjusting the geometry and choosing a proper material of lens, incident energy can be converted into plane waves. These antennas are used mainly for high frequencies as at low frequencies they acquire large dimensions and weight.

1.3 CHARACTERISTICS OF ANTENNA

It is necessary to know certain characteristics of the antenna to determine the performance of the antenna in order to be used for any specific application. These characteristics can either be related to each other or independent

1.3.1 Radiation pattern

Directivity, power flux density, polarization are some of the radiation properties of the antenna. The graphical or mathematical representation as a function of spatial coordinates of the radiation properties of the antenna is referred to as Radiation pattern. This can be represented in 2-D or 3-D. Radiation can either be amplitude field pattern which plots the electric field at the constant radius or it can be amplitude power pattern where power density's variation with respect to the radius is spatially represented.

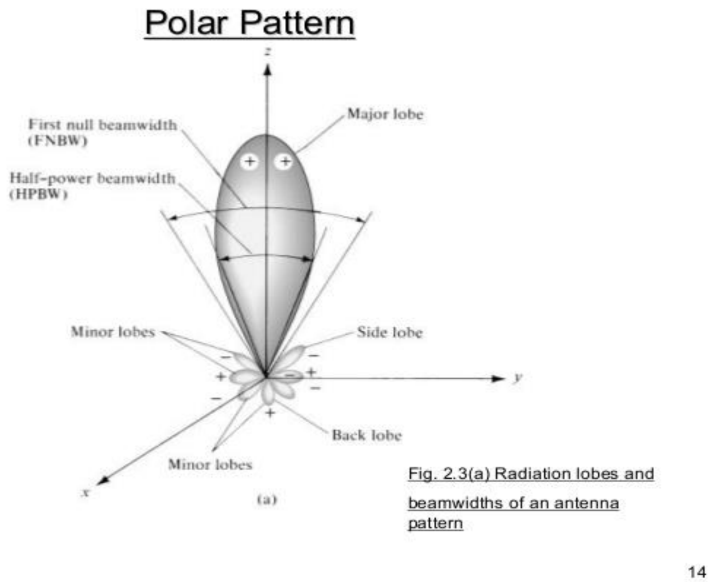


Fig. 1.4 Radiation lobes [8]

1.3.1a Radiation Pattern Lobes

A radiation lobe is defined as a part of the radiation pattern of the antenna which is bounded by regions of relatively weak radiation intensity. These are classified into four parts:

Major lobe: It is the lobe which specifies the direction where radiation is maximum.

Minor lobe: The lobe is considered to be minor if it occupies any part except for the major lobe. These produce the radiation in directions where radiation is not desired.

Side lobe: It is a lobe which radiates in any direction except the main lobe.

Back lobe: This is lobe which makes a 180-degree angle with the main beam of the antenna. It is kind of minor lobe which is opposite to the major lobe.

Side lobe level: This is defined as the ratio of power density in minor lobe to that of the major lobe. It must be low for some applications like radar to avoid false indications of the target by minimizing side lobe level. Less side lobe level results in radiation to be maximum at major lobe thereby increasing the directivity of the antenna.

1.3.1b Field Regions

EM waves exhibit different characteristics when generated by an antenna depending on the distance from the antenna. So the area around the antenna is divided into different zones in order to differentiate the properties exhibited by EM waves in different regions.

Reactive near field: In this region, electric and magnetic field are out of phase. This region is nearest to the antenna and surrounds it and is reactive in nature. Electromagnetic energy is completely stored here.

Radiating near field (Fresnel): This region lies between the reactive near field and the far field, with the increase in distance from the antenna, the electromagnetic field becomes less reactive, that is, some part of EM energy gets converted into radiation. The shape of radiation may vary with distance from the antenna.

$$R_2 = \frac{2D^2}{\lambda}$$

Far-field (Fraunhofer) region: With further increase in distance from antenna EM field is completely radiating and there is a negligible reactive field. Unlike Fresnel field, the shape of radiation does not vary with distance. In this case, electric and magnet field are in phase as well as orthogonal to each other.

1.3.1c Radiation intensity

Electromagnetic power is generated by EM waves. This radiated power has a variable magnitude which depends upon the distance from antenna and observation's direction. Therefore a normalized power density is required which is independent of distance from the antenna in the far field. This is referred to as radiation intensity.

$$U = r^2 w_{rad}$$

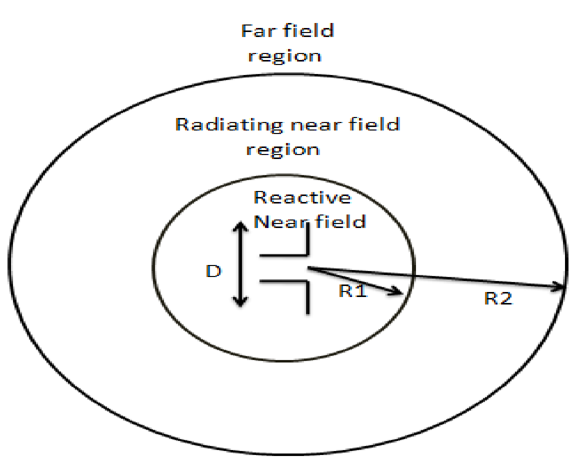


Fig. 1.5 Field regions

It can also be defined as power radiated by an antenna per unit solid angle. It denotes a far-field parameter. It is given by the equation.

$$P_{rad} = \iint_0^{\pi} U \, Sin\theta d\theta d\varphi = \iint U_0 dw$$

$$= U_0 \iint dw = 4\pi U_0$$

1.4 BEAMWIDTH

The beam width of a radiation pattern is defined as angular separation between the same points on opposite side of pattern maximum. It is an important parameter which follows inverse relation with the side lobe, that is, with an increase in beam width, side lobes decreases. The important beam widths are:

Half power beam width (HPBW): It is defined as the angular separation between two opposite points in the direction of the maximum beam where radiation intensity is one half the value of the beam.

First Null Beamwidth (FNBW): It is defined as the angle between the first nulls of the radiation pattern. The relation between the two beam widths can give by the equation:

$$HPBW = \frac{FNBW}{2}$$

1.5 DIRECTIVITY

The directivity of the antenna is defined as the ratio of radiation intensity in given direction to averaging of radiation intensity over all the directions. Its mathematical expression can be given as:

$$D = \frac{U}{U_0} = \frac{4\pi U}{P_{rad}}$$

$$\text{Dmax} = \frac{U_{max}}{U_0} = \frac{4\pi U_{max}}{P_{rad}}$$

The antenna which radiates in all directions have zero directionality and its directivity is one or 0 Db. The more is the directivity of the antenna, more it is focused or directional. However, the low directivity is desired in case of mobile phones as they have to pick the signal coming from any direction. But directivity must be high in case of satellite dish antenna as they have to receive signal only from a fixed direction.

TABLE 1.1 DIRECTIVITIES OF DIFFERENT ANTENNAS

Types of antenna	**Typical directivity**	**Typical directivity (dB)**
Shortwave dipole antenna	1.5	1.76
Half wave dipole antenna	1.64	2.15
Microstrip patch antenna	3.2-6.3	5 to 8
Horn antenna	10 to 100	10 to 20
Dish antenna	100 -10,000	20 to 40

1.6 GAIN

The gain of the antenna is defined as the ratio of intensity in a given direction to radiation intensity that is attained when power accepted by antenna was isotropic radiated. Gain is expressed as:

$$Gain = \frac{4\pi U(\theta,\varphi)}{P_{inc}}$$

Gain is more efficient in determining the performance of the antenna. Unlike directivity, gain not only determines the directional capabilities but also tells about the efficiency of the antenna. When directionality of antenna is not known, the gain is considered to be in the direction where there is maximum radiation. Gain does not take into account losses due to polarization mismatch and impedance mismatch.

1.7 ANTENNA EFFICIENCY

Efficiency is defined as the ratio of power radiated to incident power in percentage.

$$e_{ff} = \frac{P_{rad}}{P_{inc}}$$

Since the entire power incident to the antenna is not delivered to the receiver due to certain loses occurring in the transmission line. Efficiency can also be obtained by multiplication of sub efficiencies which include

Conduction efficiency e_c

Dielectric efficiency e_d

Reflection efficiency e_r

1.8 BANDWIDTH

Bandwidth is an important parameter of the antenna which specifies the range of frequencies in which antenna is capable of radiating or receiving energy inefficient manner. It is an important parameter to select an antenna for any specific application [13]. For instance, low bandwidth antennas cannot be used for wideband operations. It is given by the equation:

Bandwidth=f_h - f_l

Where, f_h=Highest frequency component

f_l= lowest frequency component

Bandwidth can be characterized by VSWR or polarization. For instance, an antenna may be highest operating at 125-400 MHz having VSWR<1.5. This means that reflection coefficient is 0.2 for the specified range, that is, out of the total power delivered to the antenna, only 4% is reflected back. But this does not mean that 96% is delivered to the antenna, there are some losses which need to be taken into account.

1.9 VSWR

VSWR stands for Voltage Standing Wave Ratio which is the measure of total power reflected. VSWR should be as low as possible which means that almost all the incident power is delivered to the antenna and there is no reflections or standing waves created. VSWR for ultra-wideband antenna is shown in the figure below in 1.5. The VSWR is always a real and positive number of antennas. The smaller the VSWR is, the better the antenna is matched to the transmission line and more power is delivered to the antenna.

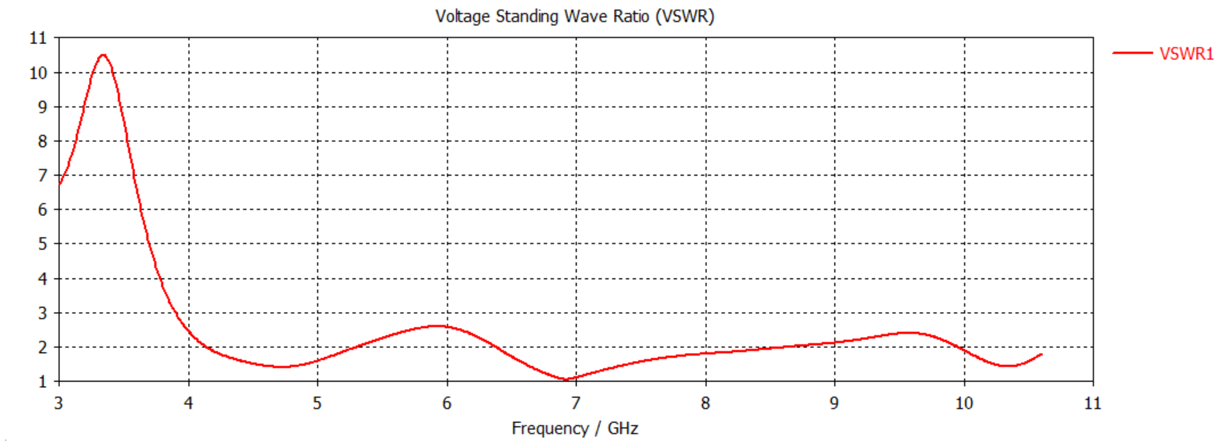


Fig. 1.6 VSWR plot

CHAPTER 2

TERMINOLOGY

- **Bandwidth (BW):** It is defined as the frequency range within which the antenna is capable of transmitting the information in the form of waves. In case of UWB antenna, the bandwidth ranges from 3.1-10.6 GHz.
- **Co-planar waveguide (CPW):** It is a form of a transmission line which acts as a conductor and lies above the dielectric material, between the ground plane. The patch, ground plane, and feed line lie in the same plane thereby producing compactness and it is relatively easy to fabricate.
- **Federal communication commission (FCC):** It is a regulatory body in order to regulate communication-related to satellite, wire, television, radio, and cable in the interstate overall of the 50 states. It has its headquarters in Washington, USA.
- **CST microwave studio:** It is a tool which is used for 3-D simulation of various components like antennas, filters, couplers etc. It provides various modules like current distribution, far-field pattern, Gain, directivity etc.
- **Vector Network Analyser (VNA):** It is a tool which is used for testing radio frequency and microwave frequency devices performance in terms of scattering parameters. This device is available in antenna labs and is used for viewing the performance of the antenna.
- **Gain (G):** This antenna parameter depicts how effectively the input power into antenna is headed in a particular direction. It is expressed in dB.
- **Band Notching:** It is a method where a specific range of frequencies is "notched" or "removed" from the overall operating band. In antenna design, this can be attained by use of filters, additional circuits or introduction of slots.
- **Slot:** A long or shortcut that is embedded into the antenna in order to attain band notching or to enhance the antenna parameters.
- **Stub:** It is a form of the transmission line which is attached on the one side and the other side is not connected to anything.

- **Impedance bandwidth:** This is defined as the range of frequencies over which there is good impedance matching and the VSWR is less than 2 such that the input power is completely transferred with minimum losses.
- **Return loss or S11 parameter:** This parameter defines the power which is reflected back. For instance, if S11=0 dB, the power is completely reflected back.
- **Photoengraving:** This is a process which uses some sort of photoresist which is sensitive to light and acts as a mask to protect certain areas while UV-exposure, which etches the unmasked areas. This process is followed while the fabrication is carried out.
- **Patch:** The radiating surface of the microstrip antenna is called a patch. It can be of any shape, most common being circular, square and elliptical.
- **Voltage standing wave ratio (VSWR):** It determines the standing waves present while transmission or in other terms it tells the amount of power reflected back. Lower values are preferable. In UWB antennas, VSWR<2 is desirable.

CHAPTER 3
MICROSTRIP ANTENNA

3.1 INTRODUCTION

Ultra Wideband technique is of utter importance and gaining prominence in the recent years due to the wideband it offers as well as high data rates for communication over a short range. It is a form of microstrip patch antenna except for the wideband it provides. Federal Communication Commission has allotted frequency spectrum ranging from 3.1 GHz to 10.6 GHz as an unlicensed range for use in commercial applications. Primarily it was designed for use in military and RADAR applications. But with increasing demand for higher data rates by the users, ultra wideband had gained great importance in the present era. First ultra-wideband antenna was proposed by Oliver Lodge in the year 1898 in the various shapes of dipole like spherical dipoles, rectangular dipoles. The major requirement for the design of UWB antenna is to have an omnidirectional pattern for the purpose of mobility of user as well as to provide freedom for setting up of transmitter and receiver at any location.

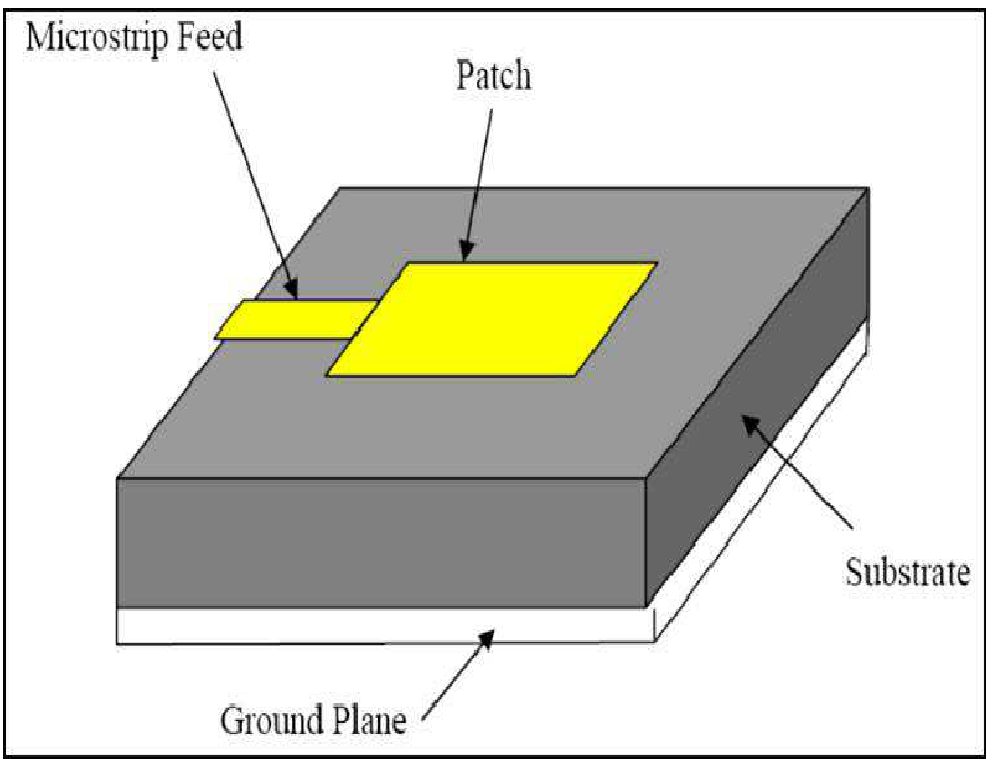


Fig 3.1 microstrip antenna [8]

3.2 CHARACTERISTICS OF MICROSTRIP ANTENNA

Microstrip antenna consists of a metallic patch embedded on a ground plane. Designing of the microstrip antenna is chosen such as it provides a maximum pattern in a direction normal to the patch. This can be achieved by choosing a proper method of excitation beneath the patch. Another important characteristic which must be considered during the design of the antenna is dielectric constant which is in the range of 2.2 to 12. Thick substrates provide better performance since they provide better efficiency, large bandwidth; radiation into space is loosely bound. But this, in turn, increases the size of the element. So a lower valued substrate is chosen which results in small element size and tightly bounded fields in order to reduce undesired radiation [11] and coupling but have small bandwidth and low efficiency.

The quality factor (Q) of the microstrip antenna is very large. Q represents the loses associated with an antenna. With the increase in the value of Q, efficiency decreases and bandwidth becomes narrow. Q can be decreased by increasing thickness of substrate which leads to increase in size of the antenna. Not only this, increase in thickness of substrate leads to delivery of total power from the source to surface waves. This results in unwanted power loss as all this power is scattered at bends and leads to degradation of characteristics of the antenna. Now to calculate length and width of microstrip patch the following equations are used:

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

W=width of patch

ε_{reff}=effective dielectric constant

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

l_{eff} =length of patch

$$L = Leff - 2\Delta L.$$

3.3 ADVANTAGES

Microstrip antenna has a simple 2-dimensional geometry which makes it design relatively easy to manufacture and inexpensive in nature. The wavelength at resonant frequency decides the size of the antenna so they work ultra-high frequency or higher frequencies. These provide a very high directive gain of 6-9dBi. Lithographic techniques help to print patch of arrays. Patch arrays can provide even greater gain than single antenna but more cost is involved in it and it requires separate matching circuits with printed microstrip feed structures.

Microstrip antenna is used for various embedded devices like handheld devices like mobile phones owing to the low profile property they exhibit. Other advantages of microstrip antenna are:

- Low weight and volume
- Ease of fabrication and implementation
- Mechanically robust when mounted on rigid surfaces
- Provides polarization diversity
- Helps in easy integration with microwave integration circuits

Major advantages like high gain, ease of conformity and low back radiations made microstrip antenna to be widely used in wireless communication as compared to a wire antenna.

3.4 DISADVANTAGES

Like the two sides of a coin, despite providing numerous advantages, there are even some demerits which are produced by microstrip antenna. Following is the list of disadvantages due to the design of microstrip antenna:

- Low gain
- Narrow bandwidth
- Presence of conduction and dielectric loses results in relatively low efficiency
- Feeds and junctions provide extra radiations
- Excitation of surface waves
- Low power handling capacity
- Feeding structure in case of arrays results in large ohmic loses
- high cross-polarization radiations

3.5 FEEDING TECHNIQUES

Various feeding techniques are used to feed the antenna elements. It can be broadly categorized into contacting and non-contacting methods. Connecting element such as a microstrip line is used to directly feed the radiating patch with RF power in case of contacting method. In the non-contacting method, the process of electromagnetic coupling is used to deliver power to a radiating patch of the microstrip antenna.

3.5.1 MICROSTRIP LINE

This is a contacting method to feed antenna element. A narrow strip is directly connected to edge radiating patch of the antenna. The width of the conducting strip is small as compared to microstrip patch. This gives the advantage of attaining a planar structure as the strip can be etched on the same surface where the patch is present. The inset cut is made to match the impedance of feed line to the microstrip patch without the use of any additional matching circuit. So the position of inset cut be adjusted accordingly

ADVANTAGES

- Planar structure.
- No additional matching circuit required so its designing is simple.
- Ease of fabrication.

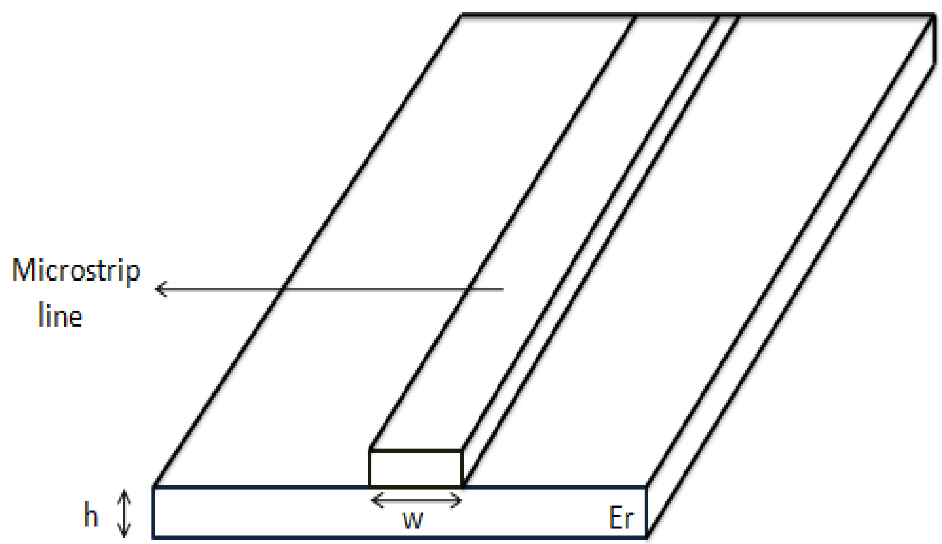


Fig 3.2 Microstrip line

3.5.2 COAXIAL PROBE

It is a form a contacting method as power delivered is via direct connection with microstrip patch. It consists of two conductors, inner and outer conductor. The inner conductor of the coaxial connector extends through the dielectric substrate and gets connected to radiating patch. The outer conductor on the other side connects the ground plane.

ADVANTAGES

- The coaxial conductor can be placed anywhere inside the microstrip patch so as to match the impedance patch.
- Easy to fabricate.
- Low spurious radiations.

DISADVANTAGES

- Modelling is difficult as a hole must be drilled into the substrate and the connector extends from the ground plane, thereby, making the structure nonplanar for thick substrates narrow bandwidth.
- In case of thicker substrates, the matching problem takes place due to increase in the length of the probe which makes input impedance more inductive.

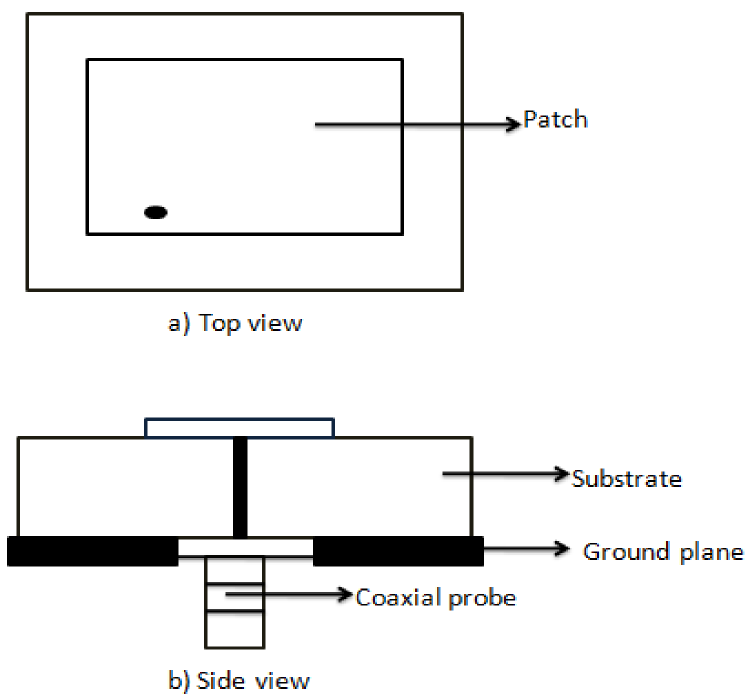


Fig 3.3 Coaxial feed

3.5.3 APERTURE COUPLING

This is a non-contacting method of feeding which involves the usage of two substrates which are separated by the ground plane. A slot or aperture is made in the ground plane in order to provide coupling between patch and feed line. Shape, size, and location of aperture decide the amount of coupling between the patch and the feed line. In order to get optimum radiations, the low dielectric material is used for the top substrate and the high dielectric material is used for the bottom surface.

ADVANTAGES

- The symmetry of configuration is acquired due to the presence of coupling slot under the microstrip patch which results in lower cross-polarization.
- Due to the presence of ground plane between the two substrates, spurious radiations are reduced

DISADVANTAGES

- Multiple layers lead to increase in thickness.
- Fabrication is difficult and narrow bandwidth.

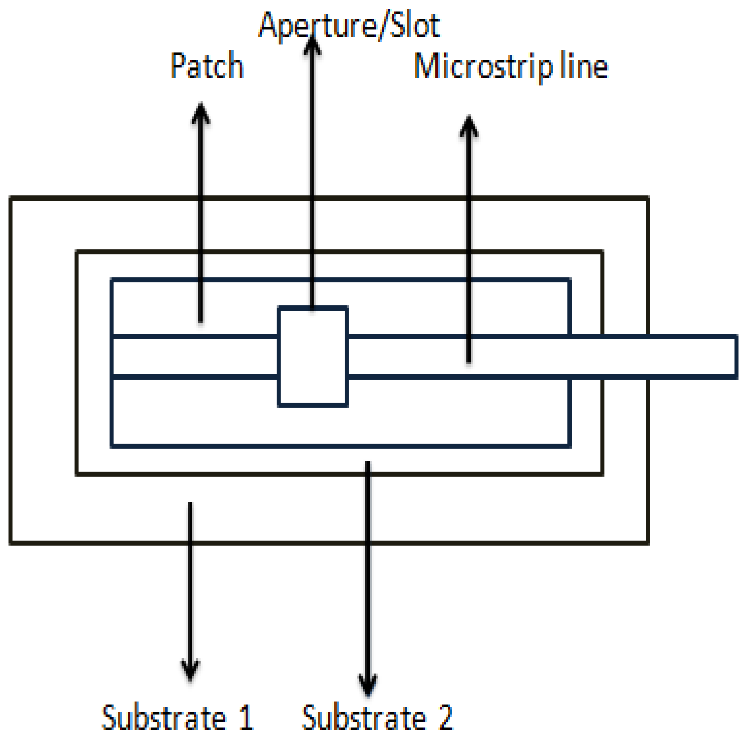


Fig 3.4 Aperture coupling

3.5.4 PROXIMITY COUPLING

This is also known as electromagnetic coupling method and is a non-contacting type. In this method, two substrates are placed one above another where feed line is between them and the upper substrates surface contain the radiating patch. Matching is obtained by controlling length of the feed line and width-to-line ratio.

ADVANTAGES

- High bandwidth.
- No spurious feed radiation due to increase in thickness of microstrip patch antenna.

DISADVANTAGES

- Increase in thickness of antenna.
- Since two dielectric substrates require proper alignment, fabrication is difficult

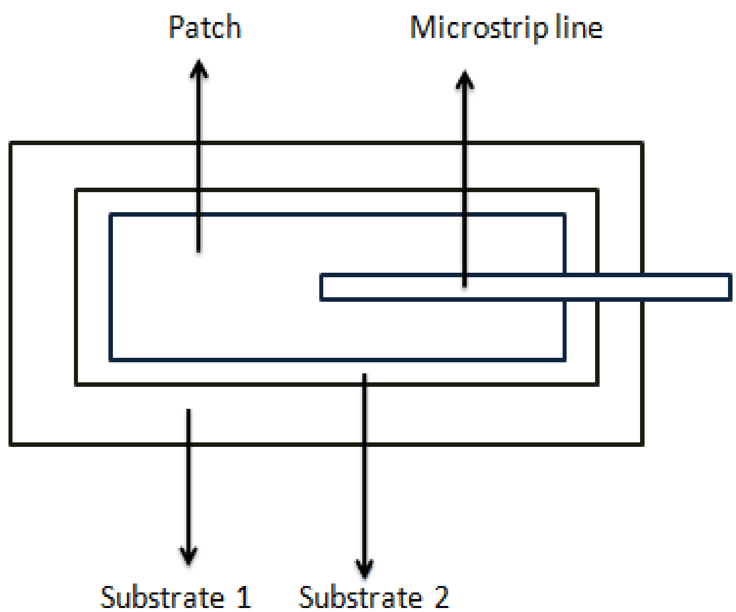


Fig. 3.5 Proximity coupled feed

CHAPTER 4

ULTRA-WIDEBAND ANTENNA

4.1 INTRODUCTION

Ultra-wideband (UWB) is a structure of microstrip antenna with a radiating patch over a ground plane which can have planar or non-planar structures. Several antennas have been proposed in recent years but planar antennas have gained high significance due to low fabrication expenditure, low profile, wide bandwidth and high radiation efficiency. UWB antennas are gaining prominence and becoming extremely attractive in contemporary and future wireless communication systems, generally due to two factors. Initially, people increasingly high demand for the wireless transmission rate and UWB properties such as high data rate, low power consumption rate and low expenditure, which give a huge boost to the UWB antennas' research.

Ultra Wideband technique is of utter importance and gaining prominence in the recent years due to the wideband it offers as well as high data rates for communication over a short range. Federal Communication Commission has allotted frequency spectrum ranging from 3.1 GHz to 10.6 GHz as an unlicensed range for use in commercial applications. Primarily it was designed for use in military and RADAR applications. The first ultra -wideband antenna was proposed by Oliver Lodge in the year 1898 in the various shapes of dipole like spherical dipoles, rectangular dipoles, and bow-tie. The major requirement for the design of UWB antenna is to have an omnidirectional pattern for the purpose of mobility of user as well as to provide freedom for setting up of transmitter and receiver at any location.

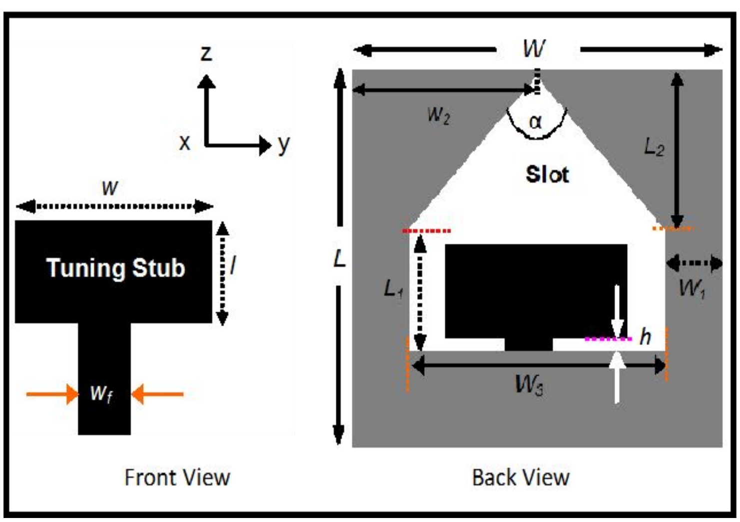


Fig 4.1: UWB Antenna

4.2 CHARACTERISTICS OF UWB SYSTEMS

The two major reasons for the use of ultra-wideband reasons is the people's increasing demand for higher data rates in the recent years as well as low power transmission required for ultra-wideband. For these systems, UWB antennas are required. The following are the major characteristics of ultra-wideband antenna:

• **Large bandwidth**: Since Federal Communication Commission has provided frequency spectrum ranging from 3.1 to 10.6 GHz, so a wider bandwidth is available for use. It exceeds 500 MHz or has minimum 20% of the central frequency.

• **High data rates**: Ultra-wideband technology results in higher data rates for short-range communication which is 150 Mbps for 30 feet (10 m). This property can be explained via the Shannon capacity theorem which is given as:

$$C = B\ log2\ 1 + SNR$$

Here C=capacity

B=Bandwidth

SNR= Signal to Noise ratio

Now in the above equation capacity is in direct relationship with bandwidth. So with the increase in bandwidth, capacity increases which results in an increase in data rate. Since ultra-wideband provides wider bandwidth, thereby it provides high capacity in accordance with above equation.

• **Short pulse transmission**: In comparison with the conventional narrowband systems like 802.11a, Bluetooth where information was transmitted in the form of sinusoidal waves, here in case of ultra-wideband technology, information is transmitted over a channel in the form of pulses of very short duration. This makes them suitable for providing very fine time resolution.

•**Low power transmission**: Power is a major constraint while the design of any system for the wireless application. But ultra-wideband requires power for transmission of data less than1mW. This causes the battery life to last longer. As a result of this, UWB technology can be used for wireless applications where replacement of the battery is not possible and this technology can operate for a longer duration due to low power consumption.

4.3 USE OF UWB ANTENNA IN UWB SYSTEMS

Ultra-wideband antenna, also known as an ultra-band antenna, operates on a wide bandwidth ranging from 3.1 to 10.6 GHz. The major use of Ultra-wideband system is in wireless communication as it provides no line of sight communication, i.e., it can penetrate through doors and walls. It is a major advantage for its use as wireless communication systems are preferred if they provide a same range in the room of its location as well as the next room instead of a system which requires the installation of a transmitter in each room. Another reason for use of UWB systems is its short range communication as it is capable of transmitting a large amount of information across a wider range of frequency. Moreover, power in the order of -41.3 dBm/MHz is required as the signal is sent in the form of short pulses thereby reducing the effects of interference. In other words, the amount of energy required for transmission is less for providing internet access, video telephony, and digital voice services

TABLE 4.1 MERITS AND BENEFITS OF UWB SYSTEMS [8]

S. No.	Merits	Benefits
1	Reduced multipath issues	High-performance capability in adverse conditions
2	Less power requirement	Highly secure with very less probability of detection
3	Works with even low signal to noise ratio	Makes it useful for noisy environment
4	Capacity of channel is high	Provision of high data rates by UWB makes it useful in wireless personal area networks
5	Resistance to jamming	Highly reliable
6	Simple design	Facilitates low power
7	Coexistence with current narrow and wideband systems	No requirement of license

CHAPTER 5
MICROWAVE IMAGING

5.1 Introduction

The rapid development of sectors using microwaves and radio frequencies brought huge changes in our daily life today, particularly in telecommunications and medical applications. Microwave imaging is one of the most illustrating examples of both industries, military and medical applications whereas monitoring, tracking and screening are needed. However, it cannot be utilized without the use of the antenna. So antenna is considered a key element in microwave imaging systems where electromagnetic energy is transmitted and/or received. Although the microwave techniques do not necessarily replace the better and same capabilities than x-ray, CT scan MRI, bronchoscopy etc. provide diagnosing techniques with low cost. As in the table, some factor has been compared as per modality, cost, complexity, and the resolution.

TABLE 5.1 Comparison of some imaging methods

Modality	**Cost**	**Complexity**	**Resolution**
X-ray	Moderate	Moderate	Low
PET	High	High	Low
Gamma camera	Moderate	Moderate/high	Moderate
MRI	High	High	High
Ultra sound	Moderate	Moderate	Moderate
IR	Moderate	Moderate/high	High
Radiometry	Low	Low	Low

5.2 Microwave Imaging Methods

Microwave methods according to Fear et al [20] defined microwave imaging as “seeing the internal structure of an object by means of electromagnetic fields at microwave frequencies of 0.3-30GHz. Microwave imaging techniques are broadly classified into three are active, passive and hybrid techniques.

Active technique: In this, the low power signal is transmitted using sets of antennae then broad scattered through the imaged tissue are used to form an image. Examples are tomography, holography, and UWB pulsed radar imaging techniques.

Passive technique: In passive, the maps are constructed based on the temperature. the cancerous tissue is most active and hosts normal tissues so they lose the thermoregulatory which means the organism to keep its body temp within certain boundaries even if the surrounding is different, so this is basically used to construct the image and this technique is a radiometer process called as radiometry.

Hybrid technique: in this technique when the microwave is used to heat up tissue pressure wave which is generated through the expansion in the heated tissue. The ultrasound transducer can detect from pressure wave. The energy is deposited in the tumor cell as compared to the normal cells as a result image is formed

5.3. Principle of MRI

The imaging technique of microwave used in the distribution of signals from an object, when it is illuminated by an electromagnetic signal. The signal broadcast by an object depends on several factors, including the environment, the signal strength, and material properties. For a source data signal, the broadcast signal depends on electrical characteristics of the equipment, particularly the dielectric constant and conductivity. This principle is used to detect tumors in the breast using microwave signals. Breast tumors have very different electrical properties (high dielectric permittivity and higher conductivity), which can be detected by analyzing the broadcast signals. The amount of signal transmitted from a breast tumor is higher than that of normal breast tissue. It may be well received by an antenna localized or modification of these emission properties due to broadcast signals can be analyzed and used for the detection of tumors.

5.4 Evaluation of Microwave Imaging System

To treat patients with brain tumors without the use of neuroimaging is impossible to imagine. From this reason, researchers do efforts to develop neuroimaging modalities for selecting and developing an appropriate therapy, detecting early treatment failure, and providing accurate and clinically relevant biologic endpoints for high-risk, but potentially hitherward, and tumor-specific therapies tailored to the unique biology of an individual brain tumor. Magnetic resonance imaging (MRI), positron emission tomography (PET) and computed tomography (CT) are commonly used as modalities for neuroimaging since those techniques provide accurate and high-resolution results. However, the cost of MRI, PET or CT scanner is relatively still expensive, particularly in developing countries with a high population like Indonesia. In addition, the complexity of MRI, PET or CT equipment also becomes another issue for implementation in rural and isolated areas

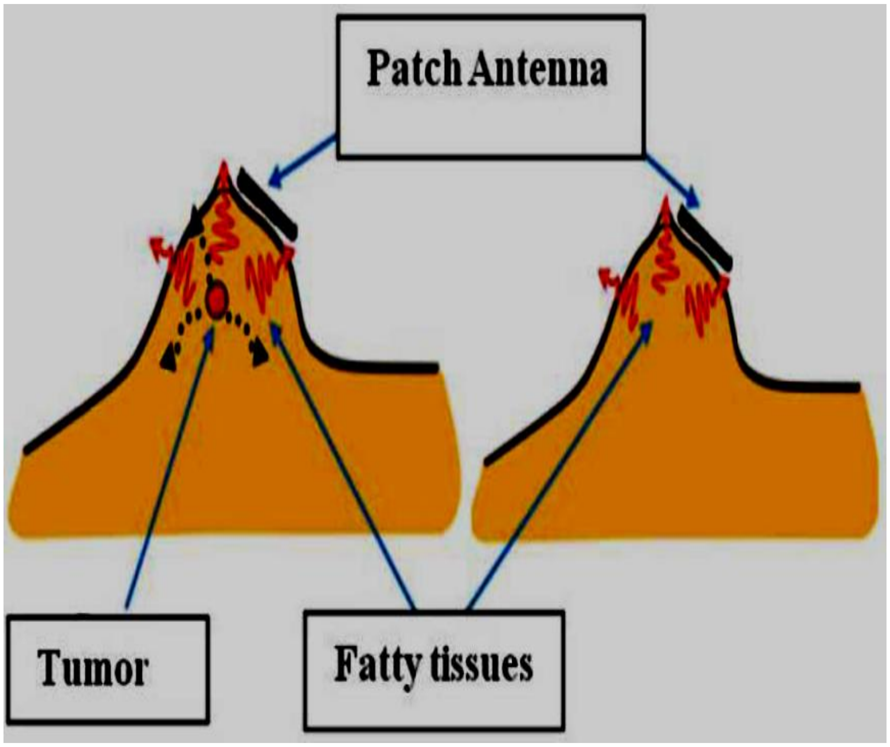


Fig5.1 Schematic representing breast, a patch antenna and tumor showing signal broadcasting. (a) With breast tumor. (b) Normal breast.

.

5.5 Fast Imaging for Security Systems using Ultrawideband Radar

Protection of civilians from terrorist threats has become a high priority in society. Because terrorists are developing increasingly sophisticated schemes to circumvent public space screening, there is a need to implement enhanced security in public areas and at airports. Radar imaging is a key element in these efforts because the method provides crucial abilities such as accurate ranging, concealed object classification via imaging and penetration through clothing and walls. Radar imaging has been applied for security purposes to the indoor tracking of people.

Unlike X-rays, radar waves do not pose health risks because they do not ionize human tissue while providing reasonable spatial resolution and penetrability. In contrast, microwave and millimeter-wave radar can be realized using relatively low-cost devices, and they have both penetration capability and sufficient spatial resolution for weapon detection. In many radar imaging applications, including body scanners, the F-K (frequency-wavenumber) migration has been commonly used, because it offers reasonable resolution and fast computation when using a fast Fourier transform (FFT) algorithm. For a moving target, however, the imaging process must be performed numerous times. Because the computational speed of the F-K migration is restricted by the speed of the FFT, it is, therefore, necessary to introduce a completely different approach that does not use an FFT. Methods of fast imaging are as follows

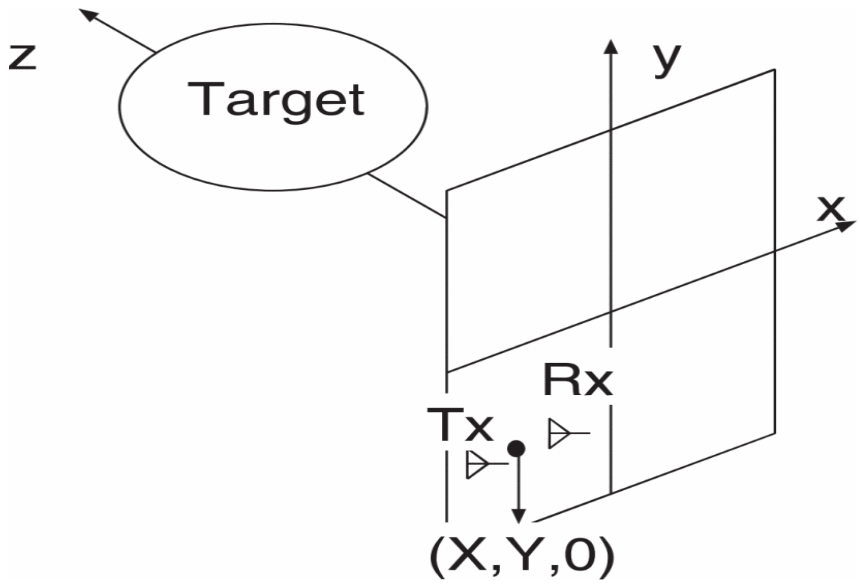


Fig. 5.2 System model with pair of antennas from (z=0) plane [25]

5.5.1 SEABED method AND bi-static IBST: This section explains the bi-static-IBST that describes the mapping from the target range to a target surface image. This transform has been used in an imaging algorithm called SEABED, which is known to be fast in imaging single simple-shaped targets. In SEABED, we first extract peaks from received signals using the criteria.

5.5.2 RPM method

The RPM has been developed to mitigate difficulties with SEABED. This method was designed to optimize an evaluation function for estimating the direction of arrival of an echo. The RPM uses numerous signal peaks in this optimization process for calculating stable images. In this section, we describe the RPM using the bi-static IBST. First, we define a weighting coefficient for a pair of peaks satisfying $S_i\ S_j\ > 0$

5.5.3 Proposed RRPM method

In this section, we propose a revised version of the RPM, called the RRPM. Although the RPM has been demonstrated to be efficient in imaging even complex target shapes, the method sacrifices the processing speed. Because the optimization process of the function it is time-consuming, we replace this process by weighted averaging. In the RPM, one must perform the following optimization to estimate the optimum $\theta = \theta_i$.

5.5.4 Millimeter-Wave Imaging

Microwave and millimeter-wave (MW and MMW) imaging techniques have been extensively used for nondestructive testing and evaluation of materials and structures. The advantages of these techniques include the ability of their MW and MMW signals to penetrate inside materials. However, the selection of operating frequency depends on the electromagnetic properties of the material under test, and in many cases, there is a tradeoff between the resolution of the techniques and penetration depth, and between operating frequency and dimensions of antennas used in these techniques. In practice, detection of flaws in materials and structures requires antennas to operate at wide frequency bandwidth to achieve high-range resolution.

5.6 Oil pipeline imaging

A crude oil pipeline imaging to study the corrosion, microwave holography for tissue imaging, and monitoring the subsurface conditions of different objects. The critical requirement for pipeline inspection using radar imaging is antenna needs to be operated in crude oil of dielectric constant 2.5, and the size of the antenna should be as small as possible. Recently, many antenna designs have been reported to satisfy the wideband operations.

A novel design of coplanar waveguide (CPW)-fed monopole antenna that can operate in crude oil with enhanced bandwidth and miniaturized dimensions is presented. The antenna can be easily fit into a pipeline without obstructing the flow of the liquids. The antenna is also able to provide seamless operation in crude oil.

5.6.1 Future application: ARM Imaging

The results shown in the “Imaging Evaluation” section indicate that the UWB eight-element array shows promise as a microwave imaging device and could potentially be used to image biological tissues within the human body. Microwave imaging of the upper and lower limbs has been of recent interest and results have highlighted that the modality could be used for continuous monitoring of forearm bone health. To explore this, a number of realistic phantoms must be created prior to any clinical imaging application. This section describes on-going research to create a number of 3-D-printed, magnetic resonance imaging (MRI)-derived forearm phantoms that in future investigations will provide measurement data for the proposed array.

The human forearm has a significant variety of anatomical features, but the bones (the radius and ulna) present with a high vertical symmetry. As a result, an initial 3-D-printed forearm phantom was created with symmetry along the vertical axis, and it is referred to herein as the two and a half dimension (*2.5 D*) phantom. Manual segmentation is applied to a cross-sectional MRI image taken approximately 50 mm from the wrist, shown in Figure 17, using 3-D computer-aided design modeling software (Rhino3D). Four different tissues are manually identified: muscle, bone, adipose (fat), and blood vessels. Tendons, different bone anatomy (cortical bone, cancellous bone, and marrow tissue), and cartilage have not been taken into account at this stage. The segmented two-dimensional cross-section is extended along the vertical axis to create the 2.5-D model.

CHAPTER 6

REVIEW OF LITERATURE

This chapter provides the overview regarding the "ultra-wideband" antenna. Out of the papers read by me, some of them are represented below. All the papers presented below are from various journals and conferences both national as well as international.

Abbosh et al. [1] a high dielectric substrate of size 13mm by 26mm, the return loss is 10 dB return loss and the bandwidth from 3GHz to greater than 15GHz and the radiation efficiency is higher than 10° .The gain is in between 0.8- 5dB for the frequency 3-15 GHz. The radiation pattern is omnidirectional and efficiency is more than 90% and its objective is to reduce the efforts and the time needed for error and trial strategy by the other papers.

Abedin et al. [2] in application of time reversal MUSIC algorithm for microwave imaging in the early breast cancer by using UWB antenna signal. Breast is considered as a two dimensional and the medium is homogeneous lossy dielectric medium. For finding the image of the malignant tissue in a crowded environment is built by backscattering. The time reversal MUSIC technique is applied to the output of the receive antenna array to determine the location of malignant tissue by making use of dielectric contrast at microwave frequencies. Usually, identification of target tissue within the clutter is a challenging problem, their diameters are considered in the range from 0.1-0.5cm. The images for breast model can be calculated from time reversal MUSIC algorithm.

Jafari et al. [3] a compact size antenna $30mm$ ×26mm for cancer detection operate in lossy coupling medium fed by 50 CPW, the antenna base has tapered to a semicircle radiating element length is set for lowest operating frequency when square monopole antenna is placed on ground plane, as it achieves good impedance matching ranging from 3.4-9.9 GHz and operate in coupling medium. The return loss is less than 9.6 dB and this proves UWB antenna is efficient for human body.

Wang et al. [4] the main purpose is through wall imaging are mostly short pulse system, using SAR or antenna technology good azimuth is obtained. Its major advantage is diversity, radio frequency interference effects or less probability of interception. When the object is wall material is concrete and size is 0.2m (thickness) then dielectric constant ε_r=4.5 and conductivity is 0.03S/m in other case object is human and material is 80% water and size is $0.2m \times 1.65m$ (body radius

×height) then dielectric constant $\varepsilon_r = 50$ and conductivity is 1S/m. The overall size is 5m ×4m× 3m and the frequency range is from 350-750 MHz For each model, imaging result is obtained using back projection algorithm after cross-correlation processing of every received echo with the transmit noise signal.

Xia et al. [5] to improve the low-frequency performance, resistive loads are added as the antenna shows a low return loss ranging from 1-12 GHz of wide frequency range when the resistance is 1000Ω.return loss is 10 dB as operate in the wide bandwidth of about 11 GHz. To improve the performance at low-frequency feedback loops have been added and to reduce the end reflection resistive feeding was used for microwave radar imaging.

Kidera et al. [6] UWB pulse radar as an advantage over optical ranging techniques is applicable to the hard optical environment like strong backlight, dark fog.as SAR(Synthetic Aperture Radar) algorithm use multiply scattered waves whose aim is to enhance the reconstructible region including the shadow of target boundary. So the extension of array antenna model algorithm is used and it enhances the visibility of the target surface without knowing the shape of the target or prior observation of surrounding. The antenna used is omnidirectional and the imaginary range is improved with large real aperture size, especially when multiple SAR method is used. This antenna is proposed for shadow region for a difficult target even though the baseline is same for both conventional and proposed model.

Abbosh et al. [7] a planar antenna array include 6× 2 UWB antenna elements $22\times 40mm^2$ are compact corrugated slot antenna. There is space limitation in breast imaging environment so to make the antenna compact a corrugation technique is applied. The substrate used is Rogrers RT6010 and a return loss is more than 18 dB. Mutual coupling between any pair of antennas is less than -25dB for good performance.

Ojaroudi et al. [9] antenna consist of the ground plane and square radiating patch with a pair of E-shaped slots and a rectangular slot with a pair of horizontal T-shaped strips protruded inside the slot, bandwidth of more than 120% (2.97–12.83 GHz). This antenna has ordinary Square radiating patch, even at high frequencies the radiation pattern is omnidirectional, and its radiation efficiency is greater than 86% and having compact size of $12\times 18mm^2. The$ return loss satisfy 10 dB requirement××s from 2.92-12.83 GHz. Insert a rectangular slot with two horizontal T-shaped strips protruded inside the slot in the ground plane to enhance the bandwidth.

Latif et al. [10] an elliptical monopole antenna is designed for biomedical imaging application and operate at 2-9 GHz, a coupling medium canola oil is used for the permittivity of 3. Breast phantom material is glycerine whose $\varepsilon_r = 9,$ the substrate used is FR4 (ε_r = 3.9, h = 1.57 mm) this antenna shows -10 dB matching from 2-12 GHz. At higher frequencies antenna is typically omnidirectional but for this application directional property is desired like directional performance will be sought using slots on the reflector at the back. The directional property of this antenna will be improved when it can be used as radar based imaging system.

Sugitani et al. [12] A compact 4×4 planer UWB antenna array with overall size of $44\times 52.4mm$ for breast cancer detection development for radar based, the bandwidth of this antenna is 12.5 GHz and centre frequency is 6 GHz respectively. By using the breast cancer the quasi-three-dimensional confocal imaging is performed. It was confirmed that 4×4 compact planer UWB antenna could detect a tumour in an inhomogeneous structure with glandular layer was 2.94 dB and in homogenous phantom the glandular layer was 4.08 dBi respectively target for SCRs and also resolve two separate tumour which is located at 23mm of depth with 10mm of spacing.

Brovoll et al. [13] radar system of the human heart is observed as the antenna is placed very near to the body and the radio wave is penetrated. The relative bandwidth is 1.52 GHz and the frequency range is from 0.75-2.27 GHz. As the layer model is concerned there are four cases first when the skin layer is 2mm the relative permittivity is 39.6, when the fat tissue is under 13mm relative permittivity is 5.4, in third cases when muscle tissue is concerned under the layer 10mm the permittivity is 54.0 and in last case bone tissue under the layer 25mm the relative permittivity is 2.60. The radar system presented the parameters and their trade-offs is a good basis for further development of UWB medical radar system and circuits for heart imaging.

Bah et al. [14] designed a BAV antenna (Balance Antipodal Vivaldi) having good impedance matching, versatile antenna, low cross polarisation and minimised coupling is achieved. As BAV antenna is operating in 2 different frequencies one is from 0.75-3.32 GHz and other at UWB antenna, as the substrate is FR4 whose height is $122\times 150 \times 1.2mm^2$and permittivity is 4.6. If the size is larger than 10cm then reduction is very challenging. The results obtained have good impedance matching, high gain and low cross polarization. This antenna employs for cancer detection and use in microwave imaging to detect and cure the tumour without touching the human body.

Pratama et al. [15] brain tumour detection as it operates in UWB antenna and this proposed antenna is a coplanar waveguide fed by a printed dipole as it provides high frequency response. The size of antenna is $30\times 25\, mm^2$which is very small and having low cost, for simulation antenna is placed at 5mm over a head equivalent phantom, as the permittivity of head phantom is 34.93 and conductivity with 35mm thickness of phantom with the peak gain approximately 0.73 dBi.

Basari et al. [16] UWB dipole like antenna based on back projection algorithm work on frequency 5.8 GHz antenna is CPW fed as the size of antenna is 30mm×25mm which is a compact size fabricated on FR4 substrate. The peak gain is approximately 0.73 dBi, the outer and inner layer permittivity is 51.4 and 83.07 and the operating frequency is 5.8 GHz than the images is successfully reconstructed and figure out by pixel histogram.

Bellarbi et al. [17] the flexible antenna is operating in S band having bandwidth 2.4 GHz with the centre frequency around 3GHz; the effect of S parameters response to inhomogeneous multi-layer model of breast is used. The overall size of antenna is 20mm×20mm suitable for radar based breast cancer. CPW (Co-Planer Waveguide) having impedance 50-Ω over the frequency 2-4 GHz. Gain is almost around 2 dB in the frequency below 4 GHz and at 3 GHz directivity is about 2.56 dBi suitable for microwave thermography. Further an enhanced bandwidth was provided when antenna was embedded with multiple-layer model of breast tissue. As per the performance the candidate can investigate to construct low cost, weight and size thermography for early breast tumour detection.

Mukherjee et al. (2016) [19] it presents a time reversal technique for target detection and localization applications using far field microwave measurements in reflection mode. The TR technique had been successfully applied for source focusing in transmission mode. Detection of source, single and closely spaced multiple targets at long ranges (~ 3:5 m), with a highest detection error of 5% and lowest imaging quality of 16 dB have been achieved. A limited angular coverage of 40° and 20 sensor elements are used. There is development in the MUSIC algorithm to closely detecting the target and in time reversal experiments through wall when cluttered media is present to investigate the super resolution techniques.

Krishna et al.(2016) [20] a square shape ring having four arms are identical in shape and stepped rectangular in which two arms are responsible for orthogonality and other two arms are responsible for microstrip feeding. The isolations are improved when slot stubs and metallic slant are inserted and the bandwidth is 3-12 GHz or more than 20 dB when isolations are measured.so a compact slot antenna having one substrate, ultra-wideband impedance matching is obtained and peak gain varies from 5 to 8 dB over the bands.

Moosazadeh et al. [21] Slits are developed to increase the gain of the antenna at lower frequencies and to extend the frequency band of low end. The frequency band of lower end limitation has been extended by the slits which are rectangular; the bandwidth is from 5-50 GHz. A small size antenna of $30 \times 55 \times 0.508 mm^3$ low cross polarisation is reduced and antenna gain $>$10dB for 10 to 50 range and $>$13 dB for 30 to 50 GHz. This antenna can be used for construction of high range resolution imaging.

Aggrawal et al. [22] for a secure line of sight the spatial coding is established, so high-resolution images are generated. In this, the coding and symbol generation is operating when numerous widely spaced transmitters. The range of frequency is from 3-10 GHz when UWB pulse is generated when number of antennas synchronized to apply spatial coding having beamwidth of 1°, this is a secure technique for communication to the objects in 3-D space with high resolution. BER of 10^{-2} at 1° and 10^{-6} at 0.47° were measured and these results give a BER $< 10^{-10}$ at the center.

CHAPTER 7

OBJECTIVE OF THE STUDY

OBJECTIVES OF THE PROPOSED RESEARCH

The major purpose of this thesis is to present a UWB antenna with miniaturized size. The following are the objectives of the proposed work:

i. To perform simulation based on various techniques and parameters of planer antennas which affect the characteristics of Ultra-wideband antenna.

ii. To design a new compact UWB antenna for the microwave imaging.

iii. To fabricate and test the designed antenna with existing antennas to compare the simulated and the measured results.

CHAPTER 8

RESEARCH METHODOLOGY

In this chapter, there basic flow diagrams showing the procedure of the complete antenna design using CST studio suite. The following procedure was followed for the completion of the antenna design:

i. The design and the simulation is carried by using software such as Computer Simulation Technology(CST) microwave studio and High-Frequency Simulation(HFSS)

ii. For the planer design, substrate plays an important role in the availability of the substrate, cost, and many others.

iii. Proper feeding and analysis of the result such as return loss, VSWR, radiation pattern, bandwidth etc.

iv. Once the optimisation is done for UWB then the fabrication of the antenna will be done.

v. The comparative will be done for the proposed antenna with the existing planer antenna for UWB antenna using imaging.

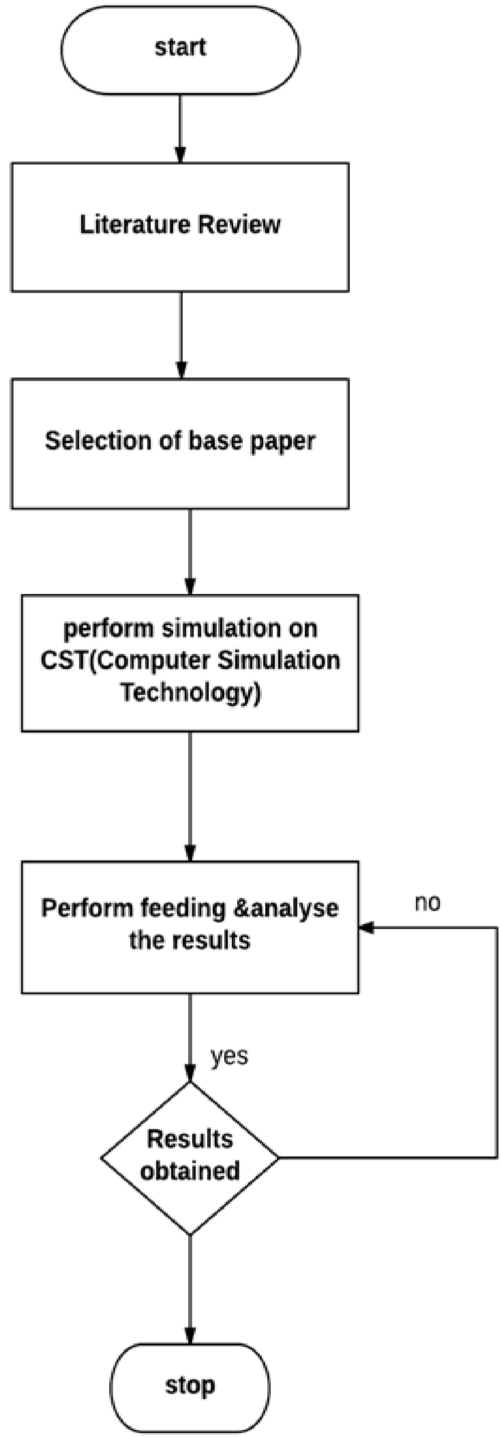


Fig 8.1 Process for antenna design

CHAPTER 9

SIMULATION RESULTS AND DISCUSSION

The simulation of the proposed antenna was carried out using CST microwave studio with the units being set to GHz for frequency and mm for length. The proposed antenna is designed on a single substrate, utilizes a stepped slot structure. The metallization on the substrate top forms the ground plane on which a square ring slot is etched. The four arms of the slot are identical and stepped rectangular in shape. Two of the arms are excited using microstrip feed lines printed on the other side of the substrate. The feed lines are also stepped for better impedance matching. The proposed antenna has resonant frequencies at 4.4GHz. It shows the variation of the reflection coefficient in dB with the change in frequency in GHz. In order to analyze the design, study of various parameters and the substrate material is conducted in terms of S-parameters and VSWR.

The s-parameters at some frequencies like in S11 (return loss) represents how much power is reflected from the antenna, and hence is known as the reflection coefficient (sometimes written as gamma: or return loss. If S_{11}=0 dB, then all the power is reflected from the antenna and nothing is radiated where S_{11} is the input port voltage reflection coefficient and S_{22} is the output port voltage reflection coefficient.

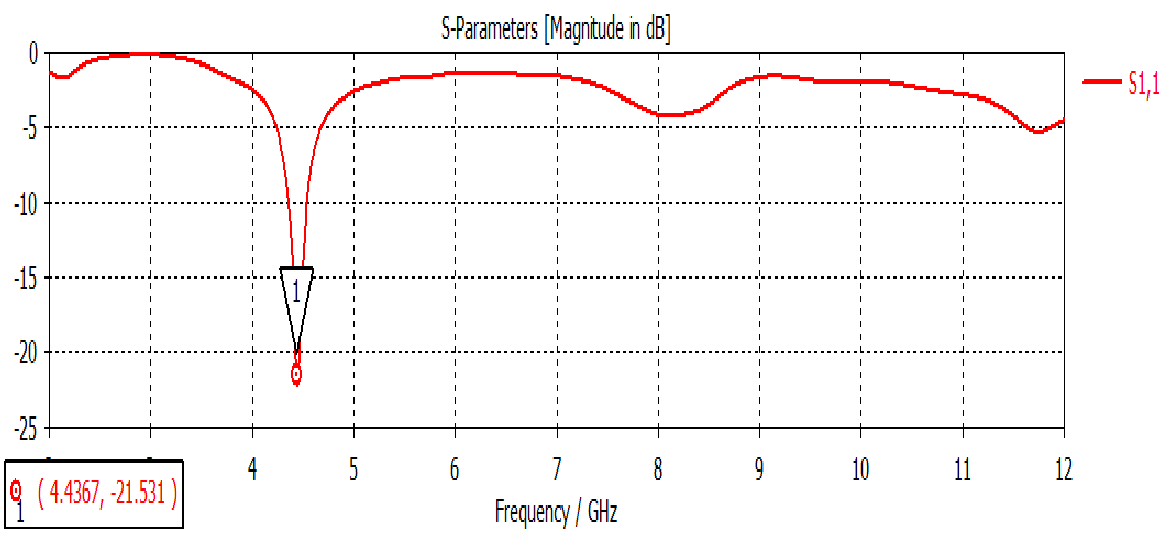


Fig 9.1 s_{11} parameters of the proposed antenna

In S_{21} (return loss) represents how much power is reflected from the antenna, and hence is known as the reflection coefficient: or return loss, by using this insertion loss could also be calculated. It therefore relates to the magnitude of the voltage reflection coefficient where S_{12} the reverse voltage gain is and S_{21} is the forward voltage gain.

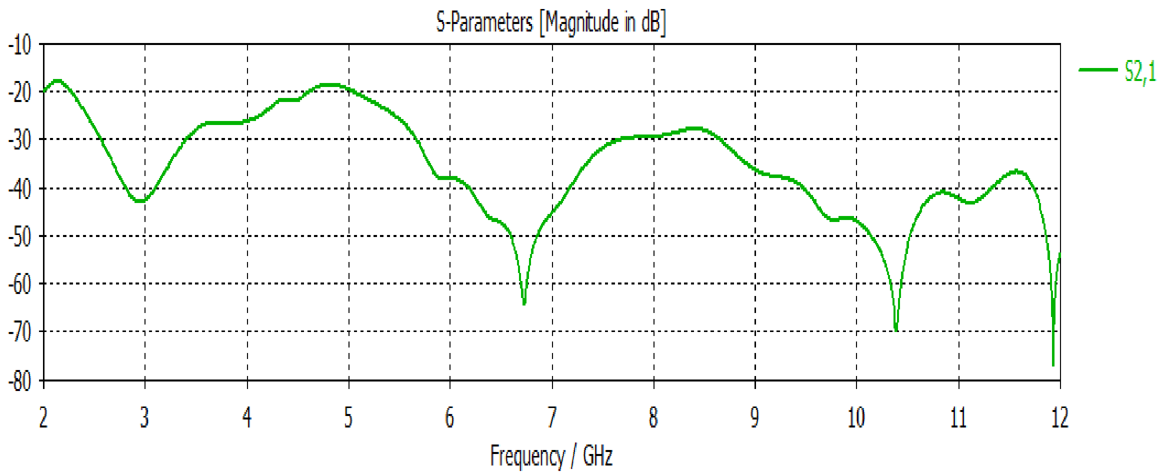


Fig 9.2 s_{21} parameters of the proposed antenna

A combined used to analyze a pair of coupled transmission lines to determine the amount of cross-talk between them, if they are driven by two separate single ended signals or the reflected and incident power of a differential signal driven across them. The s-parameter definition is in terms of incident and reflected 'power waves'.

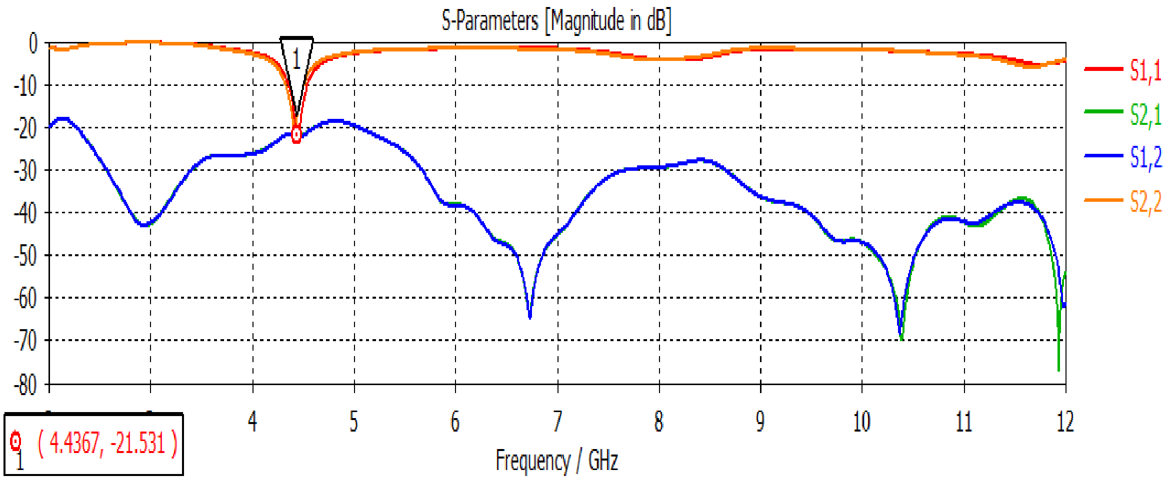
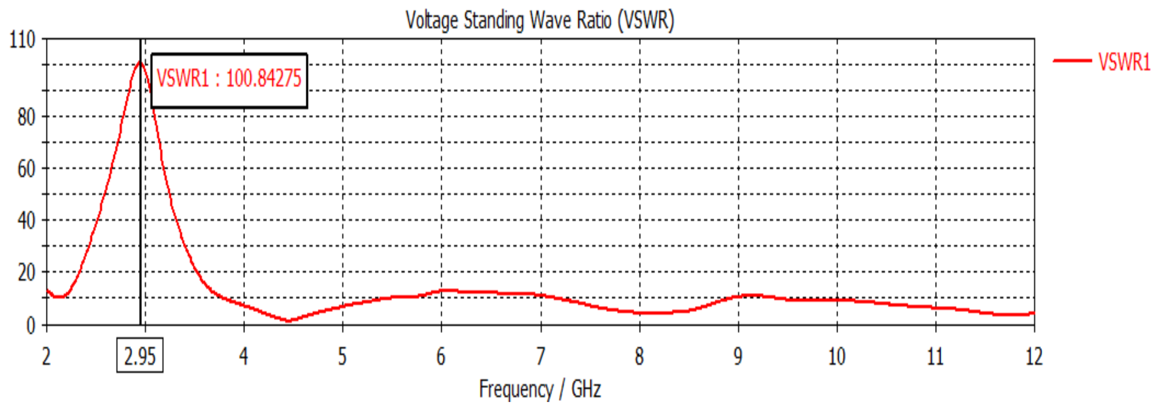


Fig 9.3 S parameters of the proposed antenna

The VSWR of the antenna using different feed width is depicted. The original design has the optimum. The standing waves are produced as a resultant of the incident wave with the reflected wave. These reflected waves are generated due to the losses present in the transmission line or the improper termination of the line. VSWR whereas with increase or decrease of the feed width, VSWR>2 for some frequency at 2.95 the VSWR is 100.84 as shown in the figure9.4



. Fig 9.4 $VSWR$ parameters of the proposed antenna

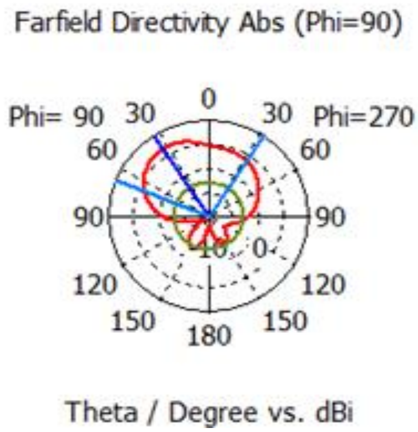
Directivity of the proposed antenna

In the proposed paper analysis of directivity is done at every frequency within the Bandwidth of antenna. The directivity is maximum at 6.2 GHz with value of 8.896 dB

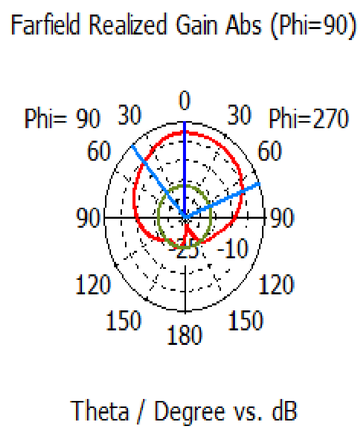
Table 9.1 proposed results of far-field parameter

S. No.	Frequency(GHz)	Directivity(dBi)
1	4.4	7.674
2	5.6	8.855
3	6.2	8.896
4	7	8.726
5	9.4	8.728

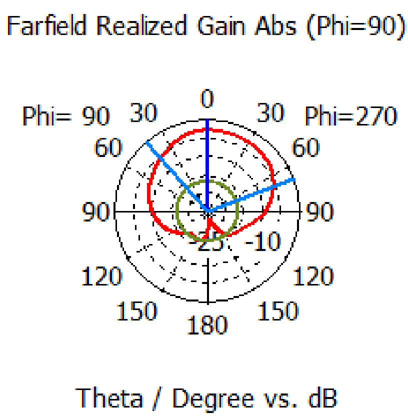
In addition to the analysis carried out by variations of dimensions, the radiation pattern of the proposed antenna is presented in figure 10.3 in which four different frequencies of 4.4, 6.2, 7and 9.4GHz. The pattern is omnidirectional in the H-plane and in E-plane pattern and shape is slightly like a dumb bell in E plane which is required for the UWB antenna using imaging. As the far field is given at different frequencies for the polar plot in which main lobes and side lobes level is shown in the plot.



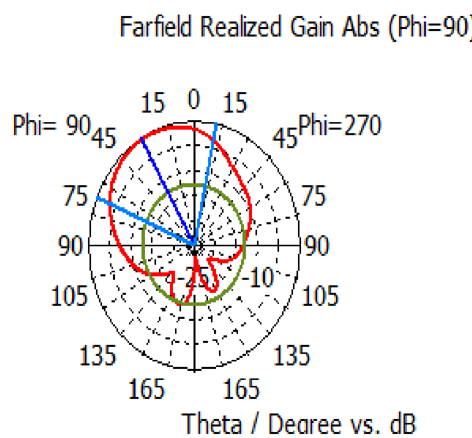
(a)



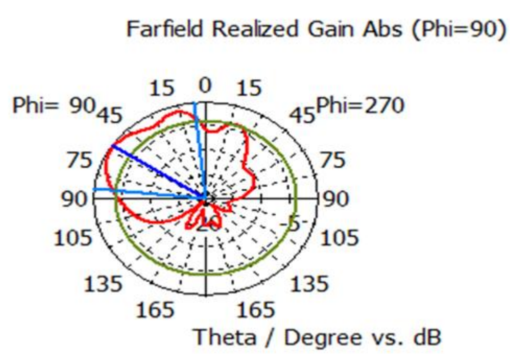
(b)



(c)



(d)



(e)

Fig 9.5 Simulated radiation pattern (a) 4.4 GHz in E-plane; (b) 5.2 GHz in E-plane; (c) 6.2 GHz in E-plane; (d) 7 GHz in E-plane (d) 9.4 GHz in E-plane

9.2 Experiment work

The proposed antenna has the dimensions of 66.25× 66.25 (L×W) and it is designed on an FR-4 substrate of 1.6 mm thickness and relative permittivity ε_r=4.4.. The metallization on the substrate top forms the ground plane on which a square ring slot is etched. The four arms of the slot are identical and stepped rectangular in shape. Two of the arms are excited using microstrip feed lines printed on the other side of the substrate. The feed lines are also stepped for better impedance matching. Further, in the longitudinal direction, the feed is offset (shifted in the direction shown by the pink block arrow near M2) from the centre of the slot arm by 1.5 mm. The starting design is a narrow rectangular slot fed at its canter which generates a linearly polarized electric field with good polarization purity.

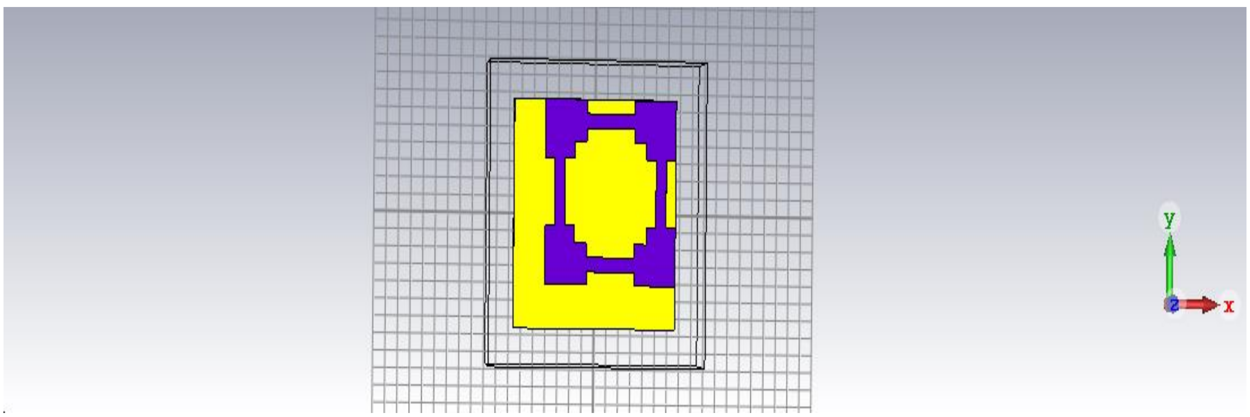


Fig.9.6 front view of the design

Section	S1	S2	M1	M2	M3
Length	19.5	17.0	9.0	7.0	8.5
Width	4.2	12.0	3.9	2.4	10.0

Table9.2 Structure of designed antenna of optimized Dimensions (in mm)

The antenna is fabricated on FR4 substrate 66.25× 66.25mm2 (L×W) which has a thickness of 1.6 mm and relative permittivity ε_r=4.4. Figure shows the parameter list and the substrate respectively. The metallization on the substrate top forms the ground plane on which a square ring slot is etched. There are four arms of the slot are identical and stepped rectangular in shape at the top side of the ground plane as shown in figure 9.6

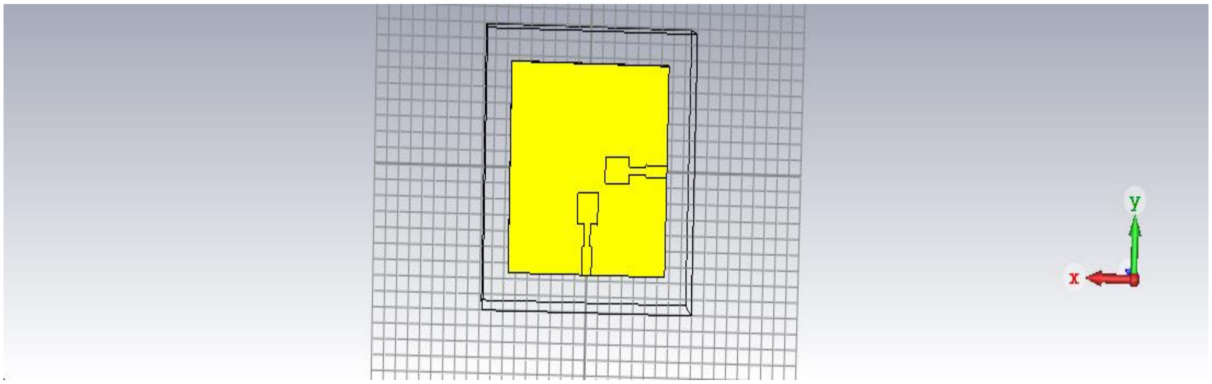


Fig 9.7 back view of the design

Now since the design is complete, ports need to be defined for simulation purpose. After the completion of design, the port is assigned to the feed line via the waveguide port as the first go to Pick→Pick face→ simulation →waveguide port as there are two ports, to reduce the impedance seen, the feed is extended beyond the slot.

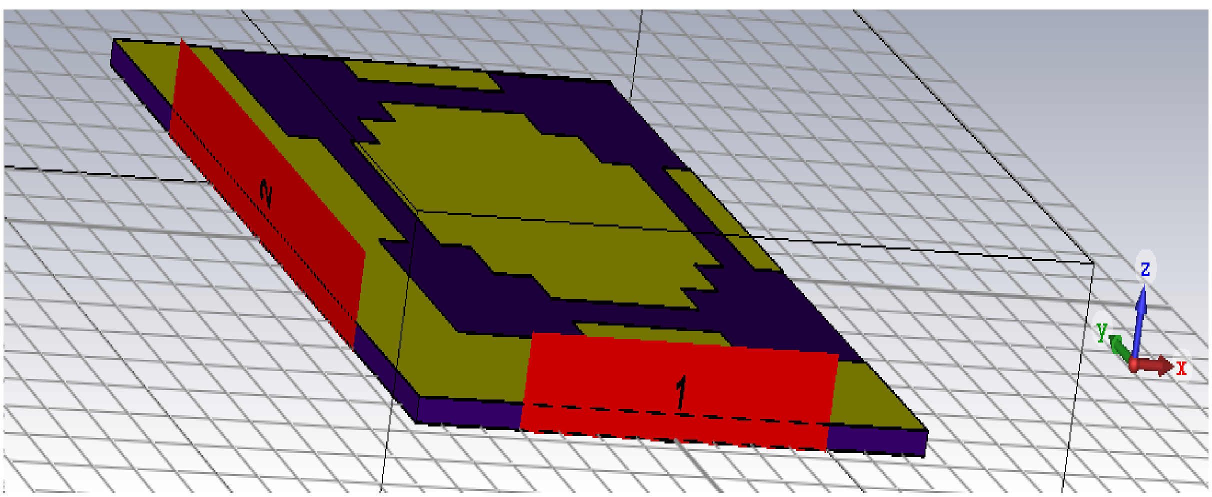


Fig9.8 proposed design with two ports

CHAPTER 10

CONCLUSION AND FUTURE WORK

11.1 CONCLUSION

In order to attain the desired research objectives, the study of the various antennas with microstrip feed has been studied. After the literature review was carried out, a new design is proposed. A new compact ultra-wideband antenna with maximum gain is proposed in the presented research work. The simulation was carried out on the CST microwave studio. The performance of the antenna is enhanced in terms of high gain of the antenna.

The size of the antenna is reduced to a more compact size which is as small as size of a coin and therefore can be used in wireless communication of imaging applications without occupying much of the space, which results in compact designing of the devices, the isolations are improved by inserting slant metallic and slot stubs at the junction of the slot arms. The antenna is further improvised by properly sectioning the slot arms and the feed line, ultra-wideband impedance matching is obtained. The Omni-directional pattern is achieved by the antenna in H-field and E-field. VSWR attained is less than two for the entire bandwidth of operation which means that there are very less standing waves and the maximum power will be received by the receiver without much loss of power while traveling.

11.2 FUTURE WORK

Since there are certain bands like WLAN and Wi-MAX which creates interference in the operating band of the UWB antenna using imaging, so there is a need to eliminate these frequencies from the working frequency of UWB antenna for imaging proposed in the paper.. So instead of using filters, slots can be inserted in this antenna which provides mismatching of the frequency within the feed line. So this leads to the elimination of the interfering bands and the UWB can operate without disruption. Another method to do band notching can be the addition of extra slot, say rectangular, with the insertion of a copper patch of the size of the ideal switch. This will act as a switch. When the copper patch is present, then it will be in on state i.e. it will eliminate the interfering band. This will make the antenna reconfigurable. The proposed antenna design can also be used for sensing in the cognitive radios. In order to sense the white spaces in the spectrum, the wideband antenna is required. So this UWB antenna offers wide band and is also of compact size, so it can easily be used in the system. The proposed antenna can also be embedded in the UWB systems for wireless transmission in wireless public area network.

REFERENCES

.

[1]Amin M. Abbosh, Marek E. Bialkowski* and Wee Chang Khor,"design of a UWB planer monopole antenna for use in a circular cylindrical microwave imaging" The University of Queensland, St Lucia, QLD 4072, Australia,2006

[2]Mohammed Jainul Abedin and Ananda Sanagavarapu Mohan" UWB Imaging for Early Breast Cancer Detection using Time Reversal MUSIC Algorithm" Proceedings of Asia-Pacific Microwave Conference,2007

[3]Hamed M Jaffari and Steve Hranilovic," a study of ultra-wideband antenna for near field imaging"published in:IEEE antenna and wireless propogation(volume: 55,issue, issue:4,April 2007)

[4] Hong Wang and Zheng on Zhou,"through wall imaging of moving targets using UWB random noise radar", Published in: IEEE antenna and wireless propagation letters,2009

[5]Xia Xiao and Takamaro Kikkawa" Early Breast Cancer Detection with Hemi-elliptical Configuration by UWB Imaging, 978-1-4244-2902-8/09/$25.00 ©2009 IEEE,2009

[6]Shouhei Kidera shadow region imaging algorithm using array antenna based on aperture synthesis of multiply scattered waves for UWB radars", 978-1-4244-9566-5/10/$26.00 ©2010 IEEE

[7] Amin Abbosh, Beda's Mohammed, and Marek Bialkowski" Planar array antenna for Ultra Wideband Microwave Imaging System", 2011 International Conference on Communications and Information Technology (ICCIT), Aqaba

[8] Constantine A. Balanis, Antenna Theory and Design, Second Edition, Wiley India(P.) Ltd, 2007.

[9] Nasser Ojaroudi, Mohammad Ojaroudi, and Noradin Ghadimi" UWB Omnidirectional Square Monopole Antenna for Use in Circular Cylindrical Microwave Imaging Systems", 1536-1225/$31.00 © 2012 IEEE

[10] Saeed Latif1, 2, Daniel Flores-Tapia3, Lotfollah Shafai2, and Stephen Pistorius1"an Ultra-wideband elliptical monopole antenna for breast microwave radar Imaging", 978-1-4673-5317-5/13/$31.00 ©2013 IEEE

[11]W. Wiesbeck, G. Adamiuk and C. Stum, "Basic Properties and Design Principles of UWB Antennas," Proc. IEEE, vol. 97, no.2, pp. 372-385, 2009.

[12] Takumi Sugitani, Shinichi Kubota, Akihiro Toya, Xia Xiao, and Takamaro Kikkawa” a compact 4 ×4 planar UWB antenna Array for 3-D breast cancer detection” IEEE ANTENNAS and wireless propagation letters, vol.12, 2013

[13] H.T. Chattha, Y. Huang, M.K. Ishfaq, S.J. Boyes, “Bandwidth enhancement techniques for planar inverted-F antenna”, IET Microw. Antennas Propag., vol. 5, Iss. 15, pp. 1872–1879, 2011

[14] Sverre Brovoll, Tor Berger, Yoann Prichard” Time-Lapse Imaging of Human Heart Motion With Switched Array UWB Radar”, 1932-4545 © 2014 IEEE

[15]Mamadou Hady BAH1, Jing-song HONG2, Deedar Ali JAMRO3**”** UWB Antenna Design and Implementation for Microwave Medical Imaging Applications”, 978-1-47-99-1984-0/1_/$31.00 ©201_ IEEE

[16] Adhitya Satria Pratama, Basari*, Muhammad Firdaus S. Lubis, Fitri Yuli Zulkifli, Eko Tjipto Rahardjo” a UWB antenna for Microwave brain Imaging”, 978-1-4799-8897-6/15/$31.00_c 2015 IEEE

[17] Basari*, Adhitya Satria Pratama, Aisyah, Sayid Hasan, Fitri Yuli Zulkifli, Eko Tjipto Rahardjo,” Evaluation on Microwave Imaging System by using Ultrawideband Antenna”,978-1-4799-8543-2/15$31.00 © IEEE,2015

[18] N. Deshpande and A. Shaligram, "Energy Saving in WSN with Directed Connectivity," Wireless Sensor Network”, Vol. 5, No. 6, pp. 121-126,2013

[19] Amal AFYF\ Larbi BELLARBI', Anouar ACHOUR', Nourdin YAAKOUBI2, Abdelhamid ERRACHID3, M. Adel SENNOUNI4,” UWB thin film flexible antenna for microwave thermography for breast cancer detection, 2nd International Conference on Electrical and Information Technologies ICEIT',20 I 6

[20] Saptarshi Mukherjee, Lalita Udpa, Fellow, IEEE, Satish Udpa, Fellow, IEEE, and Edward J. Rothwell,” Target Localization using Microwave Time Reversal,2016
Mirror in Reflection Mode”, IEEE transaction on antenna and propagation,2016

[21] R.V.S. Ram Krishna and Raj Kumar,” a dual-polarized square ring slot antenna for UWB, imaging and radar applications”, 10.1109/LAWP.2015.2438013, 2016 IEEE

[22] Mahdi Moosazadeh, Student Member, IEEE, Sergey Kharkovsky,” improved radiation characteristics of small antipodal Vivaldi antenna for microwave and millimeter-wave imaging applications” 1536-1225 © 2017 IEEE

[23] Himanshu Agrawal, Rafael Puhl and Aydin Babakhani,” Ultra-Wideband joint spatial coding for secure communication and high-resolution imaging, 0018-9480 © 2017 IEEE.

[24] E.C.Fear, P.M.Meaney, and M.A.Strichly,"microwaves for breast cancer detection?,"Potentials, IEEE, Vol. 22,pp.12-18,2003

[25]Takuya Sakamoto, tour sato, and pascal Aubry,"fast imaging for security systems using ultra-wideband radar,"IEEE transaction on Aerospace and electronics system,(volume:52,issue:2,april 2016)