PERFORMANCE ENHANCEMENT OF FLEXIBLE TEXTILE ANTENNA

A

THESIS

SUBMITTED

For the partial fulfillment of the requirement for the degree of

DOCTOR OF PHILOSOPHY

IN

ELECTRONICS ENGINEERING

P.K.University
Shivpuri (M.P.)

BY

JANABEG LONI

(Registration No. PH16GG001E)

UNDER THE SUPERVISION OF

Prof. ANAND KUMAR TRIPATHI

Prof. VINOD KUMAR SINGH

DEPARTMENT OF ELECTRONICS ENGINEERING

P.K. UNIVERSITY, SHIVPURI

MADHYA PRADESH - 473665

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P.K. UNIVERSITY

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Village - Thanara, Tehsil - Karera, NH 27, District – Shivpuri, M.P.

DECLARATION

I hereby declare that this thesis entitled **"Performance Enhancement of Flexible Textile Antenna"** is my own work conducted under the supervision of **Prof. Dinesh Babu, Prof. Anand Kumar Tripathi** and **Prof. Vinod Kumar Singh** approved by the Research Degree Committee of the University and that I have put in more than 200 days/600 hrs of attendance with the supervisor.

I further declare that to the best of my knowledge this thesis does not contain any part of any work which has been submitted for the award of any degree either by this university or by any other university/deemed university without a proper citation.

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CERTIFICATE OF SUPERVISOR

It is certified that this work entitled **"Performance Enhancement of Flexible Textile Antenna"** is an original research work done by **Shri/Smt./Km. Janabeg Loni** for the award of **Doctorate of Philosophy** from P.K. University, Karera, Shivpuri, M.P. under my/our supervision for the degree of Doctor of Philosophy in Electronics Engineering to be awarded by P.K. University Shivpuri, Madhya Pradesh, India and that the candidate has put the attendance of more than 200 days/600 hrs with me.

To the best of my knowledge and belief this thesis,

I. Embodies the work done by candidate himself.
II. Has duly been completed.
III. Fulfils the requirements of the ordinance related to Ph.D. degree of the University.
IV. It is up to the standard in respect of both content and language for being referred to the examiner.

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ABSTRACT

Modern ages have observed excessive attention from both scientific and academic communities in the field of flexible electronic based systems. Most progressive flexible electronic systems require incorporating the flexible form of substrate antenna and utilization of wearable textile materials as antenna substrate has been speedy because of the recent miniaturization of wireless devices. Wearable textile antenna is to be part of clothing which is used for the purpose of wireless communication, such as navigation, tracking, mobile, wearable computing as well as public safety. Wearable textile antenna is operating in explicit bands to offer wireless connectivity which is extremely required by today's network concerned society. In this thesis the advantages and disadvantages of wearable textile antenna has been examined. It has been concluded from the discussion that the textile antenna is more favourable as compared to typical conventional microstrip patch antennas.

This thesis characterizes flexible antenna performance under the environments developed by jeans as the substrate. Flexible antenna grounded on Jeans substrate was simulated using CST microwave studio with diverse permittivity and loss tangent. In our work, prototype antennas were built using natural jeans. This thesis advanced flexible substrate effects on antenna quality factor and its consequences on bandwidth and gain. Such antennas under bending washing environment were also found to perform better than existing designs, showing less change in their gain, frequency shift and impedance mismatch.

The aim of this thesis is to enhance the performance a light weighted flexible textile antenna for modern communication system. There are two different patch designs. These proposed antennas are compact in size, shows high directivity and large bandwidth. Expandable Jeans is used as a substrate because such antenna are bendable, wearable, cheap, require less attention and having good features like low dielectric constant, low loss tangent and better efficiency. The parameter of antenna such as return loss, gain, bandwidth, radiation pattern provide a good agreement between simulated and measured result and performance of proposed antenna. The presented novel antenna designs are compact and these antennas have great utility to receive the signals in specified range of frequencies. To design these antennas jeans is very good material utilized as a substrate and self adhesive copper tape is used as a ground and patch. The approved flexible antenna gives wide bandwidth of 106.30% covering the frequency range 2.445 GHz - 8.0 GHz. These antennas can be utilized efficiently in WLAN (2.40 GHz -2.48 GHz), HLAN (5.15 GHz-5.3 GHz), Bluetooth (2.45 GHz) and WiMax (2.495 GHz - 2.695 GHz) and broadband wireless communication (2.445 Ghz - 8.0 Ghz).

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LIST OF ABBREVIATIONS

ADS	Advanced Design System
AR	Axial Ratio
BAN	Body Area Network
CST	Computer Simulation Technology
DAB	Digital Audio Broadcast
DBS	Direct Broadcast Satellite
FEM	Finite Element Method
GSM	Global System for Mobile Communication
GPS	Global Positioning System
IEEE	Institute of Electronics & Electrical Engineering
ISM	Industrial Scientific Medical
LCP	Liquid Crystal Polymer
MOM	Methods of Moments
PDA	Personal Digital Assistant
RF	Radio Frequency
RFID	Radio Frequency Identification
SAR	Specific Absorption Rates
UWB	Ultra Wideband

LIST OF SYMBOLS

D	Directivity
G	Gain
t	Thickness
h	Height
Vp	Phase velocity
C	Velocity of light
W	Width of patch
L	Length of patch
E	Electric field intensity
H	Magnetic field
Z0	Characteristic impedance
ZL	Load impedance

CHAPTER 1

INTRODUCTION TO ANTENNA

1.1 Introduction

In the recent innovations different types of wearable textile antennas exists, which plays an important role for major wireless applications. Such antennas are generally tiny printed antennas which has capability of bending. An antenna is constructed through copper that is printed at above as well as at the lower bottom of substrate. Copper which is printed at the upper side part of the dielectric substrate acts like a patch having radiating property. Lower portion of substrate functions as the ground surface [14]. Propagation pattern near fields performs vital role, the lesser power transmits at a point as well as receiving devices, affixed to attire. Far field radiation property of antenna is in addition a necessary capacity, when a communication is setup through body worn sensors and units like personal computer, personal digital assistant, [4-8].In the field of wireless communications antennas plays an important role. Parabolic reflectors, slot antennas, dipole antennas (folded) and patch antennas are examples of wireless communication antennas. Every antenna is good in its usage and properties. So, antennas are foundation of wireless communication and almost everything without it we would not have reached this age of technology. In communication systems antennas are considered as very important component. The definition [1] of an antenna is, a device that changes a signal of radio frequency, travelling in free space into an electromagnetic wave on a conductor. Antennas indicate the property is called as reciprocity, defines as an antenna that is used to maintain the same behavior regardless it is used for transmitting or receiving. Technically an antenna is considered as resonant devices, which is used to operate for a narrow band frequency range. An antenna is considered as tuned device having attached to a radio system with similar band of frequency otherwise the reception and the transmission can be diminished. If a signal is applied to an antenna, it will give out radiation expanded into the air space. A representation through a graph of the relative distribution of the radiated power in air space is known as radiation pattern. Nowadays certain varieties of antennas having their own features and benefits exist. As per application we can select the type of antenna which is suitable. A special type of antenna consisting of a patch i.e. radiating is known as microstrip patch having different geometrical planes (for example, Circular, square, elliptical, ring and rectangular) at a side of a substrate i.e. dielectric in nature coated with a ground plane on the opposite side. It contains a few benefits such as low weight, low cost etc and with few problems such as low bandwidth.

In the event of a special antenna-like antenna to improve bandwidth by adjusting the spaces in its shortcuts and its effect is analyzed.

Patch antennas are important in wireless communication systems these days. Microstrip patch antenna (Figure 1) [1] is much simpler in configuration using the standard microstrip production process. These are widely used for patch antennas those are rectangular and circular in shape. These patch antennas acts as a simple and flexible and highly demanding system. Two features, separation (circular), double frequency performance, speed; wide band width, flexible feeding line and beam scanning may be found in these antennas very easily.

1.2 History of antenna

From the very first concept of wireless communication system led by Guglielmo Marconi in year 1895, one of the main aim of antenna research has always been to investigate by the ways to increase the information bandwidth suitable for the antenna and at the similar time instant to maintain high radiation output and keeping physical dimension to a minimum at required resonant frequency. But there are, tradeoffs in these required characteristics which are important during antenna designing as antenna size or geometry. In parts of efficient airplane, space vehicles, satellite and arrows, size, weight, cost, performance, easy installation, and streamlined profile are limited, and can be used with low antennas. Microstrip antennas can be used for basic requirements. The basic microstrip antenna is about 26 years old in the U.S.A. by Deschamps and in France by Glutton and Baissinot. After a while, Lewin received rays from the discontinuities of the line. There after a study conducted in the late 1960s by Kaloi, who described the basic structure of rectangles and squares? Work other than the first results of Deschamps, no work appeared in the literature till 1970s, when a stripped element that kept a distance from the ground plane by a dielectric substrate. This fragment of the width and width of several rows was applied with a coaxial connection simultaneously on both light layers. Shortly afterwards a microstrip investigation was investigated by Munson. Such types of antennas are low-profile, have design and random, simple and inexpensive production of modern printed technology, solid construction when installed in solid environments, compliant with MM1C- monolithic microwave circuits integrated design, and when certain patch and mode configurations are selected depending on frequency of resonant, polarization, pattern and impedance. Currently there are various commercial and government programs used such as mobile, radio and wireless communication with same features. In addition, with increasing load between the plane and the ground plane, such as anchors and varactor diodes, variable frequencies of resonant frequency, impedance, polarization and radiation pattern can be made. One feed rotating antenna is currently receiving a lot of attention. Circular segregation is advantageous because current and future commercial and military applications require additional extra liberty that does not require the adaptation of the field vector (electrical) to the receiving and transmission areas. A single feed allows for a reduction in the complex structure, weight and radio frequency loss of any of the same components and is required in such cases where, it is cumbersome to receive two combined feeds using power separating circuits. Rotated microstrip antennas have additional advantages of low size, low weight, and consistent installation and are suitable for integrated microwave and millimeter cycles, as well as integrated monolithic microwave circuits. High quality factor, separation purity, scans inefficiency, false supply emission and very small bandwidth, which is only half a percent or at least a few percent. For government application of security programs, low bandwidths are required.

1.3 Overview of textile antenna

The textile element needs a limited ground plane and operates at the discretion of the human body, in which case it can present various aspects of the antenna's behavior. Hence, anticipated textile antenna provides proper stability so that it can maintain its features in any situation. So the given examination gives solid base for fire fighter garments concept of need of new generation clothing. Adaptability and toughness of the antenna provides the utilization of this strategy through the areas near to human body and for the other wireless communication based techniques. Using all the important safeguards, we can employ the following technique in the condition of natural calamities to search the affected people of that particular region. While designing any such kind of antenna one should consider all the specific basic and required factors. In General, some key factors which need to be focused during the designing of this fabric based antennas like elasticity of textiles, due to which change in actual measurement can happen because of elongation and compression of the fabric. The alteration in dimension could lead to variation in the working frequency of antenna and the dielectric height of substrate (1mm) could also change the entire experimental outcomes. So, it is required to avoid textiles with high elasticity. In case, if the textile retains water in any way, and then also the dielectric constant of fabric gets altered very drastically because water consist very high relative permittivity. So, if textile remains longer in moisture it will drastically lower the performance of antenna resulting in changes in frequency. There will be few problems in fabrication and testing process of antenna. Few discrepancies can be there in the results of simulated and measured properties because of these inaccuracies. It is advisable, to use protective lining to cancel the changes likely to happen due to moisture. Considering that the designed antenna should be kept accurately on human body keeping in view avoiding the spots or areas like arms, elbows and joints where body movement can affect the proper working of antenna. Also, performance can change drastically in a situation where the antenna is placed close to the human body. Structure of antenna should have limited ground surface where radiation from antenna should be minimized so as not to affect the person’s health. Additionally, extra recognition should be given to certain absorption rates as it helps to diagnose problems related to the absorption of harmful radiation by the human body. In outcome, the moving body is the considered then the antenna features must have control on signals which can get distorted from dissipation. Humans are bound to have too many little movements while eating, sleeping and moving around. Generally used antennas are mostly designed made of rigid materials and they are not comfortable to the user. Antenna bearing features of light weight, low profile and tolerating bending in this manner increases its quality to be mobile. Hence it can be concluded that typical traditional antennas are best fitted for the wearing computing technology. There is requirement for textile elements made up of adjustable materials so called wearable antennas. So we should have alternate way which can confirm high precision. The antenna radiation patterns must be well defined through the laser technique. Such type of technique can gives accurate and précised results though there will be few challenges in creating the antenna design structure. Problems happen in the process of structuring and creating the hardware implementation of antenna. So many applications as of now directly use the reflector antennas as they are very easy and famous in fabrication. These structures are being reflectors utilized in gadgets (microscopes) from a long time. There are conceptually many basic methods of designing an antenna with high directivity ad sharp frequency bandwidth. The mainly used and widely recognized antenna design is a solitary surface parabolic reflector structure. The wearable textile antenna installation is reduced due to many aspects of the human body. The human body acts as an antagonist and leads to severe decay of the body through the antenna [9 - 14]. In any case, in a situation where the human body is integrated into an effective system for managing remote systems, it provides high quality transmission by the antennas.

In case of small distance remote coverage, the radiation pattern of antenna centric at body is significantly of great use which is to be associated with human bodies. Networking results in enhanced comforts and services. Prime concern of wellbeing of a person is considered when electromagnetic radiations are used [14-16].Materials bearing wearable and bendable features like fluid metallic mixtures and polymeric paper [17-20] are widely used as recent electronic appliances. But, extra features are implemented in human wearable applications. In way, wearable applications need small size, light weight and low-profile radio connectors, indicating stable electrical properties, low power consumption, sensible impedance coordinate and radiation pattern. Biocompatibility and high conductivity are offered by Characteristic elastic adaptable material having low cost and simple designing resulting most essential it is water/climate safe and condition suitable [21-24].

Antenna is considered as very important part in wireless communication for transmission of information or data. By using the antenna in different applications one can do the effective transmission of signals. microstrip patch antenna and printed dipole antenna are also called as planar oriented antenna getting considerable interest from researchers because of their efforts and benefits which they bring to the modern wireless communication system in comparison to typical antennas. In last40 years researcher made more contribution in the development of the different types of patch antennas. Thus, textile antennas are the simplest and the famous among the antennas. The shape of a very simple antenna is a circle or rectangle that can be easily engraved on a fabric substrate using copper tape as driving material.

1.4Concepts of Antenna

The word Antenna is utilized from Webster's dictionary by the fact that it is a metal device for transmitting and receiving radio waves. In some descriptions the antenna is considered to be a temporal structure between the freely available space and the directing tool as shown in Figure1.1.The transmission line is considered as a type of a hollow pipe or wave guide. Such transmission line carries electromagnetic energy from source to antenna and vice versa. In a wireless system, the antenna is used to amplify or use most of the radiation energy on one side and compress it on the other. In ideal situation the energy transmitted by the source must be fully transferred to the radiation resistance, that represents the radiation emitted by the antenna. On the other hand in the practical system, there is a dielectric loss of transmission due to loss of transmission type and antenna and due to loss of display in the visible connection between the line and the antenna on a test device. It can be a variety of forms to fill their need as part of a conducting wire, aperture, patch, array and lens etc. Antenna is a main component for a wireless communication system. A good and correct design of antenna can be utilized to full fill all requirements and to increase overall performance of system. The antenna works on a communication system for the same purpose as the eyeglasses that work on a person. The antenna field is considered strong and powerful. Antenna technology has capability to dispense through communication revolution since last 50 years.

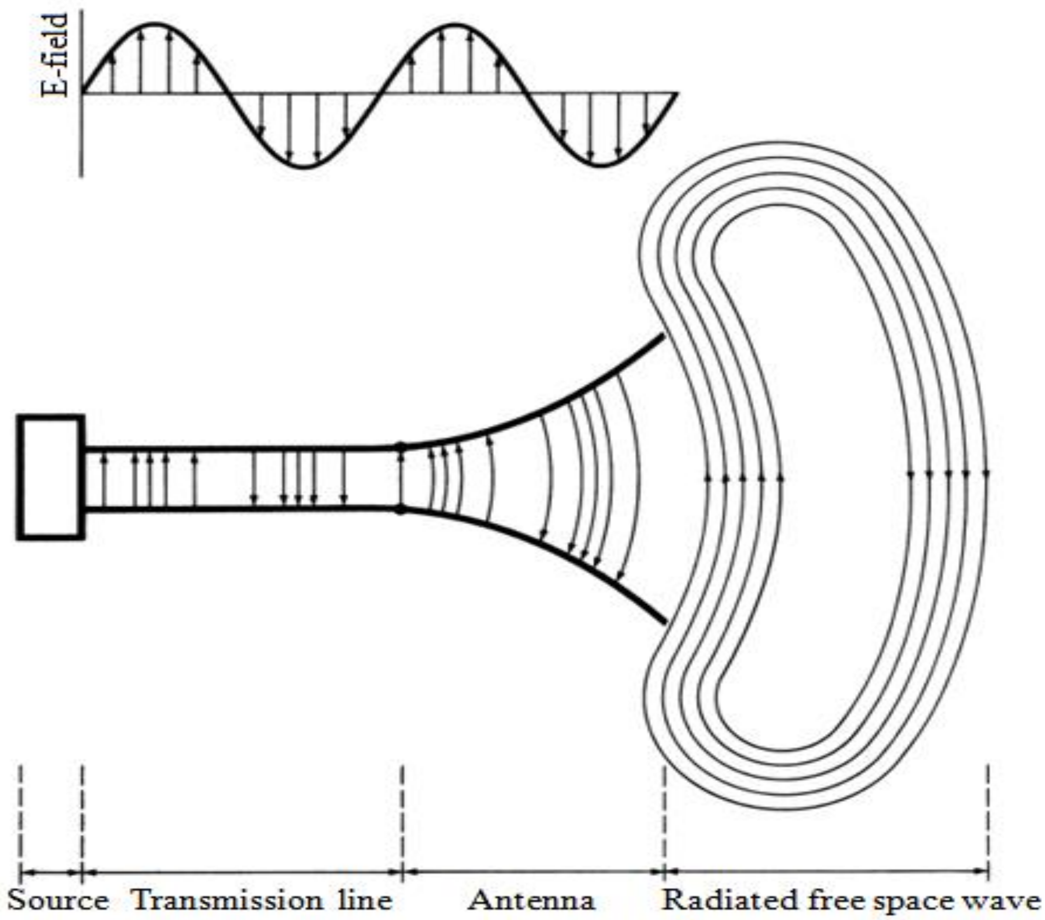


Figure 1.1 Antenna like a transition device.

Basic requirement of antenna are as follows:

- Low cost
- Light weight
- Appropriate for aviation industry
- Can be incorporated into arrays
- Easily incorporated with electronic parts
- Can be used in wireless communication

Textile antennas have developed significantly during the last past 20 years. The outcomes of the results have paved their way not only in astronomy, defense but also in industrial sector. In the last decade this wearable computing technology proved their applications which involve Radio Frequency circuitry. In commercial application areas like tracking of vehicles transfer of data through satellites and mobile phones were utilized first. Thus the future will be more significantly encourage infiltration of RF and microwave frameworks into both the working environment and individual life styles. Advanced sound communicated DAB and direct communicated DBS allowed gathering of amusement for all intents and purposes anyplace. Remote neighborhood WLANs and individual correspondences frameworks give resolute information move and interchanges. The shrewd vehicle roadway of things to come will control us through congested driving conditions and educate us concerning administrations en route. At last, frameworks utilizing GPS [4] and different methods reveal to us where we are going as well as where we ought to go. Majorly all these commercial system are cost effective, compact in size, user friendly and designed to achieve wide acceptance. The need and requirement for small devices is like a revolution which not only evolves the integration in electronics but also in the industry of antenna designing. Few, textile antennas are designed in that fashion so that it can withstand all the obstacles and hurdles by simply increasing the roughness of the device. Therefore, numerous applications as of now directly deployed the reflector antennas as they are very famous and simple in fabrication. These frameworks of are being reflectors utilized in gadgets (microscopes) since decades. There are basic methods of creating an antenna with more directivity ad sharp bandwidth. The most widely useful antenna is a solitary surface parabolic reflector.

Advantages:

- Easy and simple
- Very large apertures possible
- Can be use for wideband applications.

Disadvantages:

- Slow beam checking
- Plane should not be rigid
- Mechanical limitations, wind obstruction, gravitational deformation.

As per application more acute, smart, small size, lower cost products and more progressive antennas is required. In such condition, textile antennas are perfect because of their small size. They have good compatibility with integration technique and they can be utilized easily by their electronic counter parts. Above all, textile antenna is made with the fabrics and, accordingly they are cost effective. For application point of view in digital communication an antenna with arrays can be connected with the user though keeping the strategic distance from obstruction avoiding interference through different users. Figure1.2shows a basic fundamental antenna operation that can be represents all application of textile antennas.

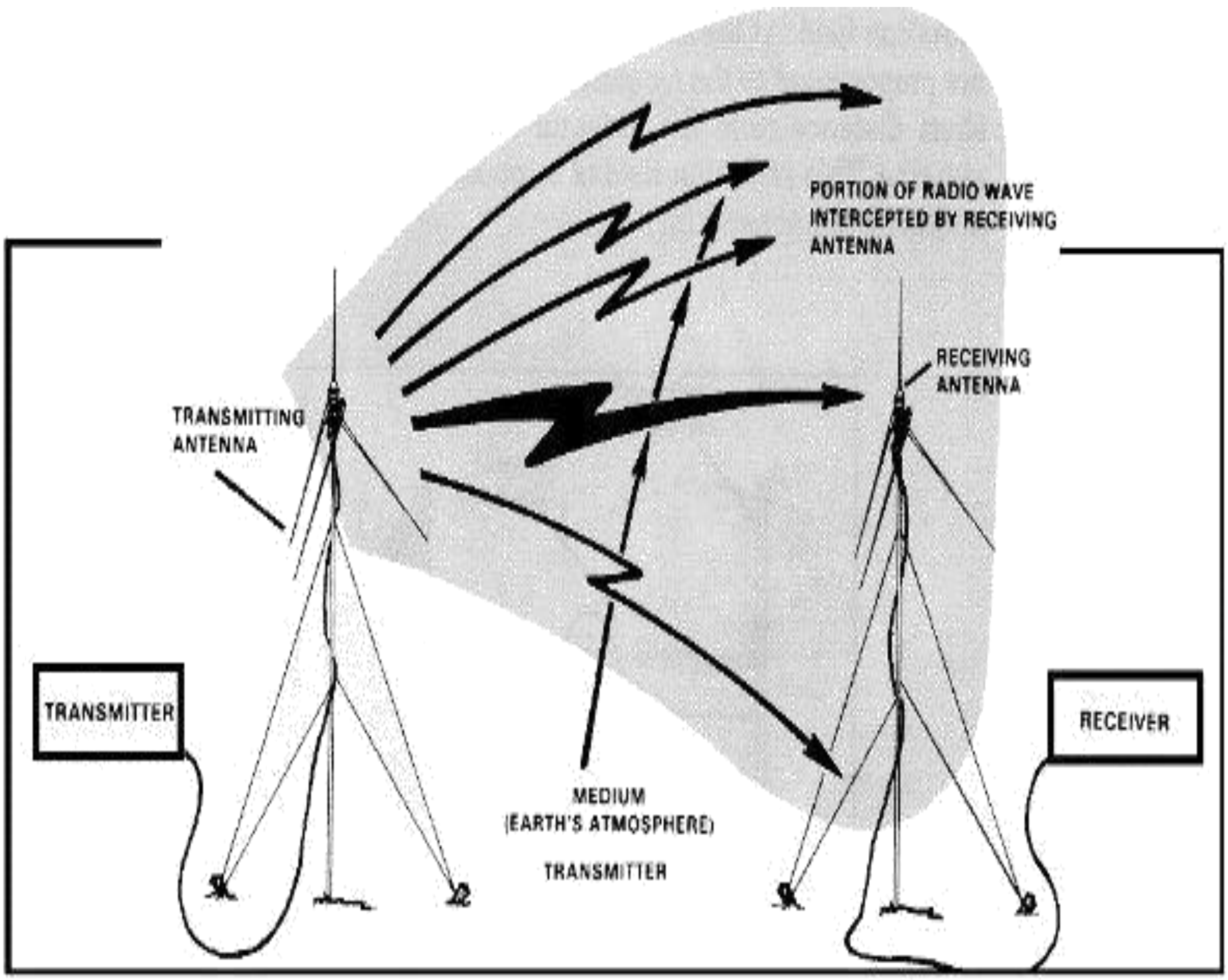


Figure 1.2 Basic Antenna mechanisms

1.5 Various Properties of Antenna

Multitude vital antenna characteristics that are discussed selecting antenna for relevance are mentioned below:

1.5.1 Resonant frequency of antenna

The resonant frequency is the range of frequency in which all functional specifications are convened by antenna. The frequency centering which sit is meant to operate is the design frequency of antenna. The actual Centre frequency of operation often becomes different as no design is perfect. Usually, this frequency is the one where best impedance matching with the feed network is obtained.

1.5.2 Reflection coefficient of antenna

It is represented by S_{11} and also known as the return loss frequently written as gamma Γ_o. And it depicts the amount of throwback power through the antenna; the antenna accepts the remnant power. This power which is accepted is moreover absorbed or radiated in the form of losses in antenna. The expression of return loss is:

$$R_L = 20 \times Log \frac{(z_1 + z_2)}{(z_1 - z_2)} \tag{1.1}$$

1.5.3Noise Temperature of Antenna

The noise temperature of the antenna is a measure of amount of noise received by an antenna at a particular frequency. Mathematically it is used as combining the cross product of the antenna directivity with the distribution of brightness temperature throughout the free space. The natural heat of nature depends entirely on various sources of noise: cosmic, atmospheric, artificial and earthy. The noise power received from the antenna terminals is indicated by Pn.

$$P_n = KT_a B \tag{1.2}$$

Where,

P_n = The noise power received at antenna terminal

K = The Boltzmann coefficient

T_a = The temperature of Antenna noise

B = The bandwidth of the receiver

1.5.4 Impedance of the Antenna

Antenna is utilized to pass on the electrical power got at its input, as electromagnetic radiation. It is a transducer used to transform electrical power to electromagnetic radiation. The efficiency of the antenna is achieved if all the input power is radiated. However, this is not possible because the antenna transmission depends not only on its frequency response signal but also on the transmission line response signal. Absolutely the overhead line has genuine characteristic impedance and the characteristic impedance of antenna is complex. Hence when a transmission line having dissimilar characteristics impedance is attached to the antenna, impedance disparity occurs [2]. Due to this impedance disparity the input power to the antenna reflects back. Thus, antenna radiates only a fraction of input power. This has a very rigorous effect on antenna recital because the gain and radiation efficiency are diminished. Some of the prevalence of impedance matching is:

- Utmost power is delivered from point of supply to antenna if there is ideal impedance matching. If the receiver peripheral such as LNA, MGA and antenna are appropriately impedance matched there is enhancement of S/N of the system.
- Appropriate impedance matching results in diminution of amplitude and phase error. Impedance matching is performed to lessen reflection i.e. to make the reflection coefficient zero. Mathematically illustration is:

$$\Gamma_o = \frac{Z_L - Z_o}{Z_L + Z_o} \tag{1.3}$$

Zo is characteristic impedance. Γ_o is reflection coefficient and Z_L is load impedance and from above arithmetic relation, it can be seen that reflection coefficient becomes zero where the load impedance becomes equivalent to the characteristics impedance, and hence there is no reflection, and if Z_L and Zo are not one and the same to each other than the finite value of reflection coefficient subsist which represents the disparity [4].

The impedance at input of the antenna is the impedance accessible at its terminals. Along these lines, proper terminals must be clear for antenna.The impedance at the input will be influenced by different reception apparatuses or objects that are adjacent, yet we presume that the receiving wire is isolated.

Impedance at the input is tranquil of genuine and nonexistent parts. The information obstruction display dissemination, which happens in two manners. Power that assent the receiving wire and do not bounce back is a type of dispersal. There are additionally ohmic misfortunes which are accord with warming on the reception apparatus structure, yet ohmic misfortunes are minute when contrasted with radiation misfortunes. The input reactance indicates the energy stored in the adjacent antenna path. Due to communication, the antenna impedance does not vary during transmission and reception.

1.5.5 Eminence Factor

The Eminence factor of the antenna may be stated as the part of the radiating energy to the total energy in the form of reactive field [6]. The quality factor is given by

$$Q = \frac{2\omega_{\max}(W_M, W_E)}{P} \qquad (1.4)$$

W_M represents the stored magnetic energy W_E are the stored energy and P is the radiated power. Quality factor is used to find out the losses of an antenna. Generally, there much type of losses in an antenna which are stated as emission loss, ohmic losses etc. The conductive losses are directly dependent to the elevation of the substrate and radiation losses are inversely dependent to elevation of substrate [7]. Suppose the dielectric pinnacle of an antenna substrate hikes, band width of an antenna also upsurges and at the same time the conductive losses also rise and when the height of the substrate declines the radiation loss becomes compelling.

1.5.6The Bandwidth of Textile Antenna

Bandwidth of a textile antenna may be stated as “the range of frequencies within which the pursuance of the antenna with respect to some characteristics, conform to a specified standard”. Bandwidth is a gauge of recurrence extends and is for the most part estimated in hertz.

$$BW_{broadband}(\%) = \left[\frac{f_H}{f_L}\right]100 \qquad (1.5)$$

$$BW_{narroband}(\%) = \left[\frac{f_H - f_L}{f_C}\right]100 \qquad (1.6)$$

Where,

f_H = is upper frequency

f_L = lower frequency

f_C = center frequency

1.5.7 Antenna Radiation Pattern

Antenna radiation design is a 3-Dimensional plot of its radiation along way by the source. Antenna radiation designs as a rule take two structures, the rise design and the azimuth design. The design of the height chart of the vibration transmitted from the radio wire takes the gander from it to the side as can be seen. The azimuth design is a diagram showing the energy transmitted from a receiving wire as if it were taking a gander at it specifically over a receiving device. The mix of the two diagrams demonstrates the 3-D outline of how vitality is emanated from the antenna. Different types of lobes are shown in below Figure 1.3(a) and (b). Back lobes and side lobes are not useful, they are undesirable.

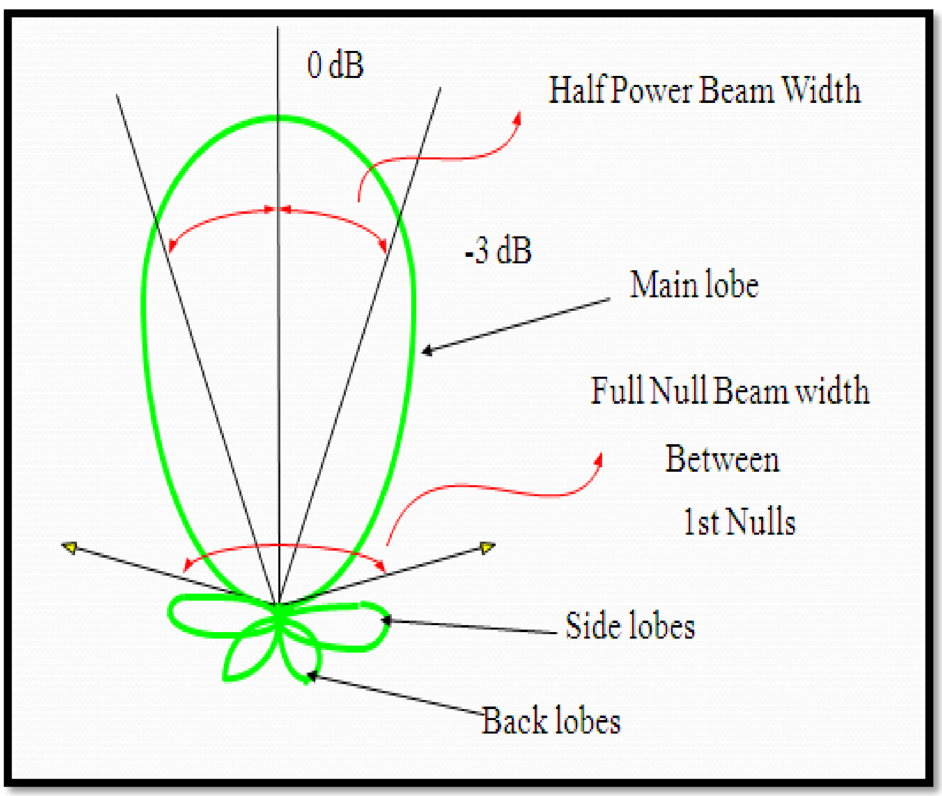


Figure 1.3 (a) Different types of lobes in linear plot of power pattern

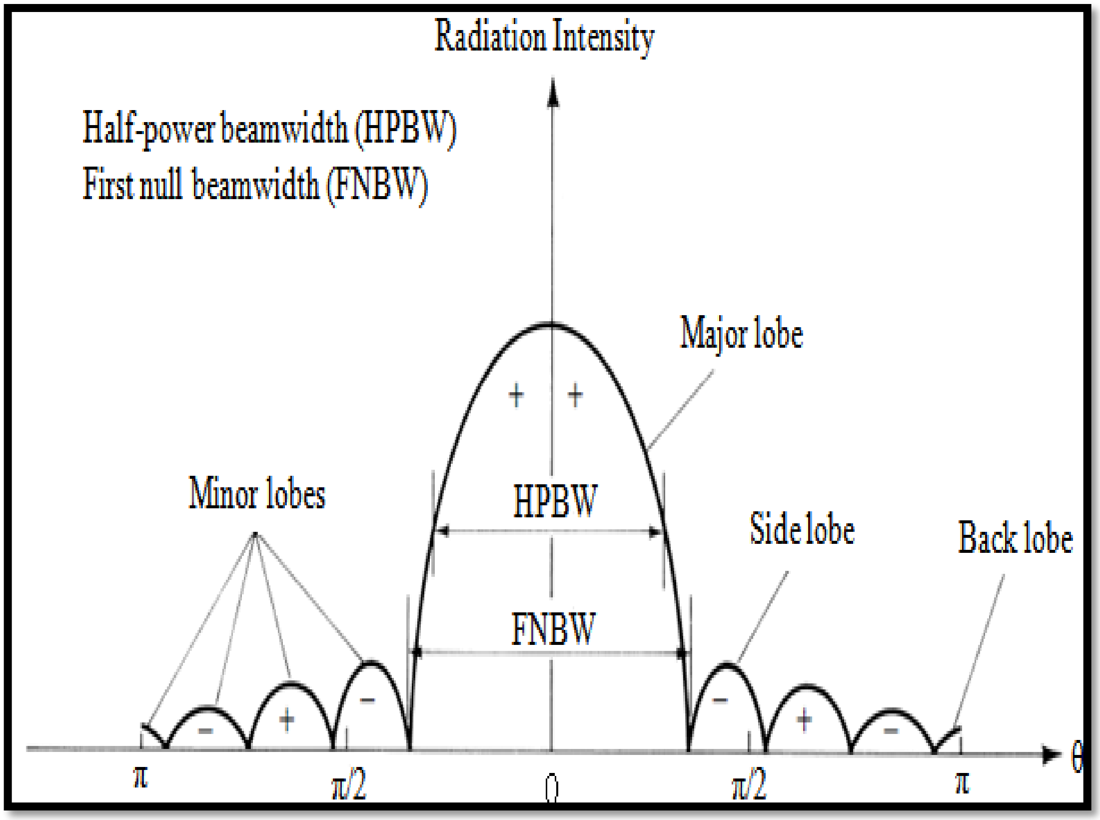


Figure1.3 (b) Different types of lobes in linear plot of power pattern

The radiation design of the antenna is a factor that greatly affects system analysis and performance. The radiation design of the antenna depicts how the antenna targets or directs the energy it radiates or accepts. Every antenna does not transmit more energy than delivered to its input connector. The radiation pattern of antenna is usually depicted as a polar plot with a 360 degree angular pattern on either of the two flashing planes and is represented on a dB energy scale, when field strength falls to 0.707 the maximum voltage in the middle of the lobe. Such points are called partial power points. Antenna side lobes, rear lobes and front to back ratio (f/b) are other important properties of radiation pattern. Practically, it is not possible to completely get rid of the side lobes and rear lobes. The lateral & posterior lobes affect the performance of antenna in a number of ways. Like the energy brought or transmitted by the lateral and posterior lobes from the other side than the expected region is therefore wasted. In transmission, the energy transmitted to the back and side of the lobes can be conducted to other acquisition pathways that cause disruption. After that receiver, power from other transmission sites can be detected by the back and side lobes causing disruption in the system.

The radiation pattern is denoted mathematically as:

$F_E(\Theta) = \cos[(\beta l/2)\sin\theta]$E-Plane with $\emptyset = 0$ (1.7)

$F_H(\Theta) = \cos\theta \sin[(\beta l/2)\sin\theta]((\beta l/2)\sin\theta)$,H-Plane with $\emptyset = 90°$ (1.8)

1.5.8 Power Gain

The ratio of the input power to the antenna from the output power of the antenna is expressed as the power gain. It is usually referred in db units. It is a measure of the power of a circuit to increase its power or amplitude of a signal from input to output.

1.5.9 Polarization

Polarization may be described as the reference point of electromagnetic waves a long way from the source. Electrical field and the attractive field are the two fields that emanate from the antenna. Radio wires contain vertical, even, and roundabout polarization are a few kinds of polarization that apply to and are most essential to get the greatest execution from the reception apparatuses [7].Polarization is also described as directing the space in the E-Field part (electrical vector) of an electromagnetic wave emitted by a transmission system. The low frequency antenna is usually vertical due to the effect of the ground (waves reflected) and the physical construction methods by the highest antennas are usually separated horizontally. Currently in electric waves used to radiate in field. Choosing and installing antenna, polarization is an important factor to consider. Almost all wireless communication systems are used in vertical and horizontal lines or separated circularly. By recognizing the differences between the polarizations may further increase the performance of entire system for the user. The spontaneous field of a planer wave, directed in the negative z direction, may be given as

$E(z,t) = a_x E_X(z,t) + a_Y E_Y(z,t)$ (1.9)

The components (instantaneous) are related to their complex counterparts by

$(z,t) = E_{X0}\cos(cot + kz + \emptyset_X)$ (1.10)

$(z,t) = E_{Y0}\cos(\omega t + kz + \emptyset_Y)$ (1.11)

Where Ex0 and Ey0 are, it defines them as the maximum magnitudes of objects x and y. In case of Linear Polarization, the linear antenna is vertically polarized where its electric field is perpendicular to the surface of earth. Vertical antenna is considered an AM radio broadcasting tower or car antenna. Horizontally linear polarized antennas are considered to be their electric field corresponding to the surface of earth. TV transmission used in USA, through polarization i.e. horizontal. Therefore, the television antennas are aligned horizontally. For a linearly polarized waveform, the difference between time & phase should be

$$\Delta\emptyset = \emptyset_Y - \emptyset_X = n\pi \qquad n = 0, 1, 2 \qquad (1.12)$$

In Circular Polarization the polarization plane rotates with a clock pattern by making one complete cycle in each wavelength. In Figure 1.4, a circular wave emits energy from horizontal, vertical planes and the entire intermediate planes. When the rotation is clockwise in the direction of propagation, such a type of behavior is called right hand circular. If the rotation is opposite the clock, the concept is known as the left hand circular.

Circular polarization may only be accomplished when the dimensions of the two objects similar and the time difference between them is different.

$$E_{X0} = E_{Y0} \qquad (1.13)$$

That is $\emptyset_Y = \emptyset_X = (+(1/2 + 2n)\,\pi$ n = 0,1,2,3.................. ….for CW

$= -(1/2 + 2n)\,\pi$, n = 0, 1, 2, 3………..for CCW

Benefits of circular polarization are:

- Radio signals are displayed or absorbed depending on the device they used to communicate with. Because like separate antennas that can "attack" a problem in only one surface, if the bright spot does not show the signal accurately on the same plane, that signal strength will be diminished. Like circular antennas sent and found on all surfaces, signal strength is not lost, but is transferred to a different surface and is still active.
- Programs with high frequency (e.g. 2.4 GHz and above) using linear polarization generally requires a clear viewing point between both points for working properly. These systems face difficulty entering the obstructions due to the reflected signals, which weaken the propagating signal. Reflected linear signals return to the propagating antenna that amplifies an opposite phase, thus weakening the propagating signal. On the other hand, polarized circular systems include the reflected signals, but the reflected signal is reversed, especially by avoiding collision with the propagating signal. The result is that circularly-polarized signals are best for bending and penetrating around obstructions.
- Multi-path is responsible because when the primary signal and the reflected signal reach the receiver at the same time. In such case it creates a problem of "out of phase". Receiving radio

should use its resources to differentiate, edit and process the appropriate signal, thereby reducing efficiency and speed. Linearly Polarized antennas are more prone to reflection due to higher reflection.

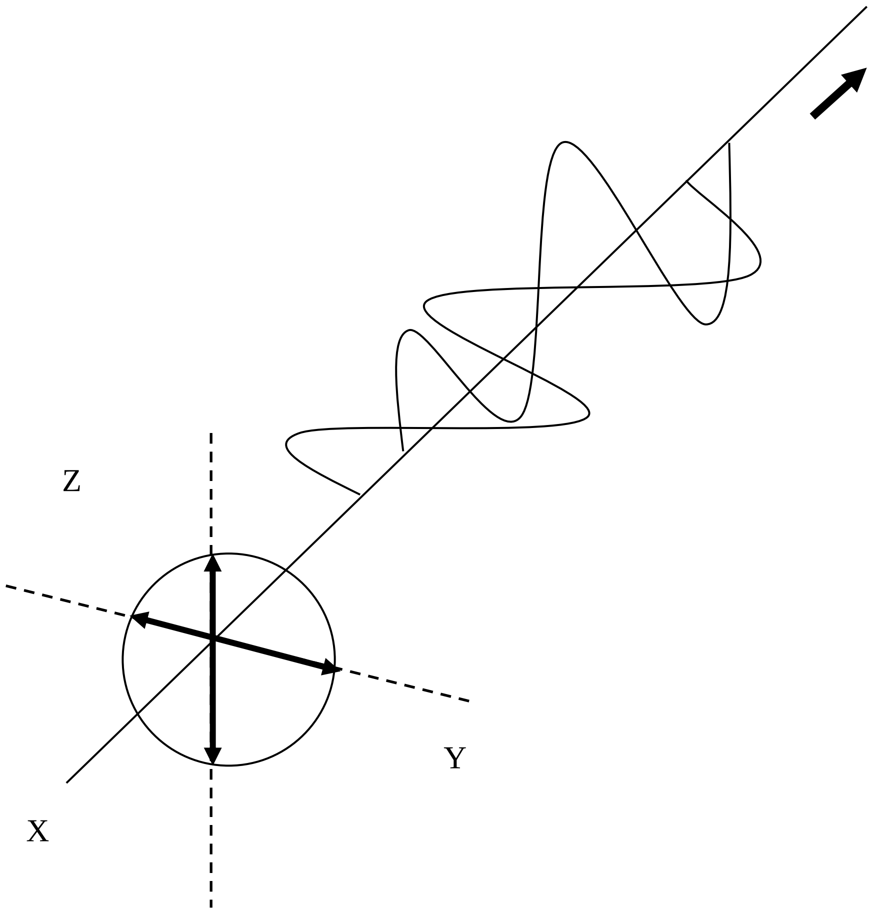


Figure 1.4Circular polarization

1.5.10 Intensity of radiation

Energy radiation from an antenna per unit solid angle in a given direction is denoted as the intensity of radiation of any antenna. At a given point it is normally achieved by the product of density of radiation and the square of distance from the radiating element is denoted as:

$$U = r^2 W_r \qquad (1.14)$$

Here, U means radiation Intensity and r is distance (in m) and W_r is radiation density (in W/m^2)

1.5.11 Radiation Efficiency

Antenna is a radiating element and it grasp a definite amount of power at its input, a part of it is lost in it and remaining power is transmitted. If the magnitude of the input power in the antenna is felt as a loss in the antenna and only a few of it is passed it is said to have low radiation power. Antenna emits low power due to reflected power leading to low impedance or decay of power ohmic loss due to high resistivity of radiating element and energy lost due to dielectric loss [9]. Mathematically the efficiency of radiation is expressed as,

$$\eta = \frac{\mathrm{Pr}}{Pt} \qquad (1.15)$$

Improving impedance disparity and using materials with low resistivity increases the radiation efficiency. Also choosing appropriate height for substrate can give best radiation efficiency.

15.12 Radiation Mechanism

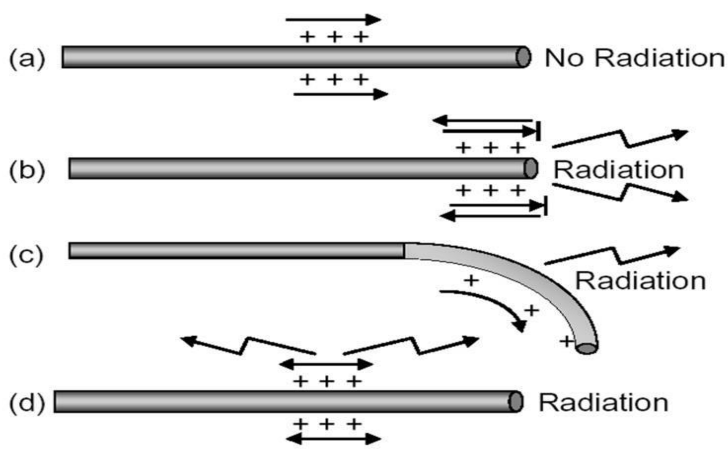


Figure 1.5 Conditions for radiation

When the cost of electricity tolerates acceleration or deceleration, electricity will be generated. So the movement of charges, that is the currents, is the cause of the radiation. Here it may be tinted that, not all current distributions will produce a strong enough radiation for communication.

- There should be a time-changing current (di/dt) or a hastening (or deceleration) of the Q-radiation charge (electric field).
- No radiation or stream will be created if the charge is not poignant.

- If the wire is straight there will be no radiation and unlimited size and moving at the same speed.
- If the wire is arched, bowed, irregular, ended, or shortened, there will be radiation.

1.5.13 Directivity

It can be termed as part of radiation intensity with an area in the direction set for radiation throughout the track. The average intensity of radiation or the intensity of radiation of isotropic source is given by the ratio of the radiated power by the antenna when divided by *4*.

Directivity is calculated as:

$$D= U/U_0 = 4U/P \qquad (1.16)$$

Here D equals directivity of antenna, U means directed emission, U_0 equals isotropic source emission intensity, P means radiated power and it's constant and is equal to 3.14.

1.5.14 Gain

An isotropic antenna emanates consistently toward all path. A directional antenna transmits a preset way. Pick up of a reception apparatus is the relative measure of energy transmitted the favored way by the radio wire, when contrasted and an isotropic receiving wire. The gain and radiation efficiency are related as:

Gain= Radiation efficiency* Directivity

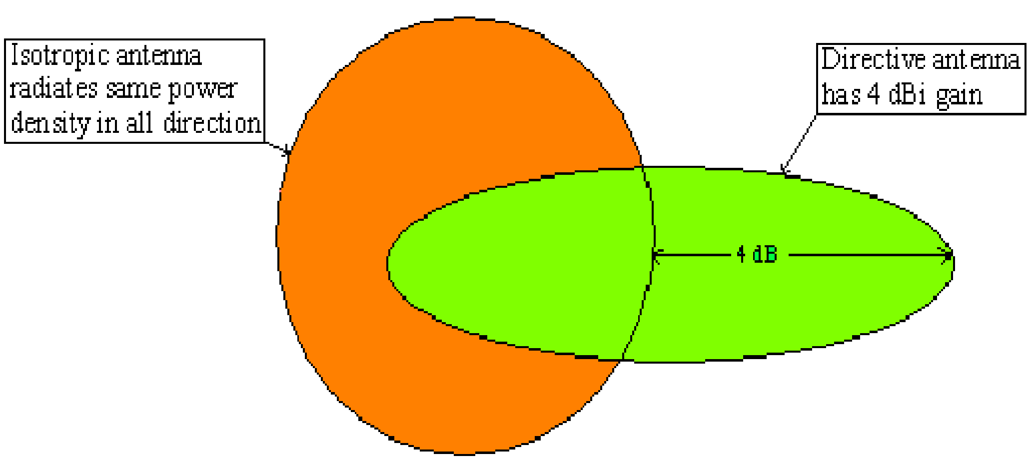
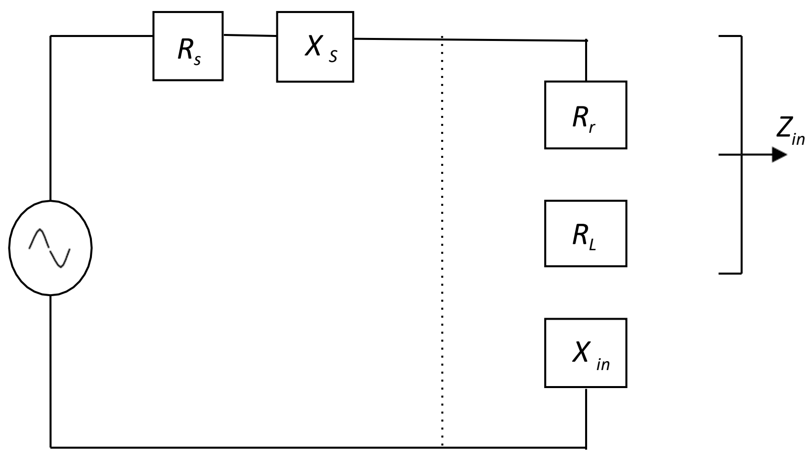


Figure 1.6 Representation of Gain

1.5.15 VSWR- Voltage Standing Wave Ratio

It is required that for the antenna to work properly, a high power transfer must take place between the transmitter and the antenna. High power transmission is only possible if the impedance of the the antenna Z_{in} corresponds to that of the transmitter Z_S. Therefore, the state of impedance matching is actually a measure of the impedance variation between the transmitter and the antenna. The bigger the inconsistency, the higher the voltage standing wave ratio and the low voltage standing wave ratio value corresponding to the full match unity. In the case of a design an operating antenna it must have an input impedance of between 50 Ωto 75 Ω since most radio application equipment is designed for such impedance, indicating that all the events in the antenna are reflected back. For active use, the voltage standing wave ratio equal to 2 is sufficient, as this is similar to the $R_L$of -9.54 dB.



Transmitter Antenna

Figure 1.7 Equivalent circuits for VSWR

1.5.15 RL - Return Loss

Return Loss is a criterion that shows the amount of lost power in the load and do not return a signal back to the antenna. As discussed in the previous section, the waves are radiated in the formation of stationary waves, where the transmitter and antenna impedance are not very similar. Return Loss is therefore a parameter like VSWR that shows how similarities between the transmitter and antenna are fully integrated. Return Loss is rated as by [6] is given below:

$$RL = -20\log_{10}\Gamma \text{ (dB)} \qquad (1.17)$$

1.6 Types of Antennas

Antennas are available in a variety of types and shapes to suit different types of wireless applications. The properties of the antenna are largely decided by its shape, size and type of material. Antennas used widely are summarized as:

1.6.1 Wire Antenna

Wire Antennas are like a normal person. They are used everywhere in cars, buildings, ships, planes, space and more. Different shapes of the wire antennas are straight wire, loop and helix. They can form a rectangle, ellipse, square or different configuration.

1.6.2 Aperture Antenna

Due to the increasing demand for more sophisticated form and the use of antennas in the opening of higher frequencies can be very common to the average person. These antennas are used for spacecraft and aircraft. They can be easily transported and placed on the skin of the plane. Such antennas can be protected from natural hazards that cannot be covered with diesel material.

1.6.3 Microstrip Antenna

In 1970, a microstrip antenna was discovered for aero-space-based applications. These days they are used for commercial and government systems. Such antennas contain a piece of metal on the base substrate. Various types of patches, such as rectangles, circles, rings, are employed in various systems. The benefits of microstrip antennas are low weight, low profile, easy mass production, low production costs, easy integration with other circuits, and a wide range of variants. It is not expensive to design using modern printed circuit technology, strong strength when placed in rigid environments, compliant with MMIC designs, and highly flexible depending on the frequency of resonant, polarization, pattern, and impedance. Such antennas can be mounted on more efficient aircraft, space, satellites, missiles, cars, and mobile phones. The main drawback of microstrip antennas is their low efficiency, low power, high Q, approximately over 100 and poor polarization.

1.6.4 Array Antenna

The term array is usually reserved for layout where the independent radiators are different and similar term is used to define the accumulation of radiators housed in a regular arrangement. Most programs desire radiation features that are not available in an individual item. The topology of the same components is the radiation from an antenna adds to extend the radiation size to a specific direction(s), minimal to another, or as desired.

1.6.5 Reflector Antenna

Because of the need to communicate over long distances, a complex type of antennas had to be used to transmit and to receive signals that could be used to travel millions of miles. The standard antenna form for such an application has come to the view of the antenna, it is parabolic reflector. These antennas are built up to 305 m wide. Such a large size is required to achieve the maximum profit required to transfer or receive signals after millions of miles of travel.

1.6.6 Lens Antenna

A good antenna will deliver all the power delivered to it from the sender to the desired location. Lenses are mainly used to combine different forces of events to prevent them from spreading to unwanted areas. By carefully shaping geometric shapes and selecting the right lens equipment, they can convert different types of diverging energy into uniform waves. These are used in many similar applications as parabolic reflectors, specifically at high frequency. Its size and weights are the largest at lower frequencies.

1.6.7 Wearable Textile Antenna

Wearable antennas are used for opportunities for ubiquitous monitoring, communication and energy harvesting and storage. Planer design and flexible building structures are a basic requirement for wearable antennas. Forgetting the good effect, the wearable antennas should be thin, lightweight, lightly kept, sturdy, inexpensive and easy to use with radio circuits (RF). Feed lines and similar impedance circuits in a standard object with multilayered board. The micro strip patch antennas are an excellent antenna for body-worn applications, because they radiate on the planer design of the antenna and its ground plane with great success. The bandwidth frequency and efficiency of the antenna i.e. micro strip are indicated by the permittivity and size of the substrate material. Textile wearable materials are used as substrates. Also, small details can be investigated with the electromagnetic properties of standard fabrics. Fabrics show low dielectric constant that decreases wave loss and increases antenna impedance bandwidth. Fabric materials, widely used and readily available, are materials for building wearable antennas for applications within and on body area networks. Fast development of antenna increases Wireless communication technology. Wearable antenna is widely in application for wireless network for mobile communication, navigation, medical field and military. Flexible wearable systems require a combination of flexible antennas that operate mainly selective band frequencies to provide wireless connectivity in the most sought after area of the modern world

1.6.8 Stacked Textile Antenna

It is made up of a sandwich of two parallel conductors separated by a single thin dielectric substrate. The lower conductor acts as a ground plane and the top conductor represents the radiating part. It's an amazingly simple and easy to do way to fabricate. Various methods have been used to raise bandwidth. A way to eliminate this difficulty is to install a second patch in front of the basic object called a stacked micro strip patch antenna. The concept of stacking patches with Electromagnetic coupling form that provides higher bandwidth. The accessible bandwidth of the micro strip antenna is approximately equal to its volume. Moreover it is possible to boost the frequency bandwidth of the micro strip antenna by simply using a thick substrate. A thick substrate in size supports the surface waves that affects the radiation pattern and reduces the efficiency of the antenna radiation. The top and bottom marks are called the radiating patch and feed patch, respectively.

1.6.9 Half Wave Dipole

Half wave dipole as per its name suggests contains the physical length having length becomes equal to half of its wavelength. In such condition dipoles may small or large in comparison with half the wavelength, actually there is a tradeoff for the performance that makes the half wavelength dipole to be used mostly. Such type of antenna is connected with transmission line which contains two wires; here as currents, which flow in the conductors having sinusoidal in nature and are same in amplitude, on the other hand it contains in opposite direction. Finally, because of the nullified effects, no radiation takes place through the transmission line. As given in figure 1.8 the currents carrying dipole have through the similar direction and the radiation through the horizontal direction is generated. In such situation for a vertical orientation, the dipole radiation will occur in the horizontal. The resulting gain dipole is about 2.4 dB and it has arrange of frequency of about 12%.Thehalfpowerbeamwidthisalmost77degreesintheEplaneand itsdirectivityis1.64, being a radiation resistance of 75Ω [4]. Figure 1.9signifies the radiation pattern for a half wave dipole antenna.

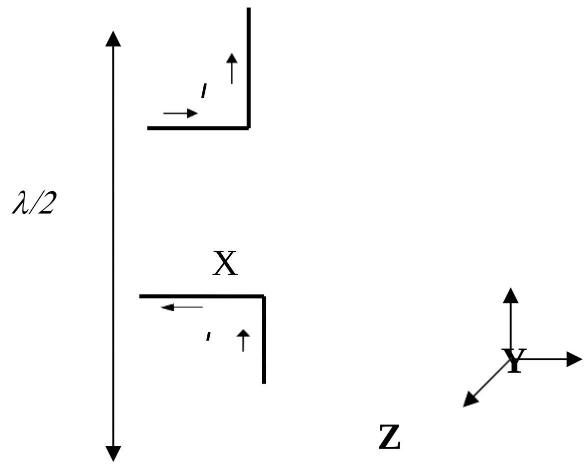
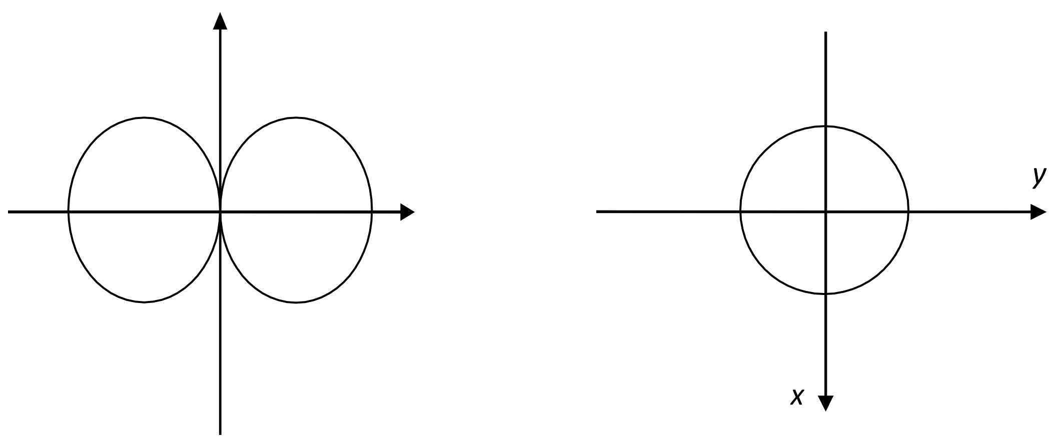


Figure 1.8 Half Wave Dipole



Elevation Azimuth

Figure 1.9 The radiation pattern for Half wave dipole

1.6.10MonopoleAntenna

Monopole antenna is shown in Figure 1.10, which is designed by using the image concept for the dipole. According to this concept, in case of a conducting plane if it kept down the single element having dimension of L/ 2 capable to produce a current, in such condition the combined element as well as and its image work as a dipole of length *L* and in such condition that the radiation pattern is generated only through space above the plane will examined by researchers [8].

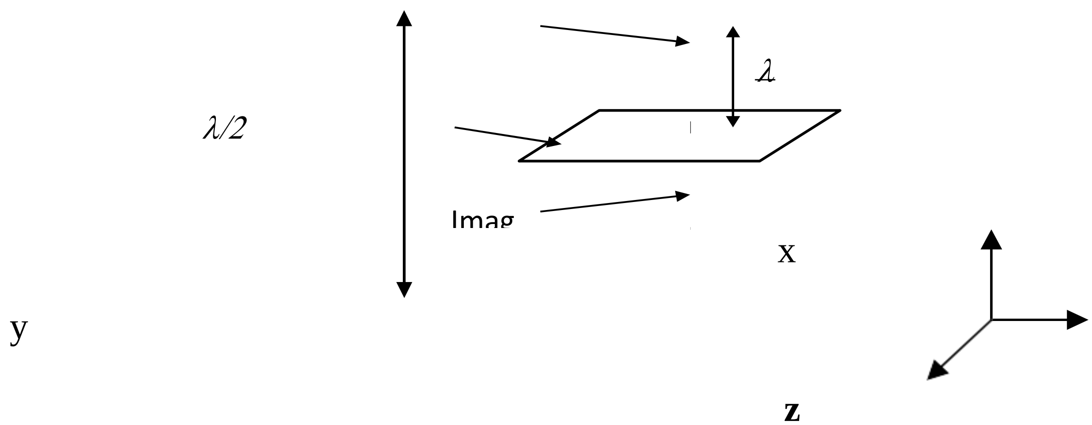
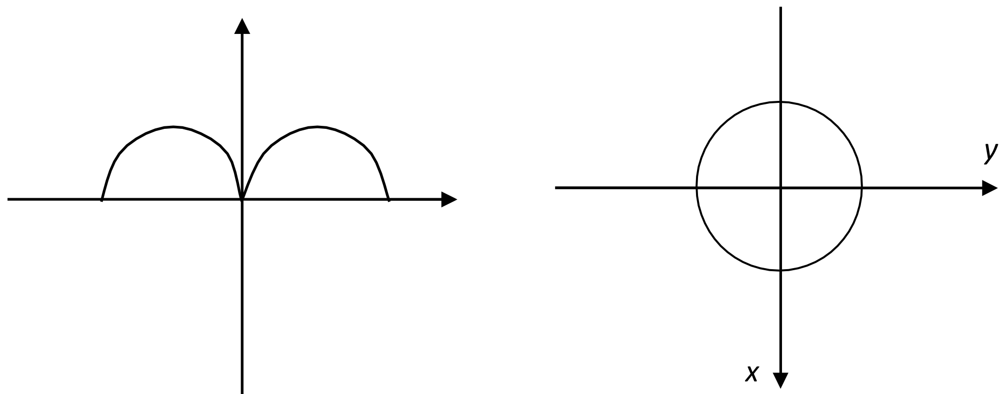


Figure 1.10 Monopole Antennas

In such type of antenna, the propriety known as directivity is increased by two times and the radiation resistance is reduced by half in comparison with the dipole. Conceptually a half wave dipole generally considered as a quarter wave (L/ 2 =λ/ 4). The type of monopole is useful for application as antennas in the case of mobile on the other hand the conducting plane must be car body or handset case. The gain for a monopole having quarter wavelength is 1-7dB and it contains a range of frequency of 11%. It contains radiation resistance of 35.6 Ωhaving directivity of is 3.28 (5.16dB) [4]. The monopole and its radiation pattern is given below in Figure 1.11

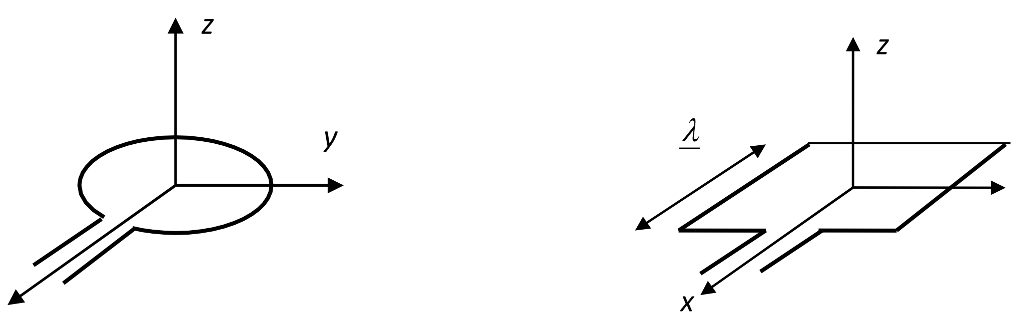


Elevation Azimuth

Figure 1.11 The radiation pattern for Monopole Antenna

1.6.11 Loop Antennas

Such antenna have in a shape that a conductor is modified by the shape like a curve with closed structure like a circular or a square having a gap with conductor to become by end points as per the given Figure 1.12. Loop Antenna is having two types such as electrically small loop antennas and electrically large loop antennas. In case of gross loop of a loop antenna circumference is considered small in comparison with the wavelength of the signal ($L<<<\lambda$), in such condition the loop antenna is considered to be electrically very small. On the other hand if loop antenna is considered as electrically larger in such situation its circumference becomes very closer to a wavelength. If we observed the field patterns of radiation with a very small loop antenna then it is seen that patterns are insensitive to not only shape but also its structure [4].



Loop Antenna with Small Circular structure Loop Antenna with Large Square structure

Figure 1.12 Structure of Loop Antennas

From Figure 1.13, it is clear such radiation patterns of such type of antenna are very similar to dipole such that the fact well known that the structure of the dipole is seen to be vertically polarized on the other hand the structure of the small circular loop antenna is seem to be horizontally polarized.

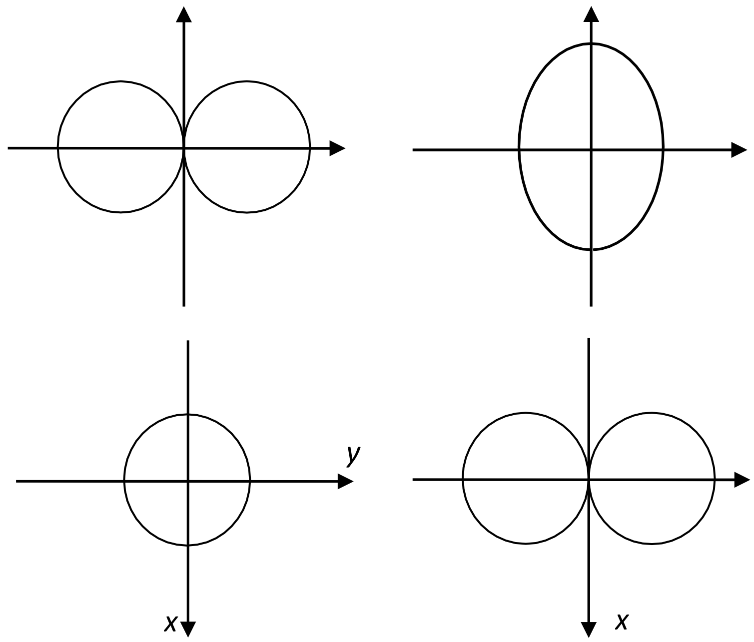


Figure 1.13 Radiation Pattern of Small and Large Loop Antenna

Loop antenna working performance can be improved through ferrite which is filled in the core with ferrite. By adopting such process, we can increase the radiation resistance which an antenna developed. In case of the perimeter or circumference which is developed by loop antenna becomes approximately equal to a wavelength height, in such condition the antenna is defined as large loop antenna.

If we compare the structure of radiation pattern of the massive loop antenna with smaller loop antenna then it is seen that both have different shape. In case of a single wavelength having square loop antenna, in such situation radiation is considered as larger which is normal with the loop throughout the z axis. In this loop antenna a lobe has direction perpendicular through the side which contained the feed with y axis, in such situation a null in the arrow parallel to the part containing the feed throughout the x axis. Such antennas mostly contains outcomes in between having -3dB to 4dB having frequency range of nearly 12%. For purpose of receiving a signal small loop antenna is preferred [4]. In pagers and multi turn loop antennas as well as in AM broadcast receivers single turn loop antennas are preferred.

1.6.12 Helical Antennas

The antenna having helical shape with material type conductor is fixed with a ground plane, known as helical antenna. Such type of a helix antenna is shown in figure 1.14. The helical antenna has quality to operate in different types of modes, but in such satiation there are two important principal modes known as the normal mode (having broadside radiation) other one is the axial mode (having end fire radiation). In case of special condition if the helix consists of very small diameter in comparison with the wavelength, in such condition the antenna forced to operates with the normal mode. On the other hand, if the boundary of the helix consists of the same magnitude of a wavelength, in such type of situation the helical antenna is known to operate in the axial mode. Both mode of operation are very important and have variety of applications.

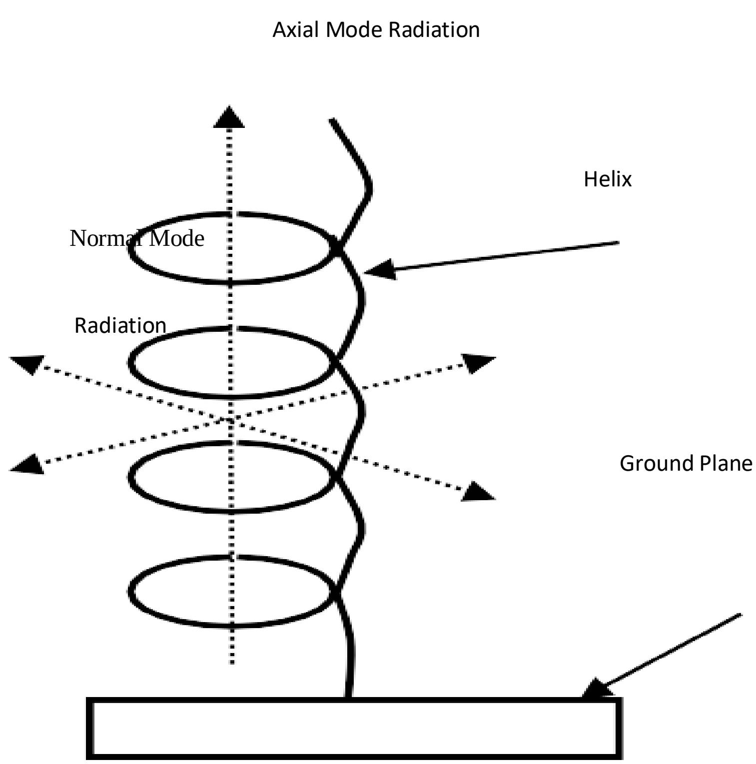
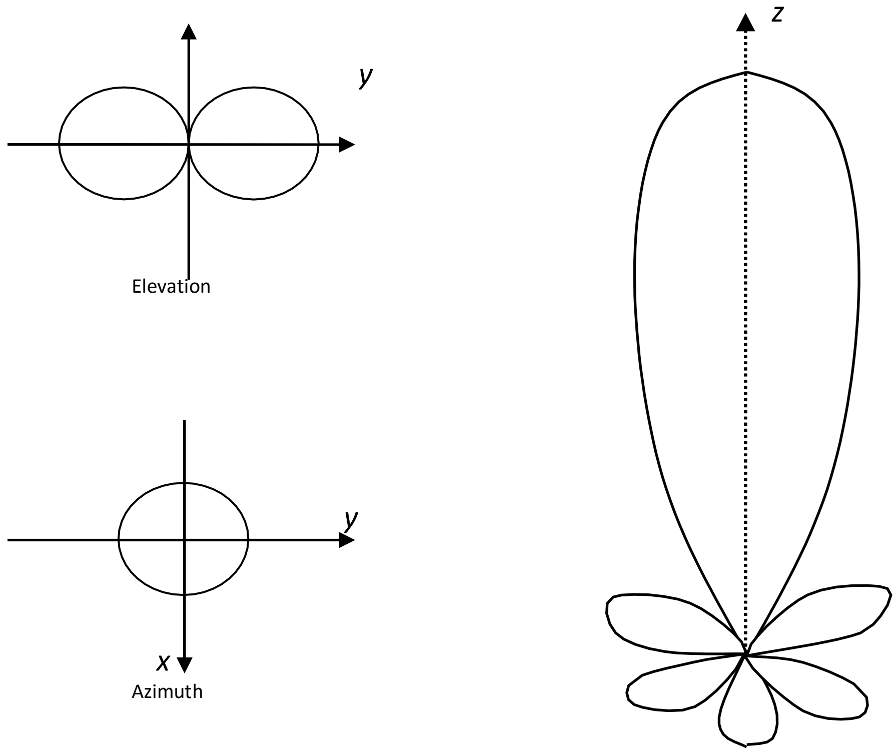


Figure 1.14 Helix Antennas

When helix are forced to operate in the normal mode, in such situation the pattern of the antenna is observed highest in plane normal with the helix axis and it is observed as minimum through its axis. In such situation mode supply smaller bandwidth so it is mostly preferred in case of the application of hand-portable mobile [8].



Normal Mode Axial Mode

Figure 1.15 Radiation Pattern of Helix Antenna

In case of antenna working with the axial mode, the helix works like end fire radiation pattern having single beam through a helix axis. In such type condition mode has quality to generate good gain (up to 25dB) [4] and better bandwidth aspect (1.7:1) in comparison with the normal mode of operation. In such condition of operation, such mode generates very narrower beams if in case of helix the number of turns continuously going to increasing. And because of its broadband behavior, such type of the antenna for the case of working in the axial mode are large number of applications some of them as satellite systems. Figure 1.15 above indicates the radiation patterns as a helix in case of normal mode as well as axial mode of behavior as well.

1.6.13 Horn Antennas

Such type are antennas mostly work in the frequency range of gigahertz with microwave region and in such condition feed method used in Horn antenna are by waveguides having standard feed, as we know that horn antennas have a waveguide for feeding purpose that's end point walls are made in the shape of flared with outwards in order to make its structure like megaphone.

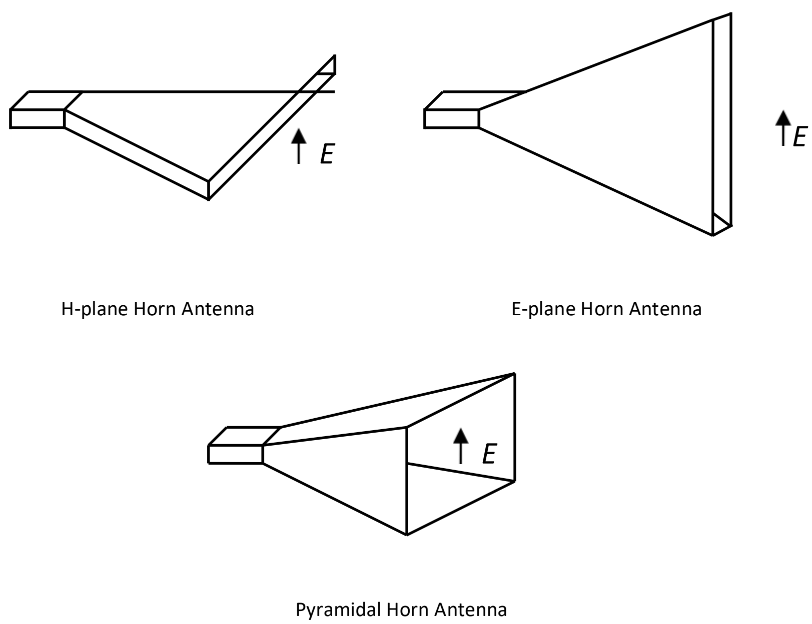


Figure 1.16 Horn Antenna Types

Horns antenna provides larger gain, with very low VSWR, with larger bandwidth of operation, having minimum weight, and have capability to construct very easily [4]. The horn antenna has special characteristics that it can be of various shapes like rectangular, or circular or elliptical. But generally, for experimental application rectangular horns are preferred in comparison to other shapes. The different types of horn antennas which are capable to utilize a shape of rectangular are shown in Figure 1.16. Such type of horns antenna is fed through waveguide of rectangular type having broad as a horizontal well which are given in the figure. In order to dominant the waveguide mode excitation, the field mode polarization occur as E-plane with vertical and H-plane with horizontal polarized. In the condition of the broad wall being dimension on the system of horn becomes flared through a narrow wall through waveguide which being left, in such situation the process known as an H-plane sectoral horn antenna which is given in the diagram. In case of the flaring occupy through the E-plane depth, known as an E-plane sect oral horn antenna. A pyramidal shape of horn antenna is utilized by flaring which obtained through twain of the dimensions. The horn is utilized to perform as a transition through the mode of the waveguide in case of the free-space mode and such type of condition is utilized to reduce the of the reflected waves and used to emphasizes the case of traveling waves that is responsible for minimum VSWR as well as larger bandwidth [4]. The horn type of antenna is mostly utilized as element for the purpose of feed in case of large radio astronomy, for the purpose of satellite tracking, as well as in communication dishes. In above paragraphs, different types of the antennas have been described. Some different type of application based antenna is the Microstrip patch antenna. The main purpose of such research is to implement a wearable textile antenna which is utilized in communication systems and such type of antenna is described in the coming section in the thesis.

Table 1: Comparison of different features of the Microstrip Patch Antennas

Features	**Microstrip Patch Antennas**	**Microstrip Slot Antennas**	**Printed Dipole antennas**
feature	Very lean in nature	Very lean in nature	Very lean
Development	Through very simple process	simple process	Also very simple
Nature of Polarization	It is linear as well as circular polarized	It is also linear as well as circular polarized	It is only linearly polarized
Possibilities of Dual-Frequency	Exists	Exists	Exists
Variation in Shape	Capability to occupy any type of shape	Rectangular as well as circular	It has fixed rectangular as well as triangular in shape
Spurious Radiation	Possible	Possible	Possible
Frequency range	2-49%	4-30%	≈29%

1.7 Possessions of Antenna on Body of Human Being

Non-ionizing radiation (sound waves, unmistakable light and microwaves) does not have satisfactory vitality to ionize atoms or particles however the vitality is sufficiently abundant to move molecules or influence them to vibrate. In this manner, the non-ionizing radiation can have satisfactory vitality to move human cells and raise the temperature of these cells. SAR simulations applications use the advantage of CST MWS.

- For SAR verification and antenna design only one tool is used.
- Major participation in IEEE standard committees and other various standards.
- Evaluation and intuitive handling of SAR calculation

Fig 1.17: Specific absorption rate

$$SAR = \frac{P}{\rho} = \frac{\sigma E^2}{2\rho} = \frac{J^2}{2\rho\sigma} \qquad (1.18)$$

1.7.1 Specific Absorption Ratio (SAR)

RF energy occupy in unit mass of a biotic body is called Specific Absorption Ratio, shown in fig.1.4.

- If we eradicate mass or volume averaging from local SAR then it is known as point SAR.
- When the whole lossy structure is divided by its entirety mass then it is called total SAR.
- When the total power loss in the entire lossy structure when divided by its preset volume then it is called as Volume Averaged SAR.

Table 2: Extreme of mass averaged SAR

In US and Canada, the mass averaged SAR	1.59 W/kg through 1.4g of tissue
In EU, Japan, Brazil mass averaged SAR	1.99 W/kg through 9.89 g of tissue

1.8 Antennas Working

Like all reception apparatuses, fix receiving wires came in setting since streams in a conductive surface prompt electric fields in the encompassing space. There are two fundamental factors about how a fix reception apparatus thinks about to other radio wire. Primarily radio wires are most usually contrasted with dipole receiving wires since they are the least complex to investigate which is likewise valid for fix reception apparatuses. In a fix radio wire the edge of the reception apparatus acts like a dipole receiving wire, inciting an electric field opposite to the transmitting edge. While the emanating edges are opposite to the E field plane the measure of the fix is likewise exceptionally surprising because of the way that a mode will be set up in the hole underneath the fix which decides the state of the streams and the shape. The state of the pit underneath the fix is extremely basic since this additionally decides the information impedance of the reception apparatus, influencing the data transmission of the fix. The modes underneath the fix reception apparatus can be broke down much like a standard cavity; this likewise reflects why fix radio wires have a tendency to have a tight data transfer capacity – their inner structure is much similar to a tuned pit.

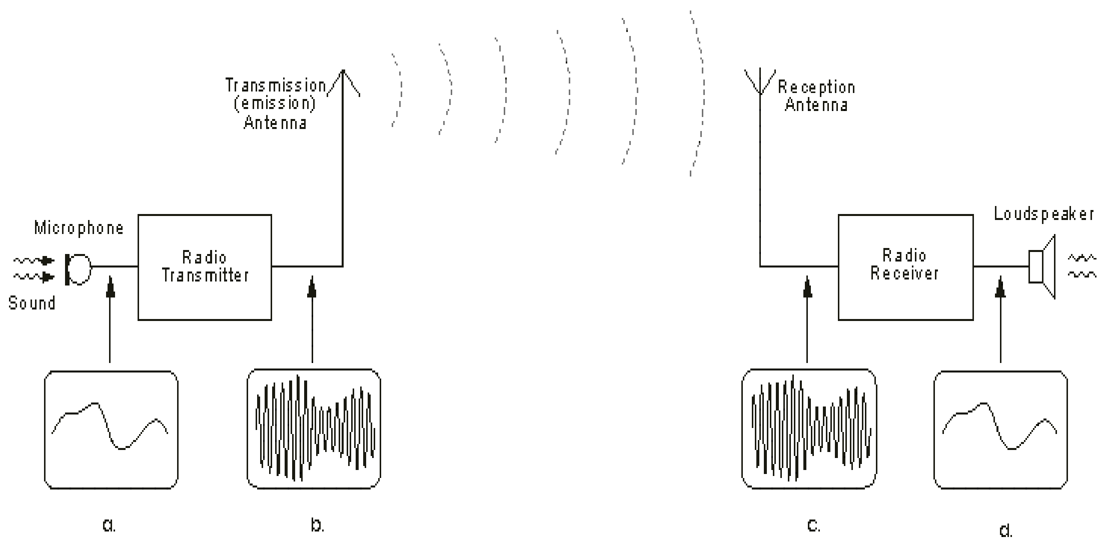


Fig 1.18: Working of antenna

After a RF flag that are produced in a transmitter, a few items has been utilized for the emanate of such flag by the space for beneficiary. The gadget which is capable to do this work is the receiving wire. The flag of the transmitter vitality is used into space through the transmitting reception apparatus; the radio frequency flag is then taken by using space as getting receiving wire. The RF vitality is used to transmit through space as an electromagnetic field. It is well known that the time varying electromagnetic field picked up through the accepting receiving wire, a energy in the form of voltage is initiated at the receiving end apparatus (as conductor). The RF voltages prompted through the radio wire are then entered into the beneficiary and make turn changed once more into the transmitted RF data.

1.9 Advantages

- Microstrip antennas have light weight.
- It has low profile configuration and may be in reality made.
- It may be manufactured in massive quantities because of fewer prices.
- This antenna has round and linear polarization.
- It may be without difficulty fabricated.
- It may be applied in different band of frequency.
- When it is installed on difficult surfaces it works mechanically as robust.
- It can be utilized in clinical field.
- Superior performance in atypical modes (TM12)

1.10 Disadvantages

- Less transmission capacity.
- Moderate effectiveness.
- Medium Gain.
- Surface wave excitation.
- Poor scanning performance.
- Poor polarization purity.
- Less power handling capacity.
- High Q (Quality factor) around 50 to 75.

But in government security networks where less bandwidth is essential, this disadvantage is noted as the benefits of the MPA.

1.11Applications

Microstrip antennas have many applications relies upon on its diverse kinds. Because of its skinny profile and low price, smart weapons structures Microstrip patch antennas were used widely on conversation linkage between deliver and satellite TV for pc consisting of GOES and SMS [1]. Here are some applications of MPA are listed below:

1. Navigation and various communication systems, landing system, altimeters.
2. Radar, proximity fuses telemetry.
3. Vehicle-based antenna, in DTH TV systems.
4. Mobile vehicle, hand and pagers telephones, man pack systems.
5. Medical applications.

1.12 Research Gap Identification

1- In order to test a textile antenna in ultra-wide band uses.
2- In order to maximize the frequency of textile antenna.
3- The CST software will be used to design the anticipated antenna.

1.13 Various Steps used to fulfill the proposed research work

The various steps for the experimental work consist of the following different important points:

1. In the beginning of the project review of the Textile antenna technology is taken. This comprises the feature of not only VSWR but also reflection coefficient, as well as input impedance.
2. By various literature surveys, various slotted shapes are provided. This is useful for the size of the patch.
3. Further choose the relevant substrate material. Such type of important information is utilized in order to check the characteristics and outcomes of the experimental antenna.
4. The software used for numerical simulation is CST.

1.14 Major Input (Infrastructure) Required

1. Software – CST (Computer Simulation Technology)
2. Substrate and Conducting Material such as Jeans.
3. To observe and analyze the antenna performance,
4. By using simulation result we can calculate the impedance, return loss, bandwidth, for the anticipated antenna.

1.15 Organization of thesis

Chapter 1: Describes the introduction of microstrip patch antenna and wearable textile Antenna, Including the types of antenna and Antenna parameters, Antenna concept working Principle, properties and disadvantages of microstrip Antenna are presented.

Chapter 2: Describes the literature review of the Microstrip patch /wearable textile antenna, in Which complete review of antenna including the basic geometries, feeding methods, Transmission line model and cavity models and enhancement of bandwidth, gain, return loss for different application are presented.

Chapter 3: Describes the fundamentals of microstrip patch Antenna, models of microstrip patch Antenna, different feeding techniques, applications, advantage and disadvantages of Microstrip patch antenna.

Chapter 4: Describes the fundamentals of textile Antenna; various textile materials used for Wearable antenna and description about materials used for substrate.

Chapter 5: Describes the designing of wearable textile antenna and result analysis and steps of designing bendable textile antenna.

Chapter 6: Describes the fabrication and experimental results, comparison of simulation and measured results with the other research work.

Chapter 7: Describes various application of wearable textile antenna in day to day life.

Chapter 8: Describes the outcomes of this research work as well as future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Survey of Textile Antennas

Balanis C A in 2004 discussed that for effective antenna application in defense services smart clothing and devices are mostly used. In defense services if huge as well as heavy devices used by soldiers it may create hindrance for mobility and because of mobility any enemies can very easily target the soldiers. So because of these issues it is required that a very compact and imperceptible, having very delicate with having desegregate with wearable system must be used in order to make more secure to the soldiers. There is different scope like E-textiles and smart clothing's in different applications such as sports, for monitoring of health, astronauts, for military, in case of emergency workers such as in case of bomb diffusing squad as well as for fire fighters and in case of various industry like entertainment. In case of clothing as antenna it will be very simple to accomplish through embracing as well as integrating required electronic parts. If we compare with hand held electronics devices such type of wearable devices are on upper edge because of the fact that such devices provide free hands and peoples are able todo their tasks freely.

Ivo Locher et al. in 2006 suggested various textile antenna for Bluetooth technology by utilizing the frequency of 2.4 GHZ. The fabric and the shape of antenna can give an easy access to an incorporation of fabric into the antennas. For this they have used 4 different types of materials and made antenna with microstrip feed technique. The suggested antenna reflects good parameters of antenna and they are very easy in terms of fabrication.

Kausik Bal et al. in 2009 suggested a review article on estimation of relative permittivity of textiles and concludes that new estimation methods need to be developed for textile materials. Time domain reflectometry technique has been explored to calculate the relative permittivity dielectric properties of textiles.

Shaozhen Zhu & Richard Langley in 2009 displayed the exhibition of a double band co planar patch antenna correlated through an electromagnetic band gap substrate. The designed antenna configuration is composed by straightforward dress texture working at 2.45GHz and 5GHz remote groups. The plan of coplanar antenna, substrate, and their incorporation is shown.

Band gap cluster comprises simply 3x3 components however diminishes radiation through body by more than 10 dB and increases the gain of antenna by 3db.

S. Sankar lingam & B. Gupta in 2005 presented the design, creation and evaluation of flexible rectangular shaped microstrip patch textile antennas for Bluetooth applications. The antenna demonstrated is effective and it can operate at different chosen frequencies. Furthermore, other famous and popular techniques for enhancing bandwidth and direction for patch antenna which will be best recommended for textile antennas. This it can be said that textile antennas can easily replace the old PCB substrates.

S. J. Boyes et al. in 2010 examined that how efficiently this compact antenna performs on living beings. Firstly, they laid emphasis on the selection of material because it has a typical and complex crucial frequency detuning and the efficiency levels, as compared to the fabric antenna. So, this can be a major reason for the selection of these compact designed antennas. Another valid reason could be that how an antenna performs in tough situations. Because it shows that in some scenario a very little distance can also affect the performance of an antenna as compare to free space.

Jung Sim Roh et al. in 2010 presented a flexible wearable antenna which has many resonant frequencies and which is shown for the receiving of Frequency waves with the help of utilizing radiating woven threads on a polyester substrate.

N. H. M. Rais et al. in 2009 presented a review article and said multiple features must be taken into consideration while structuring a textile antenna. As compared to typical PCB antenna there are many options available in textile antenna and one can select material as per their requirement. So many experiments have been done so far to check the power absorption of wearable textile antenna in human beings. The SAR will be the most important consideration while designing the Wearable textile antennas. Hence, these antennas will evolve more and more with time as it is the need of wireless communication.

P. Vanveerdeghem et al. in 2011, proposed a method by which we can reduce the power need for the antenna. These specifically designed antennas have fabric as their substrates which are making them very useful and reliable and results can also get validation. The transmission and reception both will be precise and accurate for improving the way of communication.

Rita Salvado et al. in 2012 presented a survey on the materials utilized for implementation of textile antennas. They made a conclusion that the antenna designed are majorly plane on the surface so that they can transmit the power perpendicularly to the planar structure of patch antenna with microstrip feed line. Hence, their characteristic has been examined by the thickness of the substrate material used.

H. A. Rahim et al. in 2012**,** proposed a compact and easy design of the antenna utilizing conductive textile. Proper Copper Polyester Taffeta Fabric is used as a conductive textile, in comparison with typical microstrip monopole antenna. The prototype is designed with 40mm x 60mm, the total dimension and spaced by a 2mm thick felt fabric for the devices which mainly focusing on Body-Centric Wireless Communications and works on the frequency range of 2.45 GHz.

Sweety Purohit et al. in 2013 also presented an article on flexible wearing computing technology and concluded that this type of antenna has major advantage in the sectors like defense services, medicine professionals, and emergency situations and for people suffered with natural calamities. Textile antenna might be used as a link among the machines or human being. Here they used fabric for designing the substrate of antenna and therefore it becomes an integral component of wearable computing. Relative permittivity of the material should be for reducing the losses occurred in the surface of antenna. This will be the basic criterion low of fabric is low so it is used to reduce to surface wave losses and improve bandwidth. There is a basic criterion for selecting any material as a substrate as it will also help in improvisation of bandwidth.

Aris Tsolis et al. in 2014 presented some manufacturing techniques for wearable antennas. Particular devotion was in the making of design from the woven threads. This method is advantageous for the following reasons: (i) massive production of antennas can be done once the design has been finalized and tested by using the automation technique; (ii) no need of any sort of adhesive and (iii) simple designs and can be easily incorporated into garments.

Zakir Ali et al. in 2014**,** proposed a novel structure of wearable antenna utilizing fabrics, best suited for wearable computing technology. The textile material has been selected for making the substrate of the antenna whereas the emanating patches and ground surface has been made of adhesive copper. To design a novel wearable flexible antenna which has high gain, efficiency, good return loss. Improvement must be done with the design without altering the size of the antenna and its performance.

M. K. Elbasheer et al. in 2014**,** presented textile antenna with flannel as a substrate and this antenna will work in a specific frequency range for wideband applications. Different available conducting metals are used for the preparation of radiating patch as well as ground plane.

S. Daya Murali et al. in 2014 proposed a patch antenna with the available microstrip feed line procedure. A different type of materials has been used as substrate as they have different relative permittivity and a characteristic of antenna that depends mainly depends on the type of substrate chosen for particular design of antenna. There are many types of feed techniques are available and can be fed accordingly. The outcome from the investigated Microstrip rectangular patch antenna combined with textiles like jeans, flannel, and leather and as dielectric material increases the utilization of wearable antennas.

Albert Sabban et al. has proposed a new class of wideband minimized wearable microstrip reception apparatuses for therapeutic applications. Numerical outcomes with and without the nearness of the human body are talked about. The reception apparatuses VSWR is superior to 2:1 at 434 MHz the receiving wire shaft width is around 100º. The reception apparatuses increase is around 0 to 4 db. The receiving wire resounding recurrence is moved by 5% rather the air separating between the radio wire and the human body is expanded from 0 mm to 5 mm.

Rashmi et al. has proposed that the anticipated coplanar waveguide partial ground plane microstrip antenna is successfully designed and fabricated. Three bands are observed at frequency 11.2, 12.5, and 11.4 GHz over the entire operating band and it has wide bandwidth in the frequency band from 10.5 to 16.4 GHz. Complete area 25 × 23 ×1.6mm becomes compact, so it becomes useful with small wireless devices. Antenna has constant radiation pattern over the impedance bandwidth which lies between ranges of 10 GHz to 16 GHz. Therefore, such type of antennas is used in Ku as well as X band applications.

Neha Gupta et al. proposed an antenna in which substrate material is used as jeans and foam having triple bandits its behavior and working are analyzed. The experimental textile antenna can be use for a larger range of frequency. It has quality to work by three various bands. Such type of experimental antenna can work with three distinct frequency ranges having the frequency range of 18%, 7%, and 7%. Such The antenna is most suitable for multiband application.

Sakshi Lumba et al. introduced an antenna suitable for C band, it contains a substrate like glass in that condition proposed structure are studied and analyzed. Such type of antenna structure is used for various bands of frequency and integrated size and represents sufficient gain, as well as efficiency. In this design C slotted Microstrip antenna bandwidth enhancements with direct coupling, through experimental studies and analysis of the maximum bandwidth enhancements of introduced different antenna sizes. It has also been learned that the development of a neural network becomes capable to provide direct supply point links through which antenna is capable to provide larger range of frequency.

V. K. Singh et al. has presented that the smaller reception apparatus design is 40 × 60 × 1.6 mm that is useful for other type of Radio Frequency circuits. Such reproduced as well as estimated acquires the characteristics of the phone corresponding to the radiation pattern; such type of behavior is discussed in this paper. It is pointed out that the experimental receiving wire acquisition can fully integrate the data transmission of the electronic textbook DCS 1.71 to 1.88 GHz) and the individual communication framework 1.85 to 1.88 GHz with positive radiation signals. The test results show that the experimental radio transmitter represents 60% data transmission capacity of 1.431 to 2.665 GHz with a maximum output of 90% radiation.

V. K. Singh et al. has proposed the better expansion in data transfer capacity of a microstrip reception apparatus. The actual focus of the experimental work is to verify a wideband microstrip reception antenna with diminished area. In such case data transfer capacity of 7% and 36% covered through the frequency ranges by 1.7 to 1.8 GHz and 2.2 to 3.2 GHz accomplished. The measurement as well as orientation of the pair triangular patch and in addition the moving of test encourages arranges have been advanced to accomplishing the wide data transfer capacity.

C. Hertleer et al. has suggested that such a type of clothing could identify the wearer with the marks and function of the wearer and be able to see natural conditions in a comfortable and unobtrusive manner. Wireless communication tools are required in wearable electronics system to transmit acquired sensory information. To keep the fabric structures as flexible and comfortable, the antenna must blend perfectly into the fabric. The best place to apply such type of wearable fabrics is preservative clothing as fire fighting clothing. Wireless communication infrastructure permits for the transfer of large amounts of data. The study is being developed with structure of an integrated European project that promotes the development of wearable textile object in order to become useful for extremity workers and fire fighters.

Yadav et al. in 2020 proposed an antenna which is capable is designed and tested successfully having quality of compact, wide band and wearable. A patch being used as material like copper tape in order to make a patch having quality of radiation with a ground section with an antiseptic feature of the fabric, measuring 0.35mm. The triple band impedance band of 23.3% (3.4 GHz), 56% (4-8 GHz) and 31% (10 to14GHz) frequency ranges are seen respectively. The experimental antenna also applies to circular divisions having axial ratio bandwidth properties with 10% (4 to 5GHz), 4% (5to 6 GHz) and 10% (11 to13GHz) frequency range. The quantities measured are very near to the outcomes of the simulation and it provides the positive adjustments with the estimated and simulated results. This textile antenna works on WLAN, C Band and X, for radiation efficiency, gain and SAR acceptable value (less than 2W / Kg) of 10g tissue. In this project, a textile fabric antenna is based on a fabric based fabric. The antenna demonstrates triple band operation with a minimum acceptable SAR value for the human body. In addition to this, this antenna shows circular separation, increasing the antenna capacity and reducing losses. In terms of user safety, this antenna allows low SAR according to guidelines provided by the IEC. Considering the above points this fabric based antenna distinguishes itself from other antennas.

Yadav et al. in 2020 suggested in this recent article, about the design of a compact textile antenna with the frequency band of ultra wideband which is used for the UWB system. Mathematical model has been completed by using circuit theory with the help of cavity model, result of these mathematical model verify the experimental construction. Variable slot as well as notch eliminated from the light bulb, introducing a valid ground plane, the corresponding impedance performance with the current distribution is revealed.

The experimental antenna contains significant impedance bandwidth of 118% (2.91 to11.6 5 GHz), that includes full range (3.5 to10 GHz) selected through the FCC also a highest gain 5.4 dBi at 7.3 GHz. The time zone feature is also introduced to specify advanced antenna drive distortion instances. The design of the antenna is designed to be co located and a group delay of less than 1nsec is available. The SAR utility of experimental antenna has been examined to justify the effect of radiation through the frame of human, through the experimental studies SAR utility of the antenna was 1.601 W / Kg found, but these values are lower by 2.0 W / Kg as per the international electro technical commission rules. Such point describes the effects of this antenna, now this quality of antenna distinguishes it from other antennas. By using these outcomes, the experimental proposed fabric horn for telemedicine wear and mobile health systems. The focus of actual contribution of this project is to introduce the novel compact antenna having UWB quality on fabric jeans ($\varepsilon r = 1.72$) with substrate, having microstrip line feed and the proposed partial soil. UWB textile antenna incorporate radiation exposure through prepared soil and utilize the optimal radiation feature at a frequency of 3.6 to 10.62 GHz. Real time through the body quantification has been utilized to indicate the execution of the antenna because of the effect of bending as well as humidity.

Yadav et al. in 2019 proposed U shaped wearable antenna having microstrip line feed fabricated and used successfully. In such condition adhesive copper tape is utilized in making a U-shaped patch by using the fabric (such as jean) substrate by using a modification of the ground plane. A very good result with a wide impedance bandwidth having 60% (4 to 9 GHz) and AR band frequency range of 20% (5 to 5 GHz, 7 to 7 GHz) is available in a U shaped patch with microstrip line feeds and prepared soil. The outcomes of the measurements and simulated are very similar, confirming the construction of the experimental fabric antenna. The proposed antenna provides good features with high gain radiation and it is very useful in WLAN (5 to 5.8GHz), HIPER LAN / 2 (5 to 50 GHz, 5 to 5 GHz), and the C band system.

Singh et al. in 2017 has proposed integrated fabric printed antenna having dual band having partial ground plan. The designed antenna substrate is prepared from jeans through fabric type material on the other hand patch as well as ground plan are fabricated through copper tape. The experimental antenna provides a measuring impedance limit of approximately 46%, e.g. From 3 to 5 GHz and 41%, example from 8 to 12 GHz. The antenna is also seen through a high gain of approximately 5 dB with a very powerful radiation pattern in the auxiliary band. The antenna is small in size and useful for Wi-Max (3.1-4.2 GHz), WLAN (5.1-5.3 GHz) with the X-band (8-12 GHz). Also, a comparison of the results produced through simulation is examined with the estimated results of the type being performed.

Singh et al. in 2015 we has promoted the basics of wearable products like a textile antenna that are able to monitor, warn, and seek attention whenever there is an emergency in the hospital, which is why staff and resources are being reduced. In such type of the experimental work generally fabric materials as substrate is used and in such situation the ultra wideband antenna has been fabricated specifically for medical utilizations. The results generated and analyzed indicate that the experimental antenna fabrication fulfill the operating broad bandwidth demand and provides a 13.GHz range of frequency as a frequency range by very compact, washable dimensions (you use a continuous cable for moving segment) and pliable components. Outcomes in the form of frequency range, radiation pattern, recovery loss and profit and effectiveness were introduce for ensure the suitability for the currently experimental project. The research activity completed defines large number of suggestion in case of future experimental work done and can assist patients by such comfortable monitoring and medical strategies.

Singh et al. in 2014 investigated a compact broadband microstrip patch antenna. Such type of antenna can be used for various wireless systems. The experimental antenna is designed and calculated with impedance bandwidth as well as radiation pattern. Work out result and simulated result of the pattern is compared by the measured antenna features as well as radiation and benefit pattern are introduced. It is observed that the type of experimental designed to fully enclosed the need for range of communication area (1.71 to1.89 GHz), as well as personal communication system (1.85 to 1.89 GHz) and IEEE 802.11b / g (2.45 to 2.485 GHz) having very good radiation pattern features. The test outcomes proved that the experimental antennas show a 60.25% range of frequency covering 1.431 to 2.665 GHz by 90% radiation effectiveness. Compact broadband microstrip patch antenna has been introduced with several wireless approaches. The experimental antenna is designed and the pattern of impedance bandwidth and radiation is measured. Equilibrium and balanced features of the antenna and radiation and benefit pattern are proposed. It is said that the experimental antenna fabricated to fully protect the need of range of communication area (1.17 to1.8 GHz), personal communication system (1.8 to1.8 GHz) and IEEE 802b / g (2 to 2.4 GHz) with required radiation features. The test outcomes proved that the experimental antenna produces a 60.2% of range of frequency awning 1.4 to 2.6 GHz with 90% radiation efficiency.

Rashmi Singh et al. in 2017 introduced a wide band miniaturized microstrip antenna recommended for wider demands. The expected antenna achieves a wide impedance bandwidth by cutting a rectangular line that removes the patch from the damaged form. The ground and the light bulb are on the same side of the object. The overall expected antenna size is 25 x 23 x 1.6 mm^3. The expected antenna is designed, made and tested for the desired results. The antenna results obtained by the CST software are in line with the test results.

The expected antenna is often heard on three frequencies 11.2 GHz, 12.5 GHz and 14.3 GHz from 10.5 to 16.4 GHz, which is an application of the X and Ku band. In such suggested research, the CPW sustained structure with wideband microstrip antenna is expected and deliberately developed. The antenna is built in a crippled state that pulls out a signal to achieve a wide range of frequency and optical radiation patterns from 10.5 GHz to 16.4 GHz. In such techniques the ground is elevated and the radiating patch is in the same plane of the substrate to reduce the antenna height. The ground is stretched on both sides of one radiator.

N.B.M. Hasim et al. has been investigated that the wearable fabrics on the antenna components are used to reduce the wireless device. Such type of antenna is a piece of clothing utilized in communication interest that also covers tracking, navigation, portable computer as well as public safety. All of the designs presented are based on the latest advances in wearable technology.

Wang Yazhou et al. has been suggested that the antenna consists of a substrate of thick air and a single square of the microstrip that emits a patch, which applied with two capacitive coupled discs connected through a Wilkinson power amplifier with same magnitude having 800 phases by multiple of nodes. Test outcomes prove such the experimental antenna is capable of achieving an impedance bandwidth of 69% VSWR lower than 2 and a 3dB axial ratio bandwidth by approximately 24%.

K. Shambavi et al. has been investigated for WLAN applications, that the design as well as its analysis of a stacked dual square microstrip antenna for enhancing its gain as well as its bandwidth. The designed antenna has an air gap 9 mm and its resonant frequency is 2.45 GHz, having again of about 8.05 dB. The bandwidth and VSWR obtained are12.72% and 2:1 respectively.

Wen-Shyang Chen et al. is investigated and analyzed circular-polarization performance of the microstrip antenna having square shape which includes four slits as well as truncated corners. At a given operating frequency an investigational results shows that the presented compact circular polarization antenna can have dimension minimized around 38% in comparison with the corner-truncated microstrip antenna with square shape. Hence the essential dimension for truncated corners circular polarization operation is higher as compared to the circular-polarization antenna by utilization of ordinary square microstrip patch. It will provide moderate manufacturing tolerance to that presented compact circular-polarization approach.

Kin-Lu Wong et al. introduced a practical invention, in that cutting slits take place through square patch in order to get circular polarization functioning. The obtained slits then gash in the patch in the direction of orthogonal. Because of these slits, the current trend of interesting leather is expanded. It reduces the resonant frequency of the episode. Resize slits, lengths and feeds using a single feed across the pull of the episode. The orthogonal modes of 02 with the same amplitude with a 90˚ phase difference will be happened. So they minimize the dimension of the circular function of the separation by a certain fixed frequency.

Sha Liu et al. is suggested a easiest fabrication procedure in which micro strip antenna having square shape is used to obtain single feed and dual-band circular polarization function. Designed antenna is fabricated through placing 02 pairs of narrow slots and which is parallel to patch edge, and also with02 protruding slots that is perpendicular by any single edges of the patch. More about the presented antenna designs are explained. The application of such design is in the implementation of the dual-band circular-polarization antenna for compass navigation satellite system.

Kai-Ping Yang et al. has proposed a latest plan of utilization of a unit layer slit applied on microstrip antenna by which he can achieved minimized dimension double band circular polarization radiation. Therefore the need of antenna dimension for the planned fabrication may be more significantly minimized comparatively to that required for the typical normal dimension for the circular polarization design. It can operate at the smaller frequency range of the double band circular polarization radiation. The designed slit loaded antennas having square size are built by placing 04 T shaped slits at the patch edges. Sometimes it may be 04 Y type slits, in the patch region of a patch. The 02 resonant modes one is TM10and another one TM30modes can be used.

C. Y. Huang, et al. has suggested a patch having square type antenna. It consists of useful chip resistors which are kept with the center line of the patch. In it is selected by proper position, denoted by similar regulation loading arrangement. Sometimes it may not found that, in the same direction the loading arrangement. Therefore only the resonant mode which is in the direction of the 02 chip resistors may be affected. Thus, the enhancement of bandwidth in the circular-polarization function it may not be optimized. Therefore, chip resistor fill up positioning such as orthogonal direction loading positioning is now presented to obtain a much wider circular-polarization bandwidth here. Hence in the suggested design suppose when used the loading positions s_x and s_y selected properly then quality factors having value 02 closes by degenerate resonant modes may reduce.

C. Y. Huang, et al. is planned for a compact circular polarization design in which symmetric patch structures are used. The 02 cases with symmetric patch shape are designed. The first is of square ring microstrip patch as well as a centre line cross-strip of same size of arm lengths. Another one is a microstrip patch along with a cross slot of same size of arm lengths has been proposed.

M. Hurtado et al. is suggested a square microstrip patch antenna and in it he introduced an eccentric slot. A square patch with a centered slot is considered as the next step. It has been concluded from the simulations results that the resonance frequency of the suggested antenna is lower than that of the square patch antenna, and also 500 feed points are found by correctly positioning the slot.

A.K. Bhattacharya jee, et.al has attempted to evolve simple closed form expressions. It has been planned for the input impedance as well as for far fields of edge fed circular microstrip antenna. Therefore, without any extensive background in this area it can be used by the microstrip antenna inventor.

Sudhahindu Ray, et al. has invented a suspended 04 feed square microstrip antenna. It is designed for the larger bandwidth. In this approach the Comparison of 02 and 04 feed square microstrip antenna designed so included. The IE3D software which is available commercially, have been used to carry out the studies.

K.T.V. Reddy, et al. has proposed multiport network model implemented for the study of double feed planar gap square microstrip patch. This includes the concept of circular polarization. To increase axial ratio as well as impedance band widths and higher directivity the several planar square microstrip antennas have been designed. It has only 01 square patch is feed at the 02 orthogonal and which has same amplitude as well as 90˚ phase difference. The rest other points are parasitically integrated. The size of the patch is increases forward direction to purpose for the fringing fields as well as impedance matrix of microstrip antenna is received. It is obtained from Green's function multi-port network model. To obtain the input impedance of the square microstrip antenna the segmentation method is also used.

G S Binoy, et al. has proposed an altered structure which looks like a placard shaped slot. It consists of 02 stubs which are centered in the square patch. It lowers the frequencies of the dual band functions. It intends the minimization in antenna dimension, at its double frequency mode. Therefore the 02 operating frequencies of the suggested antennas are found out. Hence it has same polarization planes as well as broadside radiation patterns. Frequency ratio of such 02 frequencies can be trimmed through comprehensively by varying the slot parameters. And hence the altered new structure for the patch dimension minimization has been successfully implemented.

Chih-Yu Huang,et.al. has proposed a circularly polarization concept of a coplanar waveguide fed microstrip antenna. In this design the coupling slot geometry introduced has an important effect on its performance of a coplanar waveguide fed microstrip antenna. A single-fed microstrip antenna for circular polarization function can be generated by selecting acceptable type slot, as a easily inclined slot or a cross slot can also be used.

J.S. Baligar, et.al. has proposed a details on an efforts for improving cross polarization levels, bandwidth as well as gain. Here a ring in the stacked type having concentric with the shorted square patch underneath is employed. Finally they obtained results are compared with its co planar configuration.

Mohamad Kamal A Rahim, et al. has proposed the concept of microstrip patch array antennas with frequency range of 2.4GHz, ISM band. It has been used circular polarization, which is suitable for point to point communication system. While selecting and installing an antennas an antenna polarization is an important factor. Linear or circular polarization can be used in most of the wireless communication systems. To maximize the system performance for the user it is better to know the indifference between the polarizations.

Takafumi Pujimoto et al. has proposed a wide band and small microstrip antenna for dual band, communication system and also vehicle information or for electric toll collection system operation is suggested.

A.K. Bhattacharjee et al. has proposed the properties of radiation of a circular microstrip antenna. Then it is compared with those of an square microstrip antenna. A simple estimation method of the far field circular microstrip antenna is suggested, on the basis of this comparison.

Shivnarayan et al. has suggested an investigation of notch loaded rectangular patch antenna. It performs the dual band operation. The dual frequency characteristic is obtained by notch loaded rectangular patch. On modal expansion cavity modal its theoretical analysis is based.

A.A. Mohammad. et al. has suggested the theory of single patch antenna. The designed antenna is operating at resonance frequency 1.5 GHz. Its input impedance as well as the radiation patterns a function of feed point. Using the cavity model the TM01 mode has been estimated. The impact of aspect ratio on the pattern of TM01 mode as well as dielectric constant has been proposed. With the help of cavity model the input impedance for (TM03) modes at another different feed position has been invented.

S. K. Satpathy et al. has suggested many number of small compact microstrip antennas. It has been designed for personal mobile communication. Such type of antennas are classified as configurations which are arising from shorting, along with zero potential plane and disturbing the field configuration will also be not disturbed. It is also possible by putting a shorting post to alter the field distribution for the required reduction in size. Experiments have been carried out on altered in circular, rectangular, as well as triangular microstrip antennas in the first category and also all these configurations as well as ψ Shaped, sartorial shaped antennas have been proposed in second category. For the thesis of shorted rectangular and ψ shaped microstrip antennas a multiport Network model has been used. The experimental results are compared with the theoretical results and that are good.

Saurabh Jain & Dr. V.K. Singh has proposed gain optimization and bandwidth wide band and gap coupled microstrip patch antenna, which is fed through a coaxial probe are presented. Using this novel technique the band width can be improved up to 85.21% covering the frequency range from 0.951-2.363 GHz and gain has been improved up to 5.8 dBi. This simulation is performed by using the commercially available IE3D simulator based on method of moments.

B. J. Kwaha and O. N. Inyang has proposed program FORTRAN and implemented for the simulation of the fundamental parameters of a antenna. Fundamental parameters with the actual parameter of the patch and also effective radius, conductance because of radiation as well as conduction and also because of dielectric loss, directivity, input resistance..These parameters are computed manually. In this 04 substrates were selected which are indium phosphide, gallium arsenide, droid, as well as silicon. When smaller antenna size and low power handling capability is required the gallium arsenide type is suitable. Droid is exceptionally used when the directivity and high power radiation is required. The measured results which are obtained from the design are compared with the manual computation results keeping the same parameters.

Abd-Elrazzak & Al-Nomay has proposed a concept of a dual frequency circular patch antenna, operating in the band of 1.45 and 4.9 GHz. The Bluetooth and high performance radio local area network applications are occupied in this range. The considered Microstrip circular patch antenna considers 02 operating points which are at double frequencies. When the return loss is lowered by 10 dB and the frequency range of 2.45 is 24 % and at frequency 4.9 is 8.1%.At these frequencies the antenna input resistance is resulted. Having nearer to 47 Ω, hence the coaxial may be directly applied. Therefore such type pattern of the antenna for the double frequency band represents the lowest radiation in the zenith area. It is nearly symmetrical in azimuth which usually is happened in case of such type of uses. The design as well as estimation of the antenna is performed by using FDTD having matched layers. The outcomes are checked through the available published data and by obtaining cavity resonance technique.

J. A. Ansari and Anurag Mishra has suggested a double frequency having resonance antenna is attaining through initiating a slot with L shaped, inside a patch. It has been estimated on the basis of circuit theory hypothesis. Resonance frequency used is 6.05 and 9.3 GHz.

Therefore a10 dB range of frequency of the suggested antenna in case of smaller resonance frequency is 4.39 % and for the upper resonance frequency is 4.66 %.By altering the dimensions of the notch as well as the slot it is very easy to adjust the lower as well as higher bands. The ratio of frequency obtained is 1.6621. The gain of the designed antenna is 8.49 dB at smallest resonance frequency where as it by 6.9 dB at highest resonance frequency. The outcomes at lower resonance frequency are 94.6 and at upper resonance is 76.3 %.The simulation outcomes are balanced with theoretical outcomes. The planned antenna design fulfills the necessities of broadband width. It gives a bandwidth of 13.08 GHz with very small size. It can also be washable and made of flexible materials. In the current suggested design the required results such as return loss, bandwidth, radiation pattern, gain and outcomes are proposed.

Z. Nasimuddin et al. has proposed an aperture coupled C shaped slot which is asymmetrical as well as square in nature for the circular polarization. It is applied at the middle through an aperture type coupling to get a circular polarization function. By inserting a C shaped slot the tightness of the antenna get easily. The wide circular polarization radiation is attained by using the slot having in asymmetrical form. Such antennas calculated 4 dB frequency range is at nearby 4.2% also the 12 dB return loss for frequency range attained is at about 16.0 %. These circularly polarized antennas are largely applied in communication applications. Based on the single feed and or dual feed type the categorization of the circular polarization microstrip antenna can be done. The single feed wideband antennas are recently becomes most popular.

R. Przesmycki et al. has suggested the fastest evaluation technology of wireless internet access. These requires the follow up of the standards applied to the wireless local area network as well as industrial, medical and scientific frequency bands which ranges from 2400 to 2500 MHz and 5725 to 5875 MHz. It has very much popular for dual band antennas. These can be applying in stationary as well as in mobile devices. The suggested paper represents the dimensional model of the antenna as adapted in microstrip antenna technology. It is working with 02 frequency bands the first one is 2.4 GHz and the second one is 5.8 GHz. Such type of antenna antennas can be used in mobile wireless network applications. The study narrates the results of simulation of radiation functions as well as electrical data of planned antenna. The simulation is performed in the software CST Microwave Studio.

K.P.Wei et al. has proposed the design of latest technique such as dual band and omnidirectional planar antenna array. To produce the effective antenna structures a cascade of transposed microstrip lines are used. These radiates in all direction that has greater efficiency, low refection, as well as has a suitable radiation pattern. The suggested paper consisting of an antenna structure, with low passes characteristics. This is due to the periodic discontinuities in the transposed junction. The design and estimation of low pass features are carried out according to the filter theory and also according to full wave simulation. Hence it requires a higher frequency radiating array that can be designed with a low pass filtering concepts. It stops the lower frequency antenna elements from resonating which at the higher frequency bands. For enhancing the impedance matching, an air gap between the adjacent transposed sections is suggested. The fork shape stub is also used at the end as a virtual short point. It will helpful to enhance the radiation at the higher frequency. Hence a single port dual band omnidirectional antenna array is designed. In the proposed design a dual band omnidirectional planar array is narrated. It operates at the frequency range of 2.32GHz to 2.56 GHz and 5.65GHz to 6.10 GHz, by considering S11 less than -10 dB stable radiation pattern.

N. Kulkarni has proposed the concept of a design with corner truncated U slot rectangular microstrip antenna. In this paper it is planned for triple band function. Among the triple band the middle bands frequency is tuned to 4.615 GHz to 4.5 GHz and upper bands frequency is tuned to 5.919GHz to 5.88 GHz, when the dimension of vertical branch of U slot is changes by 0.2 to 0.3 cm. Such type of bands is tunable in other way to frequency bands 4.615GHz to 5.795 GHz as well as to frequency bands GHz 5.919 to 8.315 GHz. The simulated results and the measured results are very close to each other. The planned design concepts of antennas are suggested and the measured results are studied. Such type of are suitable for wireless local area network applications.

S.H.S. Esfahlani et al. has suggested a tight unity layer double band microstrip antenna which is suitable in case of satellite communication. He planned for a tightly filled layer with unit feed and double-frequency antenna. In this concept a larger frequency proportion is considered. Such type of antennas has a symmetrical radiation patterns as well as broad side. It is suitable for space applications. This is fabricated on a droid 7700 substrate with permittivity is 3.2, breath is of 1.47 mm. Double band feature is obtained by a shorting pin to 1.7 to 1.706 and frequency bands 8.011 GHz to 9.17 GHz and the frequency probation is of 3.92. The antenna is reduced up to 48% as contrast with that of the patch having rectangular shape.

Mehdi Veysiet et al. has designed a typical feed, dual band, having properties of linearly polarized and in presence of patch antenna. In it he suggested that 02 single feed having double band, as well as double polarized antennas, which are applied through nearby coupling. Primary method starts by a newel patch antenna in which double band and double polarized functions with the help of a stub, that can be added the end of feed line. Hence an antenna can be designed for02 resonant frequencies. In this the primary resonant frequency has almost similar to the primary fabrication technique, where as in other case, the frequency hang on the position for on feed point over the dimension of patch, the stubs length, as well as the stubs location. It is also noticed that the discrepancy of the feed line points to that patch dimension having no remarkable result for an primary resonance frequency, but the second frequency varies. Next in next step concept the double band, double polarized approach uses a microstrip gap, and also proximity coupled feed mechanism. The radiation features such as radiation pattern, cross polarization; also the gain is acceptable by 02 bands. Hence the measured outcomes with the simulation outcomes are very close to each other.

Pradeep Kumar & Nitasha Bisht has proposed the design of stacked coupled circular microstrip antenna is presented for dual frequency operations. The two circular patches are isolated by a substrate. The lower patch is the feed patch and the upper patch is excited by the stacked coupling. The designed patch is optimized and simulated with the help of, microwave studio simulator. The designed patch antenna produces two resonances at 3.4233 GHz and 3.7395 GHz. The designed antenna produces broadside radiation pattern.

J. Ghalibafany and A. R. Attari has presented double band planar type of patch. Suggested antenna has a microstrip patch. It is then applied through coupling connector that is referred by L type connector. The radiation features of the antenna as well as the various techniques for the controlling of the resonant frequencies have been suggested.

Lin Peng et al. has proposed a design of compact dual as well as triple band microstrip antenna. The suggested paper consists of asymmetric M shaped patch antenna. The 02 resonant frequencies for first antenna are connected to particular component of the patch. Resonant frequency tuned by small outcome through another. The first antenna is utilized at a 2.44 GHz as well as 5.77 GHz, which can be measured and fabricated. In both E as well as H planes of the antenna narrates low cross polarization and symmetrical design. Finally second antenna with triple band antenna with enhanced bandwidth is presented.

Yadav Nagendra Prasad et al. had proposed that the theoretical invention of a U shape patch antenna contains half disk. It is designed through corresponding circuit and an antenna manifest dual band features having resonant frequency of 4.76GHz and 6.79 GHz. This type of dual band nature of antenna has been realized with shorting pin and by utilization of U slot through patch. The minimized frequency is attaining as 443 MHz and upper frequency is achieved as 287 MHz, and also noticed the antenna frequency proportion of 1:3.

M.A.S. Alkanhal et al. has proposed 02 three band tiny dimension with resonator microstrip antenna design for communications systems have been suggested. Such type of antennas, built up of three resonant radiators. Here different variety of resonators can be utilized which are quarter wave resonators and stepped impedance. The approached is depending on making an antenna resonator is simple. It is used for building up three different band of antenna with different defined frequency bands with the help of simple relations as well as design curves. To keep unity feed, to minimize the total antenna dimension, and to protect the concept at every band of the resonator integration has been done. The 02 suggested antennas are simulated, realized and optimized on droid substrate to confirm the concept. Measured and simulated results shows very close performance for both triple band small antennas.

M. T. Islam et al had proposed a maximum gain, larger band, L probe feeding inverted EE H model slotted patch. Such publication the concept adopted is inverted patch type design having filled dielectric of air, L probe feeding, and EE H shaped patch. The consolidated of these methods tends to a newest patch antenna with a low probe as well as useful operational features with high gain. The experimental results showed good performance with the obtained impedance bandwidth of about 21.1% at 10 dB return loss and a maximum gain of about 9.5dB. The antenna exhibits stable radiation pattern in the entire operating band.

A. Mishra et al. have been proposed the microstrip patch antenna having notch loaded. It was analyzed through cavity model. The suggested antenna represents the double band function that hang on notch dimensions, shorting wall. Frequency ratio is 1.52 for the notch loaded rectangular patch, where as for notch loaded shorted patch, it varies from 2.9764 to 2.725 with the increasing value of the notch width as well as it is invariant with notch depth. It also shows the dual frequency feature with the frequency ratio 1.7. Theoretical results are compared with the simulation as well as measured results.

Usa Kongmuang has proposed a conceptual fabrication technique of an asymmetric slit having shape of Y which is loaded on microstrip antenna. It gives larger frequency range in dual band uses such as wireless communication. An antenna has a patch by 04 asymmetric slits having Y shaped at the patch corners; also it has a two times breathed of FR4 as substrate material. From the measured result it is clear that as the bandwidths are increased up to 5.3% for the first and 25.5% for the second frequency bands. The measured results are very close to the simulation results.

G. F. Khodaei et al. had suggested an asymmetric U slot patch antenna and having low probe diameter. In this design it concludes that the reduction in probe diameter causes the reduction in bandwidth. The main features of this antenna are keeping the bandwidth 30% instead of reduction in the size of an antenna. In this paper use of low probe diameter compared to antenna is suggested. The designed antenna has been fabricated with the PCB technique. Based on the simulation and measurement the far field results have been suggested. It has high cross polarization level when using circular polarization. Hence the use of such antenna can be suggested because of its reduced size, high impedance bandwidth, high gain and easy fabrication.

J. A. Ansari et al. had investigated a patch stacked antenna having U slot loaded with H shaped and it uses parasitic elements. The antenna shows dual resonance and both the resonance frequency upper as well as lower depends on the slot width and inversely depends on slot the slot length. Upper and lower resonance frequencies also increase with increasing the value by h2. The bandwidth at lower resonance frequency is 3.66 % and the upper resonance frequency is 10.25%. The radiated power at larger frequency is 0.80dB as examined with smallest resonance frequency. Hence the conceptual outcomes are examined through the simulated outcomes.

M.A.Matin et al. has been suggested an antenna which is consists of rectangular microstrip patch having U slotted shapes. It is stacked through other patch which is of a distinct dimension and for the discrete layer, is designed and its outcomes are estimated. Circuit of such type of frame is also suggested which is deployed on widen cavity model and it predicts the input impedance. Conceptual input impedance is calculated through this structure. The measured outcomes assist the logic of the structure. Hence it provides larger bandwidth, and also the size of the patch is optimized to get very large frequency range. Larger impedance frequency range of 57% is received through such type of frame. Return loss S11 of this antenna is lowered by the fact of – 12dB and the range in between 3.12 GHz to 5.34 GHz. The radiation patterns are constant all over the band. For such antenna a coaxial feed by Gaussian modulated pulse is also utilized.

V. V. Thakare et al. had proposed so many types uses of microstrip antenna which has been provided due to narrow bandwidth. Newly design was suggested for inset feed microstrip antenna and also having slots to upgrade the bandwidth. In this paper the slotted antenna by a substrate with breath 1.6 mm is used, and provides wideband features using artificial neural network. Suggested patch antenna provide the enhanced bandwidth than the antenna without slots when same physical dimensions are used. It is also having ANN structure used for implementation of the frequency range. In such approach IE3D software is utilized, for generating training data as well as test data for artificial neural network. Few results have been taken for checking of ANN structure and the variety of variant of training algorithm of multilayer perception feed forward back propagation ANN and radial basis function artificial neural network for network model. The received result through ANN is examined with practical as well as the simulation results, and satisfactory result is noticed.

V. V. Thakare et al. has suggested the best method of computation of patch measurements of a rectangular microstrip patch antennas by the support of artificial neural network. An ANN model was implemented, and then checked in case of rectangular patch approach. It modifies the information consisting of the dielectric constant, breath of the substrate, and antennas mode for the frequency to the patch dimensions and width of the patch. The measured outcomes using ANN are checked by the simulation outcomes. Simulated data's are analyzed by approach of the microstrip antenna using electromagnetic simulator. An artificial neural network model results are very close to the simulation data.

V. K. Singh et al. has been proposed a coaxial probe feed techniques, microstrip antenna. It has been used dual bandwidth concept as well as software tool for ANN. The dual bandwidths of about 8.08 % and 8.15 % is obtained by changing the position of the feed, and then further simulation has been done by using on artificial neural network gadget. The antenna is applied through coaxial probe application method. The required frequency range through IE3D is utilized a application set to train the applied forward network of the artificial neural network. The experimental patch antenna is presented and reproduced through the IE3D software and the outcomes are checked and confirm by ANN.

CHAPTER 3

MICROSTRIP PATCH ANTENNA

3.1 Introduction

The wires which receive signals are bent in a specific direction as compared to planar and non-planarsurface stomached furthermore reasonable, in presentscenario printed-circuit innovation, which are mechanically strong when ascended on hardened surfaces, amicable with MMIC outlines. If we choose conscientious fixstructure and mode then they are exceptionally agreeable in advanceof recurrence, polarizationand impedance. What's more, by identify stacks in between the fix and the ground plane, for examplevaractor diodes.We can plan versatile components with varying thunderous recurrence, impedance, polarization, example. The limitations of Microstrip radio wires are its low productivity, lesser power and very high Q (greater than 100), as well as very poor polarization immaculateness and also poor execution, misleading food radiation and exceptionally thin recurrence data transmission, which is normally just a small amount of a percent or at most a couple of percent. In any case, there are techniques, for example, expanding the tallness of the substrate which could be utilized to increase the effectiveness (up to 90 percent excluding surface waves) and data transmission (around 35 percent). In any case, if the stature expands, surface waves are presented more often on the grounds as they separatepowerin that from space waves. The surface waves are scattered at twists and discontinuities as they travel inside the substrate for example, the truncated dielectric and ground planespoil the receiving wire and polarization qualities. By utilizing depressions while keeping up substantial transmission capacities, these waves can be dispensed.

3.2 Rectangular Microstrip Patch Antenna

A rectangular microstrip fix reception apparatus is generally utilized radio wire since they are exceptionally fitting for thin substrate and are anything but difficult to produce. Anyway a few parameters ought to be considered before outlining a radio wire. The rectangular fix receiving wire can be displayed as either transmission line model or pit show. In transmission line display the radio wire is expected to have length L and downsides by impedance Zo. In cavity demonstrate, the fix receiving wire is displayed as a variety of two emanating surface isolated by separate L.

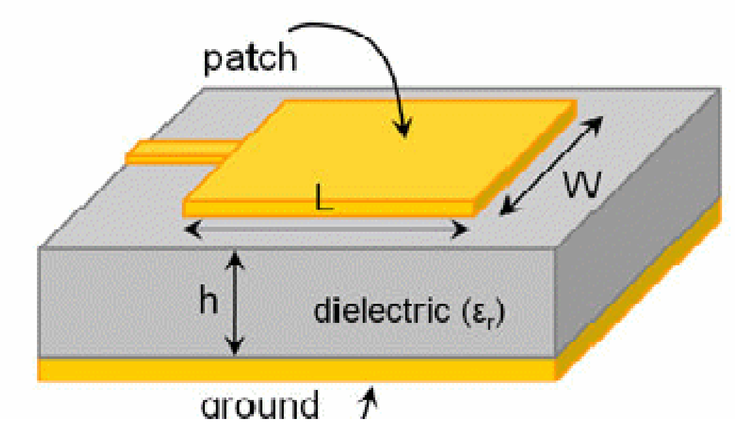


Figure 3.1Microstrip patch antenna

3.3 Equivalent Model of Patch Antenna

3.3.1 Model of transmission line

When a microstrip line gets bolstered with the information, it creates an electric field. The microstrip fix reception apparatus has limited length and width. A long these lines, at the edges of fix, the field experiences bordering. This bordering relies on the measurement of the fix, stature of thedielectric consistent of the substrateand substrate [12]. Bordering field will be cut back when the proportion of the length of fix to that of tallness of dielectric is very high. Anyway,it may likewise influence reverberation length. Because of bordering, microstrip line seems more extensive contrasted with its genuine physical measurement. To accomplish amend resounding recurrence, the viable length and powerful width ought to be considered in light of the fact that because of bordering the dielectric steady changes to compelling dielectric consistent and this progression the length of the patch.

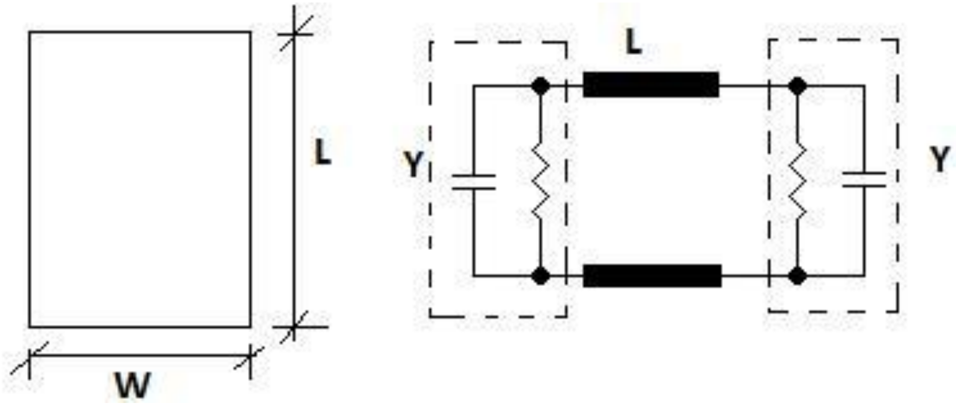


Figure 3.2 Equivalent Transmission line

3.4 Antenna's Cavity Model

It is easy to design an antenna but ignores field variation in the radiating patch. A different approach of analysis concludes the leftover part in transmission line model. This approach is the pit show. In pit show the focal point of dielectric substrate is thought to be a cavity limited by electric dividers on the best and base when the substrate stature is thin (h<<ʎ)[13].

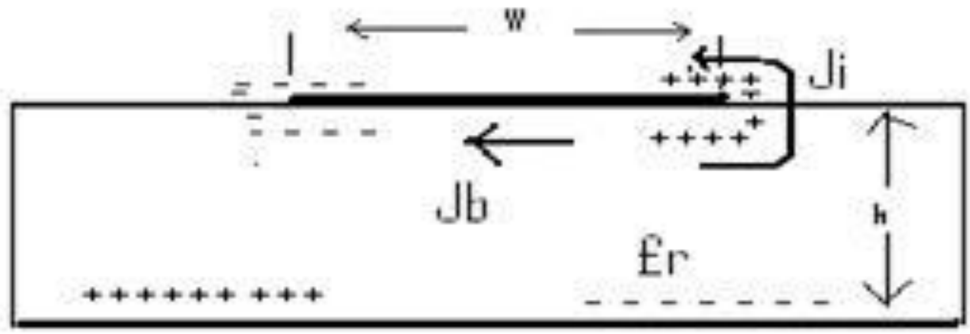


Figure 3.3 current density in anticipated patch.

At the point when the patch antenna is invigorated and charge distribution is shaped as appeared in the figure. The circulation of charge is controlled by two systems to be specific appealing component and unpleasant instrument [14]. The appealing instrument is between the contrary charges which lie beneath thepatch as well as ground plane. Therefore unpleasant system is in the middle of like charge on the base of the fix. This ghastly instrument tries to push some charge to the edges and further to the best surface of the fix and thus little current streams at the best surface of the fix. This present stream can be limited to zero if width to tallness proportion is diminished. This does not make any extraneous field on the edges of the fix. In this way this makes the four sides of the substrate to be demonstrated as impeccable attractive divider that does not aggravate any electric and attractive field underneath the fix. Anyway, in reasonable thought, there is constantly limited width to stature proportion and this prompts digressive attractive field at the best surface of the fix. On the off chance that the dividers of the depression and materials were lossless, the hole would not transmit. So as to examine more pragmatic approach the Microstrip ought to be lossy hence to address misfortune in cavity display a parameter called misfortune digression is presented. This esteem is suitably viewed as the misfortunes because of cavity and is contrarily corresponding to quality factor of a receiving wire.

3.5 Rectangular Antenna Design

A microstrip fix radio wire comprises of a transmitting component, ground plane with a dielectric substrate is placed in between. The emanating microstrip comprise of limited edges henceforth bordering happens. Bordering predominantly depends on substrate measurement, tallness and consistency of dielectric substrate. It can be seen from above assume that for the microstrip line, both air and dielectric material consists of electric field. Hence the microstrip line looks more electrical. Dielectric steady is relatively same for low recurrence, as recurrence increments so the dielectric consistent likewise increments. Along these lines at UHF recurrence powerful dielectric consistent has a limited impact [14].

3.6 Reverberating Input Resistance of Antenna

The emanating space in Microstrip fix receiving wire is spoken to as parallel equal circuit with the permission Y to such an extent that Y= G + jB [12] in light of the fact that the fix length turns out to be electrically longer because of bordering. Along these lines a length of fix ought to be the two transmitting openings ought to be isolated by a separation λ/2 where λ is the wavelength. Therefore,itisnot conceivable picked to such an extent that 0.48λ<L<0.49λ [15].

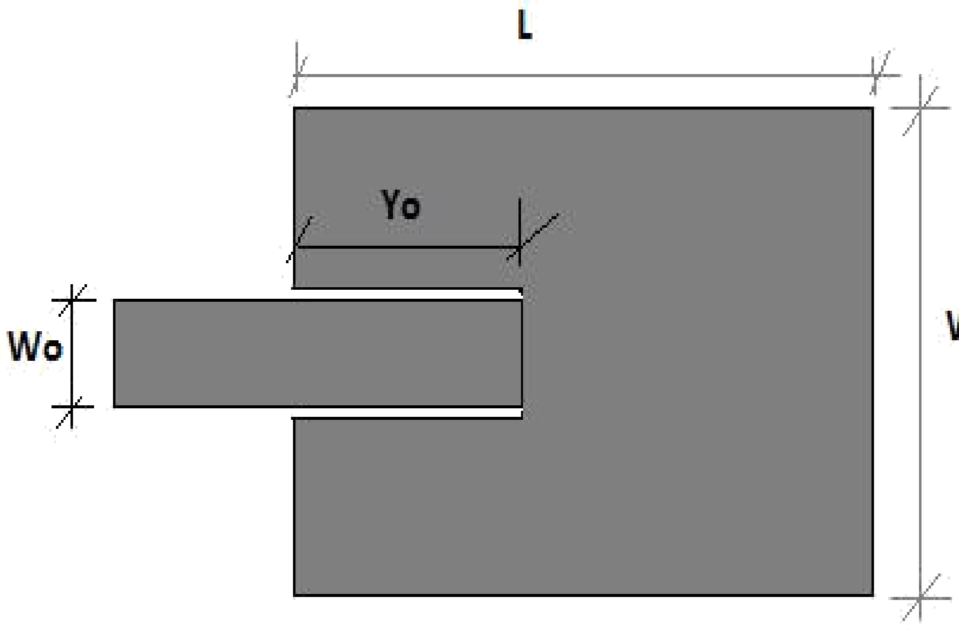


Figure 3.4 Equivalent circuit model of patch

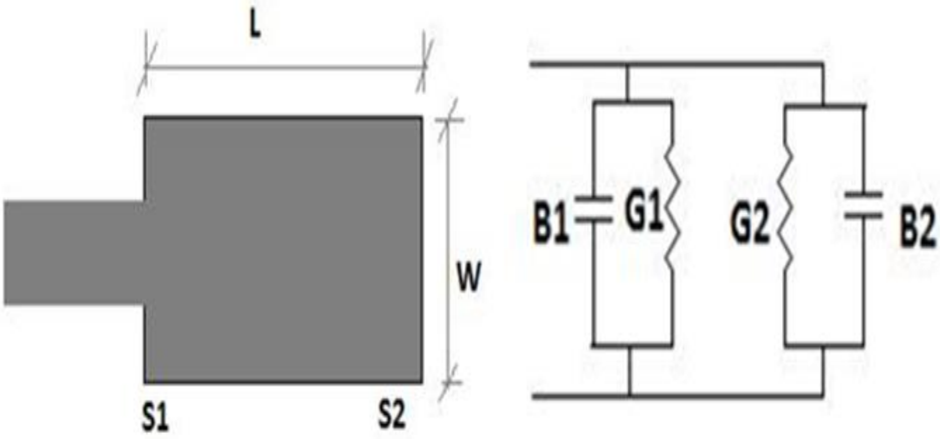


Figure 3.5 Inset feed

3.7 RFID

RFID stand for Radio Frequency Identification. It utilizes the remote revolution for discriminating the things. Bidirectional correlation in the middle of the reader and tag is delicate through radio frequency, and portion of an electromagnetic frequency range, for carrying data in the middle of a reader and a tag. These systems are differing for the other different type of jobs. Such systems may be a single reader with a single unit and also single tag or like a RFID tracing system and hundreds of products can be tagged through a RFID tag. Such systems, distributed RFID readers can send the signal to computers and hence to process the signal to this data among so many industries in different countries.

3.8 Communication Structure

In the figure below, the communication between RFID transponder and RFID reader is illustrated by a picture:

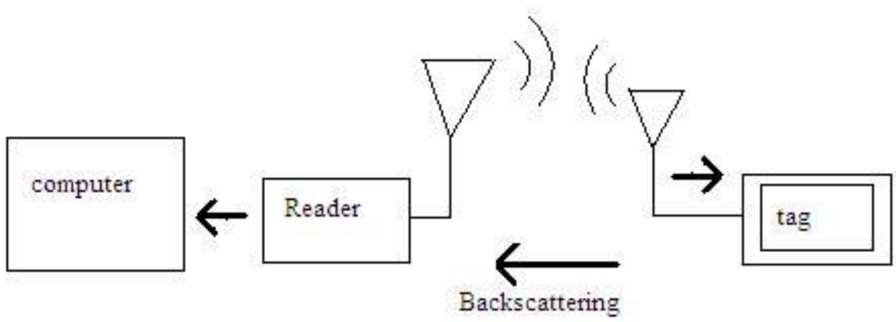


Figure 3.6 RFID system block diagram

The above depicted diagram explains, the bi directional communication flanked by reader as well as tag. This antenna receives the radio frequency data from a reader after that the data is received by a tag antenna after that it is rectified and super abounds to the chip to raise it up. Whenever the chip is rise up then it sends previous data again to reader and it acts like a signal source. Whenever the data is reached, it sends additional ahead to the computer in order to transmit and the data.

3.9 The RFID Transponder (Transmitter + Receiver)

Transponder is basically called radio transmitter plus receiver. Basically it consists of 02 segments, incorporated circuit and the receiving element. The reception apparatus capacity is to hold the electromagnetic area through reader on the different repetition. Integrated circuit subscribes transponder and also has an ability to backup the signal data that has to be sent to the reader which results the presentation of the charge and it also stores fresh data that was sent by reader. Chip is usually consisting of rectifier that adjusts the voltage resulted by radio element to the determined voltage, and supplies to remaining circuit in to the chip. It is analyzed just ultra high frequency identifiable proof equipments. It can be used as a detached chip for ultra high frequency transponder and not having inner power supply. Radio frequency pillar is sent through the reader and the receiving element inside that transponder and it gets the flag that results it, as well as it send the modified signal to the chip.

3.10 The RFID Reader

Sometimes it is also called an interrogator and is also one of the fundamental elements for RFID systems and has 02 operations, the first one is the reader give rise to radio frequency data that is utilized for energizing transponder chip. Reader in this step proceeds like a transmitter, then the signal transmitted by the reader has to be modulate with a particular code. Radio frequency data is then magnified and then sent. Transponder when accepts the data from reader it again transmits the data with information to the reader again. Therefore when the data convey back again to reader is known as backscattered data. The second one, the reader is to accept the transponders backscattered data. The moment when we receive the backscattered signal then amplified, demodulated and filtered. It will be simultaneously establish the two way l communication by a computer that attached to it and then transmits the demodulated data to the PC for next processing.

3.11 RFID Matching

Receiving components obtained radio frequency energy from Reader and also the receiving element works for a positive repetition. Therefore a reader transmits radio frequency movement with the chosen repetition, tag obtains the flag and it next gives to the chip that is fixed to the transponder. And the chip consequent to obtaining sufficient voltage which will rises. It again sends the flag with same repetition to reader. Desire in back of correlating a receiving element and its heap is to ensure the maximum power which is swapped from receiving devices to chip. Therefore, it is essential a perfect matching between the chip and radio element. The receiving element correlating can skilled by redoing the estimation of a radio element, by resulting them or may be including the receptive part.

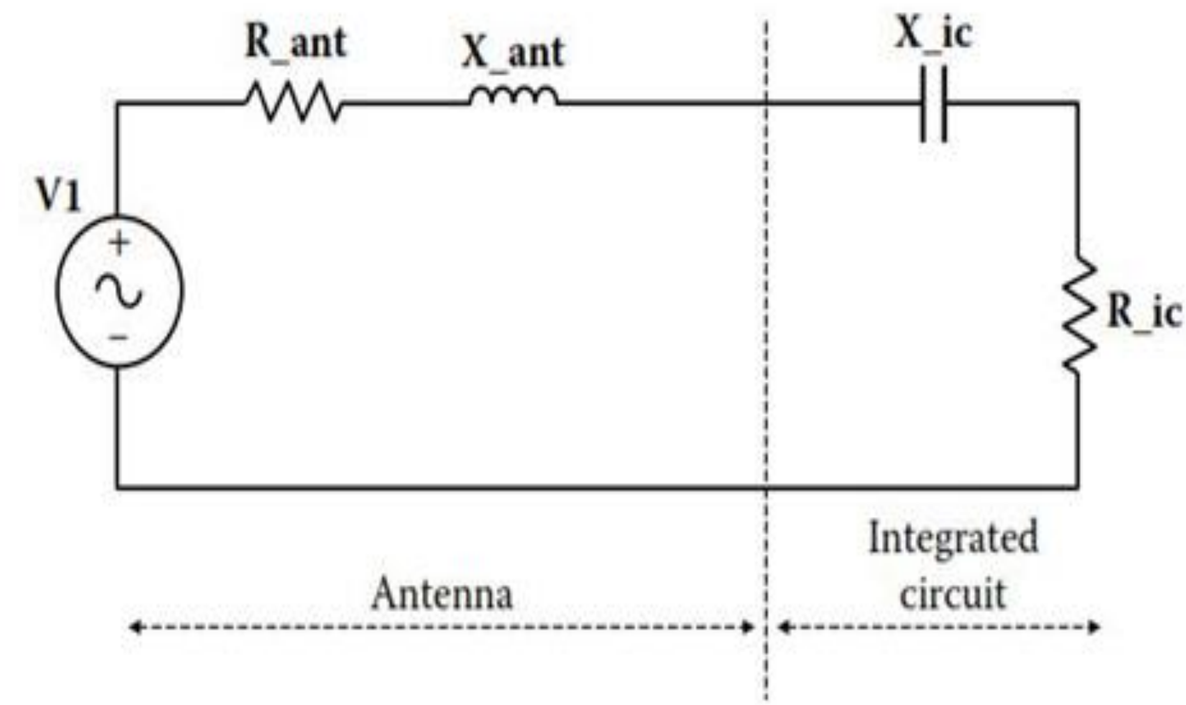


Figure 3.7 Series model for transponder chip and antenna

3.12 Feeding Techniques

3.12.1 The Inset feeding technique

This is one of the most flexible methods to be used. In this technique a patch is joined with conducting strip and hence may be considering as supplement to patch.

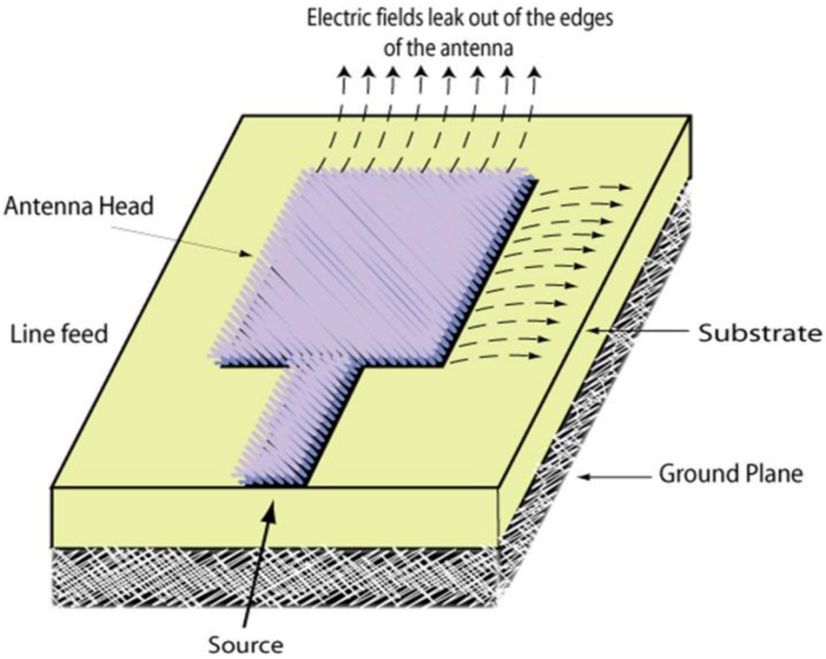


Figure 3.8 Microstrip inset feeding

3.12.2 The Line feeding Technique

The Line feeding Technique is one of the secured techniques and it is a straight forwardly managing the strip joining and can be considered as an enhancement of fix. Securing and modeling to the session is easily possible by managing the inset position. Mischief of the plan is that the substrate surface wave, ambiguous sustains radiation as well as thickness collection, expands and that will confine the conveying capacity.

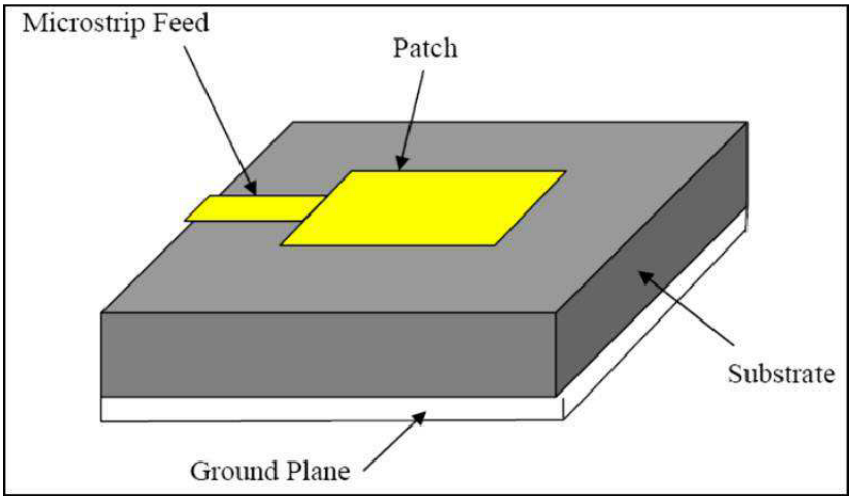


Figure 3.9 Microstrip line feeding

3.12.3 The Coaxial feeding Technique

The Coaxial feeding technique is the very helpful system. Interior transmitter of a coaxial feed is appropriate to its radiation fix of accepting element, and the outermost channel is also coupled to the ground. It is an authorized policy with an inward channel of the coaxial feed is combined to radiation fix of the radio element whereas the outer most transport is linked to ground.

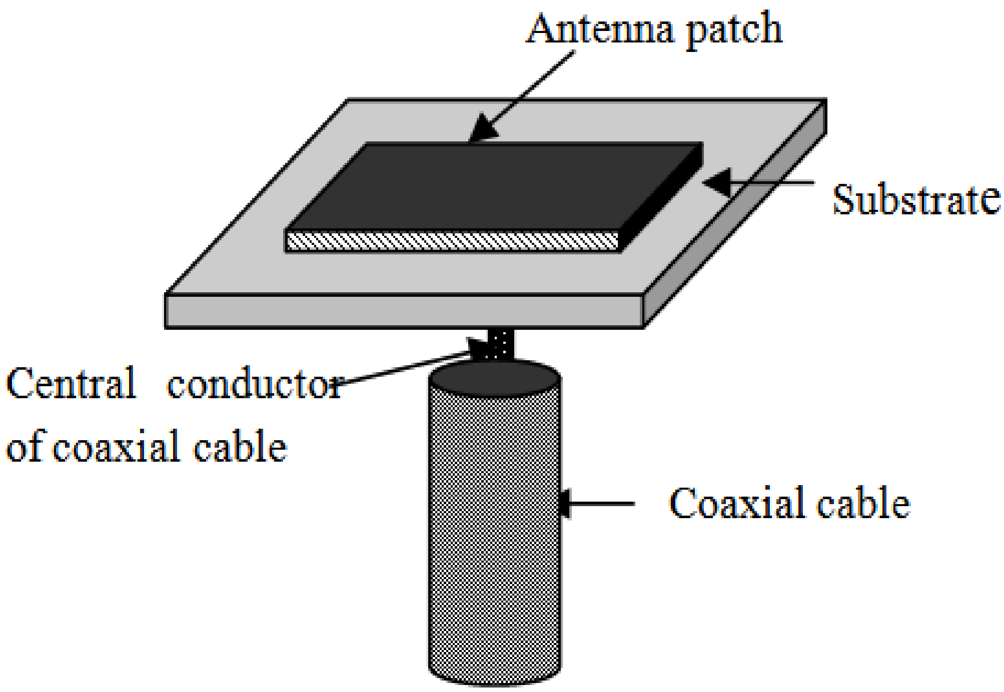


Figure 3.10 coaxial feeding

3.12.4 The Aperture coupling Technique

It is tough to installation the association among four feeding technique but this feeding method has mild spurious radiation and having low bandwidth. It consists a floor aircraft with a slot which sandwich between substrates. Microstrip is attached at the base of lower substrate and also paired to strength attaining to the patch passing via the slot within the ground plane and substrates. In this association the lower substrate made up of better dielectric cloth and higher substrate made of less dielectric cloth. The Microstrip feed line are not immediately connected to the ground, it is separated by way of a substrate, that reduces the interference and spurious radiation.

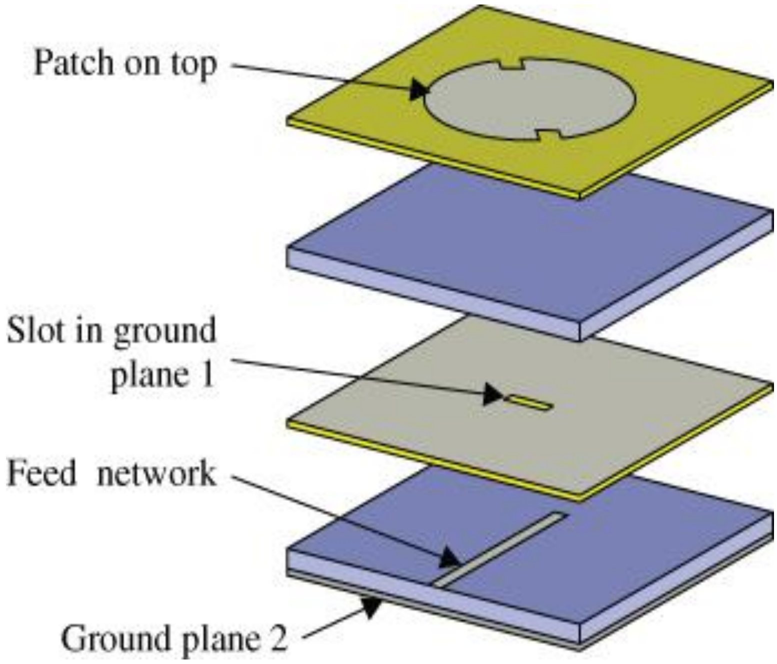


Figure 3.11 Aperture Coupling

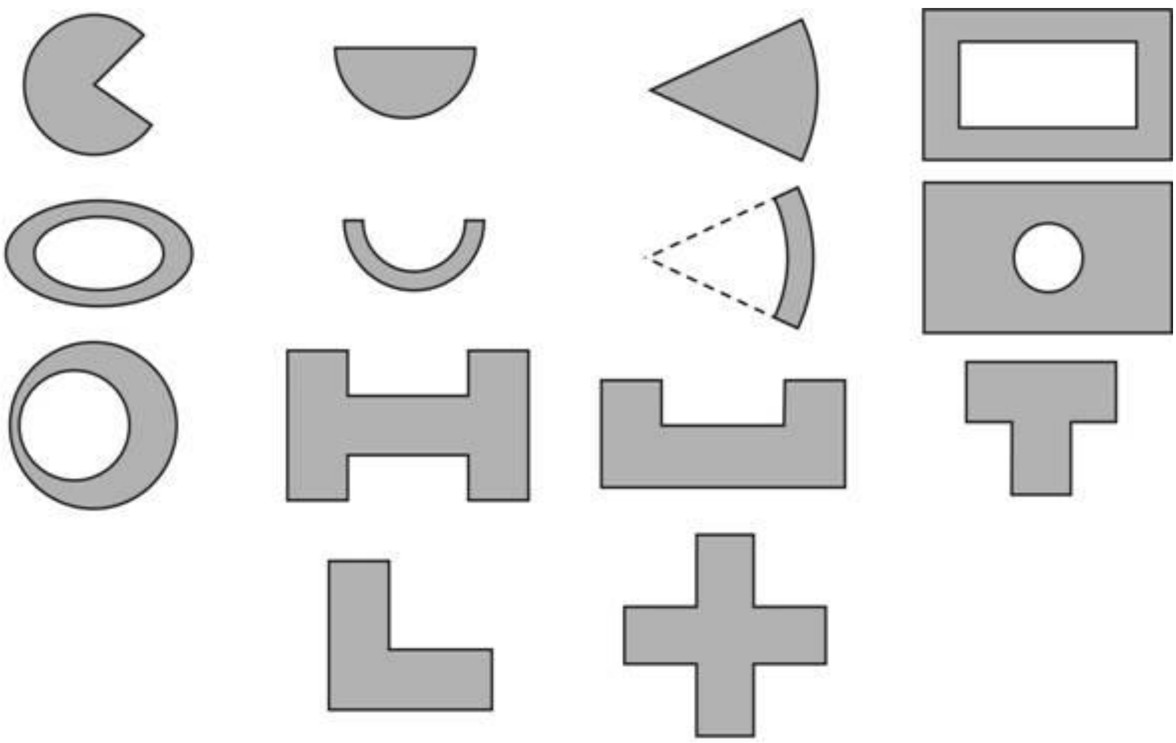


Figure 3.12 Various shapes for Microstrip antenna

Table: 3.1 Comparison between different feeding techniques and their characteristics

Characteristics	Co-axial Probe Feed	Radiatinga nd edge coupled	Non radiating and edge coupled	Gap-coupled	Insert feed	Proximity coupled	Aperture coupled
Configuration	Non - Planar type	Co-planartype	Co-planartype	Co-planartype	Co-planartype	Planartyp e	Planartype
Feed Radiation	Greater	Lesser	Lesser	Greater	Greater	Greater	Greater
Polarization	Very poor	Very Good	Very poor	Very poor	Very poor	Very poor	Excellent
Fabrication	Drilling and soldering needed	Very easy	Very easy	Very easy	Very easy	More alignment required	More alignment required
Reliability	Poor because of soldering	Best	Best	Best	Very good	Very good	Very good
Impedance match	Very simple	Very simple	Very simple	Very simple	Very simple	Very simple	Very simple
Bandwidth percentage	3 to 6%	8 to12%	2 to5%	3 to 6%	3 to 6%	14%	22%

3.13 Advantages and Disadvantages of Microstrip Patch antenna

Patch antennas are much popular for wireless applications because of its low profile. Hence mostly they are suitable for implanted antennas in small wireless component like pagers and cellular phones. On missiles, telemetry antennas and communication antennas required are very narrow and tiny and sometimes like patch antenna. These area also used in Satellite communication successfully.

3.13.1 Advantages

a. It is low volume as well as light weight antenna.
b. It has low profile antenna.
c. Fabrication cost of such antenna is very less.
d. It supports for circular as well as linear polarization.
e. Easily integrated to microwave circuits.
f. Dual and triple frequency operation is possible.
g. Mechanically strong.

This type of antennas suffers from various disadvantages, compared to that of conventional antennas. The major dis-advantages are as mentioned below:

3.13.2 Disadvantages

a. Bandwidth is very narrow.
b. Efficiency is low.
c. Gain is low.
d. Extraneous radiation through junctions as well as feeds.
e. End fire radiators are poor.
f. Power handling capacity is low.
g. Surface wave excitation is occurring.

High quality factor is also one of the main features of an antenna, denotes the noise that is generated from antenna, because the more the quality factor that leads the lower the efficiency as well as narrow bandwidth. The quality factor may be reduced as we can increase the thickness of the substrate. And also when the thickness go on increasing it tends to increase the total power transmitted by the signal source that enter into a surface wave. Its donation may be considered as an undesired power dropping due to its scattering on dielectric bends that creates mortifications in an antenna features. There are another some issues also present like lower power handling capacity, lower gain. These can be reduced through array arrangements.

3.14 Applications of patch Antenna

In the early years because of itssmall size, low profile, and very minimum manufacturing cost, thepatch antenna has been seems to be very much demand for the defense and thecommercial applications.

3.14.1 DCS - Digital communication systems

Digital communication systems cover a wide area of different communication techniques, which includes digital transmissionand digital radio. In this communication system digital pulses are transmitted between two or more points. Digital radio is the transmition of digital modulated, analog carriers signal between two or many more points in this communication system.

3.14.2 PCS - Personal communication systems

Basic level personal communication systems, describes a group of wireless communication capabilities. It permits for few combinations of mobility (terminal), mobility (personal), accurately. Personal communication systems mention for many types of wireless audio as well as data communication systems. Customarily, assimilating digitalized technology, which provides assistance same as that of paging services and advanced cellular mobile. Personal communication system may be utilized for providing other types of communication services, such as services which permit persons to receive the communication that are away from their home, and also communication to working offices, houses, and also other locations. It can be explained in more commercial way that the PCS- Personal communication system is a formation of mobile technology which connects a span of characteristics, services remarkable to those analog as well as digital mobile systems, which will be giving people all in one service such as messaging, mobile, paging, as well as data services.

3.14.3 WLAN - wireless local area network

It is the fastest developing Wireless communication technologies. Now a days it is very much demanding, everywhere for connecting the devices without the use of the cable. WLAN - Wireless Local Area Network can be found in office buildings and on college campuses, as well as also in many public areas. For the small wireless LANs the IEEE 802.11 wireless LAN technology is used and it is sometimes called wireless Ethernet and Bluetooth.

3.14.4 WiMAX - The worldwide interoperability for microwave access

This method of communication is based on MAN (Metropolitan Area Network) technology. It is also the recent and wide band wireless technology. Such methods look forwards to carry the broadband services, to enterprise, residential. Like the WiFi the WiMAX is also similarly operates but it is only at the greater Speeds, up to larger distances, only for maximum users. It is also having capability for providing services to users, in the remote areas.

3.14.5 UMTS - Universal Mobile Telecommunication System

The European proposed for IMT – 2000 prepared by ETSI is called universal mobile telecommunication system. It will provide an integrated system. In this the users have an access to particular wanted services via consistence service access producers. These services may be cited as similar to those provide to users by wire line terminals. The UMTS - Universal Mobile Telecommunication System grow by GSM community and selected the path for 3G development. The Universal Mobile Telecommunication System is the international telecommunication unions' families of the mobiles 3^{rd} generation communication system. The Universal Mobile Telecommunication System utilizes a W-CDMA air interface.

3.14.6 UWB - ultra wide band

Ultra wide band is an useful technology for broadcasting data and that will spread over a large bandwidth greater than 500 MHz. In appropriate situations, it can be capable to distribute the spectrum to other users. Managerial settings by the federal communications commission in the United States deliberate it to give the sufficient utilization of greater bandwidth and it enables the high data rate. Wireless connectivity with PAN, lower signal rate applications, larger range, as well as also in radar and in image systems. Main difference between UWB - Ultra Wide Band and those radio transmissions is such that, the conventional structure transmits signals by changing frequency, the energy level, as well as the phase of a continuous wave. The Ultra Wide Band frequency transmits information after creating radio energy at particular intervals of time; it occupies a maximum frequency band. Hence therefore, it is enabling the PPM – pulse position modulation or TM. The signal may also be modulated on - Ultra Wide Band frequency by encoding the sign of the pulse, amplitude, with the help of orthogonal pulses. These Ultra Wide Band signal can be sent intermittently at a lower pulse rates to help PPM - pulse position modulation or TM - time modulation, which may be transmit at the rates until the inverse of the ultra wide band pulse frequency bandwidth.

3.14.7 GPS - The Global Positioning System

The GPS - The Global Positioning System begins before 35 years for military assignment. It has been developed to have important business applications. In this GPS - The Global Positioning System the 24 satellites are revolving around the earth continuously for every twelve hours on its altitude of about 20200 km. Every satellite endlessly transmits the codes at 02 separate frequencies in L band, at any time for 24 hours, 04 satellites together can support the user on the ground station and it set on its accurate position and with an exact accuracy of about 15 meter as well as the period to an exact accuracy of 100 ns. Such thousands of the Global Positioning Systems ground station terminals were used through United States army in the Persian Gulf War for navigation**,** location finding, as well as for fire control. It is look forward to millions of such same units that can be utilized economically by the normal theory for an land vehicles, aircraft, as well as for determining their directions as well as its position. An Omni directional antenna which is required for the ground terminal has low-gain and wide-beam. To reduce the antennas weight, antenna size, and antenna costs in L band frequency, the antenna becomes a very good candidate. Hence the reduced structure of the microstrip antenna was manufactured through the Ball Corporation. Hence it is concluded that it is very hard to explore the next different types of antenna for replacing the patch antennas characteristics, such as mass, prize as well as the size for GPS - The Global Positioning System applications.

3.14.8 DBS - Direct Broadcast Satellites System

The Direct Broadcast Satellites system can be provided for television services to the public in many countries. Direct Broadcast Satellites system is a ground user antenna, which requires higher gain up to 30 dB and requires an operating frequency around 12 GHz. Now days parabolic antennas are appropriate for so maximum users. But parabolic antennas have not been hidden easily or fixed onto buildings due to its covered and its heavy structure. It will also require a separate real estate for its installation. Hence this results, the development of so many flat microstrip patch array antennas for the Direct Broadcast Satellites system. Due to this reason the it's lightweight feature, and easy installation on the constructed building, delicate attractive, as well as lesser manufacturing prize.

3.14.9 The Remote Sensing

In this the Synthetic Aperture Radar Technique is used to decide plants type, class of ground soil, speed of ocean wave as well as direction. It is having very important business effect on the population with respect to weather forecast, agriculture. Consider a C-band SAR 1341 newly implemented by NASA. It has been efficiently estimated the features of waves of the ocean that will contribute to the weather forecast. For radar platform like microstrip arrays which are isolated by a distance is a flush mounted on the side of the DC-8 flame, an aircraft can be used. Each array has a rectangular aperture. In the broadside direction ,It will generate a fan structured beam. It has 02 rows of the square patches, and rows are excited in the opposite phase, to get cross polarization. Relatively the maximum number of radiators is kept sequentially to reduce insertion losses and achieved better efficiency. Such type of arrays are achieved lesser cross polarization in the main lobe region and the total efficiency of about 72% and with peak gain of about 23.8db

3.14.10 The Medical Hyperthermia

For treating of tumors in the medical area the microwave energy is the most important type of hyperthermia. Diffusions have been found when warming a large number of tissues. Therefore the required characteristic of a microwave applicator comprise of the precipitation of the energy in the tissue, and achieved good impedance matching to the surface which is to be treated. Hence lesser leakage of microwave energy results at the outside of the utilized area. An antenna element has to be light weighted, easy to handle the design. The microstrip patch antenna is suitable and met all this type of requirements. Older approaches of microstrip antenna for the use of hyperthermia were dipole antennas, have annular rings at the frequency, S-band and the latest usefulness of a circular microstrip antenna is of frequency L-band. Microstrip element and coupling as well as its separation have to be used at a UHF range of frequency, for measuring the temperature gradient for the human body.

CHAPTER 4

FUNDAMENTAL OF TEXTILE ANTENNA

4.1 Introduction

The expanding universal movement in body territory systems (BANs), remote individual region systems (WPANs), and restorative sensor systems has offered ascend to reestablished enthusiasm for wearable receiving wires which intends a task on the body of human, assortments of creatures. In military itis utilizedas a versatile radio gear; fusing receiving wires near the body, for a long time.Improvement of the pager, cell phone implied the numerousinvestigations of reception apparatuses along the body have been embraced [18].presentingthe numerous kinds of smallsensorslike body worn medicinal has improved that a capability as wireless restorative sensor. The capacity of specialists on the screen expands when their patients are at remote place, consequently empowering asset sparing through early patient discharge from doctor's facilities.

Table: 4.1 Different types of textile materials

Non Conductive Fabric	Dielectric Constant (ε_r)	tan δ
Felt	1.22	0.016
Corduroy	1.90	0.0098
Cotton	1.60	0.0400
Silk	1.75	0.012
Jeans	1.7	0.025

These improvements show various new and energizing difficulties for radio wire this part. Subsequent to portraying a helpful classifier and calling attention to the cozy connection between reception apparatus execution and radio wave proliferation in the particular area.The possessions of the body are explored as well as a part of the electromagnetic distribution of sources on the body are distinguished. Resulting areas portray narrow range radio wire plan, texture-based reception apparatuses, and ultra wideband receiving wires lastly the execution of various reception apparatus frameworks on the body [19].

The advancement and use of wearable receiving wires has developed quickly as of late for application in the scaling down of remote specialized gadgets. The principle preferred standpoint of wearable radio wires is that they are outlined as components of attire ready to transmit or get remote signs. The wearable radio wire framework assumes an essential part in numerous fields, including following and route. Wearable correspondences frameworks require that the transmitter be smaller, limit control utilization, and be streamlined for flag transmission on the human body. Planning a reception apparatus to meet these criteria is a testing undertaking. The outline must fulfill various prerequisites including: scaling down, as to be undetectable on the body; create aunidirectional radiation example to give transmission paying little heed to receiving wire introduction and collector area; tuning change in accordance with adjust for body impacts.

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Figure 4.1 Wearable Textile Antennas

4.2 Various Regions of Operation

At a framework level BANs, WPANs, and therapeutic sensor systems are groupings embraced, which is helpful to talk about a next classifier, at the radio wire level, and gives understandings into electromagnetic difficulties that face reception apparatus architect. Capacity of wearable reception apparatuses can be separated within three classes.

4.3 Consequences of Human Body on Textile Antenna

For the radio wire human body is lossy and disintegrates the correspondence interface. Evans proposed two figures of legitimacy for body-worn radio wires:

4.3.1 Induced gain in body

It is the ratio of additions in dB between body-worn reception apparatus that of the receiving wire in free space.

4.3.2 Efficiency of body worn

This is the ratio of aggregate emanated control considering radio wire which can be worn in the body to the aggregate transmitted power (in free space). In body it speaks to the general power misfortune.

4.3.3 Effect of body on impedance

When the client is excessively near the reception apparatus [7] then a receiving wires impedance will be bring down.

4.3.4 Body detuning

Dielectric constant of some tissues is of the request of 20-50.Dielectric stackingcauses due tohigh estimation of dielectric. Therefore the thunderous recurrence moves aroundthe radio wire which is found nearby to it. Proficiency of a receiving wire is regularly enormously diminished as a result of assimilation by bringing itnear to the human body. If the receiving wire body detachment separate is little, retention commands and diminishment of effectiveness is the actual impact, when impact of the human body on reception apparatus radiation properties is two-crease.

4.4 Things to Consider Before Making Textile Antenna

There are three principle issues. To begin with issue is identified with the reception apparatus substrate material choice. It is to know the electrical conduct of the material so as to choose appropriate substrate. This material information isn't accessible and along these lines' electrical portrayal of various material materials is required. This isn't a totally insignificant errand and distinctive estimation procedures must be utilized as a part of request to assess parameters, e.g. dielectric consistent. Second issue manages the receiving wire execution under twisting condition or stress. Since receiving wire is gathered in garments it encounters distinctive sort of twisting conditions. The main problem is to keep up the basic reception apparatus parameters at worthy levels in all conditions viewed as typical activity condition. Such parameters are: Axial proportion (strong against twisting), Operating recurrence (steadiness because of bowing), Efficiency (forestall human tissue to corrupt effectiveness). Third issue manages the real creation. The principle concern is the manner by which to make the reception apparatus sufficiently vigorous against assembling resistances.

Textile material, for example, texture and yarn are fundamentally congregations of filaments. The filaments are for the mostly part will be made up of straight and long chain polymers and also haveproportion oflarge length to width. The electrical conductivity of a large portion of these strands is low with the goal that they can be utilized as a dielectric for material reception apparatuses. The permittivity of a material is generally offered with respect to free space dielectric consistent (ε_r). Dielectric constants of the receiving wire substrate have a critical part in the reception apparatus planning. Distinctive substrates having diverse dielectric constants influence the receiving wire execution in different ways.

4.5 Various Textile Material used for Wearable Antenna

Materials along with textile include fiber.Fibers are usually made up of long chain polymers types and lengthyup to estimation extent. Since the electrical conductivity of these polymers is very low,so usuallythese are considered as separators.

4.5.1 Highlights of textile materials

The major features of textile material are described below.

4.5.1.1 Fabrics dielectric constants (ε)

Dielectric characteristic depends upon temperature, frequency, surface, moistness substance faultlessness and uniformity of the material. Furthermore, it depends upon electric field presentation because material materials are an isotropic. Unmistakable strategies used for the correct estimation of dielectric properties are: Transmission line methodology, Cavity Perturbation Method, Resonance Method and MOM-section strategy.

4.5.1.2 Dielectric fabrics thickness

It is an indispensable parameter that chooses profitability and transmission limit of planar microstrip accepting wire. Material materials have a particularly limited extent of permittivity regards, so thickness may indicate impressively greater assortments and choose the information transmission, input impedance and booming repeat of the receiving wire. It in like manner impacts geometric size of the radio wire [18].

4.5.1.3Fabric's moisture content

The strands are ceaselessly trading water atoms with air and dependably build up harmony with stickiness of air, the temperature. The point at which the water is consumed by the material filaments there it changes an electromagnetic properties and also expands the dielectric consistent as well as misfortune [9-10]. Climatic changes and additionally vicinity of receiving wire to skin will make the texture assimilate dampness from skin and henceforth influencing the reception apparatus execution.

4.5.2 Antenna Parameters

Material gathering mechanical assemblies for trades for the base station of the body are all things considered depicted according toits volume when these are fitted into minimum electronic rigging, their information facilitates on the gatherings need. If the receiving wire is made united with clothing, gauge is little basic, very high frequency is required. Efficiency Confirmation is risky, routinely chosen by reenactment. Emission configuration canbe controlled by uniting human subject or a body phantom to a standard estimation design. In Figure 7.1 it exhibits body enclosed in a ring passing on the receiving wire, demonstrating that estimation should be at the field far away is expel, managed by the body measure instead of the gathering contraption measure, and anyway when in doubt this detachment may be fumblingly far reaching and shorter ones are used. If the gathering device is depended upon to be used as a piece of a vivaciously confused, multipath rich condition.By the radiation configuration altogetherisminimum objective, for small receiving wires when the radiation configuration is veryhard to control Suppose the gathering contraption is speak with other on body then, the upper size, match as well as capability are critical.

4.5.3 Antenna design procedure

The geometry of a receiving wire created for body wearable applications includes a thin, directing rectangular copper fix on a protecting texture substrate sponsored by a copper tapeas a ground. The estimation of a dielectric consistent of the texture as substrate materials are resolved tentatively by utilizing a novel strategy (in light of reverberation technique) proposed by the creators in [14]. The plan of microstrip fix radiator includes the calculation of its fix measurements. The fix width (W) majorly affects the resounding recurrence (*fr*) and it is computed utilizing the accompanying recipe [15].

$$W = c = 2\,fr \tag{4.1}$$

4.5.4 Some Electrical features of the Homosapien Body

The body of human is made out of vast assortment of tissue writes, every having diverse dielectric properties, also this information is imperative for outline of textile wires. There are various investigations regarding dielectriccharacteristics of body tissues for radio frequencies as well as microwaves. Estimations can't be made on live tissue, with the exception of on account of tongue and skin, and much estimation is made on human examination things or naturally executed creature. Estimations can be made over a recurrence scope frequency ranging from 10 to 20 GHz, which described with a 4-Cole show. There is huge variety of parameters with recurrence. The Muscles arehaving a significantlymuch high permittivity as well asthe conductivity than the fat. For instance, the profundity is 100 mm, for muscle at 100 MHz, where as it is around 30 mmfor at 2 GHz. Therefore, qualities are around 400mm individually.

4.5.5 Waves and sources on the Body

The low genuine part implies that as a radio wire is kept near the surface, receiving wire impedance shall be emphatically crisscrossed. Receptive part can imply that the full recurrence shall be lessened, because it contrarily relative to the reactance in the radio wires equal circuit. Ithappens when the reception apparatus is an electric source, for example, a dipole, for example, an opening. This wonder is seen by and by Reduction in productivity and contortions to the radiation design additionally happen. On account of reception apparatuses planned for correspondences to another on the body, at that point the idea of radio wave engendering on the body ought to be examined on the off chance that the body is in a diffusing domain, for example, a jumbled room; at that point this will likewise impact the got control. This is borne out by near estimations of connection misfortune for different receiving wires, which demonstrate way misfortune brings downon a channelto 10 dB, which is from the chest to belt when it moving on an individual for the monopole radio wire contrasted with a circle. The distinction is close to two or three dB by and large, due, it is accepted, to the strength of room wave engendering in belt to wrist channel.

4.6 Formulation of the Present Work

Construction of antenna structure on a fabric of cotton as substrate and conducting patch as e-textile on CST STUDIO and then textile antenna hardware is to be formed and verify it practically. Overall project with hardware and practical result of simulated antenna which we have designed, Comparison have been done after practical results. Practical results are calculated using vector network analyzer, a tool used to calculate practical results of designed hardware antenna. Microstrip antenna consists of various properties which make it very useful for many applications.

4.7 Analysis of previous research in this Area

Media transmission frameworks coordinated inside articles of clothing and wearable items are such strategies by which medicinal gadgets are having an effect on improving human services arrangements all day and all night. These pieces of clothing when completely created will be equipped for cautioning and requesting consideration if and when required alongside limiting healing center assets and work. Besides, they can assume a noteworthy part in safeguard sicknesses, wellbeing abnormalities and unexpected heart or mind issue in obviously solid people. This work introduces the attainability of researching an Ultra Wide Band (UWB) receiving wire produced using completely material materials whichareused for substrate and leading parts of the planned radio wire. Recreated and estimated comes about demonstrate that the proposed reception apparatus configurationreaches the necessities of broad working transmission capacity, gives 13.08 GHz data transfer capacity smaller size, launderable and adaptable materials. Results as far as return misfortune, transfer speed, radiation design, current circulation and in addition pick up and proficiency are exhibited to approve the helpfulness of the present original copy plan. The work displayed here has significant ramifications for future investigations of an independent suite which may help to give wearer (persistent) with solid.This task exhibits a multiband space radio wire with adjusting geometry sustained by coplanar waveguide (CPW) transmission line. The properties of the radio wires, for example, return misfortunes, radiation examples and pick up are resolved by means of numerical reenactment and estimation. The new idea of a wearable material framework has made its entrance into the material world. This idea is gone for improving the personal satisfaction for individuals by furnishing them with a wearable ceaseless checking framework. Checking as a rule is an important movement in hazardous conditions, for example, mining, plunging, mountain moving and different sorts of military and security activities. Nonetheless, medicinal observing exceptionally is observed. It is important the end goal to exchange information for inpatients in healing facility condition, in home for homebound patients, even outpatients. Consequently, all these expansive utilizations of checking with information transmission capacities can be accomplished by using wearable radio wires that don't drive the wearer to desert the safe place with such minimal and tough materials. Like past materials not at all radio wires, receiving wire configuration is monitoredcan be equipped for the meeting.The requirements of wearable light electronic appliance. Warm-hearted, expending a little measure of energy, being agreeable to wear with adaptable materials and exceptionally minimized size reception apparatus models. What's more, the present original copy materials utilized can ensure washing of the wearable gadget and in like manner reuse of it.

4.8 Proposed Approach

In Markets there is an availability of extensive variety of Potential necessities and examinations for these novel material materials actualizing radio wire outlines and applications. Since 1997, wearable media transmission frameworks have turned out to be prevalent themes in look into organizations. Various papers have been distributed regarding the outline creation and applications of wearable receiving wires and frameworks. The improvement of rectangular fix reception apparatus utilizing texture substrate materials was considered. Keeping in mind the end goal to explore the appropriateness of utilizing substrate Fabric materials for radio wire plans comparative examinations have been done.

Furthermore, another examination utilizing electro-material for outlining microstrip fix receiving wire was accounted. As a rule, receiving wire comes in every single diverse shape and sizes. In any case, UWB receiving wires appear to be most appropriate for combination into garments. These radio wires comprise of a metallic fix over a dielectric substrate. It is mounted onto a conducting ground plane. Circuits plan, for example, shape, sustain structure and encourage point area. As to wearable material frameworks, these reduced receiving wires are most suitable to and a place on a piece of clothing.In low or medium information rate applications, as wearable processing, Antenna offers low-control activity and to a great degree low transmitted power, subsequently being exceptionally alluring for body-worn battery-worked gadgets. However, a few wearable reception apparatuses angles add to the general 324 Materials. Configuration features of the radio wires, for example, the shirking of flexible textures, considering wetness aspects and thinking about twisting states of the wearable framework. Besides, planners need to guarantee that the wearable media transmission gadgets work appropriately in the region of human body. Also, the innovation of this undertaking lies with new textile. In any case, past material receiving wires were normally made up of materials which were unrealistic to permit reusing,washing of the wearable cloth. Our recent reception apparatuses were produced using material materials alongside new element gave by being effortlessly and specifically coordinated into garments, which ensures washing of the wearable gadget and appropriately reuse of it. In addition, the material utilized can oppose the ordinary states of utilization.

4.9 Materials Used for Substrate

Utilizing textures as substrate materials rather than unbending circuit sheets empowers the position of little receiving wires and sensors. In this work, our examination centers around utilizing pants as a substrate material which is reasonable for wearable applications. A large portion of substrate texture material inquires about that were accounted for before did not consider the stacking issues of texture layers. The word material is regularly utilized for radio wire class and texture to portray specific material.

4.10 Materials Used for Conducting

The end goal for manufacturing the correspondence frame work leading materials is required, which is to kept in mind. These Communication gadgets or frameworks require proper materials and structures and should be Compatible with wearable material reception apparatus prerequisites. An efficient report is shown utilizing two kinds of leading materials. In any case, because of the unrealistic use of the copper Conducting sheet the other kind of leading material is proposed. This leading material is a sort of amazing directing string. As per producer determinations, this leading string is produced using a silver-Plated Nylon string to guarantee Superior quality and conductivity alongside the capacity to oppose the ordinary states of utilization, for example, different mishappening.

4.11 Wearable textile antenna

Wearable textile antennas are more popularbecause of the advancement of the wearable computing which has covered its way into integration of technology into textiles. Therefore, a complete analysis done in this report which will evaluate and investigates the operation of wearable textile antenna and it will also shows an integration of antenna into jeans fabric as substrate. The performance enhancement in textile systems has changed the idea of smart clothing. In these new technology clothes are capable of monitoring all the activities as well as signs of the observer and surroundings.

Wearable textile antennas are made up fabrics as a substrate and having a patch as well as ground plane and built up with copper which can easily linked with fabrics or any other object. These are usually used with wearable computing as it is a latest and fastgrowing field. It is gradually developing state of miniaturization in electronics along with the different technologies that willpermitsan integration of clothing into new devices. Usingsuch type of antenna in medical field is the best example of it as it can be easily monitors the condition of patient from distance .Hence itis therefore become attainable for integrating these sensing devices within a clothingby this technique,and which offers inconspicuousness and body proximity. Further, patients will get medical support for their health related issues and can be directly linked to the medical professionals whenever it is needed. The implementation of textile antennas are therefore is the very important step. Further applications of textile antennas comes under vehicle automation industry, as in GPS system vehicles or it may be in steering of vehicle.These textile antennas have to be more flexible as compared to common antennas so that it may not create any problem in movements of the body parts. Therefore, the textile antennas are better when compared to conventional antennas in terms of flexibility. On other hand the fabric wearable antenna should have plane surface so that it does affect the comfort of the user and make it friendlier for the users.Textiles antennas which are available are designed with circular patches having probe feed that cangive a polarization (linear). It is used in different applications, such as computing to wearable related, as well as the direction of the textile wearable antenna can be as a purpose of time function. For an example when a person who will wear the antenna makes movement. The relative orientation of transmitting antenna as well as receiving antenna polarization lead the way a dependence of the efficiency of antennas. On the other hand probe feed lead to conceited an antenna, therefore it is impractical for wearable textile computing.Themain aim of a textile antenna is to overcome the disadvantages of micro strip antennas which can be convenient for frequency which is ranges from 1.75 to 1.85 GHz (GSM), and 2.45 GHz for Bluetooth, also for the different band of frequency which is ranges from 400 MHz to 20 GHz, to operate by using already available communication technologies.These antennasare also convenient for moving objects, and therefore to provide wearable textile antennaswhich are designedwhich makes it cost effective to manufacture.

Textile antennas have come out with an important material which can be used as substrate as well as radiating parts of textile antenna technology. In future time it gives the complete liberty to create an antenna schemes associated with garments, and are termed as smart garments which can gain easy acceptance nowadays. This technology will come up with so many innovative devices for defense personnel’s, medicine practitioners, astronautsafter few years.These wireless communications can permits features related to digital media. Thereforethe analysis on wearable computing technique the institutes and engineers as well as research scholars, are showing great enthusiasm towards textile antenna. The basic requirements and specifications which will be common for all the antennas are cheap, robust, light weight andset-up requirements are also not required.

Due to the jeans material and copper adhesive tape which can be utilized for radiating parts,results the antenna to be wearable, light weight and cost effective. Therefore, the suggested antenna design can be linked with the garments without facing any problem to the positioning of antenna. Normally, antennas are expensive, rigid, and huge in size that makes it not user friendly. Thus, the textiles materials which we are using in this antenna design are very low cost so we can conclude that this is the best material for commercials and industrial products.

Wearable computing technique may be a fast emergingfield of application based analysis. The main objective and target of these techniques is to be linked with the electronic devices which will become our need on daily basis. These garments represent as monitoring devicesthat will be serving us as an assistant. The computing system will always be in working condition and thereforewill not create any sort of hindrance to the activities of users.

The key point of the wearable textile antenna is to provide an improvement standard for living style of people by combination of clothes and electronics. The basic idea behind this research is that the integration of the textiles to the electronic circuitry can definitely leads to the new generation smart clothes. These clothes have the capability to sense the pulses and then can transmit it to the medical center for the better medical gadgets. But for this there should be a wellassociated system and communication among the textiles and body should be accurate, to getthe best result from these textile antennas. The use and implementation of these types of textile antennas are very easy and simple and can be easily proficient by following the basic principles of wearable computing.

The main major important applications of wearable textile systems are as below:

1. Automation of vehicles
2. Astronomy
3. To check pulse count
4. During war like situation for defense personnel's

The main favorable and required aspects of wearable textile antenna system and their practical implementation will be covered and discussed in the next chapter of the thesis.

4.12 InteractionHuman body with the antenna

Human body is just like a fixed formed medium or it may be an unbending medium with recurrence subordinate conductivity and permittivity. Dispersion of an electromagnetic field in a body, and the dissipated field that depends to a great extent for physical body parameters, configure recurrence, and polarization. Because of high permittivity of a body tissues [22] resounding recurrence of reception apparatus may change and can be detune to the lower one. One moresignificant factor is reception apparatus gain, that straight forwardly impacts on power transmitted in the maximum radiation course The addition will gets let down as there is some piece of transmitting intensity of a radio wire will be consumed, because of loss of human body by it.

Wearable textile antennas are usually made up of fabrics which have air gaps in threads and may simply retain moisture. The wetness in wearable textile can be easily changing the performance parameters of the antenna. So the operating frequency, bandwidth and the return loss will change very frequently. Mostly the necessities of textile antennas are specific as per the utilization. Some common needs for several applications are:

1. Fabrication cost is less.
2. Maintenance cost is less.
3. Installation and Setup is not required

4. Robust to resist hard from obstacles.
5. It is very flexible.
6. Light in weight, compact in size.

It is not easy to manufacture antenna in bulk with the same material, because of twisting and turning the fabric of antenna. It can easily get deformed and therefore, performance of antenna will get affected.

4.13 The dielectric constant of the fabrics

One of the foremost important parameter which affects the capability to send quick dynamic messages with the fabric transmitter because the relative permittivity of substrate may change and would be varying material to material. By this phenomenon return loss in the transmission line can also be affected. The permittivity is expressed as:

$$\varepsilon_\gamma : \varepsilon = \varepsilon_0 \varepsilon_\gamma = \varepsilon_0\, (\varepsilon_{R1} - j\varepsilon_{R2}) \quad (4.2)$$

Where, permittivity of the vacuum (ε_o) is considered as 8.854 $\times 10^{-12}$ F/m. Generally, frequency, temperature, substrate surface as well as conjointly on the moisture, actual dimension and rough edges of the fabric will affect the dielectric properties of textile materials. The actual real part of the relative permittivity of material, ε_{r1}, is known as dielectric constant. It is a ratio of the imaginary part to that of actual real part is called a loss tangent and that can be represented as:

$$\tan \delta = {}^{-\varepsilon_{R2}}/_{\varepsilon_{R1}} \quad (4.3)$$

Therefore, the behavior of the fabric has been examined in different ways like orientation, tested in a specific electric field expressed by arelative permittivity. The behavior displayed by the materials mostly depends on their dielectric properties and the types of fibers and their density. Hence, the correct evaluation of dielectric properties of textiles is challenges such as the, resonance method, cavity perturbation method, transmission line method and free space method. Materials which have low dielectric constant because of the pores available in textiles filled with air that make their permittivity to reduce. The surface wave losses can also be removed by using material of low dielectric constant. Therefore, it will increase the spatial waves by decreasing the relative permittivity and hence the impedance bandwidth of antenna will also increase.

4.14 Height of the dielectric fabrics

Thebandwidth and efficiency of a patch antenna and that with feed line is principally recognized with the type of substrate material used and its relative permittivity as well as its dielectric thickness. These permittivity values of textile materials are quite narrow in range,so, their thickness will determine the bandwidth and its frequency resonance as well as antenna's input impedance. To get the maximum bandwidth of a antenna, substrate thickness and relative permittivity is chosen, That will not only enhance the efficiency of antenna and thickness of dielectric material is trade-off among andthat how much an antenna is efficient and its bandwidth.

4.15 Bending effect by human body movements

A bend on the body comprises of a superimposition of curves in an unrestricted ways. As a result they have better adaptability and flexibility to adjust well with the surfaces. Accordingly, protective linings can be utilized to cancel the changes that occur due to moisture. Instead of this the designed antenna should be kept properly on human body keeping in mind to avoid the spots or areas like elbows, arms, and joints where body movement can affect the proper working on antenna. The performance can also change very drastically that the textile antenna is placed near to the human body.

Textile antenna must have limited ground plane where radiation from textile antenna should be minimum and could not affect the person's health. Instead, the variety of the geometric elements of the various wearable textile components foran antenna therefore their stretching or compression eliminates the geometry of antenna's shape, that affecting its behavior, as well as its resonant frequency.

4.16 The electrical surface resistivity

The most significant parameter that can be considered is the conductivity of the texture,its unit is Siemens/meter (S/m), for the receiving wire plan. For a decent exhibition of the receiving wire the most significant factor is to Choose of the conductive texture for the fix and the ground surface other than the dielectric consistent of the substrate material. For the contemplated sew material which is made up of silver plated polyamide filaments, the surface resistivity distortions under 8% of stretching with the bearing of the Wales marginally change. It may, when extending the sewed texture witha heading of the courses, and the electric surface resistivity gives that the stability up to 3% of prolongation.However the increments at 8percent of extension it achieves three times the underlying worth. Structure because of surface resistivity of texture might be better comprehended by the Figure 4.2 which shows plans of ordinary examples of textures, the pullovers sew and the silk 5 weave.

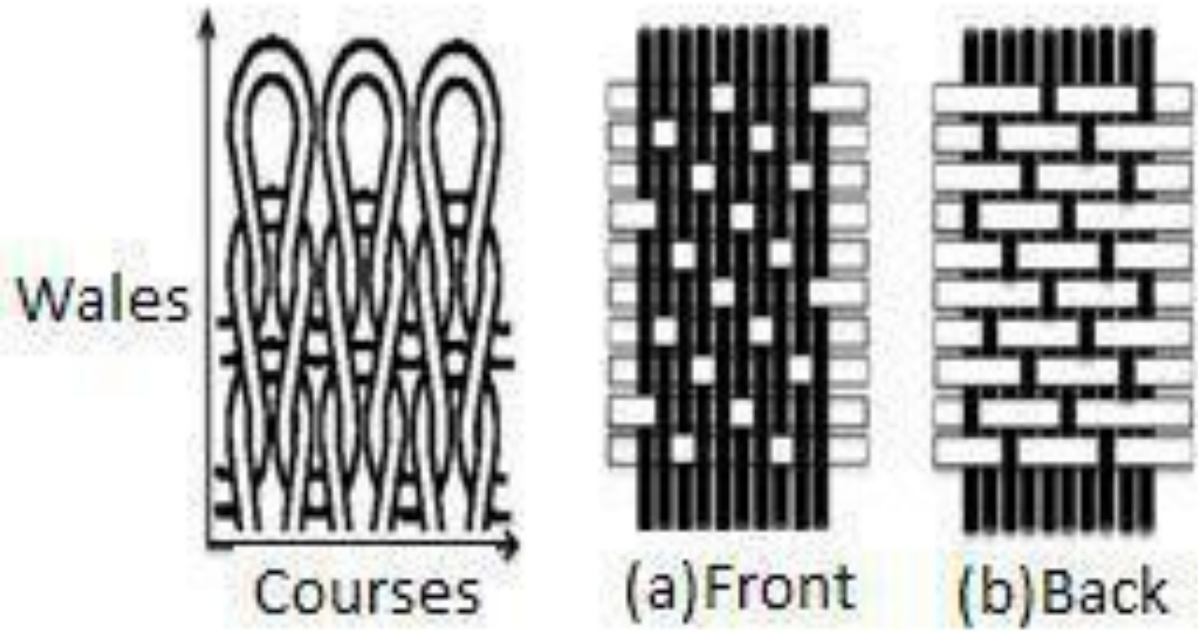


Figure 4.2 Knitting of various materials (jersey, satin woven)

The privilege and posteriors of the glossy silk 5 woven are unmistakably unique as shown in figure 4.2. In this a glossy silk 5 woven made out of conductive yarns (spoken to by white bars), non-conductive yarns (by dark bars) and was tried in small scale strip resonator estimation for considering the impact of the distinctions among appearances on an electrical properties of the planar structure. So keeping a conductive face against the dielectric substrate materialwill be increasingly finest for the reductions of electrical misfortunes.

CHAPTER 5

SIMULATED RESULTS AND DISCUSSION OF PROPOSED ANTENNA

5.1 Liquid Textile Adhesive

This technique is used for fabricating wearable textile antenna. It is applied on conductive layer of textile. In this, fabric layer must bevery smooth and thin because it shows soaking effects but this is not practical. The cement fluid fills in as protecting material in the middle of the conductive yarns or strings in light of the fact that the layer isn't equally thick so electrical opposition demonstrates homogeneity. This homogeneity could increment by a factor of ten at various spots of the texture.

5.2 Spray Conductive Technique

It is the most flexible and popular fabrication technique. It is applicable to any type of textile material in this method the spray is formed on the fabric inthat composition of copper plus gases are under pressure. Conductive layer is generated on the textile surface by this spray which is evenly distributed on the fabric.

5.3 Point Wise Deposition of Conductive Adhesive

Adhesive is placed atparticular points on the fabric. The sheet resistance cannot increase becausespacing in fabric is 1 cm. The first drawback is bad mechanical stability. Second limitation is imperfect attachment of antenna patch for preserving geometry.For small area applications this technique is very suitable. These types of adhesives are rigid and fragile.

5.4 Method of Sewing

This technique is used to fabricate antenna. By sewing some creases are formed over the fabric plane. The space between the seams should at least be less than 2cm to minimize the wrinkling problem as in Figure 3. Due to uneven distance which corresponds to wrinkling to the ground plane as well aspatch, the antennacharacteristic is distorted. A single stitch touched to ground plane as well as an antenna patch. Estimations (Electrical) of a receiving wire uncovered shorts between radio wires fix and ground plane in light of the fact that thelittle conductive filaments from the fix through the substrate are pulled by the needle. Due to this reason this sewing technique isn't appropriate for spacer texture substrate. The substrate for all time is compacted by the high weight of the sewing crease.

5.5 Layered Sheets by Ironing

The Electrical estimations of the receiving wire uncovered shorts between radio wires fix and ground plane in light of the fact that theneedle pulled little conductive filaments fromthe substrate. Due to this reason this sewing technique isn't appropriate for spacer texture substrate. The substrate for all time is compacted by the high weight of the sewing crease

5.6 Copper Tape Method

The copper tape method is the easiest method of the textile antenna fabrication. The tape made up of copper and being applied to substrates then additional fabrication process is not necessary. Copper tape can cut easily according to the geometry and the shape of textile antenna patch. By using copper tape, the patch can easily be designed.

5.7 Steps of Designing of bendable Textile Antenna

The essential parameters required to design a textile antenna are: (i) operating frequency (f_r), (ii) dielectric constant (ε_r) of a substrate (iii) substrate thickness (h). The formula for effective dielectric constant is [1].

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + \frac{10h}{W}\right]^{-\frac{1}{2}} \tag{5.1}$$

Here, W- represents the width of micro strip patch ;h- represents the height, of its substrate, and ε_r represents dielectric constant, ε_{reff} effective dielectric constant. Therefore, the patch width can be calculated using equation [1]

$$W = \frac{C}{2f}\sqrt{\frac{2}{(\varepsilon_r + 1)}} \tag{5.2}$$

Fringing length of patch is increases electrically. Therefore, incremental length is given as [1]

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.300)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.813\right)} \tag{5.3}$$

Where, ΔL denotes length extension. Thus, effective length is given as:

$$L = \frac{1}{2 f_r \sqrt{\varepsilon_{reff}} \sqrt{\mu_0 \varepsilon_0}} - 2\Delta L \tag{5.4}$$

Therefore, the frequency of resonancecan be calculated as:

$$f_r = \frac{1}{2L\sqrt{\varepsilon_r}\sqrt{\mu_0 \varepsilon_0}} \tag{5.5}$$

The frequency of resonance is calculated as:

$$f_{rc} = \frac{1}{2L_{eff}\sqrt{\varepsilon_{reff}}\sqrt{\mu_0 \varepsilon_0}} - 2\Delta L \tag{5.6}$$

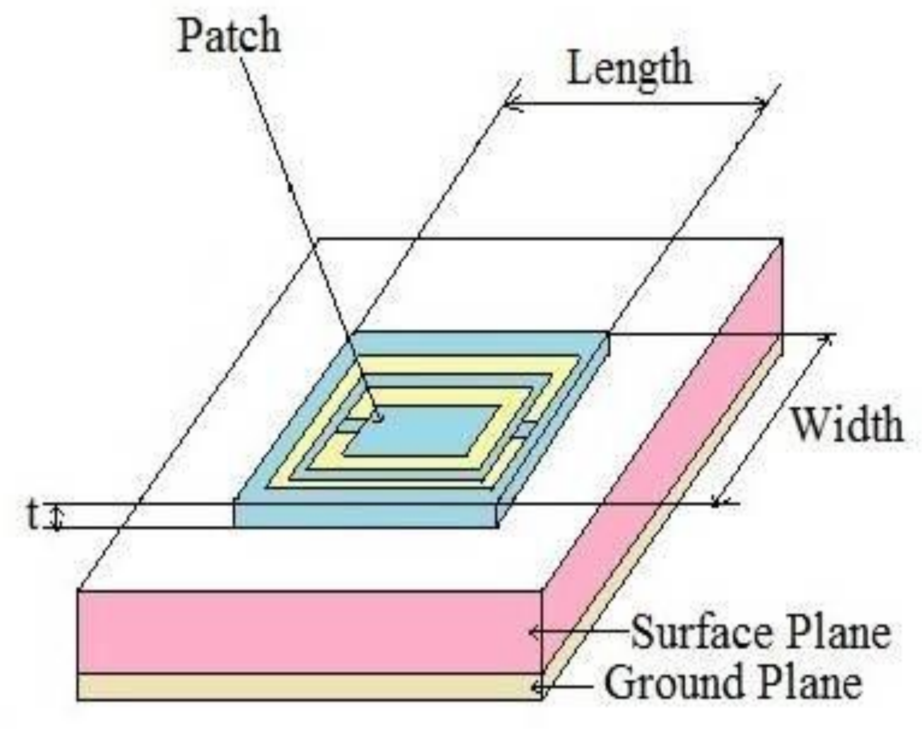


Figure 5.1 Geometry of Conventional Microstrip patch antenna

5.8 Anticipated textile antenna Design-I

The front outlook and back outlook of the simulated antenna are represented in the figure 5.2. Design parameters are shown in the table 5.1. Theground plane dimension is 15 mm×50 mm. The substrate, which is used in the presented structure, is jeans with dielectric constant 1.7. Patchradius is 14 mm andslot 10x10 mm with length of feed line17mm.

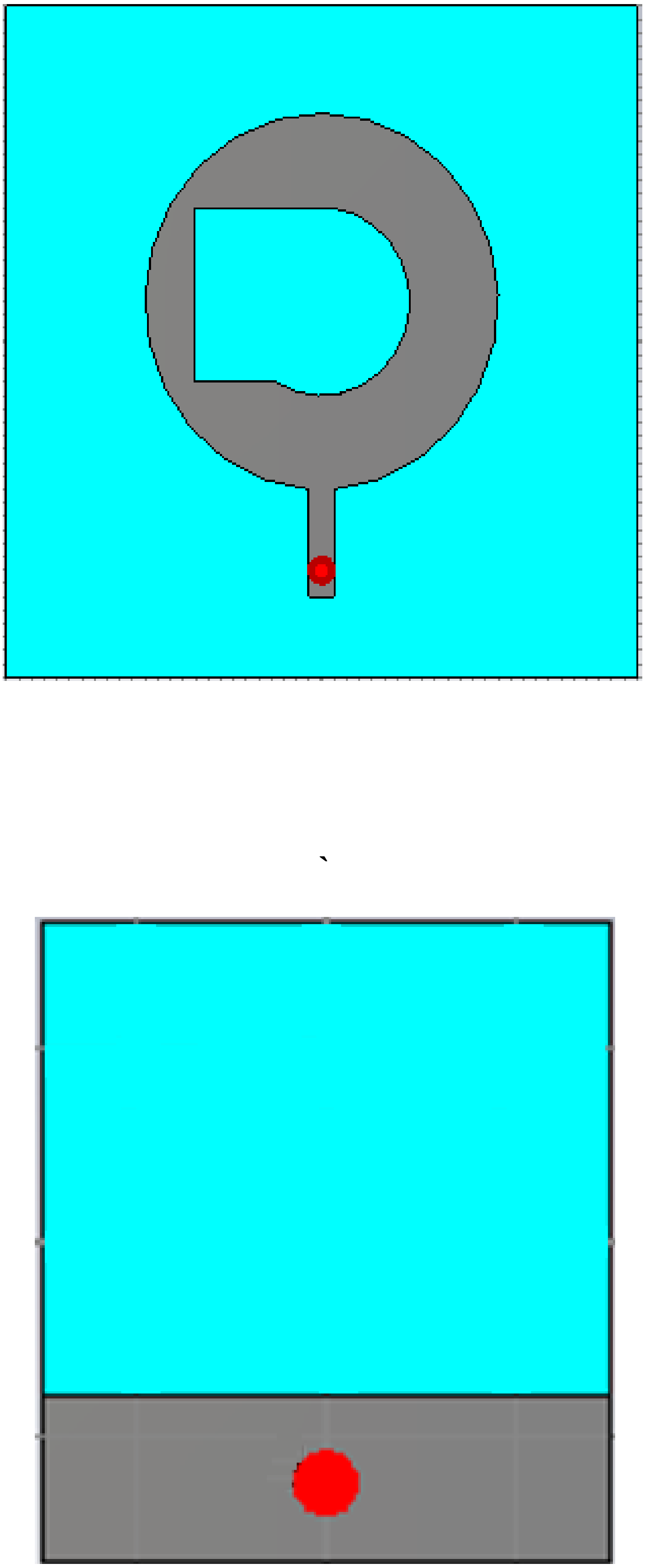


Figure 5.2 Front and Back outlook of proposed antenna-1

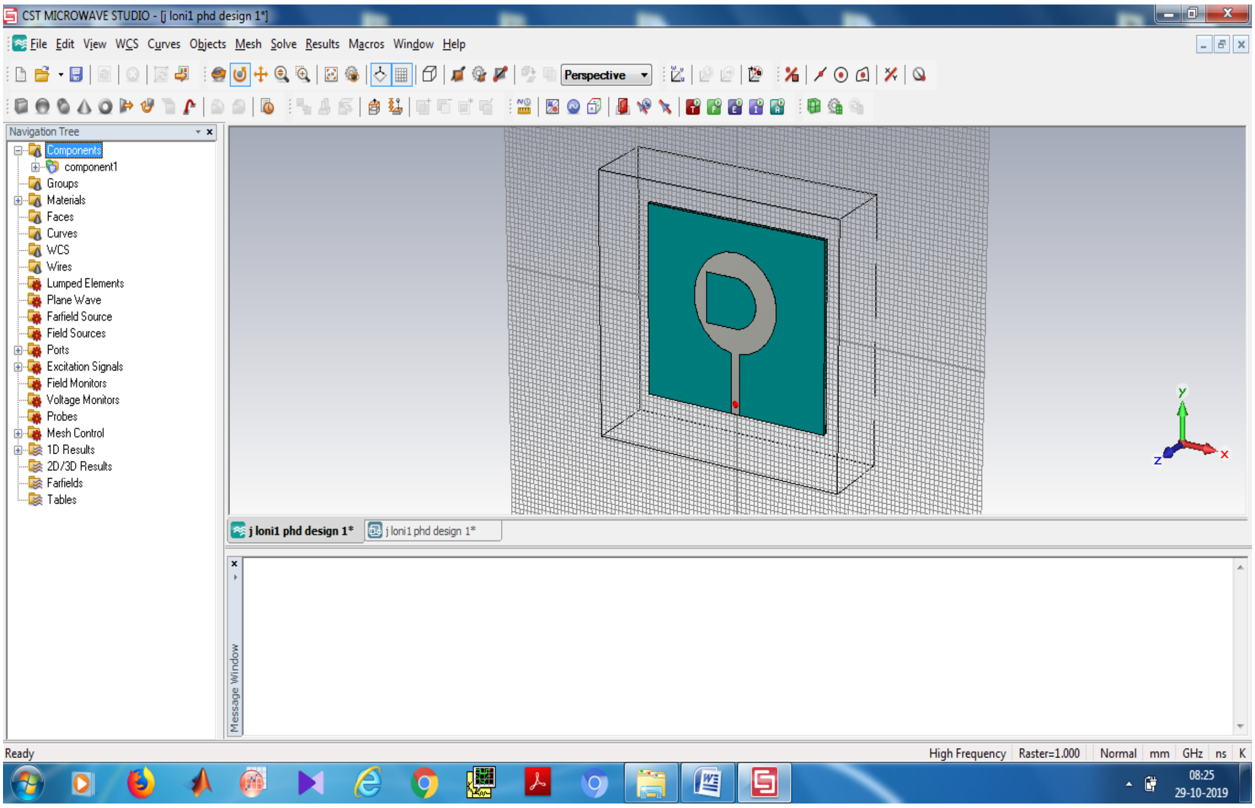


Figure 5.3 Anticipated design of textile antenna on CST software

Table 5.1: Dimension of presented textile antenna-1

Antenna Parameters	Values
Substrate Thickness(h)	1
Relative Permittivity(ε_r)	1.7
Semi circle radius[mm]	14
Rectangle width[mm]	14
Rectangle length[mm]	10
Substrate Dimension	50×50
Ground Plane Dimension	15×50

5.8.1 Outcome and Discussion

In the Figure 5.4 it shows the reflection coefficient vs. frequency plot at resonant frequency of 3.76 GHz and figure 5.5 shows the snapshot of reflection coefficient of anticipated textile antenna on CST software. The far field 3-dimensional plot and far field 2-dimensional radiation pattern of variable textile antenna and which is given below.In the figure 5.6 and 5.7it shows the directivity of 3.124db.The presented novel design provides better results as compared to some existing antennas described in table 5.3.

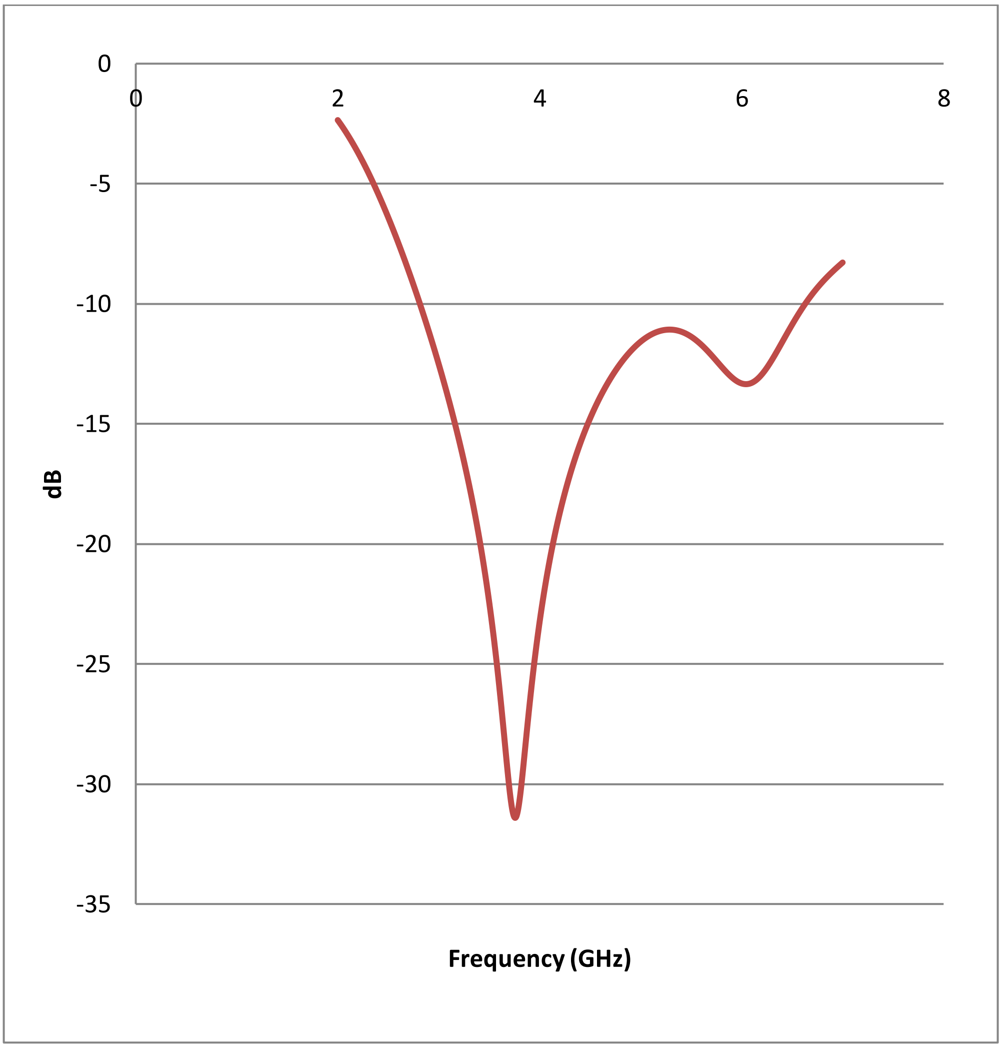


Figure 5.4 Simulation Reflection Coefficient of Textile Antenna-1

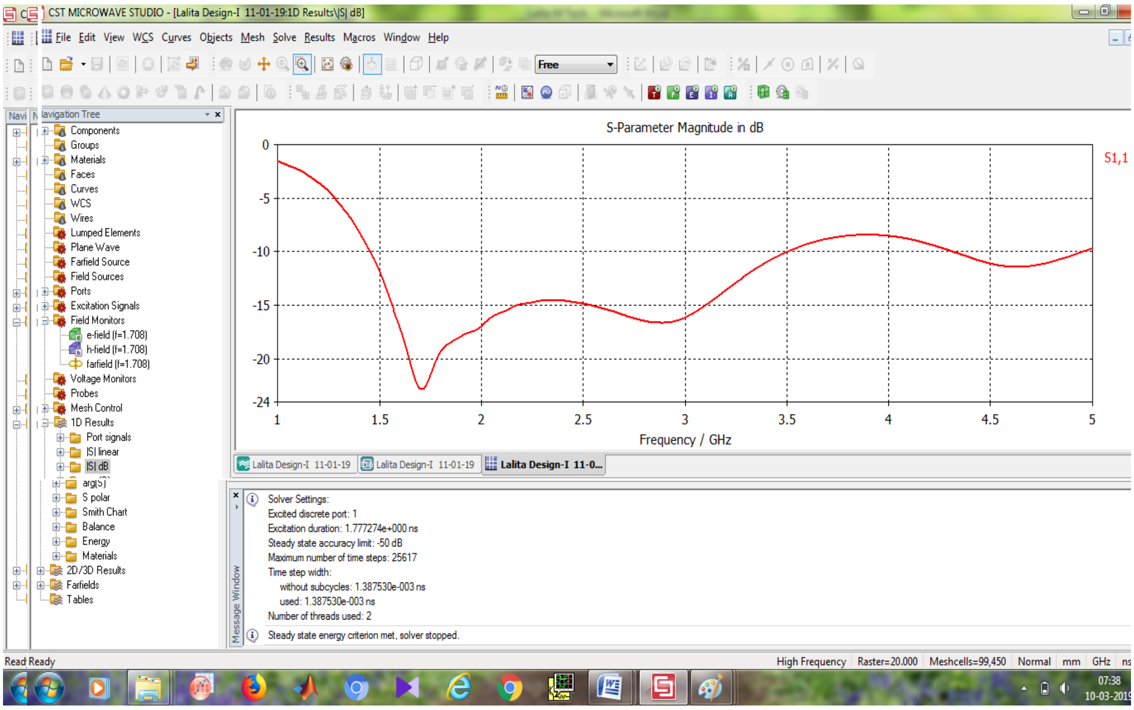


Figure 5.5 The Snapshot of the Reflection Coefficient of Textile Antenna on CSTsoftware

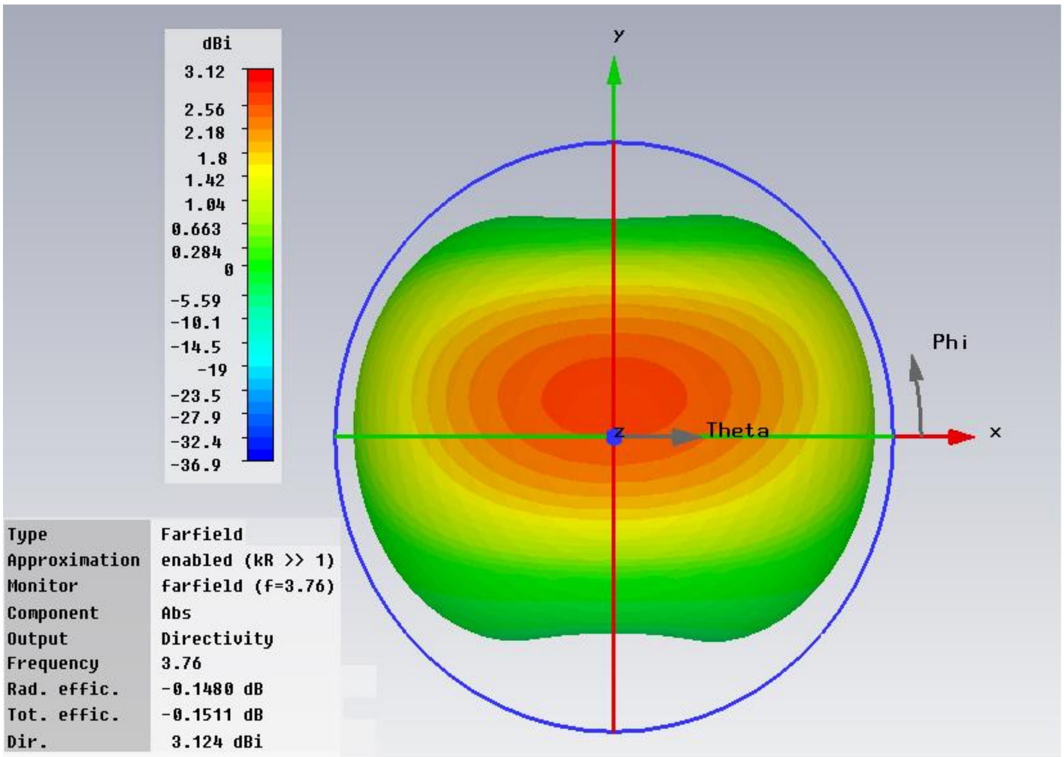


Figure 5.6 The Far field 3- Dimensional radiationpatternwhich shows directivity of Antenna-1

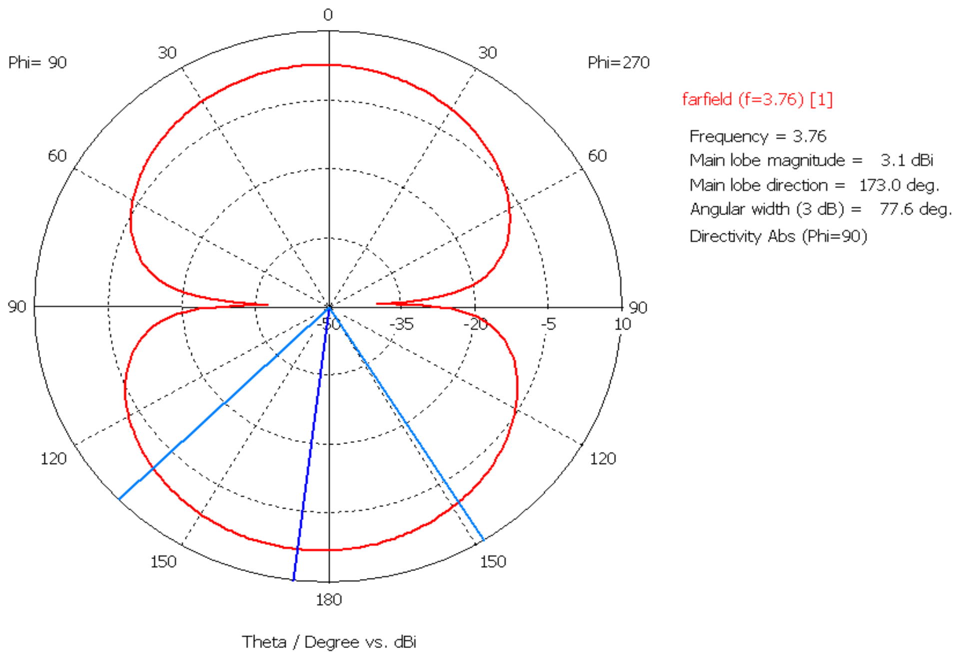


Figure 5.7 The radiation patterns polar plot at frequency 3.76 GHz, of Antenna-1

5.8.2 Antenna Optimization

Table: 5.2 Antenna Substrate Dimensions

Designs	Semi-Circle Radius (mm)	Substrate dimension (mm)	Substrate thickness (mm)	Feed Width (mm)
Antenna-1	5	50x50	1	2.0
Antenna-2	6	50x50	1	2.0
Antenna-3	7	50x50	1	2.0

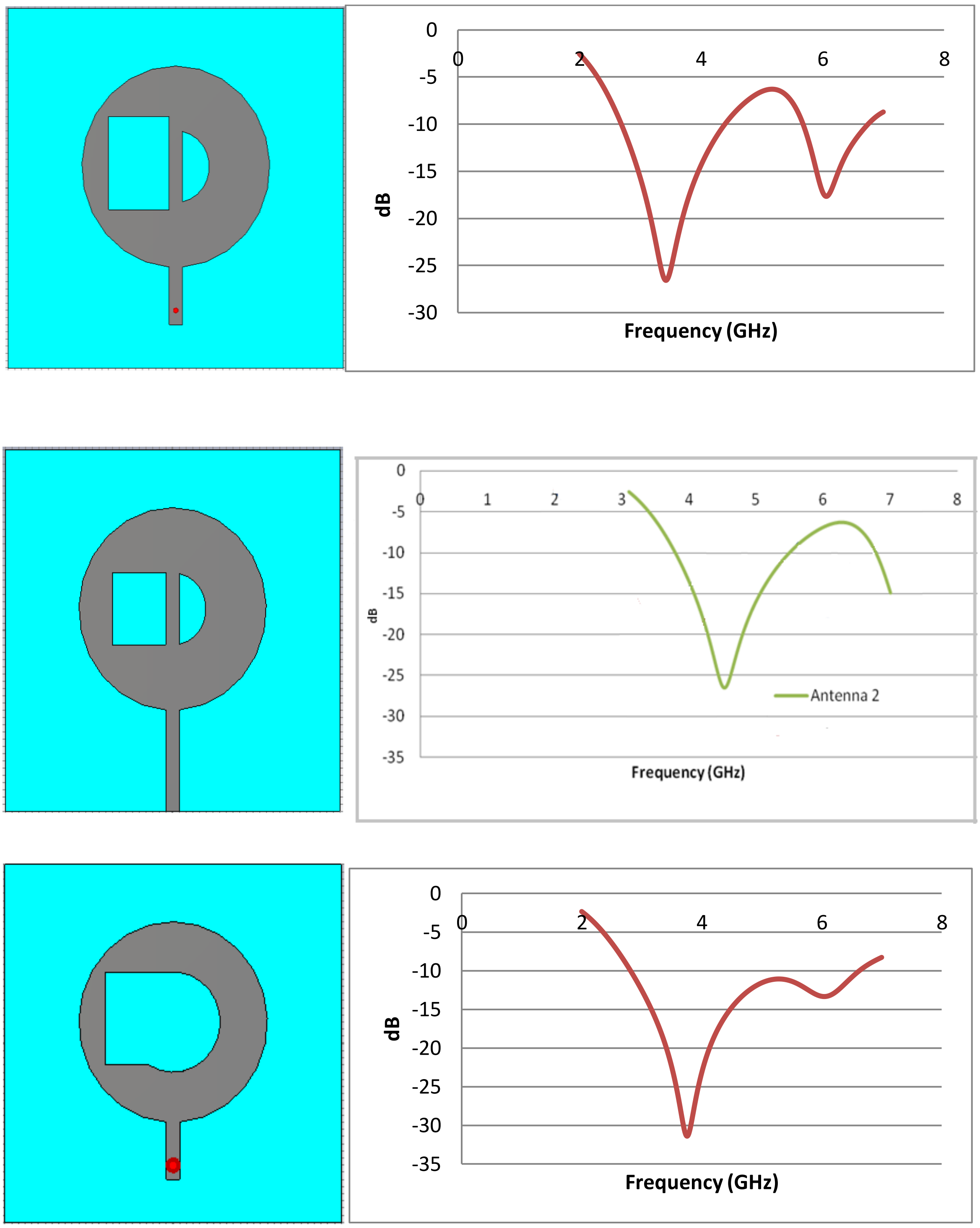


Figure 5.8 Different antenna designs and their Simulated Reflection Coefficients

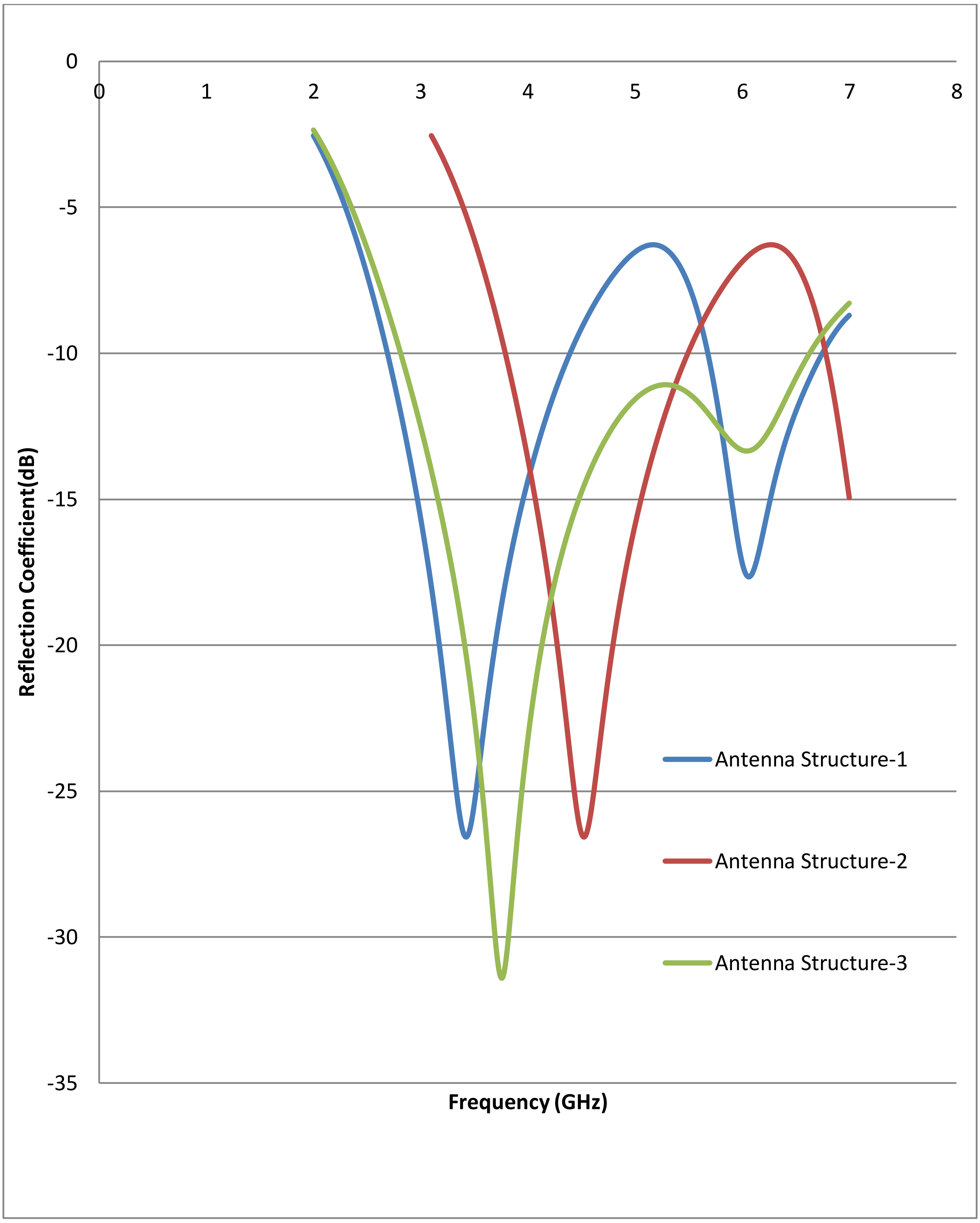


Figure 5.9 The reflection Coefficient Vs Frequency plot through Optimization

Table: 5.3 Comparison of Performance between existing and proposed antenna-1

References	Substrate	Range of frequency	Size in mm	Band width	Peak gain in dB
Ling Xu [24]	Felt ε_r=2.4	2.4-2.5GHz 5.725-5.875 GHz	70x40x03	2.40% 6.40%	2.7 dB
Marcus Grilo [25]	Denim ε_r=1.77	2.45 GHz	43.3x38x1.4	15.00%	0.78 dB
Rawat and Sharma [26]	FR-4 ε_r= 4.4	4.04-7.28 GHz	30x30x1.59	60.30%	3.0 dB
Proposed Antenna	Jeans ε_r=1.7	2.185- 6.625 GHz	50x50x1.0	100.90%	3.124 dB

Table: 5.4 Comparison between reference antenna and proposed antenna-1

Antenna	Gain (dBi)	Operating frequency (GHz)	Thickness(mm)	Bandwidth
Reference Antenna [23]	FR-4	4.04-7.28 GHz	30x30x1.59	60.30%
Anticipated Antenna	Jeans ε_r=1.7	2.185GHz-6.625 GHz	50x50x1.0	100.90%

5.9 Anticipated Textile antenna Design-II

The front outlook as well as back outlook of Simulated Antenna is represented in figure 5.10 Design variables are shown in the table 5.5. The ground plane dimension is 15 mm×50 mm. The substrate, which is used in the presented structure, is jeans with dielectric constant 1.7. Patch radius is 14 mm with slot 10x10 mm; feed line length is 39.2mm.

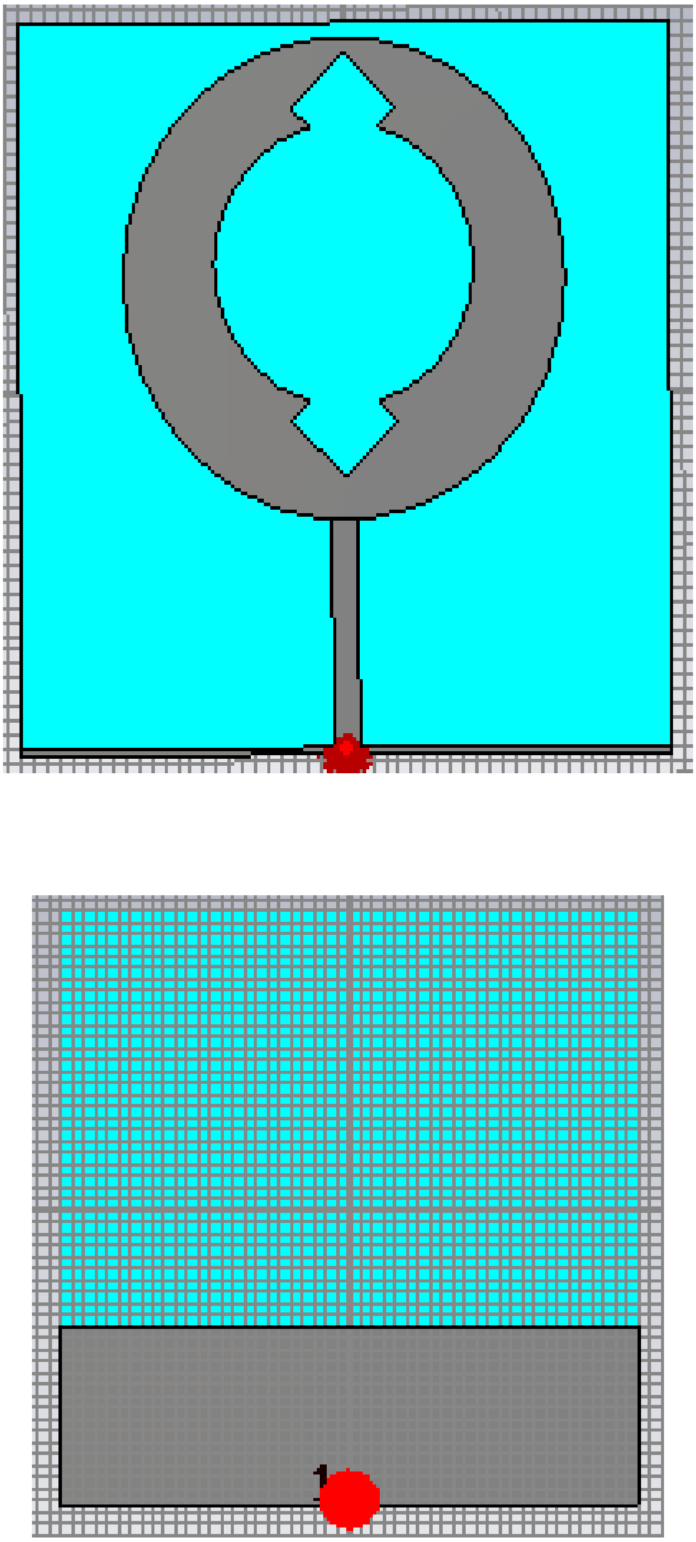


Figure 5.10 The Front and Back outlook of proposed antenna-2

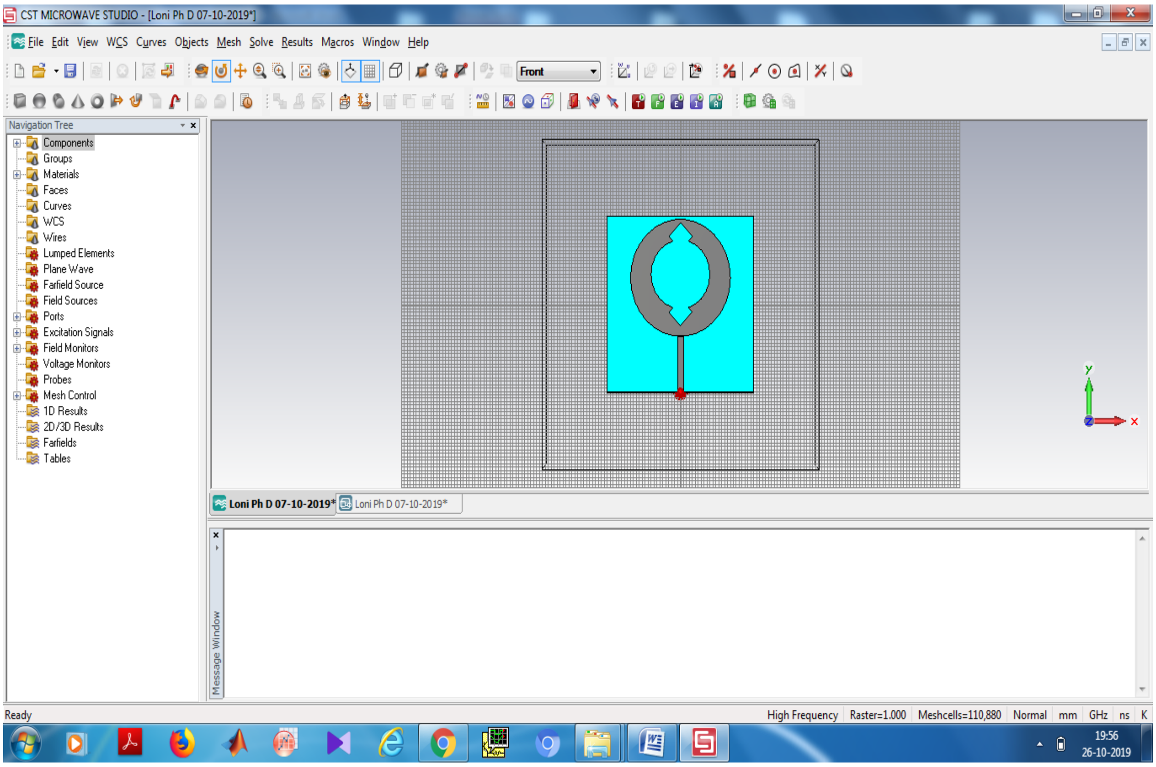


Figure 5.11 The Snapshot of anticipated design of textile antenna on CST software

Table:5.5 Dimension of presented textile antenna-2

Antenna Parameters	**Values**
Substrate Thickness(h)	1
Relative Permittivity(ε_r)	1.7
Semi circle radius[mm]	14
Substrate Dimension	50×50
Ground Plane Dimension	15×50

5.9.1 Outcome and Discussion

Figure 5.12 shows the reflection coefficient vs. frequency plot with frequency of resonance is 3.20 GHz as well as 4.80 GHz. Figure 5.13 shows the snapshot of anticipated textile antenna on

CST software. The far field 3-Dimensional plot and 2-Dimensional Radiation pattern of Textile Antenna is given below in figures 5.14 and 5.15 which shows the directivity of 3.609dB and 4.519 dB respectively. The presented novel design provides better results as compared to some existing antennas described in table 5.6.

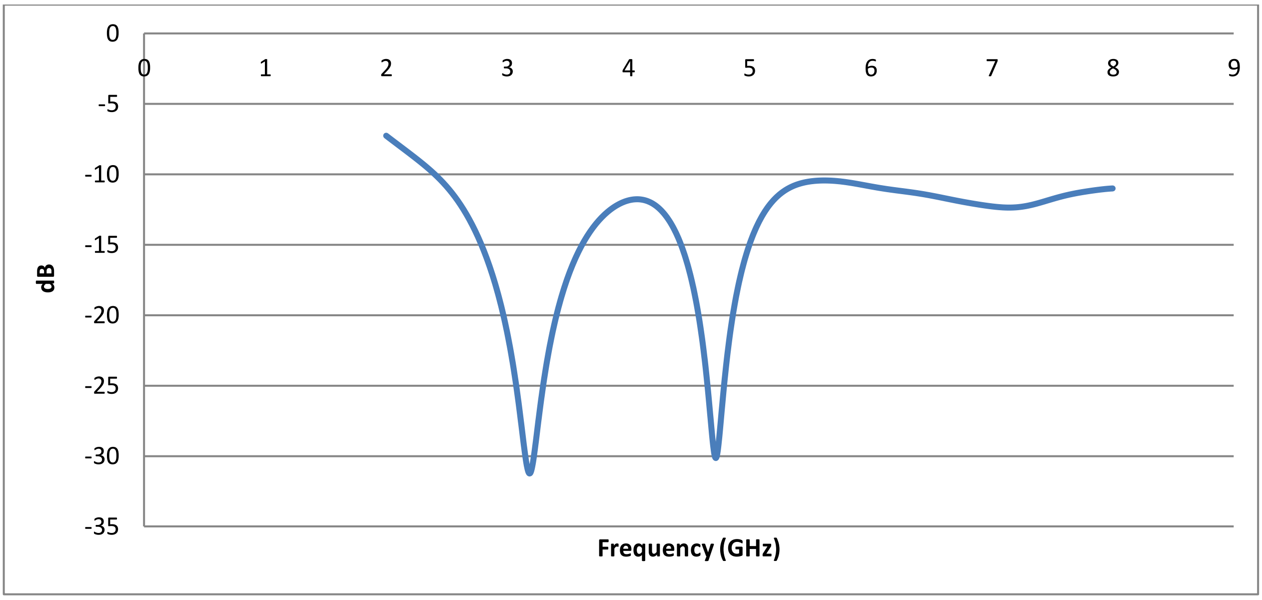


Figure 5.12 The simulation reflection coefficient of textile antenna-2

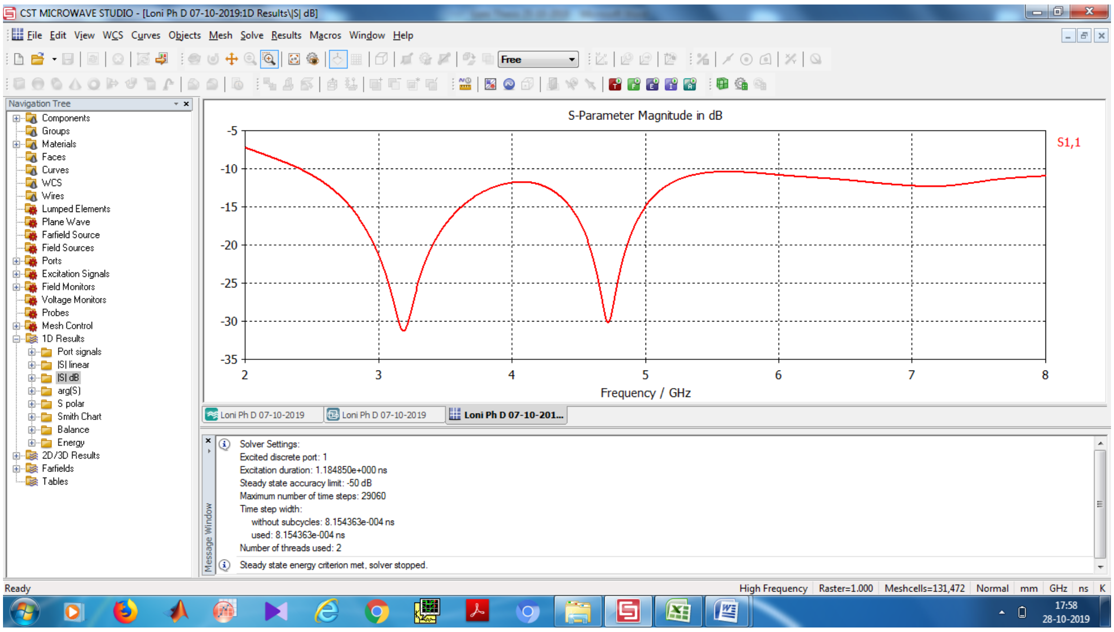
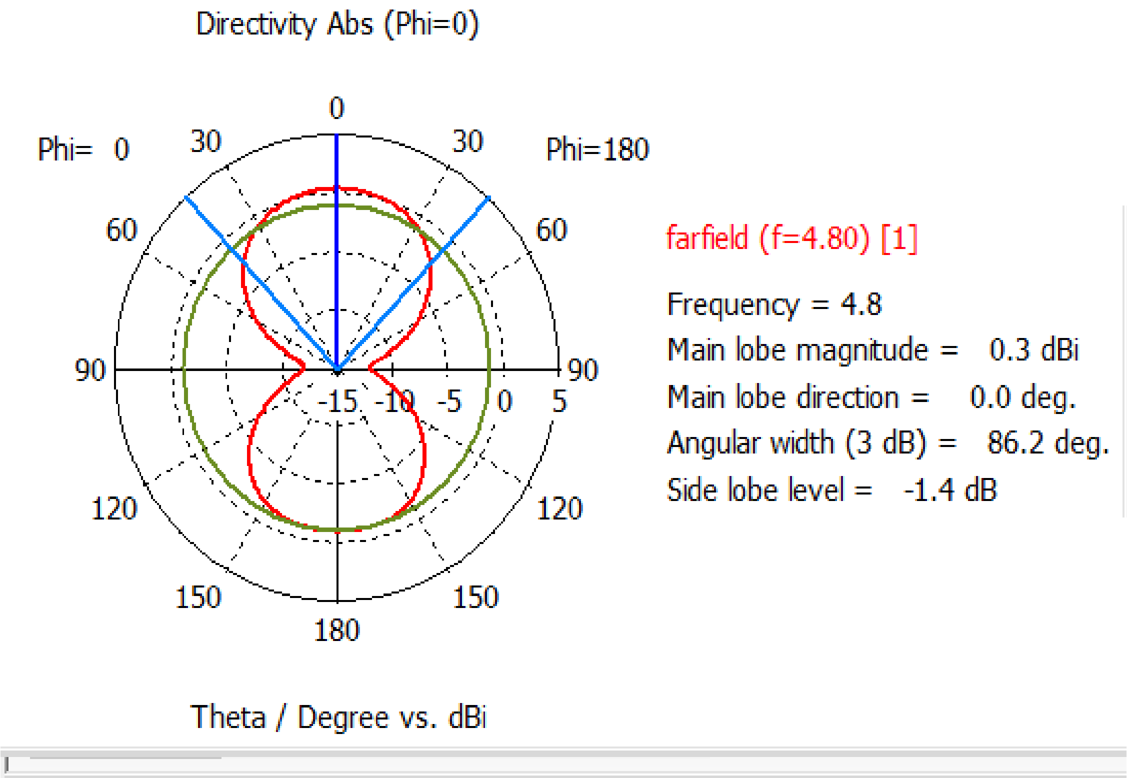
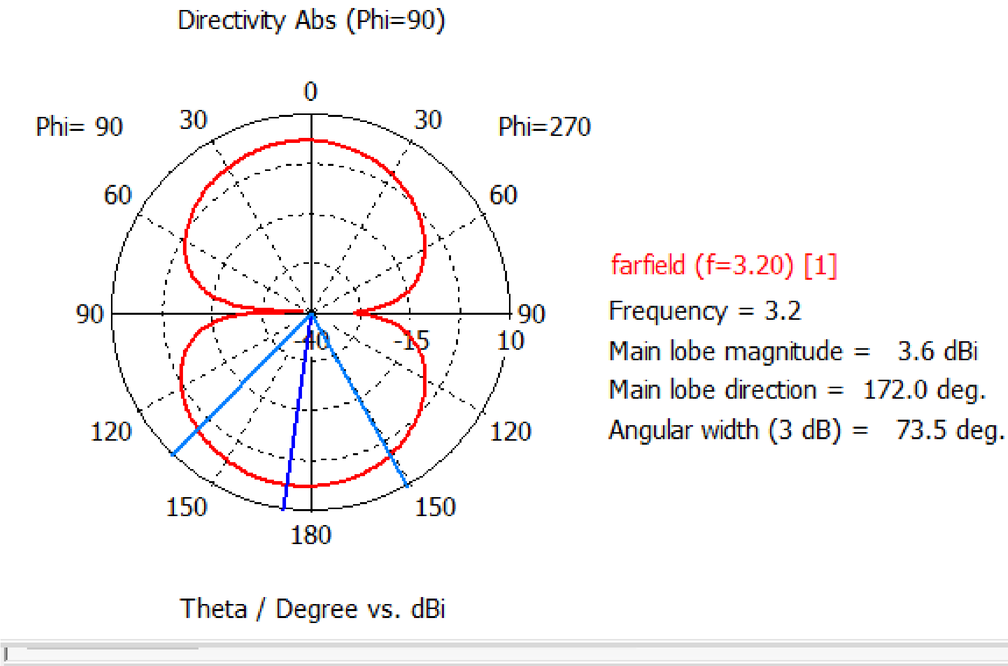


Figure 5.13 The snapshot of reflection coefficient of textile antenna on CST software


Directivity Abs (Phi=0)
Phi= 0
Phi=180
0
30
30
60
60
90
90
120
120
150
150
180
-15 -10 -5 0 5
farfield (f=4.80) [1]
Frequency = 4.8
Main lobe magnitude = 0.3 dBi
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 86.2 deg.
Side lobe level = -1.4 dB
Theta / Degree vs. dBi


Directivity Abs (Phi=90)
Phi= 90
Phi=270
0
30
30
60
60
90
90
120
120
150
150
180
-40 -15 10
farfield (f=3.20) [1]
Frequency = 3.2
Main lobe magnitude = 3.6 dBi
Main lobe direction = 172.0 deg.
Angular width (3 dB) = 73.5 deg.
Theta / Degree vs. dBi

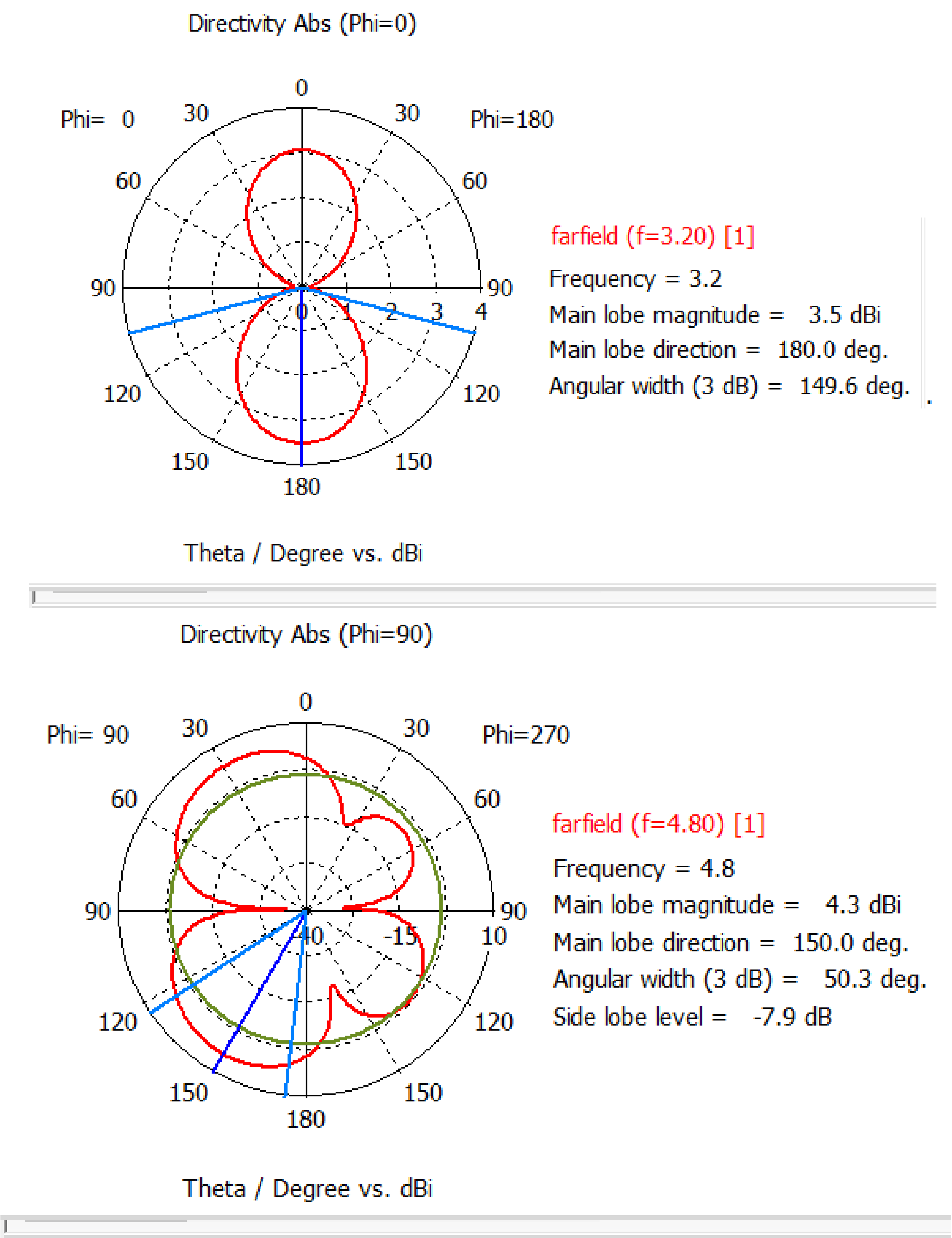
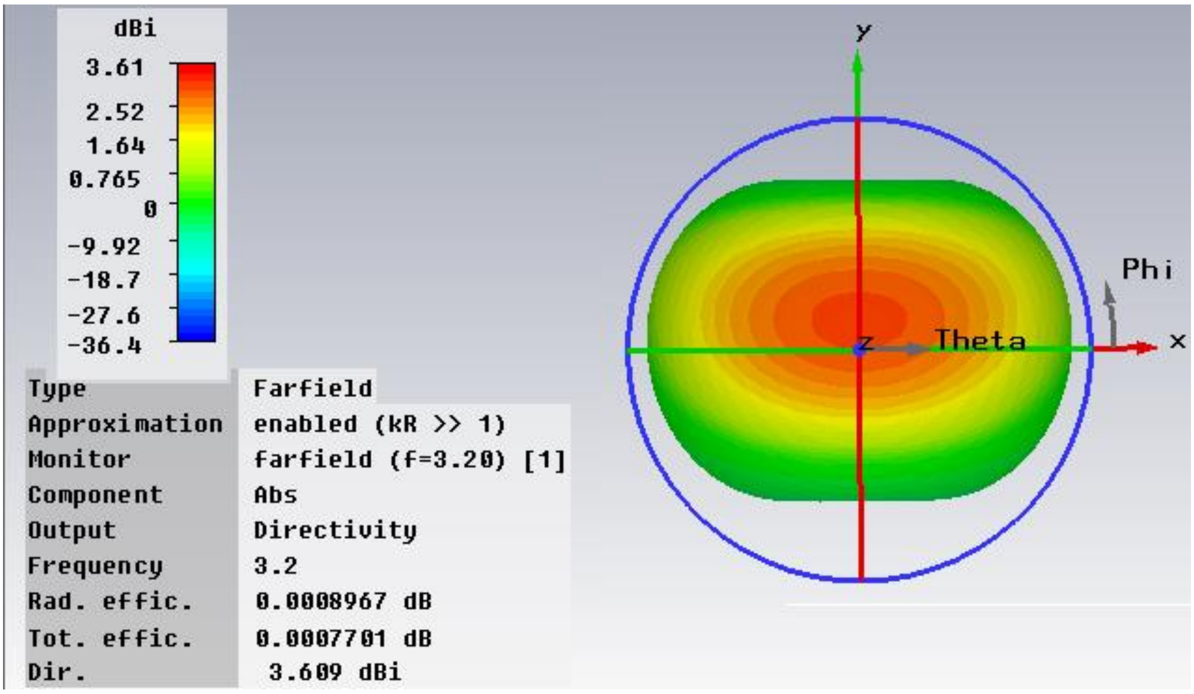


Figure 5.14 Polar plot of radiation pattern at frequency 3.76 GHz



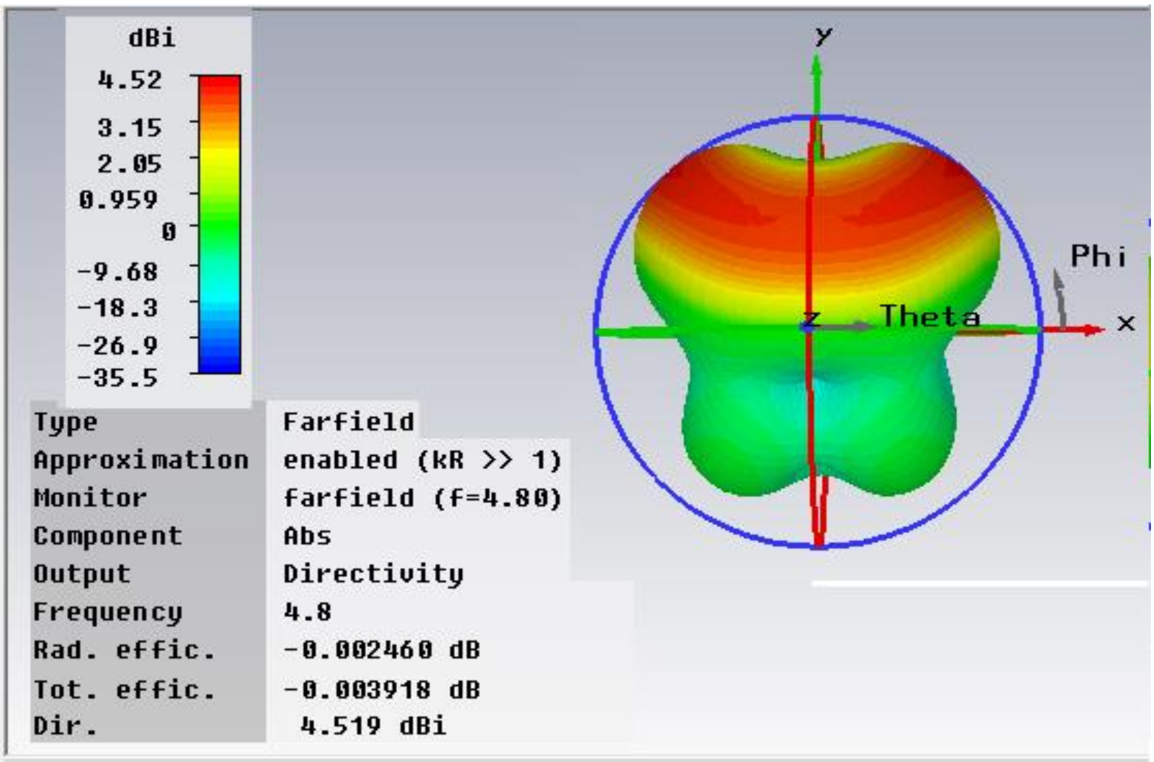
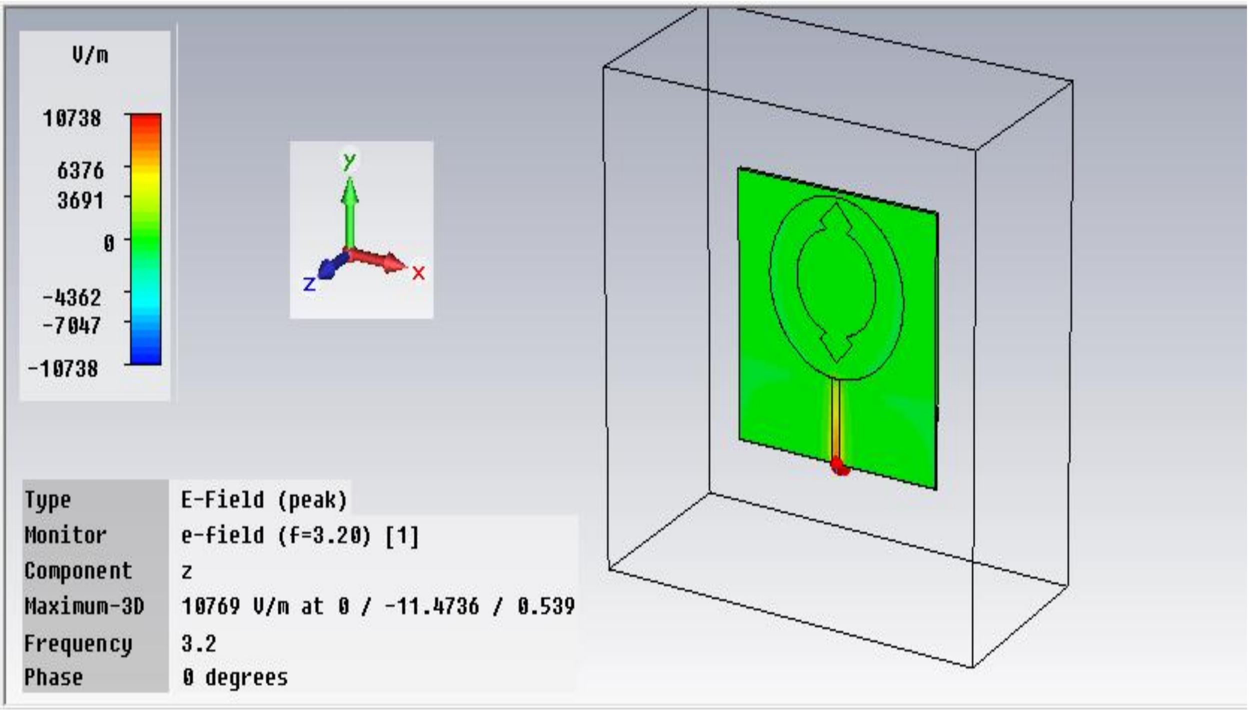
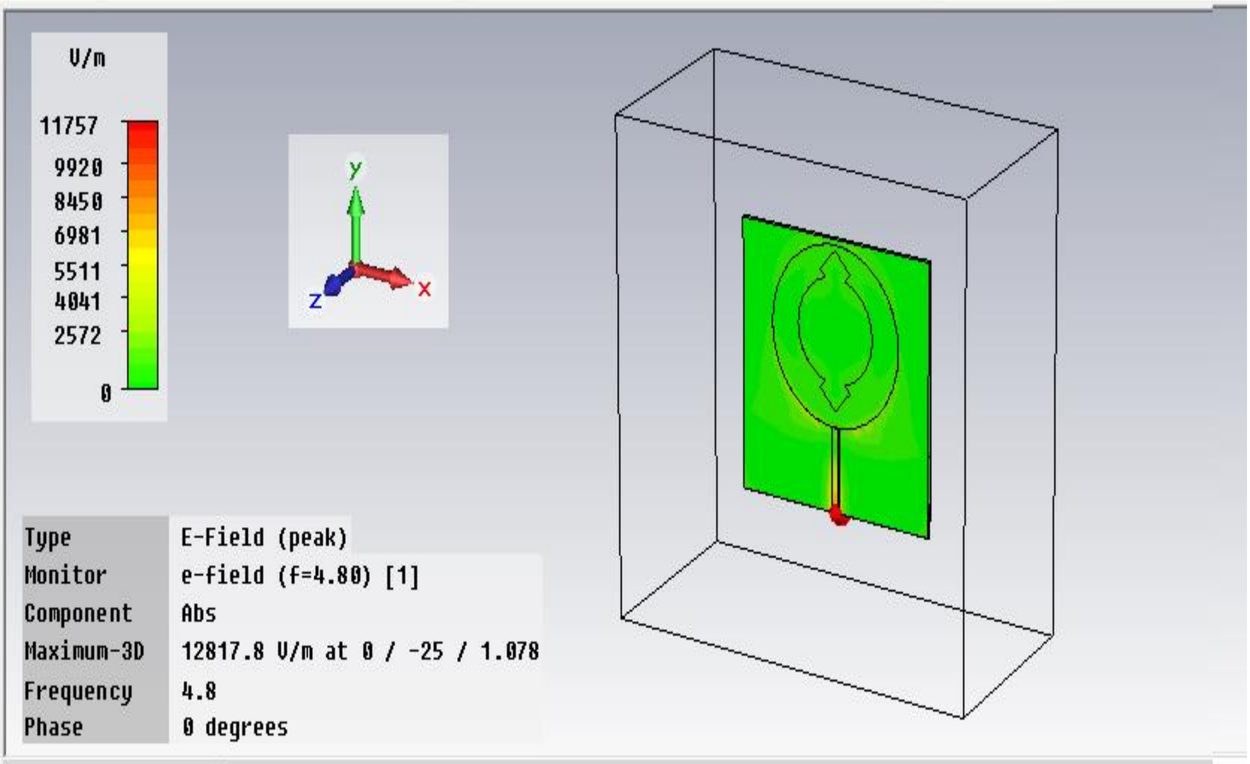


Figure 5.15 The far field 3 dimensional radiation pattern shows directivity of proposed textile Antenna-2



(a)



(b)

Figure5.16 Electric Field pattern of Anticipated TextileAntenna at (i) 3.2 GHz (ii) 4.8 GHz

Table: 5.6 Comparison of the Performance between existing and proposed Antenna-2

References	Substrate	Range of Frequency	Size in mm	Band Width	Peak Gain (dB)
Ling Xu [24]	Felt ε_r= 2.4	2.40 - 2.5GHz 5.725 - 5.875 GHz	70x40x3.0	2.40% 6.40%	2.7 dB
Marcus Grilo [25]	Denim ε_r=1.77	2.45 GHz	43.3x38x1.4	15.0%	0.78 dB
Rawat and Sharma [26]	FR-4 ε_r= 4.4	4.04 - 7.28 GHz	30x30x1.59	60.30%	3.0 dB
Proposed Antenna	Jeans ε_r=1.7	2.445 - 8.00 GHz	50x50x1.0	106.30%	4.51dB

Table: 5.7 Comparison between reference antenna and proposed antenna

Antenna	Gain (dB)	Operating frequency (GHz)	Thickness (mm)	Bandwidth
Reference Antenna [26]	FR-4	4.04GHz-7.28 GHz	30x30x1.59	60.30%
Anticipated Antenna	Jeans ε_r=1.7	2.445GHz-8.0 GHz	50x50x1.0	106.30%

CHAPTER 6

FABRICATION & EXPERIMENTAL RESULTS

6.1 Fabrication Methods of Textile Antenna

The type of fabric material which we use in designing the wearable antenna leads to the consideration of fabrication method which we opt for design. Therefore, the type of method which we select is additionally an important aspect while defining and deciding the general expense of the antenna. Distinctive fabrics are been utilized in designing of antenna and they all need different fabrication techniques as per the type of material. Mainly following strategies are used to create and fabricate the textile antenna.

6.1.1 Conductive Spray Technique

Conductive spray procedure is the most adaptable and famous fabrication method. It can be utilized with any type of textile material. Copper in liquid form along with gases kept under pressure and which can be utilized as a spray to form a conductive layer of copper on the surfaces of the material. This will form similar layer on the material. This strategy gives reliability and flexibility for general textile antenna design.

6.1.2 Point Wise Deposition of Conductive Adhesive

An adhesive is place at specific points only on the textile in this method. The spacing in fabric should be 1cm so that the sheet resistance can't increase. Regardless, the mechanical steadiness is fundamentally more awful worse as compare with the material. The imperfect connection for safe guarding geometry is another setback of this method. This method is not appropriate for area-wide manner on textiles but it is valuable for small textile area applications. These sorts of adhesives are normally firm & fragile.

6.1.3 Liquid Textile Adhesive

The type of fabric material which we use in designing the wearable antenna leads to the consideration of fabrication method which we opt for design which is because of completely various material utilized for the antenna style, needs different kind of fabrication techniques.

Therefore, the method which we select is additionally an important aspect while defining and deciding the general expense of the antenna.

6.1.4 Method of Sewing

The thread which is made up of copper has been used here in this method. By this method wrinkles are formed on the fabric surface and the seams have a spacing less than 2cm as displayed in Figure 5.1. The antenna property is distorted because these wrinkles provide uncertain gap among the patch and ground plane of antenna. A stitch contacts each radiating patch with the back portion of the antenna. The Electrical estimations of the antenna displayed gaps among the patches and the back surface of the textile antenna. Due to this reason the method of sewing is not appropriate for spacer texture substrate.

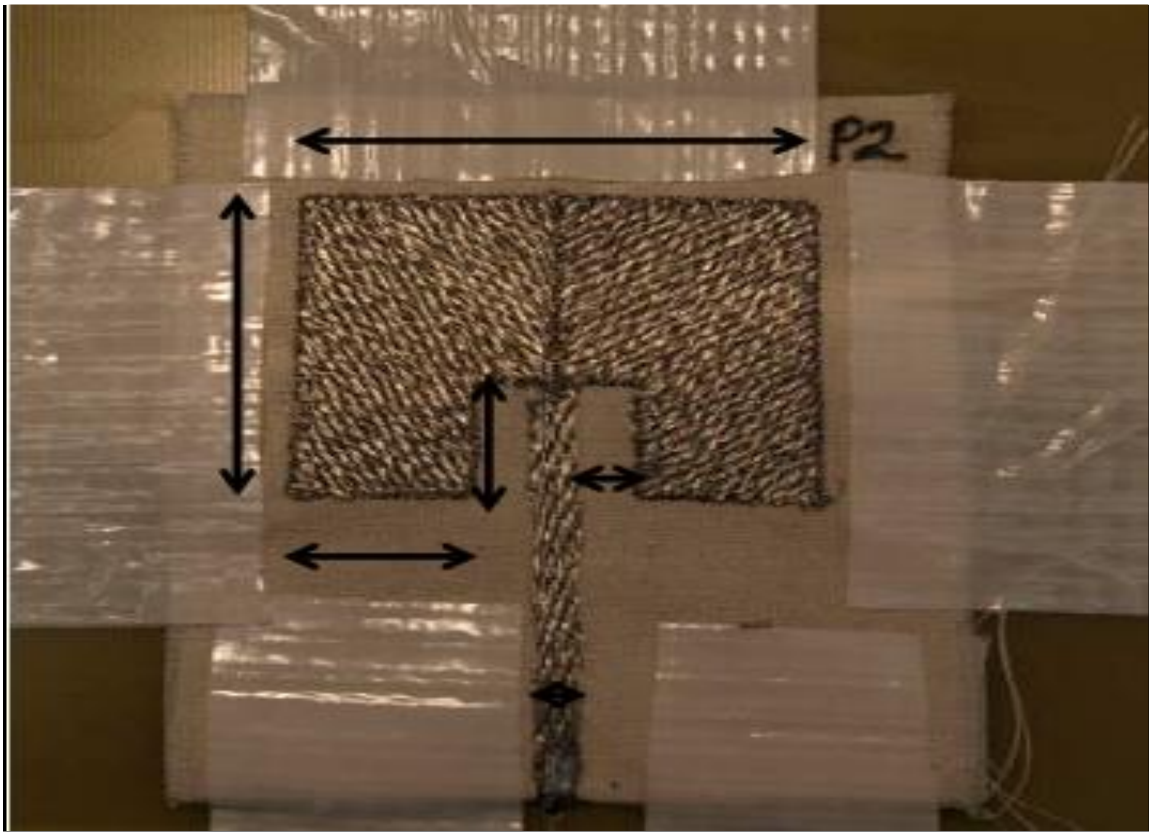


Figure 6.1 (a) Stitched Textile Antennas

Figure 6.1(b) Stitched Textile Antennas

6.1.5 Layered Sheets by Ironing

The strategy is prevalent for accomplishing favorable outcomes. In this technique layers of conductive material are formed by pressing. Additionally, glue should be applied to conductive material in such a way so that it can easily fixes sheet obstruction and the relative permittivity of substrate will not get affected.

6.1.6 Copper Tape Method

Fabrication of the textile antenna by copper tape method is the simplest and easiest technique available. In the figure 5.2 copper tape has been directly put into the substrate therefore additional fabrication procedure is not required. Copper tape can be cut effectively as indicated by the geometry of patch in textile antenna. Patch can be drawn on the substrate by with the help of copper tape. We can utilize adhesive tape to connect it to substrate we must be very sure that the properties of the fabric shouldn't get affected but measurement of the antenna must be retained little bit. With the help of soldering we can attach the SMA female connector to the hardware of antenna. Though the performance of wearable antennas gets affected in copper thread and conductive spray method but copper tape is the most reliable in troublesome conditions. Nowadays, copper thread has also been there, so if we wish to make a design, we need to go to the company and ask them to make it on the same cloth. Design will be ready and it would be more reliable but it will take time and will be not that economical as well. Copper tapes are lot less expensive and simple to fabricate.

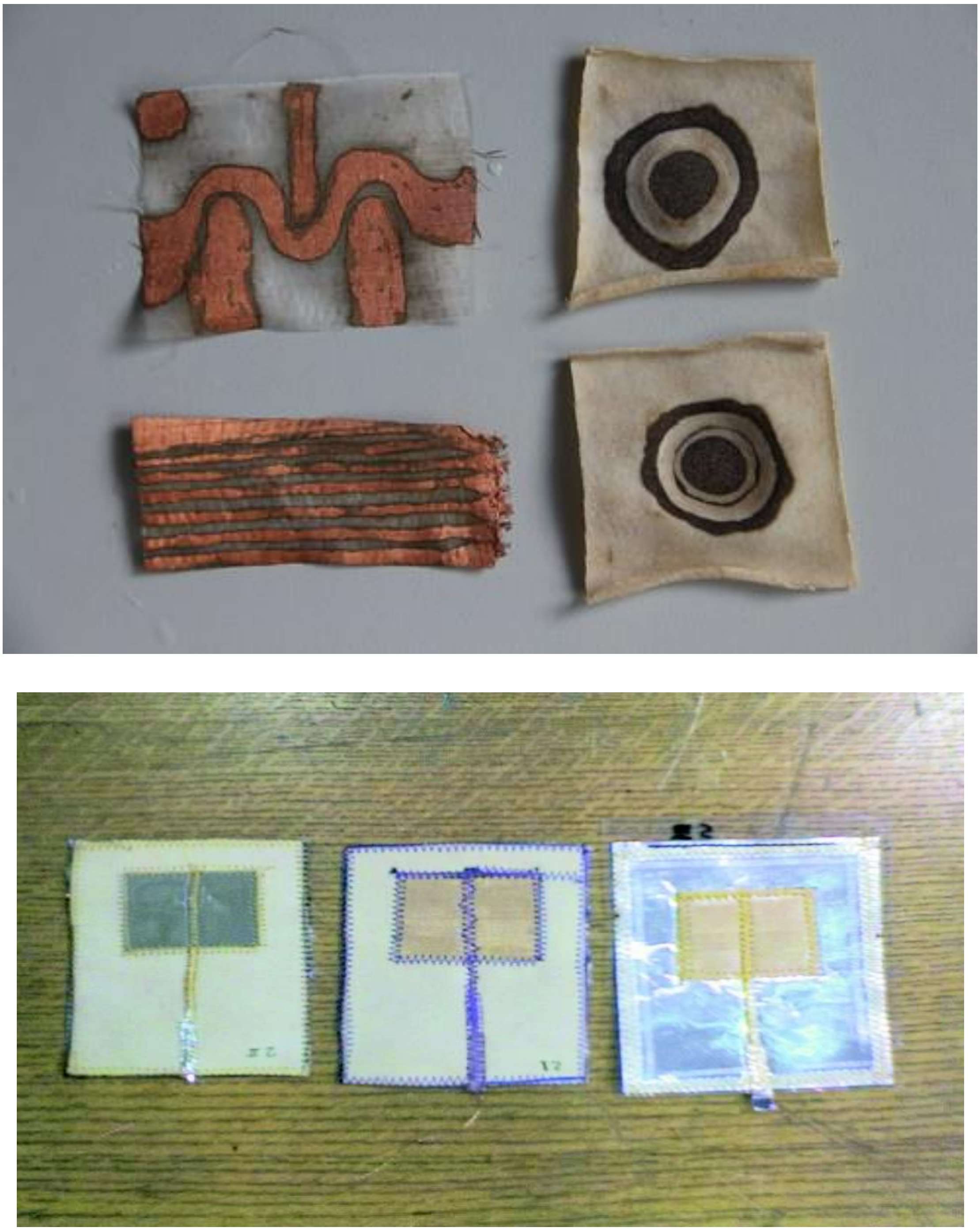


Figure 6.2 Fabricated textile patch antennas using embroidery method and copper tape method

6.2 Testing of Fabricated Anticipated Antenna-1

In the first design copper tape can be used as patch and partial plane of ground as represented in figure 6.3 photograph. The SMA female connector has been soldered at the point on feed as well as on the ground of proposed antenna. Figure 6.4 illustrates practical setup at BIET Jhansi microwave lab to measure reflection coefficient of anticipated antenna and obtained measured reflection coefficient Vs frequency plot as displayed in Figure 5.5.

Figure 6.3 fabricated antenna using jeans substrate (i) front View (ii) back View.

Figure 6.4 Setup for measuring reflection coefficient of proposed antenna

6.2.1 Comparison of Measured vs. Simulated Reflection Coefficient

Figure 5.5 demonstrates the Comparative graph of measured and simulated outcomes of reflection coefficient. The simulated outcome is represented by red line whereas measured outcome is represented by blue line. Frequency ranges for simulation are from 2 GHz to 7 GHz. Figure. 5.3 show the hardware of circular patch and ground plane made up of copper tape. Adhesive copper tape is stuck on the jeans substrate to make partial ground plane and circular patch.

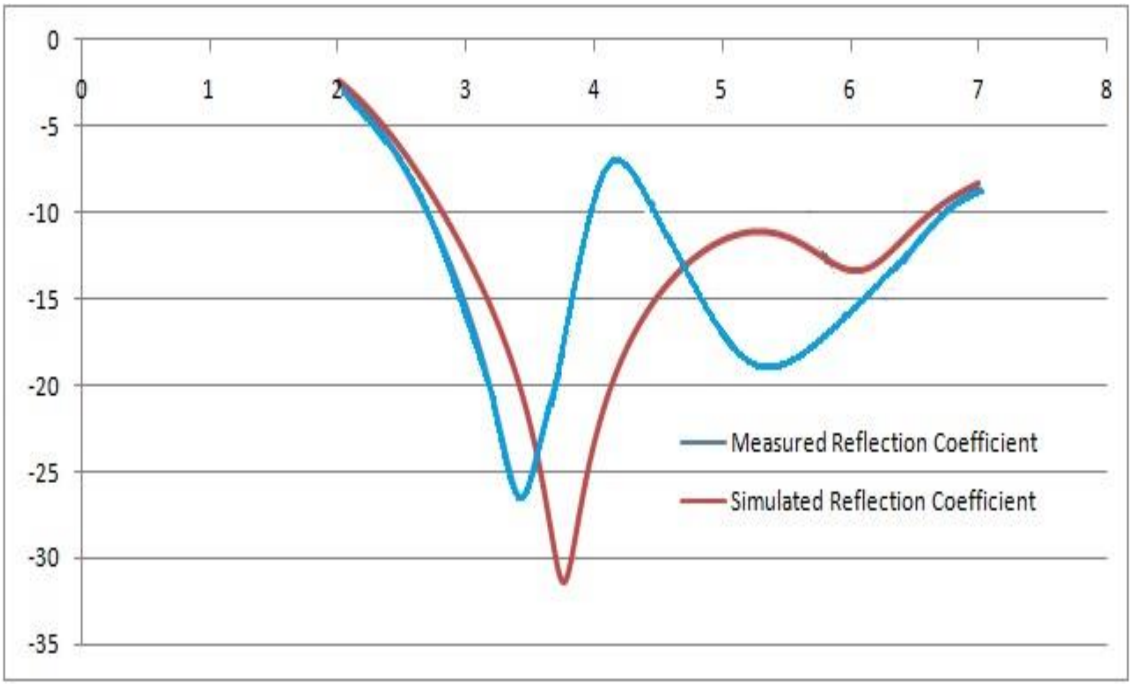


Figure 6.5 Comparison of Reflection Coefficient Vs Frequency of the Measured and Simulated Outcomes of the Designed Antenna

6.3 Testing of Fabricated Anticipated Antenna-2

In the second design copper tape is used for patch and partial ground plane, shown in figure 5.6 the photograph. The SMA female connector has been soldered on the feed and on the ground of the proposed antenna. Figure 5.7 illustrates practical setup at BIET Jhansi microwave lab to measure reflection coefficient of anticipated antenna and obtained measured reflection coefficient Vs frequency plot as displayed in figure 5.8.

Figure 6.6 Fabricated antenna-2 using jeans substrate (i) Front View (ii) back View.

Figure 6.7 Setup for measuring reflection coefficient of proposed antenna-2

6.3.1 Comparison of Measured vs. Simulated Reflection Coefficient

Figure 5.8 demonstrates the Comparative graph of simulated and measured output of reflection coefficient. Red line reflects the simulated output while the blue line reflects the measured outcome. The frequency ranges for simulation are from 2 GHz to 8 GHz. Fig. 5.6 shows the hardware of circular patch made and partial ground plane made of copper tape. The adhesive copper tape is stuck on the jeans substrate to make partial ground plane and circular patch.

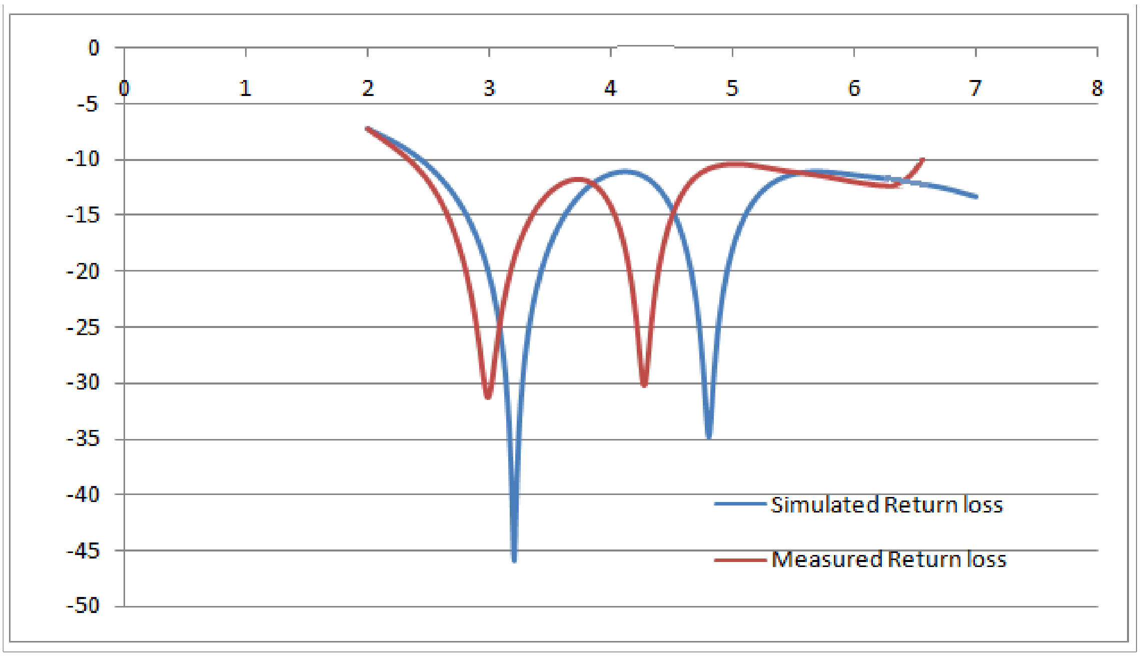


Figure 6.8 Comparison of reflection coefficient Vs frequency of the measured and simulated outcomes of the designed antenna.

Table 6.1 Simulated and Measured outcome of proposed antenna-1 and Antnna-2

	Simulated Bandwidth		Measured Bandwidth	
Antenna Designs	Range of frequency in (GHz)	Bandwidth in (%)	Frequency range in (GHz)	Bandwidth in (%)
Antenna-1	2.185 - 6.625 GHz	100.90%	2.694 - 4.389 GHz 5.68 - 6.74 GHz	47.88% 17.07%
Antenna-2	2.445GHz-8.0 GHz	106.30%	2.33 - 6.49 GHz	94.33%

6.4 Comparative Studies of Designed Antenna and Reference Antenna

Table 6.2 Comparative studies of designed antennas and reference antenna

Parameters	Antenna-1	Antenna-2	Reference antenna [26]
Simulated Bandwidth	100.90%	106.30%	60.30%
Frequency range	2.185GHz-6.625 GHz	2.445GHz-8.0 GHz	4.04GHz-7.28 GHz
Application	Wi-MAX/WLAN Application	Broad band wireless communication	Broad band wireless communication

6.5 Advantages of Textile Antenna

The most common advantages of textile antenna are as follows:

- Light in weight,
- Fabrication cost is less,
- Maintenance cost is less ,
- Installation and Setup is not required,
- Robust to resist hard from obstacles,
- It is very flexible,
- Can be used in wet climatic conditions.

6.6 Disadvantages of Textile Antenna

6.6.1: Elasticity of fabrics

Changes occur in measurement of antenna because elongations and compressions are common in textiles. Resonant frequency of antenna changes when change in the dimensions. So, it is recommended to avoid fibers with more elasticity.

6.6.2 Wetness

If the fabric assimilates water, at that time its relative permittivity will vary drastically, because the relative permittivity of water is a lot more. So, when the textile antenna retains water, dampness of the textile could change the execution properties of antenna very drastically. This could also change the resonant frequency of antenna. Textile antennas may also absorb perspirations or it may get drenched in rain henceforth, some kind of protection or covering layer is needed to eliminate this effect.

6.6.3 Bending

As a rule, these flexible wearable antennas will get affected by bending or twisting so to avoid this situation to occur one should always be cautious in placing of the antenna. Twisting and turning can also affect the important characteristics of antenna particularly if it is designed for a very specific frequency.

6.6.4 Vicinity of Human Body

If we place an antenna near to human body then its performance will change drastically. They ought to be planned according to the need of living being with finite ground. Therefore, exceptional consideration should be given to the SAR (Specific Absorption Rates) that will help in investigation of radiation factors which is deliberately needed to keep away from human body.

6.6.5 The Thickness of Substrate

The thickness of substrate for patch antenna should lie between 1mm to 4mm for RFID antenna. The simulation result we get according to this value but when we fabricate, the thickness of jeans fabric is not constant. It’s being a fabric material there is some changes in thickness which cannot be considered as smooth surface.

6.6.6 Dielectric Constant

When designing a wearable textile antenna it is needed to associate the ground and conducting patch to the substrate chosen for antenna. The connection of radiating patch and substrate is normally done by the applying the glue between them. Now, glue is applied on the lower and upper part of the substrate and hence relative permittivity of the substrate will get increased. As we know the square root of relative permittivity can be inversely proportional to the frequency. This can shift the operating frequency of an antenna and changes can be easily seen on S11 plot.

6.6.7 Rough Edge

At the time of manufacturing fabric is cut into desired shape as per our need and for this we use scissors, cutter or knife. These tools which we use are not that accurate and because of which some mistakes happen like, parallax mistake and the sides are also not accurately cut. Due to this, final results may vary. While giving shape to the fabric some threads come out and this leads to affect on an antenna radiation pattern of and can cause decrease in the RFID range as compared to the expected results.

The issues which we have discussed earlier can be eliminated if we take cautious measures at the time of fabrication. Designing of textile antenna is simpler compare to printed antenna. Hence, we should fabrication under proper guidance and tools in an industry but because time constraint, we needed to do it on our own. Anyway this gives us a chance to get familiar with fabrication process and to manage the issues which occur during fabrication process.

6.6.8 Homogeneity

After applying the glue on the surface of textile substrate, the connection among the radiating patch and jeans fabric becomes non homogenous. This will also hampers the performance of antenna.

CHAPTER 7

APPLICATIONS OF WEARABLE TEXTILE ANTENNA

Recent improvement in textile technology is that, the latest material and compact electronics systems are making wearable systems the most expedient. As per the end user affirmation the wearable components which are suitable and flexible may be considered as the major factors of the textile antenna. These objectives may give only by inscribing mechanical resistance as well as longevity of materials even in the severe environment for the society and as well as human body for electronics. Finally, in our research we find out wide bandwidth of 106.30% covering the frequency range 2.445 GHz to 8.0 GHz. These antennas can be utilized efficiently in applications such as wireless local area network of frequency range 2.40 GHz to 2.48 GHz, Bluetooth of frequency of 2.45 GHz as well as Wi-Max frequency range of 2.495 GHz to 2.695 GHz.

Presently there is a tremendous growth in the field of communication where wireless technology plays an important role and it dominates in every day to day applications. Figure 7.1 illustrates the major areas of applications where wearable textile antenna is used.

Figure 7.1 Major application areas of wearable textile antenna

7.1 Health monitoring system

Supportive living technologies are highly demandable for the elders to ensure their health and well-being. The older people require frequent check-ups because most of them are chronic patients of multiple vital signs, example, blood pressure and blood glucose, which differ on the basis of the daily activities of the elders. To observe vital signs endlessly for a 24 hours period, the development of novel wearable intelligent systems is critical for comprehension the development of chronic manifestation in the old. The wearable technologies applications for transient cardio vascular observations can also be done while drinking water. There was an indication of rise in blood pressure because of increase in heart rate about 9 bpm, P less than 0.001. Also the pulse transit time reduced at about 5 ms, P less than 0.001. This can be achieved easily in addition to monitoring system with the textile antenna.

Figure7.2 Health monitoring

7.2 Fire Fighter Garments

Wearable textile techniques are based on the concept of integration of antenna and textile materials. The activities and vital signs of users and its surroundings can be observed and monitored through the smart clothing. On that basis, it will help the wearer to perform task. A major and important application of these types of garments is the fire fighters work requires protection so they need protective clothing which is in the form of fire fighter garments. With the help of smart clothes fire fighters can communicate with their team members, detect toxic chemicals in the environment, locate the responders, and therefore there will be less harm to firefighters.

Figure 7.3 Smart Protective Suits for Firefighter

The wearable textile antenna has been suggested the concept of wearable textile structure. In such a garment an antenna has been embedded in it and capable for monitoring the wearer's vital signs as well as activity. It is also able to observe the environmental circumstances, where ever the wearer is working. An important application of such type of systems are doubtlessly protective clothing in the working like fire fighter garments as wear cloths shown in figure 7.4 below. The antenna requires a finite ground plane when it is integrated into the garment, and it works in the presence of body and in the condition it may result in modify in the antenna features. In fire fighter garment the antenna plane as well as ground is covered with several layers of textile materials, which covered in such way that it is for next generation of fire fighter garments.

Figure 7.4 Fire fighter garments

7.3 Activity Tracker

Activity Tracker can be used to track the activity of the user and most importantly they monitor person's fitness. There are so many devices available nowadays, for monitoring speed monitoring heart rate, quality of sleep, calorie expenditure and many other activities. The activity trackers basically refer to wearable components which observe as well as record a person's position and heath activities.

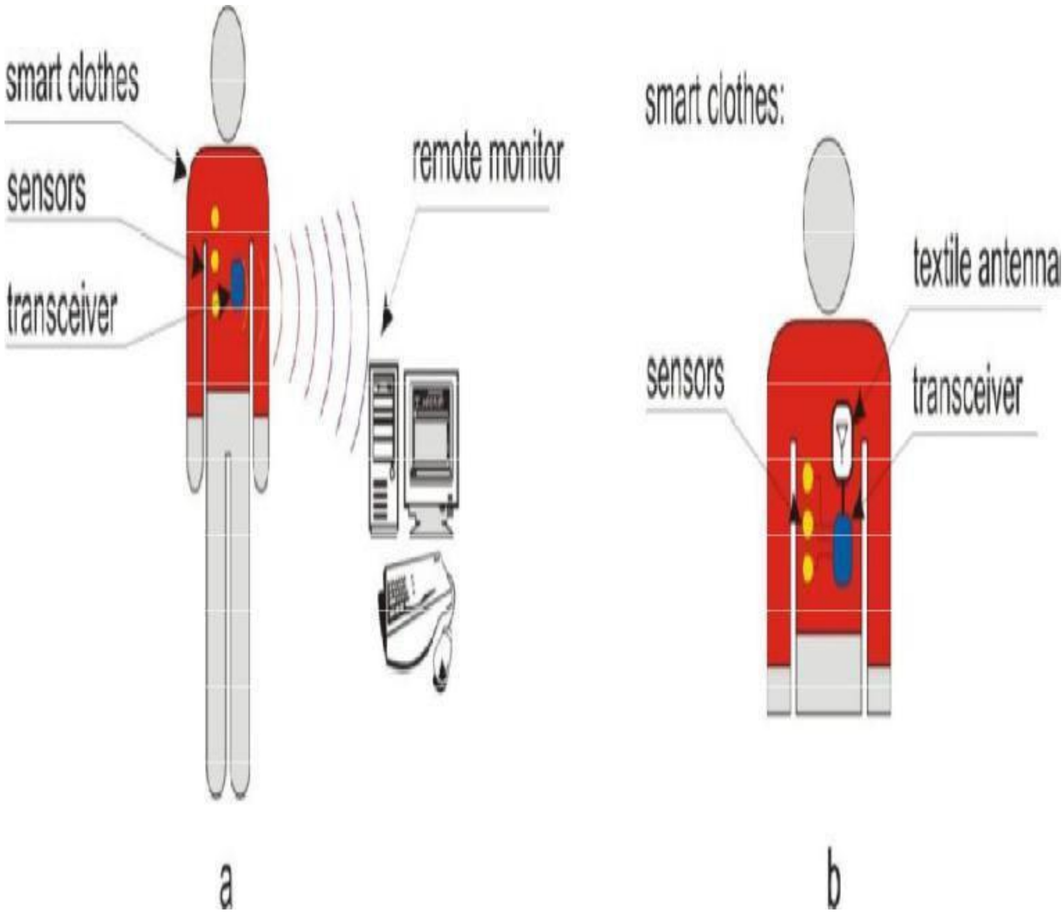
Figure 7.5 Activity Tracker 1

It is also possible to automate the observing and storing of health activities and also to integrate them easily to wearable component due to the improvements in wearable technology and textile. In1981wearable heart rate monitors were available for athletes. Wearable heath tracking components such as heart rate monitoring (wireless) that can be combined with commercial grade health components found in sports training and activities and gyms.

Figure 7.6 Activity Tracker 2

Activity tracker can also be used as following applications.

1. It is used for monitoring pilot or truck driver tiredness.
2. It is used for tracking the status as well as position of soldiers when they are in action.
3. It is used for monitoring workers handling dangerous materials.
4. It is used for sleep analysis of a person.
5. It can be easily locate defense personnel.
6. It can help in monitoring handling unsafe materials.



(a) Wearable computing system (b) Connection of antenna

Figure 7.7 Antenna in wireless smart clothes

7.4 Application of Smart hats

Textile based spiral antennas can be demonstrated for combine to hats as well as reading of deep brain neuro potentials. This is very much useful for the treatment of tremor, epilepsy and Parkinson’s.

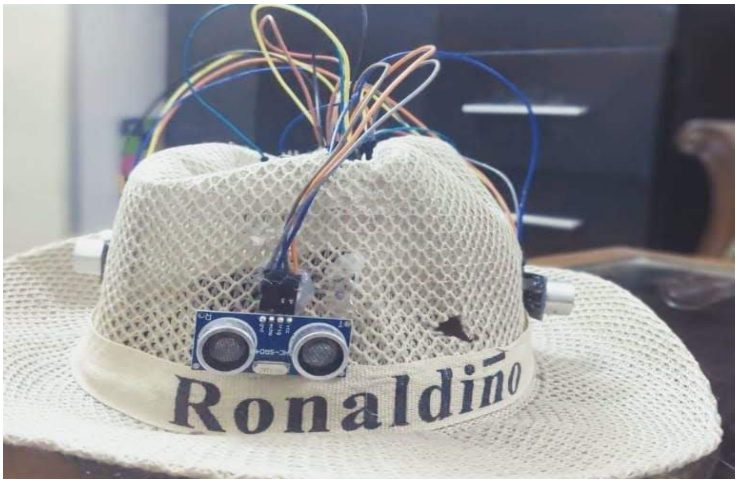


Figure 7.8 Smart Hat

7.5 **Spacesuit Applications**

For the patch and ground plane the Nickel–copper rip stop was selected as the best textile material. Layered ultra firm fabric stabilizer was used as dielectric. Spray adhesive is used to join the patch to substrate and to ground. Hence the wearable technology can also be used for space suit applications.

NDX1 Suit

Figure 7.9 Space Suit

7.6 Applications of Wearable E-Textile

In the wearable textiles conductive traces are noticed through electronic ornamentation of conductive E threads, and batteries are then the batteries are directly printed on fabrics through conductive inks. Such type of technologies is extensively used in designing the wearable devices. Some of the applications of wearable E-textiles are as follows:

7.7 Flexible conductive traces

Antennas, transmission lines are required fabrication of conductive traces and rely on digitization of the suitable pattern in a computerized simulation platform and also stitching on a fabric substrate through electrically conductive threads and an electronic ornamentation machines.

Figure 7.10 Flexible Conductive Traces

7.8 Stretchable and flexible prototypes

The E textile embedded design can be embedded to a stretchy polymers, when the stretch ability of such prototype is required, instead of its elasticity, the non conductive fabric substrate can be detach, example through melting as shown in figure 7.10.

Figure 7.11 Stretchable and flexible prototypes

7.9 **The Colourful Prototypes**

In this embroidery process depend on unicolour E threads in the bobbin of the embroidery machine. It is required to stitch the antenna on its back side of the clothes for the realization of colorful prototypes. The colourful assistant yarn is also threaded through embroidery needle of machine and is used to protect the E thread.

Figure 7.12 Colorful Prototypes

7.10 The Textile Based Batteries

The textile based batteries may be designed via depositing alternating regions of silver as well as zinc dots on fabrics. When it is contacted with body fluids, then the silver is acting like positive electrode and reduced, while the zinc is acting as the negative electrode and oxidized.

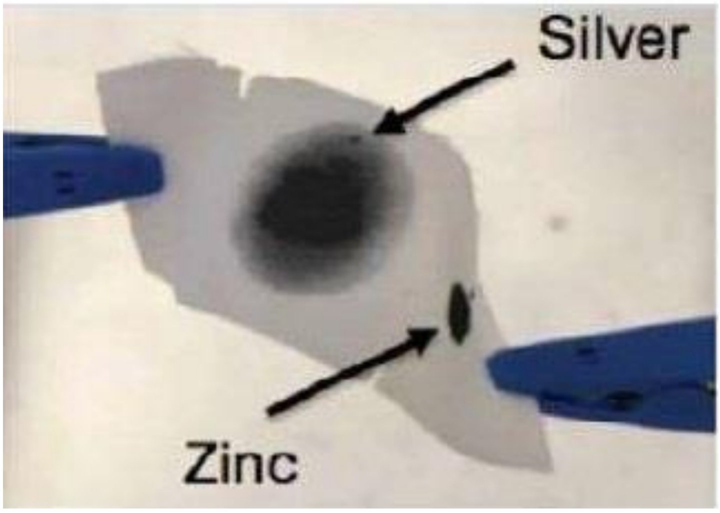


Figure 7.13 Textile based batteries

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

8.1 Conclusion

The presented novel antenna designs are compact and these antennas have great utility to receive the signals in the specified range of frequencies. The textile antenna is an appropriate applicant for clothing applications. They may be logically integrated into clothing hence the hands free application can be achieved. To design these antennas jeans material can be a very good substrate and self adhesive copper tape is used for ground and patch. The material used in textile antenna has much smaller dielectric constant. It can increases the percentage of the antenna bandwidth and also reduce the losses of surface wave. In this approach the textile material is used such as jeans and having dielectric constant of 1.6. The approved flexible antenna provide the larger bandwidth of about 106.30% and the frequency range covers from 2.4 GHz to 8.0 GHz. These antennas can be utilized efficiently in wireless local area network applicatin in the frequency range from 2.4 GHz to 2.4 GHz, in Bluetooth application of frequency 2.45 GHz as well as in the Wi-MAX application in the frequency range from 2.49 GHz to 2.69 GHz.

8.2 Recommendations and Future Works

The future recommendations of the work empower the complete chance to present a flexible antenna over sharp articles of clothing. A couple of individuals require additional confirmation against word related dangers in the midst of the master practices better materials are used than influence this phenomenal class of guarded to attire. Little and simple receiving wires endlessly get in criticalness in the present universe of cell phones and remote framework. Extent of extension, directionality and capability may be modified and also may be enhanced in view of applications while obstructions can be offered on account of material science. The new fields in this change are material gathering contraptions. Joining of receiving wires in materials displays a heap of additional arrangement objectives. The Microstrip patch antenna is better for clothing applications because the patch can built up with textile materials as substrate. These materials have lesser dielectric constant that is 1 to 2. Therefore, reduce the losses such as surface wave losses and also improves the antenna bandwidth. Antenna may also bend even when during the movement and when doing some physical work also. The physical parameters of antenna may change when antenna bends, and the radiation parameters may also changes. The presented antenna in my work is large in size. The antenna bends lesser when the size of the textile antenna is smaller. There are so many antenna size reducing techniques are present, for an antenna which is made from copper. The upcoming work can be done for minimization of such textile material antenna which leads to less bending miniaturized textile antenna, as well as stable and proper output can be obtained.

An improvement in the efficiency of radiation is also challenging task for the antenna which is made from textile material. The approached research may also be investigated in future the work. The nature of performance decay under wet condition is also required to keep away. Such type of research work carried out with the help of water proof materials for next wearable antenna concept.

SAR is also a main parameter to be estimated for any antenna representation. It is very necessity for wearable antenna when they are placed in very close to the body. There is no particular separation and considered as wearable devices. Further the reduction of SAR is also sensible and major aim.

Therefore an estimation of specific absorption rate features of wearable antenna implementation and its analysis could be carried out as upcoming work. Copper tape is used in present design for radiating as well as conducting part and. Therefore such designed antenna is called Partial wearable antenna. But when we use electro textile material for conductive part, we can make a completely wearable or in other words textile material antenna. Hence it can be wearable when complete textile material is utilized as a substrate. Electro textile material is used for both ground as well as radiating element then it can be called as completely textile wearable antenna. Therefore this may also be done for future work.

Wearable technology suitable because it is a category of electronics components which can be implanted in the body, worn like accessories and embedded into clothes, and also for tattooed on the body skin. Wearable antenna is most common in consumer electronics. It is interesting research work in body concern communication. Such wearable textile antennas are meant to be a part of clothing and body which is primarily use for communication purpose which includes defense, navigation, telemedicine portable and radar applications tracking and public safety. It is also used in medical field for patients monitoring.