Analysis of Microstrip Patch Antenna For Breast Cancer Detection

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Abstract- *A Microstrip antenna in its simplest configuration consists of a radiating patch on one side of a dielectric substrate, which has a ground plane on the other side. The patch conductors usually made of copper or gold can be virtually assumed to be of any shape .However , conventional shapes are normally used to simplify analysis and performance prediction. The radiating elements and the feed lines are usually photo etched on the dielectric substrate. The radiating patch may be square, rectangular, circular, ring, elliptical or any other configuration .Square ,rectangular and circular shapes are the most common because of ease of analysis and fabrication. The antenna parameters like Return loss, VSWR, Radiation pattern are verify and stimulated on CST Microwave Studio.*

Keywords- Directivity ,Gain,Return loss,Bandwidth

I. INTRODUCTION

Cancer is a disease in which abnormal cells divide uncontrollably and destroy body tissue. Among different types of cancers, breast cancer is one of the harmful diseases that kills thousands of people every year. Approximately 40,610 women and 460 men are expected to die from breast cancer in 2017. A microstrip patch antenna was designed which operates at ISM Band in order to detect the presence of cancerous tumors. Copper has been used to create both the ground plane and the patch. To create the substrate, flexible material FR-4 has been used. FR-4 was chosen primarily because of its availability, high dielectric strength, resistance to moisture, cheap cost and its capability of delivering proper result in higher frequency [1]. The antenna patch and ground planes of both sides are connected to each other through a via made out of annealed copper. Meander line technique was used to design the printed elements of the antenna for the reduction of the antenna size. There are two ways to reduce the resonant frequency of a monopole by meandering the monopole element. First one is by increasing the width of the meander line sections. Therefore, the increment of the capacitance to ground reduces the resonant frequency. In order to maintain the overall length of the antenna, reduction of meander section numbers also reduces the effective self-capacitance of the monopole element[2] However, these proposed antennas insufficiently suitable for creating antenna array for breast cancer detection. In this paper we have presented a microstrip patch antenna designed using meander line technique to reduce the antenna size to make it suitable for creating antenna array to help developing portable medical device for breast cancer detection.[3] . This research work further led to the development of image formation algorithms to enhance tumor responses by reducing early- and late-time clutter and analyzed the feasibility of using small antennas for tumor detection [4]. Therefore, later many different types of antennas were presented for the detection of breast cancer, such as: compact antenna for radar based tumor detection [5], stacked wideband microstrip patch antenna analyzed using FDTD method [6]

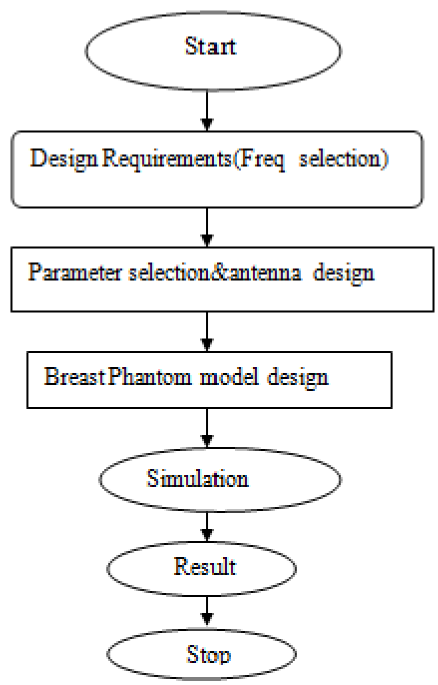


Fig.1: Data flow diagram

II. METHODOLOGIES

a) Circular microstrip patch antenna

The paper describes , a circular microstrip patch antenna was designed in the ISM band and simulated. The compact size and easy accessibility of on-body design makes the antenna a preferable method to the rest**.** To create the substrate, flexible material FR-4 has been used. The reason that copper was chosen was due to the fact that copper is an amazing conductive material and it is very efficient in terms of distributing electrical energy. Also, due to the fact that copper is relatively cheap.

ISM band works at the range of (2.4-2.48 GHz). The antenna is working at a resonant frequency of 2.885 GHz. The gain of the antenna was found to be 2.453 dB.

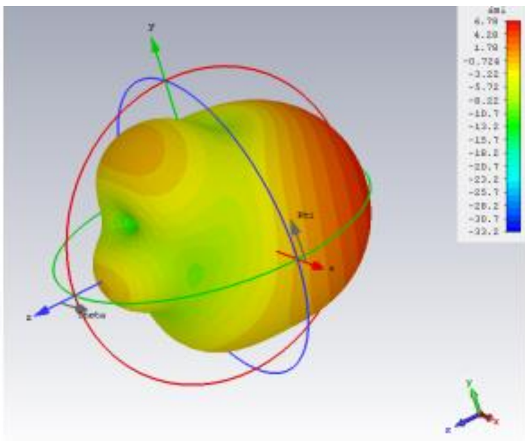


Fig.2:shows the farfield characteristics

From the above figure ,the resonant frequency of the designed antenna is at 2.354GHZ with a farfield of 6.79dBi.

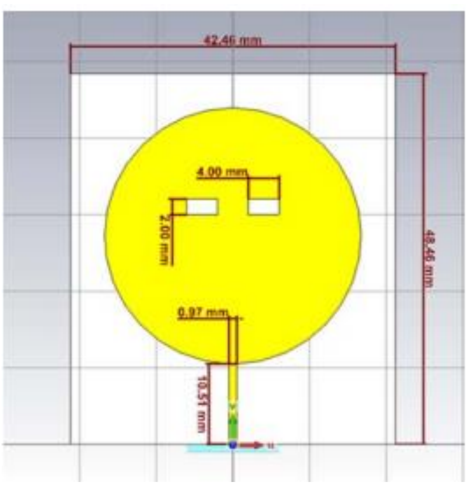
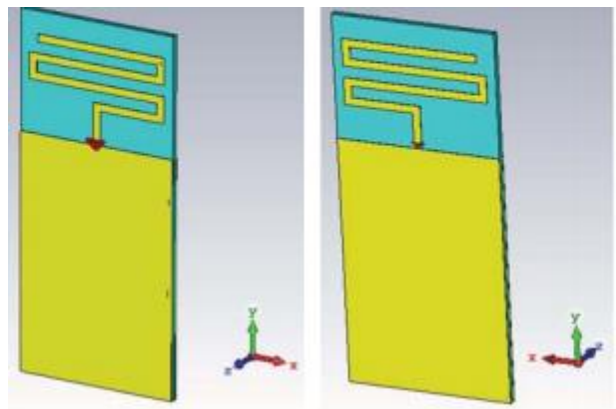


Fig-3:circular antenna design

From the above figure ,the circular shaped slot based radiation element fed by waveguide port

b) Four planar printed meandering monopole microstrip patch antenna

For the localization of breast tumors 4 planar printed meandering monopole microstrip patch antennas of operating frequency 1.5 GHz was designed using CST Microwave Studio. A flexible organic material 5-(4- (peruorohexyl) phenyl) thiophene-2-carbaldehyde compound from previous literature was used as the substrate of the antenna having dielectric permittivity (r) 2.64 and loss tangent 0.03 . The patch elements and ground plane are made out of annealed copper (Cu). The antenna patch and ground plane are printed on both sides of the substrate and are mirrored to each other. The antenna patch and ground planes of both sides are connected to each other through a via made out of annealed copper. Meander line technique was used to design the printed elements of the antenna for the reduction of the antenna size.



(a) Front (b) Back

Fig-4: printed meandering monopole microstrip patch antenna design a)front b)back

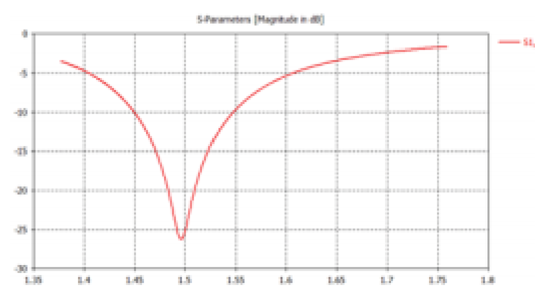


Fig-5:Return loss of the antenna at 1.5GHZ

From the above figure the resonant frequency of the designed antenna is at 1.5GHZ with a return loss -26.5dB.

C) T –shape microstrip patch antenna

In this antenna design, the patch and ground are made up of copper, substrate is of FR4 epoxy. The feed line is inset fed as it increases the performance of antenna rather than transmission fed. Since, radiation box is responsible for the return loss, the size of it is large enough. Dual characteristics, circular polarizations, frequency agility, dual frequency operation, broad band width, feed line flexibility, beam scanning can be easily obtained from these patch antennas. A gain for the MSPA obtained is 5.39dB. The shape will provide the broad bandwidth which is required for the operation of fourth generation wireless systems. A microstrip patch antenna is comprised of a radiating metallic patch situated on one side of a nonconducting substrate panel with a metallic ground plane placed on the other side of the panel.

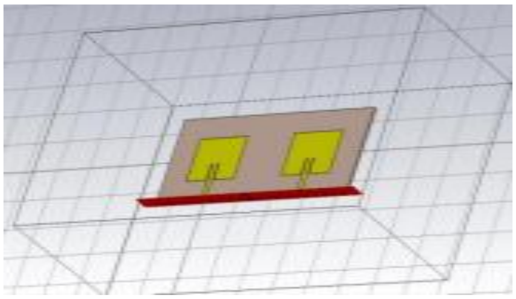


Fig-6:T-shape array antenna design

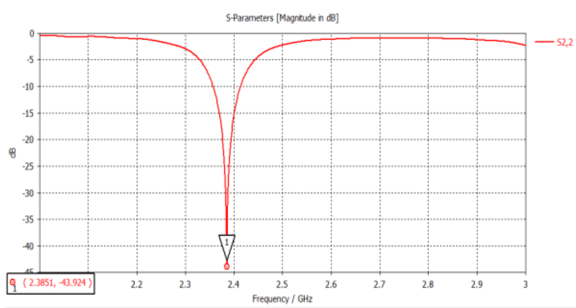


Fig-7:Return loss at the operating frequency 2.45GHZ

From the above figure the resonant frequency of the designed antenna is at 1.5GHZ with a return loss -43.92dB.

d) Bow –tie antenna

The antenna is printed on substrate with dielectric constant of 2. The bowtie antenna is represented by two metal sheets which have lengths le (55 mm) and separated by feeding gap (0.66 mm).Flare angle (α) is 60o which is determined the distance between two metal sheets. Any changes in antenna size affect the performance of antenna parameters. Therefore, any antenna size should be fixed by varying another antenna size in order to obtain bandwidth enhancement. Parameters which are analyzed are return loss, radiation pattern and VSWR. The antenna’s -10 dB bandwidth which spans in 3.1-10.6 GHz.

The key problem with the antenna design procedure is that the proposed antenna bandwidth should comply with the UWB requirements

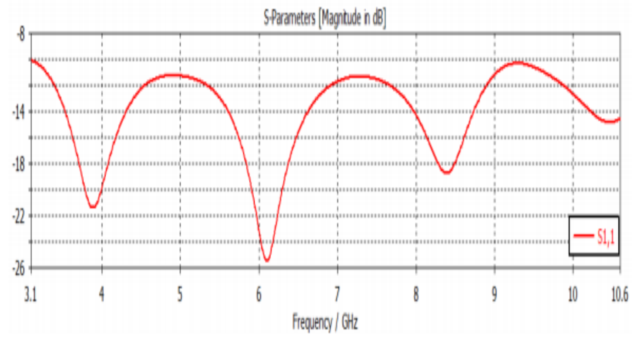


Fig-9:S-parameter(s_{11}) characteristics

Figure 9 illustrates the S parameter characteristic of the proposed antenna at four different frequencies 3, 4.5, 7.5, 9 GHz respectively. Four of them has omnidirectional radiation pattern characteristics which is acceptable feature for a better coverage of the breast surface.

e)Wearable microstrip patch antenna

This paper illustrates a novel design for a wearable microstrip patch ultra-wide band (UWB) antenna with improved bandwidth design to be used in breast cancer detection. The operating frequency of the proposed antenna ranges from 1.6 GHz to 11.2 GHz. The antenna consists of a rectangular radiating patch fed by a rectangular feed line. This antenna design will be part of a wearable device for women to detect breast cancer early. To support wearable property, 100% cotton has been utilized as the substrate with dielectric constant 1.6, while the transmitting component patch and ground planes are composed of copper as the conductive material. The analysis of the antenna and breast models was carried out using CST Microwave Studio. Simulated results in terms of return loss, bandwidth, radiation pattern, and gain and efficiency are presented .

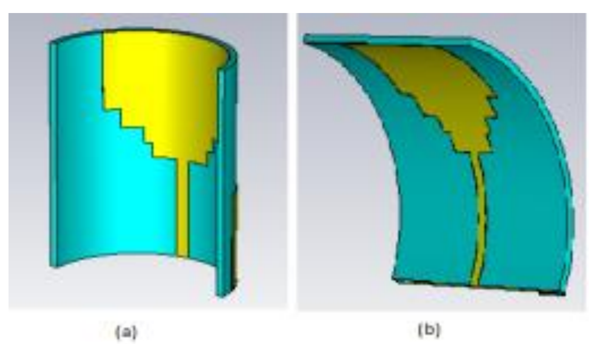


Fig-10.wearable microstrip patch antenna

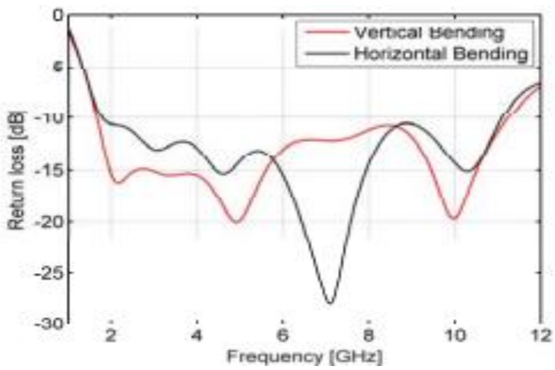


Fig-11:Return loss of different bending modes

Fig-11 shows the measured results of the return loss when different bending situations are applied to the proposed antenna; the return loss parameter is still almost UWB, and no major differences occur. Therefore, the antenna will be able to operate within the desired frequency range.

III. RESULT ANDISCUSSION

In this paper ,the different antenna structure such as circular microstrip patch antenna**,** Four planar printed meandering monopole microstrip patch antenna,T shape microstrip patch antenna ,wearable microstrip patch antenna ,wearable microstrip patch antenna design were analyzed.From the observation it is inferred that T-Shape microstrip patch antenna obtained by simulator produce the value of -43.92dB resonant at the frequency of 2.45GHZ.The VSWR curve of 1.015 resonate at the frequency of 2.45GHZ.

IV. CONCLUSION

In this survey paper ,various antenna designs were analyzed .From the observation it was found that T-Shape microstrip patch antenna produced an lower return loss of 43Db.The proposed T shape antenna is designed to place it on human breast to detect the presence of tumor cell.

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