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CPW-Fed Circular Microstrip Patch Antenna for Early Detection of Skin Cancer

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ABSTRACT

An antenna is a radiating object which converts the electrical energy to EM radiations. Oncology is branch which deals with the study of Tumor cells. This research paper proposes an antenna for early detection of Skin Cancer. The proposed antenna consists of CPW Fed, Microstrip patch antenna, which is of Flower shape with Crescent slots. The proposed antenna radiates at a frequency of 10 GHz with the return loss of 22.50dB and has a bandwidth of 3.28GHz resonating at 10GHz and at 4GHz with an impedance bandwidth of 3.37GHz. It has maximum gain of 9.42dB. The proposed antenna is designed on the Felt substrate, with the refractive index of 1.22. It also consists of an AMC backed structure to enhance the gain of the antenna. The proposal designed using HFSS (High frequency structure simulator). Rbin caliskan at all, Proposed a Microstrip Patch Antenna Design for Breast Cancer Detection. In this paper a 3D breast structure has different permittivity and conductivity is modelled in HFSS by using Finite Element Method (FEM) to solve electromagnetic field values and a microstrip patch antenna operating at 2.45 GHz is designed and substrate material is FR4 (Ir = 4.4 F/m). Slotting on microstrip patch and modifying ground plane, imaging quality is increased. About this, electric field, magnetic field distribution and current density on the antenna are evaluated.

1. INTRODUCTION

Tumor cells are basically of two types of which malignant tumors may be hazardous for life, thus need to be traced as early as possible. There are various methods available such as PET, X-ray Tomography, and Ultrasound which can be of use for the detection of cancerous cells [1].

There are several research works in the literature related to the Microwave imaging applications. Microwave imaging applications, basically works on the principle of the different electrical characteristics of different tissues of the human body, these differences on the electrical characteristics are due to there are differences in the water content of the different constituents cells of the tissues [2]. One of the most recent technologies for the detection is Microwave Imaging utilizing the non-ionizing radiations for the detection of the tumour cells, thus the mental and the physical harassment of the patients is very less, due to it, the microwave imaging applications are gaining a lot of importance nowadays and a lot of research is focused on developing systems related to the microwave imaging applications [3].

Body Area Network is one of the most important Biomedical applications which is gaining a lot of Focus nowadays, Wearable antennas consist of various types of antennas which are used as different sensors to take readings different parameters to be measured [3].

A wide band antenna will be off great help, for developing the biomedical applications for the identification of the tumorous cells.

As per IEEE the X-band frequencies operates from 8 to 12 GHz and is suitable for this application of detection of skin cancer. As Higher frequencies, will have lower penetration of the skin depth than that of the lower frequency operations. X-band frequencies have been a preferable frequency range of operation for the detection of heart rate variability and skin cancer [4-7].

In the following paper we have proposed an antenna for X-band operation resonation at 10GHz the proposed antenna is of circular shape and with Crescent slots. We have used anonymous a conductor, to reduce the back radiations and thus enhances the radiation pattern and the gain of the proposed antenna. The prototype has been simulated using HFSS.

2. GEOMETRY OF PROPOSED ANTENNA

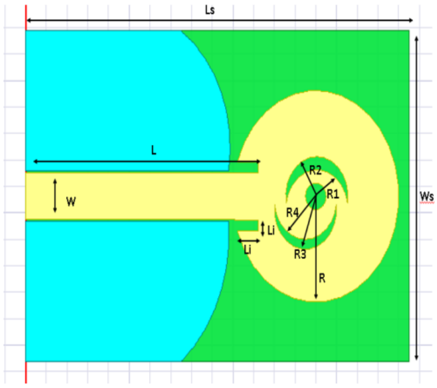
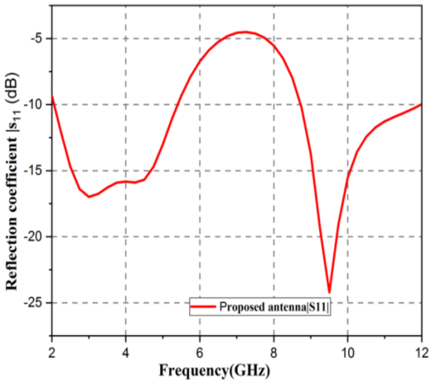


Figure-1. Proposed geometry of the Antenna

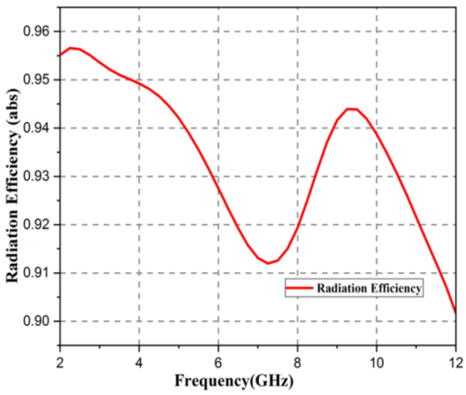
The complete process of designing of the antenna is being divided into two parts the first part includes the designing of the circular microstrip patch with the Crescent slots with CPW feeding. The second part includes the designing of the AMC has been utilized for enhancing the antenna parameters.

Felt is being used as the substrate for the proposed antenna with the relative dielectric permittivity of εr = 1.22, loss tangent of 0.016, with the height of h=2mm. Felt is an Electro textile. Material with a high quality of nylon-based substrate coated with tin/copper, which provides a good fabric. The main advantage of utilizing such a material is that it is tear resistant and flexible.

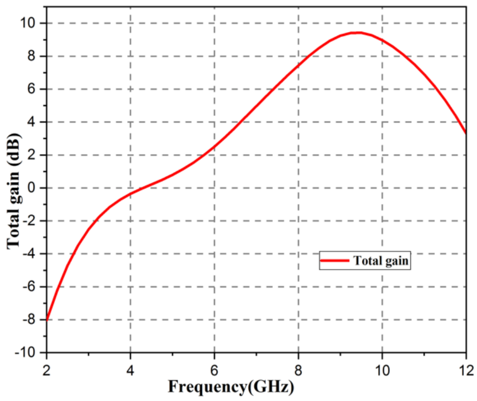
Figure-1 represents the diagram of the proposed antenna. The dimensions of the proposed antenna have been displayed in Table-1.



(a)



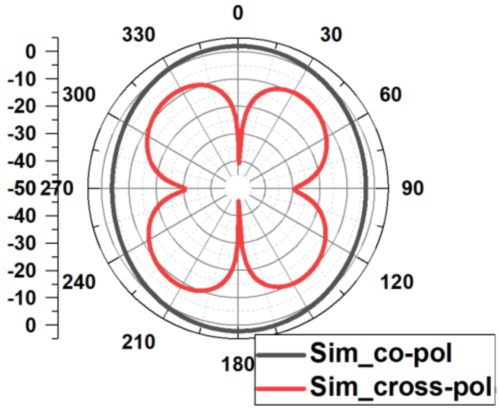
(b)



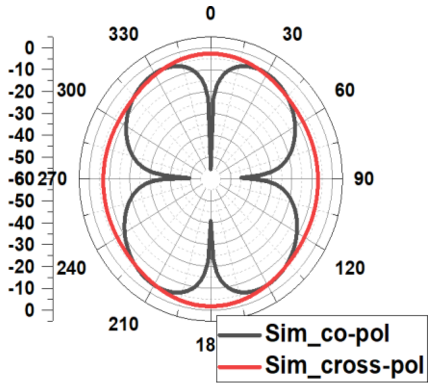
(c)

Figure-2. Antenna Parameters (a) Return Loss (b) Radiation Efficiency (c) Total Gain

The antenna parameters of the proposed antenna at the resonating frequencies have been discussed in the figure-2. Figure-2(a) represents the return loss of the CPW microstrip patch antenna Whereas in Figure-2(b) the peak gain of CPW fed microstrip antenna has been displayed. figure-3 represents the radiation pattern of the proposed antenna. The proposed antenna shows an almost omni-directional behaviour.



(a)



(b)

Figure-3. Antenna Radiation Parameter (a) 4GHz (b) 9.7GHz

3. GEOMETRY OF AMC

An AMC structure is required to reduce the back traditions of the given particular antenna as well as to enhance the radiation pattern parameters such as gain and the directivity of the given particular antenna. The dimensions of the proposed AMC is shown in Table-2, the phase reflection property of in an AMC is utilized. To reduce the size of the antenna and to provide a better bandwidth, The properties of the AMC reflector, such as bandwidth and the regional proxy determined by the geometry and the Dielectric permittivity and thickness of the substrate. A circular shape AMC has been has been utilized dimensions of the AMC unit cell is shown in figure-4. The behaviour of the AMC has been simulated utilizing HFSS to study the reflection coefficient for the standardized plane wave in the cell structure.

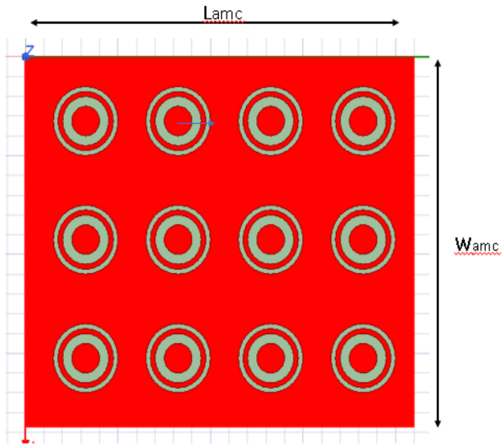


Figure-3. Structure of AMC

Figure-5 shows the phase reflection coefficient of this unit cell related to the frequency of the resonance of the proposed antenna It has been found that the AMC performance for the range of -90 to 90 will not cause any destructive interference.

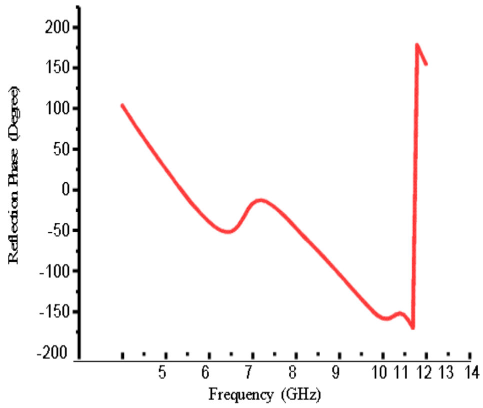


Figure-5. Phase reflection coefficient of AMC

4. SIMULATION OF SKIN PHANTOM WITH PROPOSED ANTENNA

Figure-6 represents the proposed antenna. With the AMC structure which has been utilized to define the characteristics of the normal skin Phantom as well as cancerous cell in the phantom.

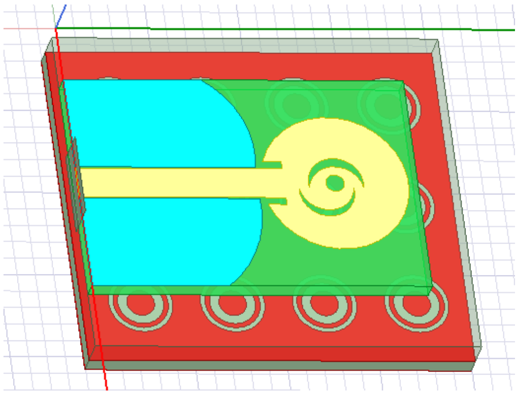
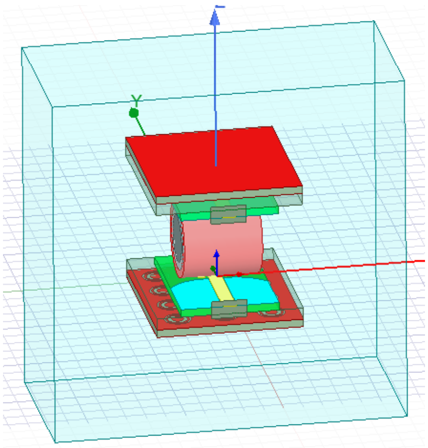


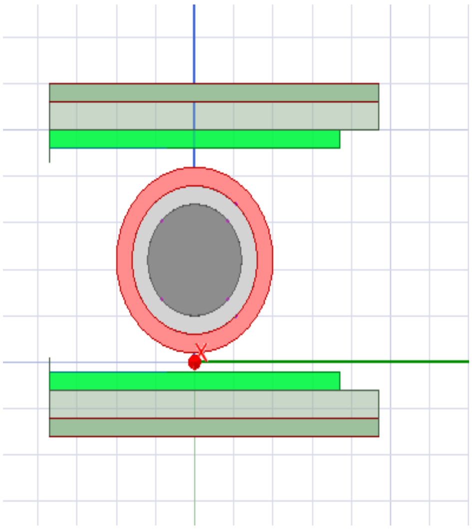
Figure-6. Proposed Antenna with AMC

Figure 7(a), 7(b), 7(c), 7(d) and 7(e) represents the complete 3D structure of the skin cell phantom with the proposed antenna structures. For calculating the S-parameters for the normal skin phantom and the Phantom containing the cancerous cells, the simulation setup consists of two antennas with the Phantom in between them, in the literature review the different electrical properties for both the normal cell and cancerous cells has been defined. The dielectric values for the normal skin has been defined as 38 F/m, whereas for the cancerous cells the results has been found to be 50 F/m.

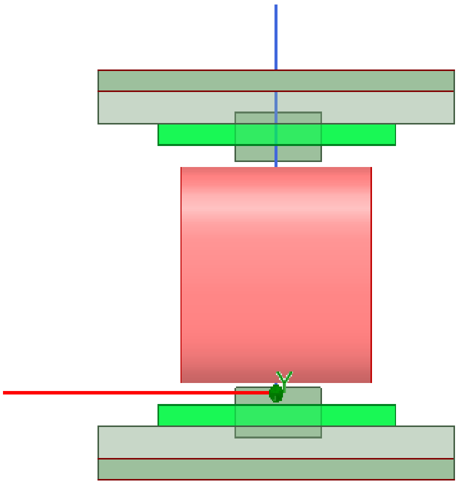
Proposed Structure	**Dimension Of antenna (mm)**	**Bandwidth of antenna (GHz)**	**Minimum Impedance matching (dB)**	**Gain of the antenna (dB)**
[8]	30×40×1.5	4-12	-18	2
[9]	50×50×1.5	3.1-10.6	-25	5
[10]	75×70×3	4-12	-30	3
[11]	30×40×0.75	3-16	-30	5
Our Structure	42×37.5×70	2.05-5.42, 8.72-12	-22.50	9.42



(a)



(b)



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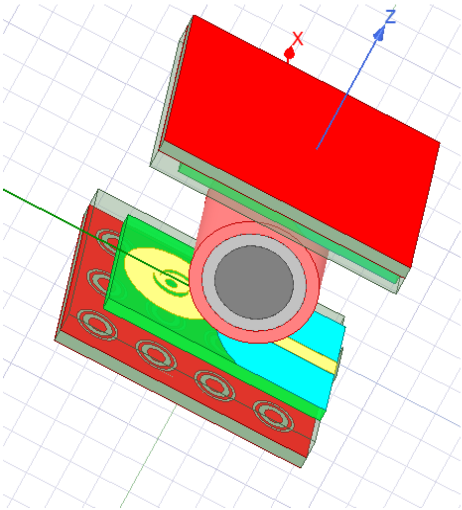

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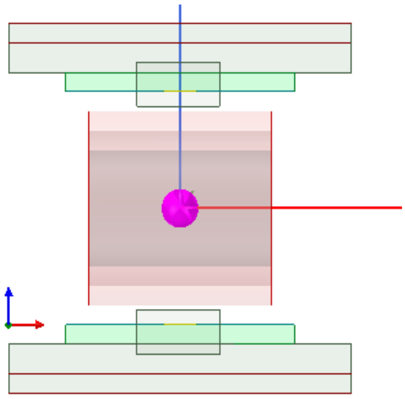

(e)

Figure-7. Antenna trans-receiver system for the detection of Skin Cancer

Figure 8 represents the simulated result of S21 the free space for the system with the proposed antenna with the AMC structure, the normal skin cell phantom in between the trans-receiver system and with the cancerous cell in the skin cell phantom and between the trans-receiver systems. With the S21 plot we are able to differentiate between the normal skin cell phantom and the Phantom containing cancer cell.

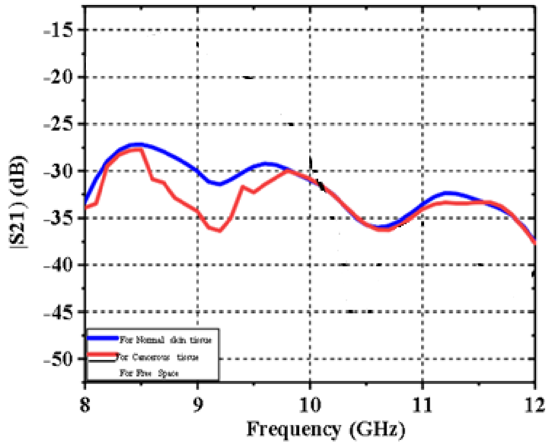

Figure-8. S21 for non-cancerous and cancerous cells

A comparison of the proposed antenna with the antenna published in the literature has been displayed in Table-3. The proposed antenna has a higher gain and low profile and has comparatively smaller size. Our proposed structure gives the highest gain 9.42 dB among all antennas as studied in literature survey.

5. CONCLUSIONS

A circular microstrip monopole antenna with crescent slots is analysed for early detection of skin cancer in medical imaging. Due to differences in electrical properties of the normal tissue and the cancerous tissues, they were examined utilizing this monopole antenna. The scattering parameters S11 and S21 were plotted, which were able to characterize the different electrical properties of the cancerous and the normal tissue. Using the HFSS simulator the simulations were carried out for the circular microstrip antenna and was found to be suitable for the detection. The proposed antenna has a return loss of 22.5dB with the impedance bandwidth of 3.28GHz resonating at 10GHz this antenna also has the maximum gain of 9.42 dB. It also resonates at 4GHz with an impedance bandwidth of 3.37GHz. An AMC structure has been utilized with the microstrip antenna to enhance the gain of the antenna as well as to avoid the back radiations. Thus provides a low profile, higher gain and lightweight antenna for the Medical imaging application.

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