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Design of Phantom and Flexible Antenna Array for Early Diabetic Foot Detection

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ABSTRACT

This paper deals about designing a phantom and a flexible antenna array for detecting the diabetic foot ulcer at the earlier stage itself. Phantom is something apparent to sense but with no substantial existence. As we cannot use the real time leg in software for detecting the diabetic foot ulcer we use phantom .Phantom is designed by selecting the appropriate dimensions and the dielectric properties of human leg. Initially the design of antenna is done and simulated then the phantom for leg with and without wound is designed and they are getting simulated. The variations in E-field, H-field, and Current density are measured. It is found that the current density value has been increased twice than that of the leg without wound, E-field and Magnetic Field value get reduced in the presence of wound. The entire simulation is done using the HFSS software.

*KEYWORDS-**HFSS, Phantom.***

I. INTRODUCTION

Diabetic foot ulcers are crimson sores that can arise most usually at the pad (ball) of the foot or the bottom of the massive toe. That is due to the improper manipulate of diabetes and the other reasons can be because of poorly fitted footwear, especially on the perimeters of the foot, the tops of the toes, or the heel of the foot. As we detect at the sooner level it reduces the future headaches. The hazard of decrease extremity amputation is 15 to 46 times better in diabetics than in people who do now not have diabetes mellitus. Furthermore, foot headaches need frequent need for hospitalization in sufferers with diabetes, up to twenty-five percent of all diabetic admissions in USA and high-quality Britain. The majority of diabetic foot complications ensuing in amputation start with the formation of skin ulcers. Early detection and suitable remedy of these ulcers may also save you up to eighty five percentage of amputations .indeed, one of the ailment prevention objectives outlined inside the "healthy human beings 2000" project of the U.S. department of fitness and Human offerings is a forty percentage discount in the amputation price for diabetic sufferers. physicians have an essential position in making sure that sufferers with diabetes receive early and most desirable care for skin ulcers regrettably, several research have located that number one care physicians every so often perform foot examinations in diabetic patients for the duration of routine office visits. The feet of hospitalized diabetics will also be examined often. Examination of the diabetic foot on an ordinary basis is one of effective measures for stopping foot headaches. Suitable care of the diabetic foot calls for reputation of the most not unusual factors for limb loss. Many of these danger factors may be identified based on specific factors of the records and a quick but systematic examination of the foot. So for everyday inspection it need to be of low value on the opposite side accuracy is need to so the layout satisfies all of the above necessities.

II. RELATED WORK

In (4)the authors proposed a circular antenna array to detect the breast cancer .The antenna is made circular so that it can be directly faced to the breast phantom for better Wound detection. The principle behind the microwave breast imaging (MBI) consists of a transmitter microwave signal to emit signals inward the breast and receivers to detect those emitted signals after they interact with the breast. In the presence of a tumor, usually with higher dielectric properties than those of the other tissues of the breast, the amount of Signal energy scattered by the tumor is higher than the one scattered by the fabrics of a normal breast with no tumor. In this paper, they also proposed an inset-fed rectangular patch antenna for microwave imaging using a 2.45GHz signal. Also the performance characteristics of five antennas working in the same frequency range is evaluated by placing them

on the breast skin to obtain an antenna that satisfies the design criteria for 3-D antenna array system for microwave breast imaging.

In (5) a Fractal based micro strip antenna for Lung tumor detection and a phantom with and without tumor is proposed. This proposed antenna is designed and simulated using computer simulation technology (CST) microwave studio (MWS), where a technique called finite integration is being used. The proposed antenna is simulated upon Lung phantom with and without tumor separately and the variations in current density, E-Field and H-field is analyzed to find the presence and the absence of tumor. The antenna has a current density value of 789 A/m2 which is twice than that of the lung without tumor, E-field of 2769V/m which is greater than the lung having no tumor and Magnetic Field of 10.96 A/m which is greater than the lung having no Tumor.

In (1) the authors proposed an flexible antenna array for detecting the breast cancer .Here the concept of radiometry is used .Initially the microwave signal is generated using the microwave source and it is allowed to pass through the breast tissues and the radiated signal is allowed to measure by the designed flexible antenna array and finally the output is simulated .As the dielectric properties of the affected tissue and the normal tissues varies we could see the difference between the affected tissue and the normal tissue the difference is shown in the form of color variation.

III. PROPOSED METHOD

Initially the flexible antenna array is designed and simulated and then the phantom for with and without leg is designed and simulated then initially the signal is generated from the antenna and then which is allowed to pass through the phantom(both phantom with and without wound) and then the radiated signal is being received by the antenna and then it is simulated where the parameters such as E-Field ,H-Field, Current density and SAR is being analyzed for leg phantoms with and without wound. Fig.1. shows the entire process flow.

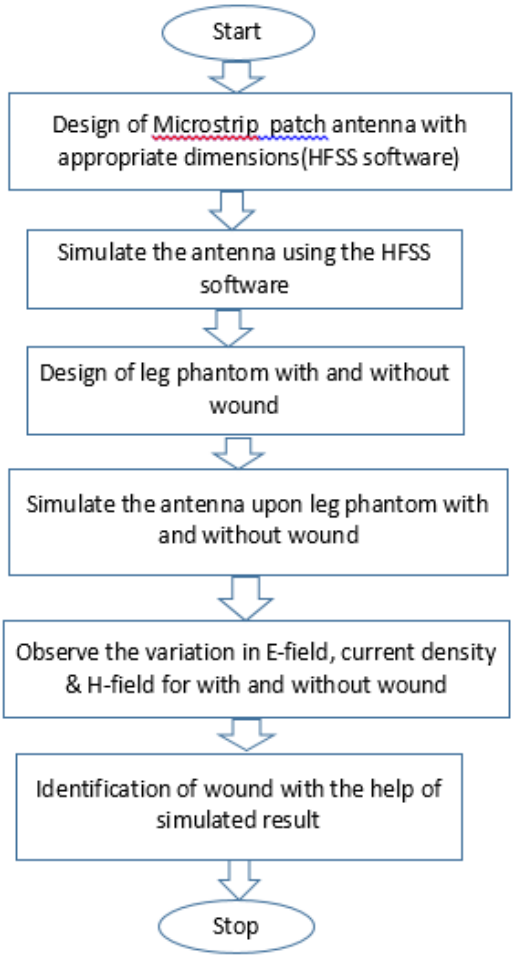

Fig.1.Process Flow

A) Antenna design

The antenna design plays an important role in the paper. To accurately detect the wound, an antenna is needed. The antenna design starts with a basic rectangular inset-fed micro-strip patch antenna resonating at 2.45GHz with a total dimension of 37.26x28.82mm on an FR4 substrate with a relative permittivity (εr)of 4.4, a width of 65.4mm, a length of 88.99mm, and a thickness of 1.588mm, and studding antennas are placed on the skin of the leg shape to find the different values of the electric as well as magnetic fields and the current density of a healthy leg tissue with and without wound inside the leg shape.Fig1 present an antenna with the dimensions and substrate defined.

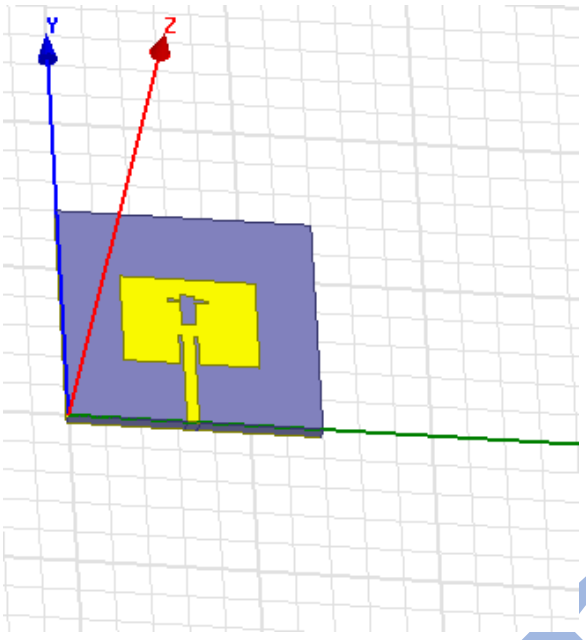

Fig.1. Antenna design

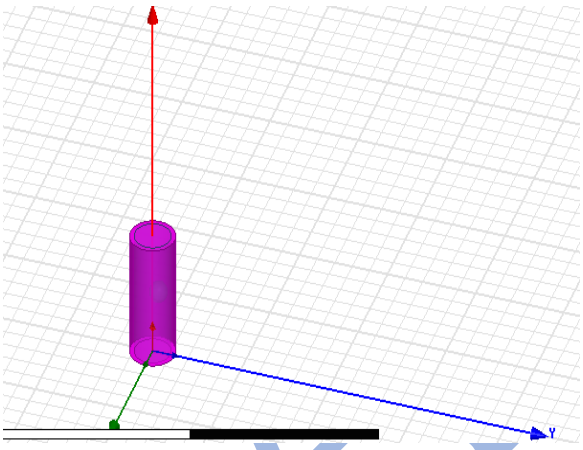

Fig.3.phantom with wound

Table.1. Antenna design parameters

S. No	Antenna Specifications	Dimensions
1	Length of patch	54.5 mm
2	Length of ground & substrate	60 mm
3	Width of patch substrate & ground	80 mm
4	Dielectric substrate	2.2
5	Height of substrate	1.6 mm
6	Feed to patch	Microstrip line feed
7	Width of feed	2 mm
8	Length of feed	5.5 mm
9	Length of slot	1 mm
10	Width of slot	50 mm

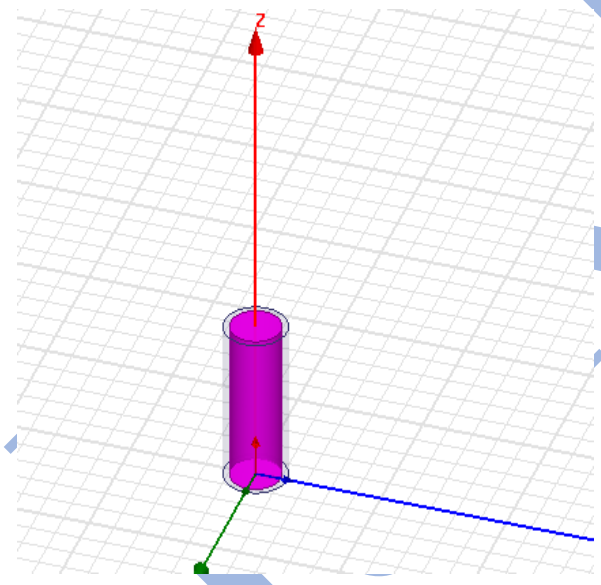

Fig.2.phantom without wound

Fig .2 and 3 shows the phantom of a human leg with and without wound .In fig.2. the wound is designed in the Z-ais where both are simulated and then their parameters such as E-field,H-field,Current density are being compared and tabulated.

Table.1. describes the antenna parameters where its dimension of the substrate, patch and ground is being specified and here the microstrip line feeding technique is being is used. Antenna dimensions plays a important role in this paper as it decides the final output accuracy, gain and everything. The advantage of using the antenna array is that we can able to get high resolution by placing it in a circular and appropriate fashion. The position is highly important as it helps to produce high resolution.

Table.2.Dielectric properties of human leg and wound

Tissues	Permittivity (ε_r)	Conductivity (σ)	Thickness
Skin	41.405	0.86674	1100
Fat	5.462	0.051043	1100
Bone	13.270	0.0869	1850
Wound	74.85	0.000956	2591

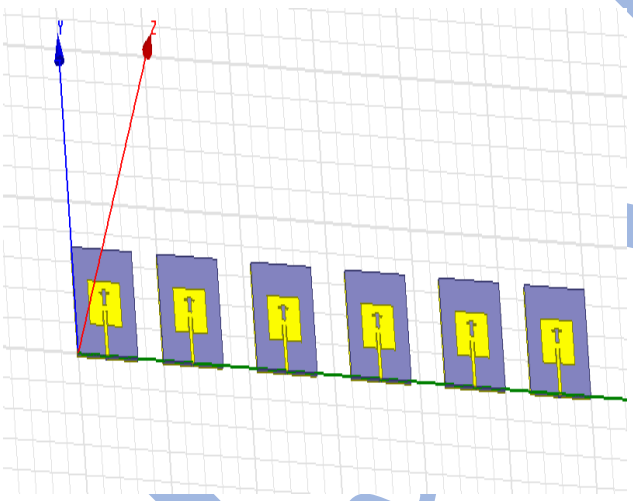

Fig.4.Antenna array

Table.2. shows the dielectric properties of human leg where the permittivity, conductivity and the thickness of the normal human leg and the wound has been discussed. The above parameters are needed to design the phantom where the appropriate substrate is selected and then above mentioned permittivity, thickness and the conductivity is being assigned and then the wound in the leg phantom is being designed in the same way where the appropriate permittivity, conductivity and dimension is assigned to the appropriate substrate.

After the completion of the entire phantom and the antenna designed they are separately simulated and

Table.3.output parameters

then both are simulated together by fixing the phantom of the normal leg in front of the antenna and similarly the phantom with wound is being fixed in front of the antenna

Electric Field (Vm)		**Magnetic Field (Am)**		**Courant Density (AM^2)**	
Without Wound	With Wound	Without Wound	With Wound	Without Wound	With Wound
117.55	115.26	0.922	0.901	46.21	47.90

and simulated. In the simulation process initially the microwave signal is being generated and the it is allowed to pass through the normal leg phantom and the phantom with wound and then the reflected signal is being received by the antenna and then simulated by positioning the antenna we can improve the results and the parameters such as E-field,H-field and current density is compared between the two phantoms with a and without wound.

Table.3.shows the Electric field, magnetic field and the current density of the phantoms with and without wound. Where the electric field and the magnetic field decreases in the presence of wound and the current density increases in the presence of wound.

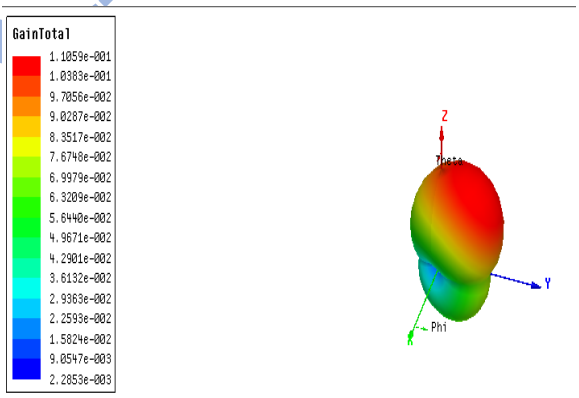

Fig.5.Radiation pattern

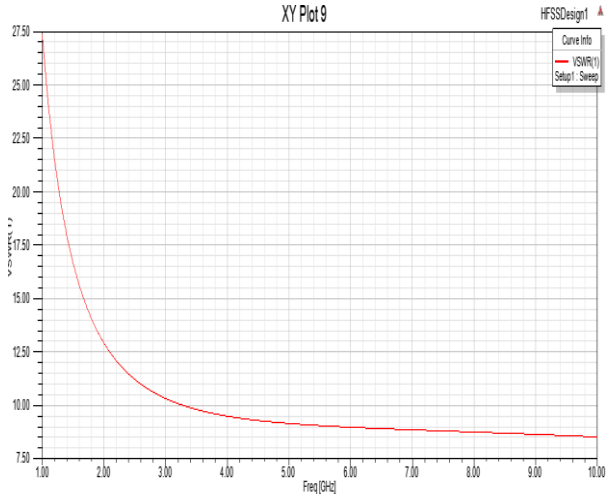

Fig.6.VSWR

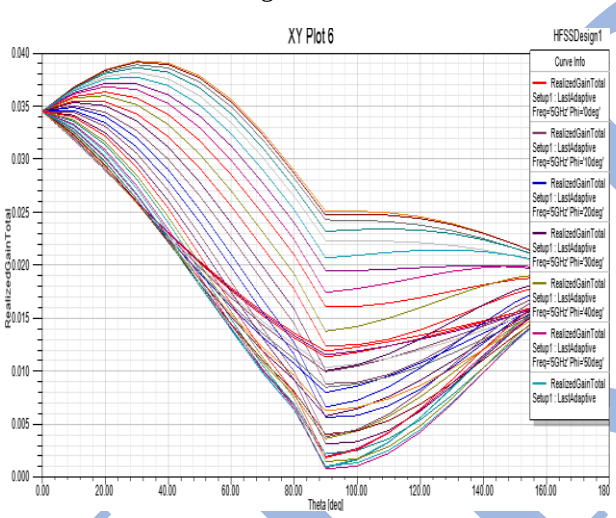

Fig.7.Realized gain

Fig 6 and 7 shows the VSWR and the normalized gain of the antenna where the normalized gain is the gain of the circular polarized antenna.

IV. CONCLUSION

An antenna is designed using the HFSS software and then phantoms with and without wound has been designed and then they are simulated by placing in front of the antenna and then simulated seperately and finally the parameters such as E-Field,H-Field,current density is being anlysed for both phantoms with and without wound.With the help of these parameters we can able to find whether the wound is present or not because the parameters varies as the E-Field and H-Field decreases in the presence of wound and the current density increases in the presence of wound.

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