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TUMOR DETECTION IN SKIN USING ELECTROMAGNETIC BAND GAP STRUCTURE ANTENNA

Dr. V.PRAKASAM[*1], R.MEGHANA[#2], A.SRAVANI[#3], SK.KARISHMA[#4], B.DIVYA[#5], N.CHANDU[#6]

[*]Professor, ECE Department, Visvodaya Engineering College, Kavali, Nellore (Dt.) Andhra Pradesh.
[#]UG Student, ECE Department, Visvodaya Engineering College, Kavali, Nellore (Dt.) Andhra Pradesh.

Abstract - *Tumor in skin could lead to death if not taken proper attention. Sometimes it may lead to most serious situations like skin cancer, which is Glioblastoma. The death rate is about 0.7 in last 2 years due to delay in the diagnosis. This distributed nature of the cancer also made this challenge in the treatment and diagnosis of the tumor or cancer in the skin muscles. Imaging techniques are traditionally used in detection of tumor in skin. Another approach is by using RF reflection approach, in which detect of tumor in skin done by analyzing variations in received signals from the skin model with and without tumor. So, in this work a EBG based monopole patch of circular shape with rectangular slot antenna is proposed that can detect the cancer related tumors in skin. The patch is pasted in the economical dielectric substrate Polymide. The design has its dimensions of 35 × 35 × 1.5 mm³ and that can radiate with a maximum gain if 1.12 at ISM 2.4GHz with 0.3519 GHz bandwidth from 2.2987 to 2.6506 GHz. The radiating efficiency of antenna is 65.3%.*

Keywords: Monopole Antenna, Skin Tumor, Monostatic Radar and radiation efficiency.

1. INTRODUCTION

In nature there are many health issued that cause human that, in which caner is one which causes significantly high death rates. This is happened due to late identification and also lack of self confidence [1-2]. There is high possibility of increasing patient life time, and sometimes cured if it identified in early stages like first and second stage. The many imaging techniques such as PET-CT (Positron Emission Tomography scan, Computed Tomography), Magnetic Resonance Imaging (MRI), Electro Encephalography (EEG), Magneto Encephalography (MEG), Magnetic Induction Tomography (MIT), and Electrical Impedance Tomography Technique (EIT) etc., are used in the detection of suspected tumors. But these methods require pre medical preparation of patient and need of experience doctor's observation. The process is time taking and costly. And also the results are not obtained instantly. So latest investigations in RF engineering is made to support the bio medical application such as in detection of tumor cells in human body with less time and low cost.

In this sensor antenna plays a vital role. An impressive flexible antenna that used to detect various glands based on Electromagnetic Impedance Tomography technique using microwave frequency to detect tumor [3-4]. There are various works made bay changing substrate properties like Giigml1032, FR4, Taconic (TLY-5) substrate etc., and obtained satisfactory results detection of breast cancer in [5-8]. But the sizes are not comfort to patient to fit over breast. In [7] smart antenna using PCA and LDA classification algorithms also applied to differentiate cancer tumors form normal glands. Some works used the Inverse Fast Fourier Transform (IFFT) for spectral analysis to filter out the noise for accurate results. An antenna array is proposed in[10] to detect tumor, that is fabricated on PET substrate. A polyester based antenna array and skin wearable array antenna for skin tumor detection is proposed by Alqadami et.al, it has multilayer and large size. [11-12]. The detection is done by imaging system. Compact a conformal antennas are also used based on EMIT technique to detect tumors.

From above literature, a pentagon slotted disc monopole antenna is proposed in this work. The proposed design is patched on 1.6 mm FR4 substrate with dielectric constant of 4.4. The article is organized to four sections. Section I includes introduction along with literature, the patch antenna design geometry is discussed in section II, Human skin modeling using CST values covered in Section III, results and discussion are in Section IV, and finally Section V concludes the work. The design made to radiate at ISM 2.4 GHz band. Design and simulation is done using CST studio software and results are recorded.

The proposed circular patch micro strip antenna is constructed by three layers; they are ground layer, substrate and patch. Here the shape of patch is considered as circular. The substrate material is Polymide dielectric material and the properties of this material are noted as: height is 1.5 mm, dielectric constant of 3.5 and 0.0025 loss tangent. The micro strip line method is used to provide the excitation. The dimensions of substrate is 35 x 35 x1.5 mm³ and this is the size of proposed antenna. length of the feed line 17.134 mm, and width of the feed line 4.4 mm.

A reactangular shape of slot is introduced in a circular patch. In this the ground is removed till the feed line that allows radiation in the desired ISM band frequency. The finalized design shown in Figure 1 is obtained by number of approximation using the software and the final design metrics of proposed antenna are listed in Table 1.

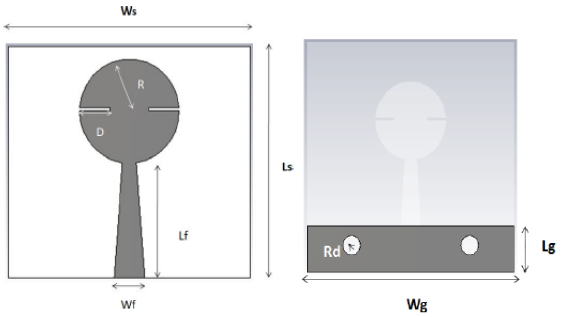

Figure 1: Design Model of the proposed antenna

Table 1: Design parameters of the proposed antenna

Variable Name	Symbol	Unit (mm)
Width of substrate	Ws	35
Length of substrate	Ls	36
Width of the feeding line	W_f	4.4
Thickness of substrate	T	1.5
Length of feeding line	L_F	17.134
Radius of circular disc	R	6
Length of one side ground plane	L_G	5.9
Width of one side ground plane	W_G	35
Radius of EBG unit cell	Rd	1.5
Length of one side slot in patch	D	4.4
Width of one side slot in patch	D1	0.5

3. MODELING OF HUMAN SKIN

The proposed antenna is designed for detecting the stroke in human skin. The human skin models of three layers were created in CST MW Studio with the help of dielectric properties. The three layers of human skin model are skin, fat and bone. The dielectrical properties are dielectric constant and conductivity depending upon the size and thickness of layers. The Figure 2 shows the placement of antenna in front of human skin model. Then the antenna exhibits parameters like electric field, magnetic field, surface current and current density. These values are analyzed and then tumor of size 3 mm is placed on human skin model.

The same antenna parameters are analyzed and compared with previous parameters of antenna. The figure 3 shows the human skin mode with tumor model.

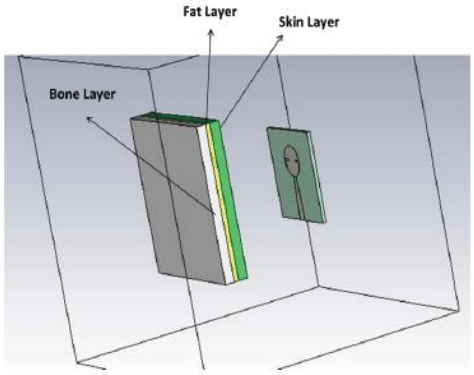

Figure 2: The positioning of proposed antenna in front human skin model in CST MWS

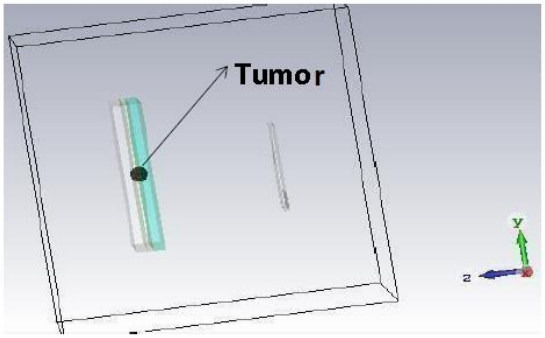

Figure 3: The spherical shape of tumor is introduce in human skin in CST MWS

Table 2: Human skin and tumor model

Skin model	Depth of layer (mm)	ε_r	σ (S/m²)
Skin (Dry)	2	38	1.5
Fat	2	5.3	0.1
Muscle	4	53.5	1.8

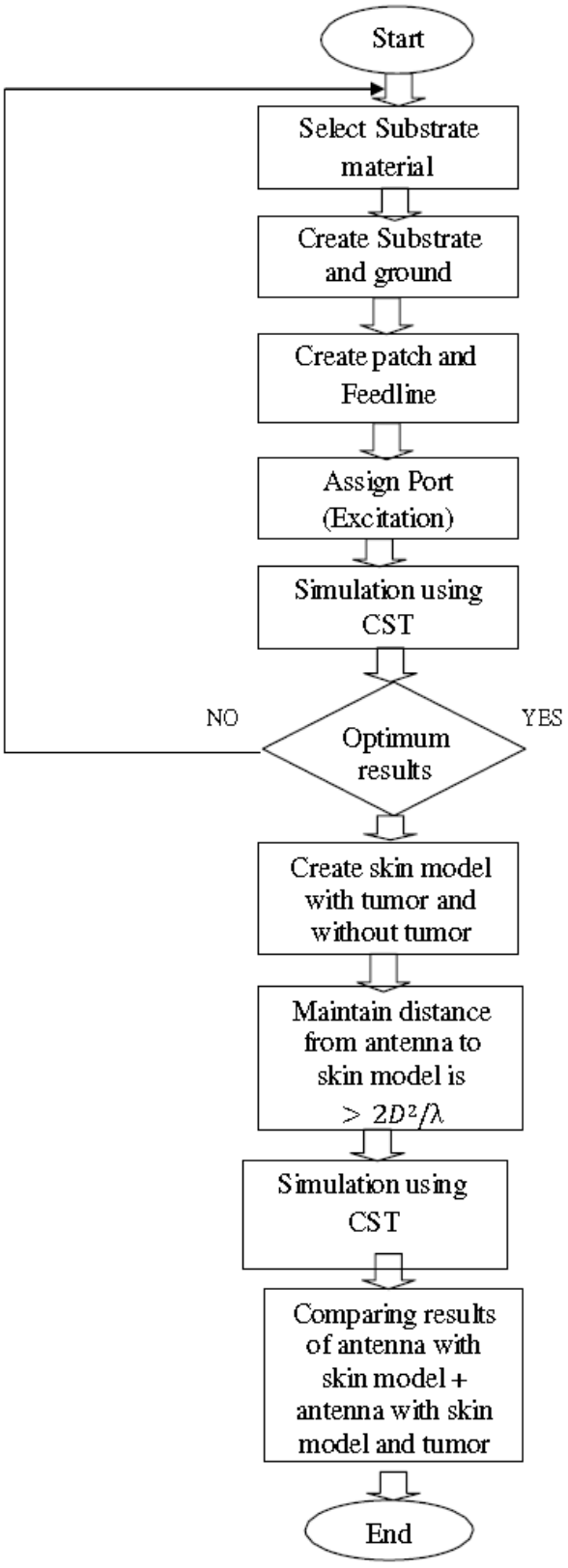

Figure 4: Flow chart of proposed design

4. RESULTS AND DISCUSSION

The simulation results of proposed micro strip patch antenna shown in figure 4. By observing the S-parameters graph(return loss Vs Frequency), the proposed antenna operate at 2.45 GHz frequency and it provide band width 351.9 MHz at -10 db return loss and reflection coefficient is -15.265. An efficiency of 63.5% and gain is 1.12 dB in a normal position for proposed circular patch antenna which is being simulated in free space.

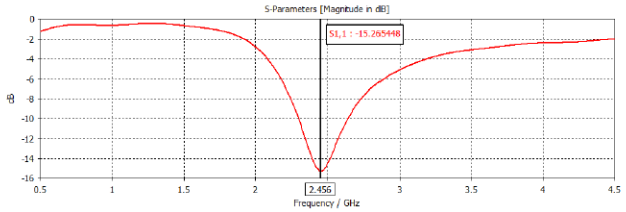

Figure 5: S-parameter plot for the proposed micro strip patch antenna

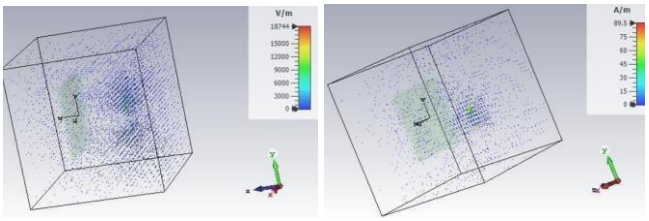

Figure 6: Electric and Magnetic Field values of the proposed antenna with skin model in CST MWS

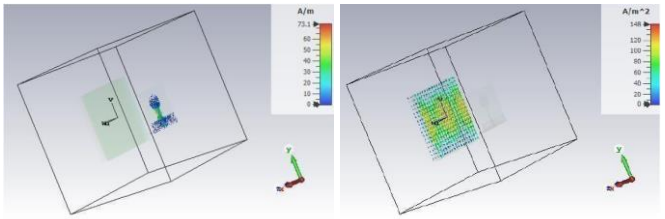

Figure 7: Surface current and current density values of the proposed antenna with skin model in CST MWS

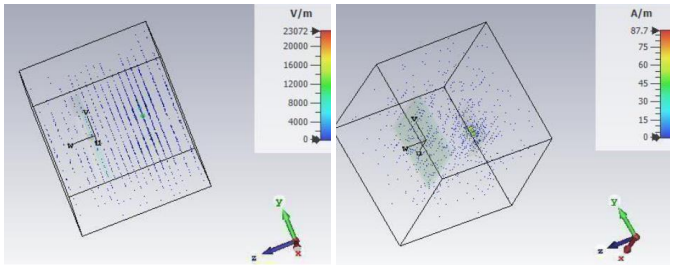

Figure 8: Electric and Magnetic Field values of the proposed antenna with skin model and tumor in CST MWS

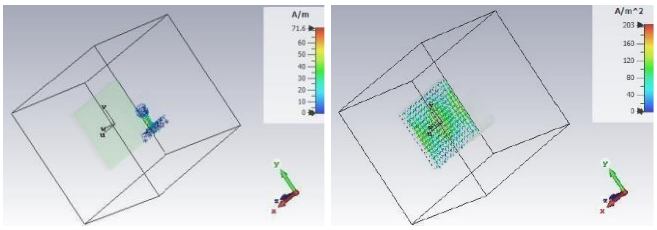

Figure 9: Surface current and current density values of the proposed antenna with skin model and tumor in CST MWS

Table 3: The result comparison among the proposed antenna without tumor and with tumor

	Electric Field (V/m)	Magnetic Field (A/m)	Surface current (A/m)	current density (A/m^2)
For proposed antenna with skin model without tumor	**18744**	**89.5**	**73.1**	**148**
For proposed antenna with skin model and tumor	**23072**	**87.7**	**71.6**	**203**

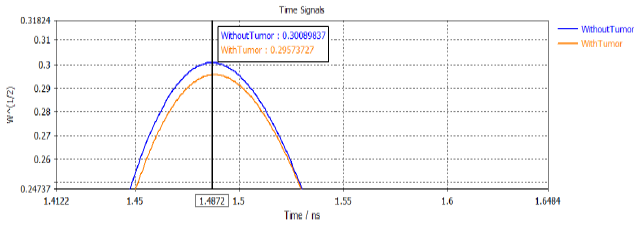

Figure 10: Amplitude Variation between Reflected signals with and without tumor model

Table 3 shows the comparison of antenna parameters among the proposed antenna without tumor and with tumor. From the above table, electric field, magnetic field, surface current and current density values for without tumor and with tumor are varied, with help these threshold values and also using the variation in Reflected signals with and without tumor model (shown in figure 9), the proposed circular patch antenna able to detect tumor in skin.

5. CONCLUSION AND FUTURE SCOPE

In this article a rectangular slotted and circular shaped microstrip patch is proposed for tumor tissue detection in skin that can radiate 2.4 GHz. It has significant radiation band from 2.2987 to 2.6506 GHz) allows S and applications along with ISM 2.4GHz band. Removal of complete ground gives the radiation similar to monopole. The slot provided in the patch makes the patch radiate at low frequencies, so one can treat it as electrically small antenna. The size 35 × 35 × 1.5 mm^3 shows compactness and easy to use with patient. More accuracy can be obtained by using a group of such pact antennas by forming a curved shape to suit the skin structure.

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BIOGRAPHIES

Dr. V. Prakasam received B.Tech degree from JNTUA, M.Tech degree in VLSISD from JNTUK and completed p.hD from SSSUTMS. He is currently an Associate Professor in the department of Electronics and Communication Engineering at VEC, Kavali. His research interests Signal Processing, Image Processing, Microwave Engineering and RF Engineering. He has more than 28 publications in various journals and conferences at national and International level including SCOPUS, IEEE, Springer, Elsevier and UGC.

R. Meghana, as B.Tech student in the department of ECE at Visvodaya Engineering College, Kavali. She has completed B.Tech from JNTUA University. Her areas of interests are Communication Systems, Embedded Systems, Java and Python.

A. Sravani, as B.Tech student in the department of ECE at Visvodaya Engineering College, Kavali. She has completed B.Tech from JNTUA University. Her areas of interests are Embedded Systems, Networks, Communication Systems and Object Oriented Programming Language.

Sk. Karishma, as B.Tech student in the department of ECE at Visvodaya Engineering College, Kavali. She has completed B.Tech from JNTUA University. Her areas of interests are Communication Systems, Electronics, Java.

B. Divya, as B.Tech student in the department of ECE at Visvodaya Engineering College, Kavali. She has completed B.Tech from JNTUA University. Her areas of interests are Communication Systems, Networks.

N. Chandu, as B.Tech student in the department of ECE at Visvodaya Engineering College, Kavali. She has completed B.Tech from JNTUA University. Her areas of interests are Embedded Systems, Communication Systems, Networks.