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A Novel Method for Constructing Planar Antennas of Integrated Microwave Imaging Radar for Earlier Breast Cancer Detection

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Abstract— **In this paper, a compact design and construction of microstrip feed Planar antenna comprising both coupling and decoupling structure is presented. Antenna gain and polarisation properties of planar antennas are enhanced. The Planar antenna design comprises two monopole antennas for transmission and reception Each antenna element working under wider frequency range of about 2-16 GHz. The proposed module customises the imaging radar tool's patch antenna design considerations and achieve better gain within the proposed frequency of about 3.3GHz to 8.5GHz, which certainly reduces discrepancies. The tool is best suited for diagnosis of earliest breast cancer causing tumour cells having resolution of about 3 mm. The main concern of this project is to diagnose the benign tissue at the earliest as most cancer cells are completely curable at the earlier stage.**

Keywords— **Breast cancer, Planar Antenna, Isolation factor, Insertion factor, Microstrip feed, skin effect.**

I. INTRODUCTION

The dramatic development of wireless communication leads to the development of microwave imaging technique to image human body has been taking place now. As reported in [1], breast cancer is one of the most incident tumours among the female population. Since 95% of the cures are possible if they are identified in the benign stage and it could be treated as well and prevented from being the tissue to be malignant. These Microwave integrated devices has its wider applications in the biomedical field. Microwaves do have certain characteristics of skin effect and backscattering and these waves acts accordingly with the nature of human tissue and could able to differentiate benign and malignant tissue [7], and target the tumour cells. These Microwaves with its non-invasive and non-ionisation properties along with Antenna designs in the microwave integrated circuits such as integrated microwave imaging radar tool along with imaging techniques able to target the tumour cells [4], of about 3 mm and have good resolution. Microwave integrated imaging radar tool comprises a pair of patch antennas upon which a radar receiver is being embedded in between. Each antenna is made of metal patches placed on the dielectric and fed by microstrip or coplanar transmission line is called as microstrip antenna or a patch antenna. The microstrip antennas are best suited where size, cost, weight and performance, ease of installations which demands a low profile antennas. The concrete reason for adapting this microwave radar tool is to avoid the conventional X-Ray imaging which has enormous disadvantages such as ionising radiations which are very hazardous to human body. Due to the presence of dense granular tissues which leads to the prediction of 10-30% of false negatives [8]. X-Ray mammography consists of compressed breast which is a most common diagnostic tool to detect these non-palpable breast tumours and this conventional X-Ray imaging has lot of disadvantages.

The limitations extends with the usage of electromechanical switching system to interface 60-element antenna array to 8 port vector network analyser. This certainly introduces losses and the number of simultaneous measurements are limited. The calculation and the Acquisition time increases. Ease of transportation is very high that is it engages huge hydraulic trolley mounting. So to limit all these factors and to achieve a better imaging radar tool a dedicated radar transceiver along with two patch antennas whereby the design considerations of these antennas should be managed with the basic properties of patch antennas to enhance the bandwidth and gain properties and to achieve better polarisation and dynamic range of bandwidth is proposed in this paper.

This paper focus on the demonstration of wideband patch antenna [6], and its simulation results subjecting to various frequency environments. It basically aims at gaining a fairly omnidirectional pattern to achieve a better dynamic range of around 106 dB.

II. PLANAR ANTENNAS

Planar antennas are the newest generation of antennas boasting such attractive features such as low profile, low weight, low cost and ease of integration into arrays. These features makes them ideal components of modern communication systems, particularly in biomedical field. Here in this paper the planar antennas are used for the designing a novel Microwave imaging radar tool which has its valuable usage as a diagnostic tool in the detection of tumour cells at an earlier stage. In this planar antenna layout the strip is designed and feed is through a microstrip line with 50 ohms microstrip line [2, 3].

III .UWB PATCH ANTENNA DESIGN

A. *Theory*

The proposed module comprises two antenna element which are considered to be the monopole structure. Each antenna element working under a wide bandwidth and has an operating frequency range of about 2 to 9 GHz [5]. Antenna top layer layout depicts the transmitting and receiving radiating patches. The radiation pattern combines both the rectangular and circular patches. The semicircular tapering part gives a better impedence matching all over the bandwidth. The feeding line is chosen to be centre feed. The centre microstrip feed line to these radiating patch provides equal current distribution and provides a good power patch. Impedence matching should be equal to 50 ohms, that certainly provides better input and output transmission and reception. Top layer of the antenna structure depicts the coupling structure where the monopoles are placed facing at the same face. To achieve a compact design the monopoles are placed very close to each other which causes mutual coupling between the antenna. These mutual coupling introduces losses and there is a need to avoid these mutual coupling. To avoid this unavoidable mutual coupling a T-shaped decoupler is being added to the back of the laminate, which reduces the losses introduced.

B. Antenna Design

Factors determining the antenna compact design includes insertion and isolation factors. For perfect input and output matching to get occur insertion should be high, thereby the insertion loss should be low as possible. Isolation between these monopoles should be high and isolation loss should be as low as possible. The upper part isolation control is adapted by the parameters say ***wd2*** and ***ld2***. Isolation control is adapted by the parameters say ***wd1*** and ***ld1*** which controls the isolation between the two radiating patches, at the lower part with an operating frequency band of about 2 to 9 GHz. Parameter optimisation is done using software Agilent Advanced design systems.

Table1: Design considerations

Frequency	***3.3 GHz to 8.5 GHz.***
Substrate Thickness	***1.524***
Loss Tangent	***0.0027***
Feed line (Top Layer)	***Length = 9.9mm***
	Width = 1.7mm
Substrate Dielectric constant (εr)	***3.55***
Ground Plane	***Length = 67 mm***
	Width = 34 mm

These design properties are used to shed new light on their operating principles. That is, a few number of configurations can be used for antenna elements for obtaining better simulation results within operating frequencies.

C. Antenna Geometry

The Planar antenna geometry is illustrated in the figure 1. The antenna layouts includes the (a) Top layer layout for the coupling structure and (b) Bottom layer layout for decoupling structure with partial ground plane and overall dimensions given. The layout is schematised using a software Agilent Advanced Design Systems. The parameters that are needed to calculate includes S parameters, reflection coefficients and VWSR. The designing of monopole planar antennas in advanced design systems software includes Laying out the radiating planar patches. Microstrip line feeding through various feeding techniques and here centre fed is given to ensure that the entire radiation patch is getting equal power distribution. Schematic of the line feed being created and all attached to the radiating element and consequently the ports are been checked for coupling, which energises transmission and reception. Upon estimating mesh frequencies S parameter simulation frequencies are being set up to get the radiation pattern. The top layer and bottom layer are simulated individually to get the radiation pattern. The parameter analysed includes polarisation and radiation pattern measurements in magnetic plane is made.

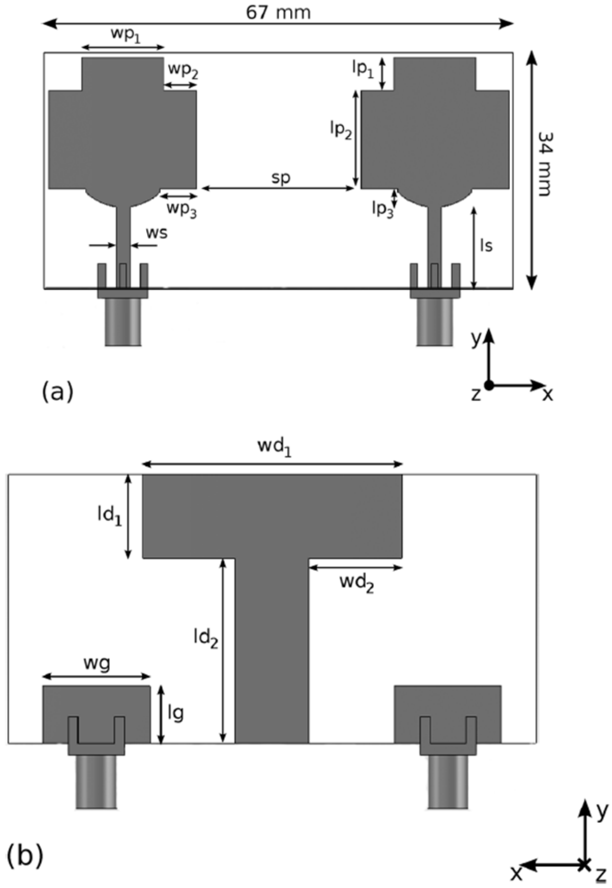

Figure1: Layout of antenna structures (a) Top layer layout with transmitting and receiving radiating patches (b) Bottom layers with decoupling structures an partial ground plane. Dimensions $wp1$=10mm $wp2$=4mm, $wp3$=4mm, $lp1$=4mm, $lp2$=12mm, $lp3$=2.1mm, ws=1.7mm, ls=9.9mm, sp=20mm, wg=11.5 mm, lg=6.25mm, wd1=28 mm, $wd2$=10 mm,$ld1$= 9mm, $ld2$=20mm.

C .Simulation results

Various simulated radiation pattern has been observed upon subjecting to frequencies from 2 to 9 GHz in (x-z) plane is illustrated in figure 1. The results for the frequency say 2 GHz being calculated and shown in figure 1. The simulated and measured magnitude of reflection (S11) of transmission (S21) coefficients shown in the graphical figure 2. Using the Advanced design system software, simulated antenna radiation pattern on the magnetic (x-y) plane .The three dimensional view of the coupling structure is given in figure 3. The three dimensional view of decoupling structure is given in figure 4.

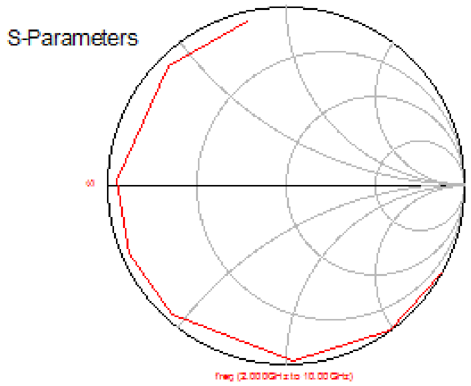

Figure1: Simulated radiation pattern for top layer

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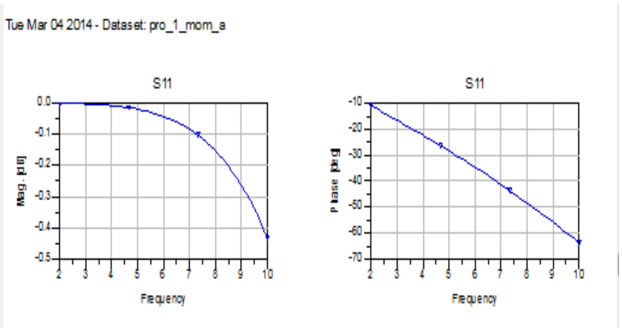

Figure 2: The simulated and measured magnitude of reflection (S11) of transmission.

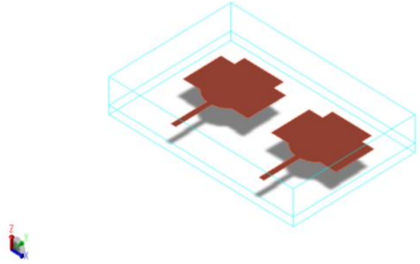

Figure 3: The Top layer view of coupling layout.

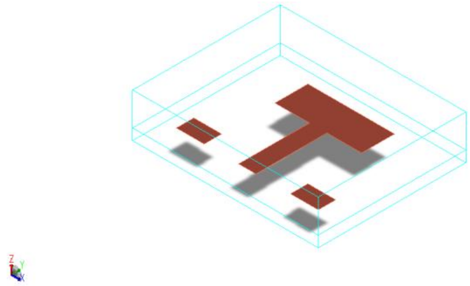

Figure 4: The Bottom layer view of coupling layout.

A. *Results and Discussions*

From the simulation radiation results , inference is that a fairly omnidirectional pattern is obtained from about 2 GHz but there is a chance of getting certain hump and discrepencies at these frequencies which are certainly losses to the radar integration. So the radiation pattern achieved between 3.3GHz to 8.5 GHz are regarded as best operational frequencies to achieve dynamic range of about 106 dB, upon integration with the radar receiver. So upon further extension with this dynamic range the planar antenna design constraints are well determined to achieve better omnidirectional pattern, good polarisation and isolation factor to be high enough to achieve this novel design of microwave imaging radar.

IV. CONCLUSION

The antenna design of the novel imaging radar are best upon considerations of antenna parameters that are all used so far in this paper. This is one among the better attempt of integrated customised device model for imaging radar transceivers. In particular these radars are used for the earlier diagnosis of breast cancer. Additionally advantages added up are performance, cost and size of antenna design. The hardware design may be customised and effectively contributed to the development of technology.

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