A Survey on UWB Antennas Used For Breast Cancer Detection

Aswathy Sam[#1]
Department of Electronics and Communication Engineering
Karunya university
Karunya Nagar,Coimbatore

Mr.Amir Anton Jone.A[*2]
Department of Electronics and Communication Engineering
Karunya University
Karunya Nagar, Coimbatore

***Abstract*— This paper is based on different types of antenna used for breast cancer detection .It is based on the principle of synthetically focused Ultra wide band radar imaging technique. These antennas are operated in UWB range of frequency from 3 to 10.6 GHZ. Different antennas for the survey are horn antenna, bow tie antenna ,half oval patch and stacked patch antenna. A comparative study of these antennas are done are from this wide slot antenna has excellent performance than other antenna.**

Keywords*— *Breast cancer detection, ultra wide band antenna ,confocal microwave imaging.

I. INTRODUCTION

Breast cancer is the most common form of cancer among women. The early detection there is a high chance of successful treatment and long term survival [1]. To reduce the morality of this disease ,it is to be detected early when the cancer is very small and has not spread to other parts of the body. The current and most widely used method of detection for this type of cancer is mammography in which the breast is exposed to low-power X-rays [3]. This method has some demerits such as false negative rates ,high false positive rates, and the ionizing nature of X-rays which poses a considerable risk of causing the very cancer it attempts to detect [2],and also this method is very expensive. To provides a safer and /or more accurate method than traditional mammography.

An alternate method of breast cancer detection is microwave imaging [3]. The applications of microwave technology were increasing in the field of biomedical engineering for diagnostic purposes. This technique is based on the variations of the dielectric properties of normal and tumors tissue[4].It is because it contains more water and blood in malignant tissue than normal tissue, due to more water in this region more heat is there. Due to this strong scattering take place when microwave hit the tissue into the malignant tumor.[4].There are two different approaches that have been proposed in order to image the breast are: Microwave tomography and ultra wide band radar imaging [2] .Both of this method uses antenna arrays. Microwave tomography [9] it is similar to MRI, which aims at creating the cross-section image of the body by scattered energy. The advantages of the microwave tomography include the whole view of body tissue but the problem is that every tissue is not clearly identifiable..Furthermore, the signal processing is very complex which requires solving non-linear functions[13].

Another method called ultra wide band radar imaging also called confocal imaging. [9].This method does not provide a complete electrical mapping of the region of interest. Instead it identifies location of significant scattering. This method typically uses a single antenna scanned in a flat array pattern above the breast or a cylindrical array of very small broadband antennas. For planar imaging, the patient lies face up, and the antenna is physically scanned in a plane above the breast .For cylindrical imaging, the patient lies face down. One of the antenna in the array transmit a short pulse, it is then transmitted into the body. Then the reflected signals are detected by one or more receiver antennas placed in different locations. Moreover, by using phase or time shift, more sets of signals can be collected for calibration in order to reduce noise and clutter [13]. This radar based scheme is used for producing high resolution images without using any algorithms; this is because of the wide band nature of UWB signals [2].

II. METHODOLOGY

A. Bow-tie Antenna

A bow tie antenna is designed for the purpose of breast cancer detection. The antenna geometry is a modified version of a slot line bowtie hybrid, which is immersed in a dielectric medium [5].Radar-based approaches make use of ultra-wideband signals to achieve resolution without excessive signal attenuation. This implies the use of an appropriate sensor. To image the breast, an antenna capable of radiating a pulse with high fidelity over an ultra-wide frequency range is required. Bowtie plates are attached to the slot to provide control over antenna beam width shown in fig.1. For the breast cancer detection application, the antenna is immersed in a dielectric material similar to breast tissue. Bowtie design, chosen because its cross polarization allows for effective removal of the backscatter due to the chest wall while unsymmetrical tumours were permitted. By using this antenna able to detect 1.5 cm long ellipsoidal tumour with a depth of 1 cm . Although this shows that the overall method of microwave detection is feasible, an improvement in the sensitivity with regards to tumour depth and size is sought after. It is desirable to have subcentimetre detection of breast cancer tumours, as these tumours usually have not metastasized. Detection of the tumour before it has a chance to metastasize is critical in extending the life span of those afflicted with breast cancer. It gives a return loss greater than 10 dB over the 2.5–10 GHz band, and greater than 5 dB over the 1–10 GHz band. The tumour reflection decreases with distance, the tumour was repositioned to depths of 0, 1, 2, 3 and 4 cm from the aperture [14].

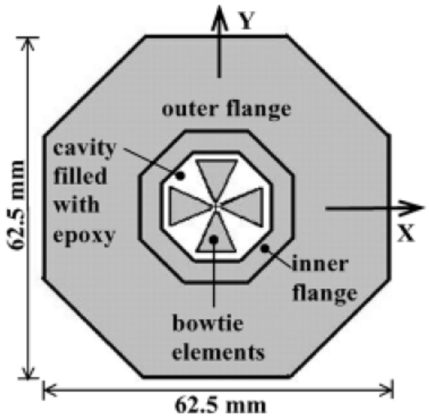

Fig. 1 Bow-tie Antenna

B. Horn Antenna

A novel horn antenna placed in a solid dielectric medium is proposed for microwave imaging of the breast [12].The major design requirement is that the antenna couples the microwave energy into the tissue without being immersed itself in a coupling medium. The antenna achieves this requirement by 1) directing all radiated power through its front aperture, and 2) blocking external electromagnetic interference by a carefully designed enclosure consisting of copper sheets and power absorbing sheets. In order to achieve antenna features: 1) good impedance match, at the antenna aperture, and 2) good coupling efficiency.

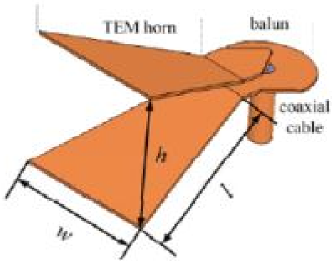

Fig.2 Horn antenna

For microwave scanning of the breast, the antennas and the tissue are typically immersed in a coupling liquid with dielectric properties as close as possible to the average properties of the breast tissue in the operating frequency band .This medium minimizes the reflections occurring at the skin interface and increases the penetration into the tissue. The coupling medium complicates maintenance and requires replacement to avoid contamination. It uses frequencies range from used is 3.1-10.6ghz.

This UWB TEM horn antenna is about 75mm.The outer surface of the antenna is covered by copper sheets and a microwave absorbing sheet. Additional copper sheets, on top, bottom, sides are used .So, size of the antenna increases. Here less number of antenna arrays are used about 4-6 array. So due this it does not give accurate location and position of tumors. This antenna structure is very complex and expensive.

C. Half Oval Patch antenna

A simple half oval patch antenna is proposed for the active breast cancer imaging over a wide bandwidth. Cubic chamber integrated with patch antenna arrays are used in this method [11]. One chamber can contain one breast immersed in a matching dielectric medium. For a breast imaging system, the antenna should be compact, lightweight and suitable for directly touching the breast .It uses an operating bandwidth of 2.7-5 GHz.

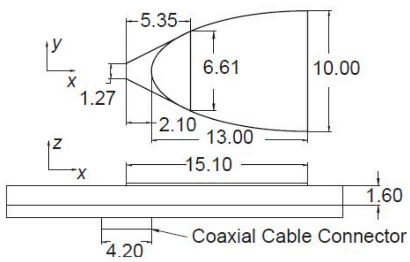

Fig.3 Half oval patch

The antennas will be mounted on four vertical panels of a cubic chamber. Each panels has the same number of antennas. To obtain the data for reconstruction of the breast dielectric distribution, the antennas are switched electronically between source and receiver one by one. In each scan process, only one antenna is used as the source and the others act as receivers.

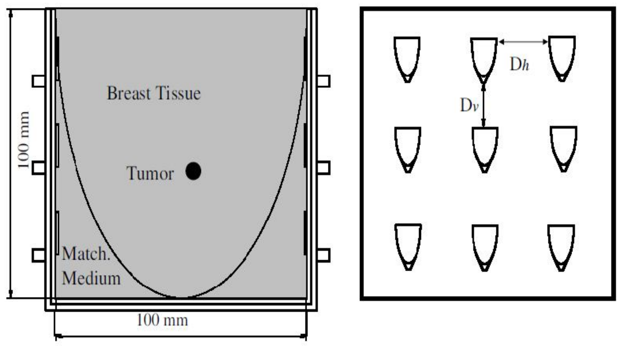

Fig.4 Imaging chamber

The more antennas the wall contains, the more imaging data can be obtained from each scan, but the undesirable coupling may be stronger and the array becomes more expensive .Size of antenna is complex. This antenna obtains a return loss less than -10 dB from 2.7 to 5 GHz.

D. Stacked Patch Antenna

A stacked patch antenna is being designed and investigated which consists of a micro-strip line feeding slot, which in turns excites an arrangement of stacked patches[15].

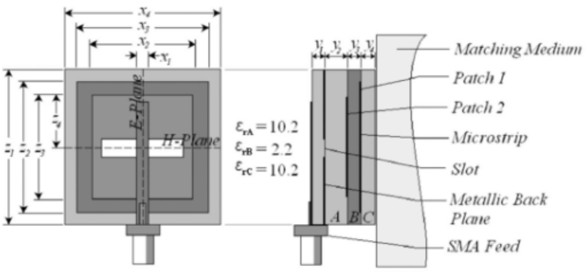

Fig.5 Stacked patch antenna

In the configuration the slot feed is used to eliminate the inductance associate with a probe feed. The patches sandwiching the lower permittivity substrate and their size is chosen because of lower order resonance was achieved at either end of the desired frequency band .It operates with a frequency range from 2-10GHZ.

The stacked patch antenna has a directional radiation pattern ,its return loss is about -27Db for this frequency range. Its efficiency is very less about 35% only. This antenna needs two dielectric material of different permittivity. It is complex and expensive.

E. Wide slot Antenna

A wide slot antenna is being designed, which consists of an wide square slot in the ground plain in one side of substrate with relative permittivity of 10.2 and on the other side of the substrate is forked micro strip feed which splits below the slot, from 50 ohm feed into two 100 ohm sections that excites the slot [15] .The antenna is simulated with the given frequency range 5GHz to 10GHz. The fork feed was chosen as a means of increasing the operational bandwidth. The fork-like tuning stub here is all positioned within the slot region in the opposite side of the printed wide slot. Through proper selection of the parameters of the fork-like tuning stub, it can be expected that the coupling between the microstrip line and the printed wide slot can be controlled more effectively, which makes possible significant bandwidth enhancement of the printed wide-slot antenna.

The feeding mechanism is called fork like tuning stub because shape of feed is look like fork.This wide slot antenna operates with a frequency 3-10.6ghz.It has a omnidirectional radiation pattern is obtained ,means power radiated in all direction. For bandwidth enhancement fork like tuning stub is used. It is compact in size.

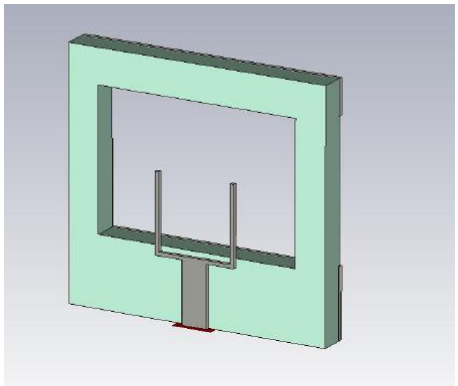

Fig .6 Wide slot antenna

III COMPARISON OF STACKED PATCH AND WIDE SLOT ANTENNA

TABLE I
PARAMETER ANALYSS

Parameters	**Stacked patch**	**Wide slot**
Beam area	326	327
Beam efficiency	.78	.69
Stary factor	.21	.30
Bandwidth	5.7%	7.2%

TABLE 11

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COMPARING SIMULATED AND MEASURED RESULTS

Parameter	**Stacked patch**		**Wide slot**	
	simulated	**measured**	**Simulated**	**measured**
Directivity	2.92	3.44	2.1	3.43
VSWR	1.956	1.96	1.0477	1.0477
Efficiency	35.7%	34%	67.6%	65%
Impedance	56.0	54.56	48	46.660
admitance	.0144	.01756	,02143	.0207

IV. CONCLUSION

A survey of different types of antennas used for breast cancer detection is done .while comparing the performance of antenna wide slot antenna has better results. Wide slot antenna return loss is improved to -34 Db.Its bandwidth is improved to 7.1%.stacked patch requires two dielectric material and also it is sandwiched with patchs .Its geometrical model is very complex .whlile comparing size wide slot is three times smaller than stacked patch.The efficiency of wide slot is improved to 67%. This wide slot antenna is low profile, easy to manufacture and also for high frequency purpose it is the best choice.

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Aswathy sam, I am doing my M Tech in communication system in karunya university. I did my Bachelor of engineering in electronics and communication engineering in Mar Baselious Christian college of engineering and technology under Mahatma Gandhi university in the year 2011.And my area of interest was antenna and propagation. And I am cotinuting my work in array of antenna used for breast cancer detection.