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Design and Optimazation of Triangular Shape Dual Band Microstrip Antenna for SAR Applications

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ABSTRACT : Antenna Technologies have revolutionalised the mobile communications including SAR remote sensing applications. In this research work the proposed microstrip antenna consists of three layers, each containing a triangular patch of a different size. During this process more than 100 designs of different shapes considering triangular shape were carried out. It was found that at 2 to 6 GHz best results were obtained which are discussed and presented in this paper. The performance of triangular antenna is based on Radiation pattern, Bandwidth, return loss, VSWR and Gain are presented. The main objective of design of triangular patch antenna and its implications for application in SAR are discussed.

Keywords : Triangular shape microstrip patch antenna

I. INTRODUCTION

Due to the rapid development in the field of Satellite and wireless communications there has been a great demand for low cost, light weight, compact antenna that are capable of maintaining high performance over a large spectrum of microwave frequencies. On the last three decades, microstrip antenna structures are the most commonly used to realize millimeter wave monolithic integrated circuits for microwave, radar and communication purposes including SAR applications for remote sensing. Compact microstrip antennas capable of dual polarized radiation are very suitable for applications in wireless communication systems that demand frequency reuse and polarization diversity.

A microstrip patch antenna generally consists of a dielectric substrate sandwiched between a radiating patch on the top and a ground plane on the other side as shown in Fig. 1.

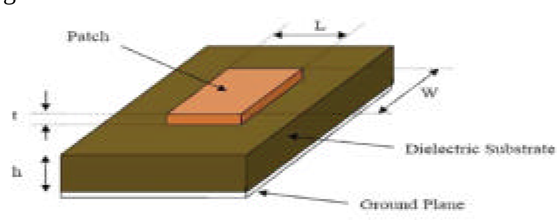

Figure 2.1 Structure of a Microstrip Patch Antenna

The patch is generally made of conducting material such as copper or gold that can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. The patch is generally, square, rectangular, circular, triangular, elliptical or some other common shape. Microstrip antennas can be fed by a variety of methods either connecting or non connecting. In the connecting method the RF power is fed directly to the radiating patch using a connectivity element such as a microstrip line. In the non connecting scheme electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular techniques used are the microstrip line, coaxial probe, aperture coupling and the proximity coupling.

II. OPTIMAL DESIGN METHODOLOGY FOR DUAL BAND TRIANGULAR MICROSTRIP ANTENNA

In general, microstrip are half wavelength structure and are operated at the fundamental resonant mode TM01 or TM 10, with a resonant frequency given by

$$f \equiv C / 2L\varepsilon r$$

where C is the speed of light, L is the patch of the rectangular microstrip antenna and εr is the relative permitivity of the grounded microwave substrate. The radiating patch has a resonant length L is directly proportional to $1/\varepsilon r$ and the use of microstrip substance with a large permitivity can result in a small physical antenna length at a fixed operating frequency.

With a size reduction at fixed operating frequency the impedance bandwidth of microstrip antenna is usually decreased. One can simply increase the substrate thickness to compensate for the decreased electrical thickness due to the lowered operating frequency. But as the height of the antenna increases losses due to surface wave effect and extraneous radiation result in poor performance characteristics. Usually substrate with $\varepsilon r \leq 10$ are preferred. With a substrate of low dielectric constant the fringing field that account for radiation will be enhanced. But in order to obtain smaller patch size substrate with high εr are required. Thicker substrate besides being mechanically strong will increase the radiated power, reduce conductor loss and improve impedance bandwidth. But it will increase the antenna weight, dielectric loss and surface wave loss.

In this research work even though more than 100 designs were simulated and studied. The following two designs were selected and presented in this paper. T h e designs and simulations were carried out using IE3D software.

(*a*) Three triangular shape microstrip antenna with the following dimensions as shown in figure 3 and its photo is as shown in figure 2.

L = 18 mm, W = 9 mm

L1, L2, L5, L6 = 6.70 mm

L3, L4 = 9.4 mm

D = 6 mm

Feeding point (*x*, *y*) = (0, 2)

(*b*) Triangular shape microstrip antenna with change of feeding point (*x*, *y*) = (0, 3.1) as shown in Fig. 3.

Fig. 2. Photo of triangular shape microstrip antenna.

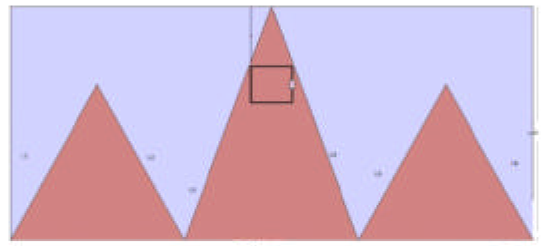

Fig. 3. Triangular shape microstrip antenna.

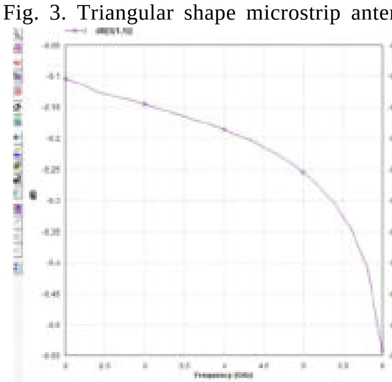

Fig. 4. dB and Phase s - Parameter.

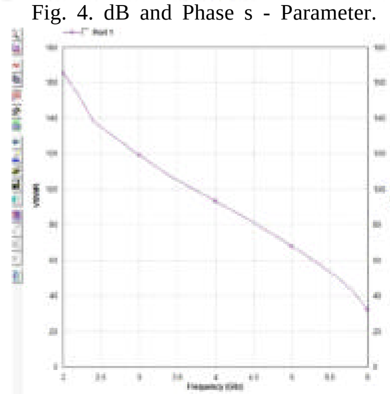

Fig. 5. VSWR.

III. RESULTS AND DISCUSSION

The results of return loss, VSWR, radiation pattern and current distribution for triangular shape microstrip antenna with the feeding point (*x*, *y*) = (0, 2) are placed at figures 4, 5 and 6 respectively.

The return loss, VSWR and radiation pattern and current distribution for triangular shape microstrip antenna with feeding point (*x*, *y*) = (0, 3.1) are presented at figures 8, 9 and 10 respectively.

It is seen from the figures 4 and 7 that best return loss is obtained for the triangular shape microstrip antenna with a feeding point (*x*, *y*) = (0, 3.1) in comparison with the same antenna with the feeding point (*x*, *y*) = (0, 2).

Dual band and dual polarization operation were successfully incorporated into a single patch. The effect of varying the slit length, slit width, patch design feeding and slot length were studied under great details with the help of simulated results. The proposed patch yield desirable result throughout the operating frequency range. Above all the antenna was found to produce a return loss -22dB whereas it is seen that antenna with return loss below -10dB are practically used. Practical experiments could not be carried out due to non availability of test equipment.

The substrate thickness has to be increased in order to obtain high gain and improved bandwidth. So microstrip patch antenna usually suffers from very low gain and bandwidth. But increasing the substrate thickness produces surfaces wave loss extraneous radiation.

Use of conventional microstrip antennas is limited because of their poor gain, low bandwidth and polarization purity. There has been a lot of research in the past decade in this area. These techniques include use of cross slots and sorting pins, increasing the thickness of the patch, use of circular and triangular patches with proper slits and antenna arrays. Various feeding techniques are also extensively studied to overcome these limitations and primarily focused on triangular microstrip patch antennas in this work.

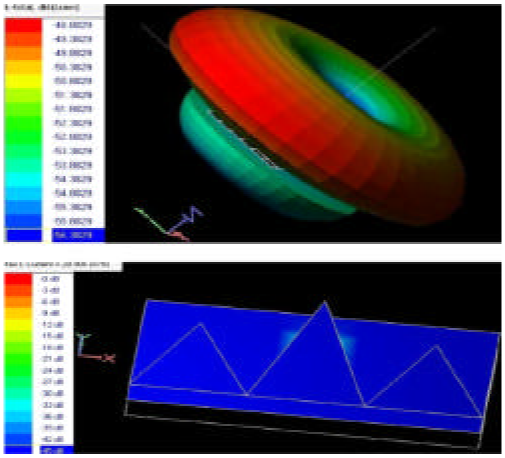

Fig. 6. Radiation pattern & current distribution.

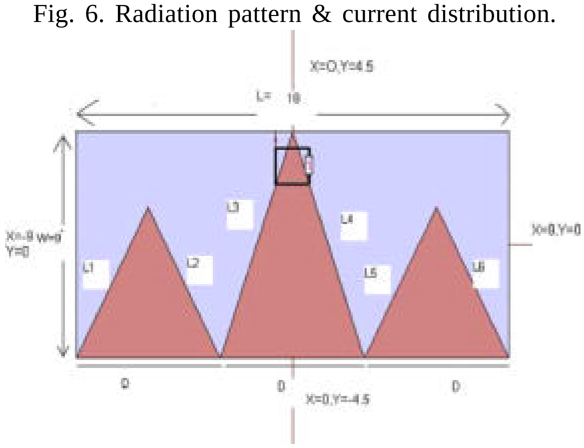

Fig. 7. Triangular shape microstrip antenna.

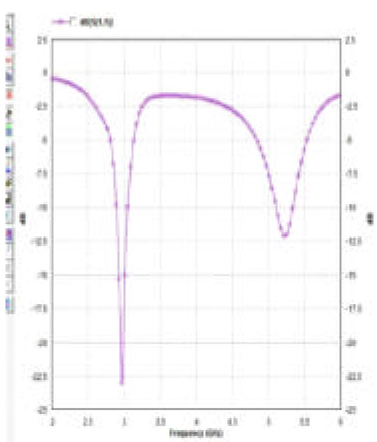

Fig. 8. dB & Phase s – Parameter.

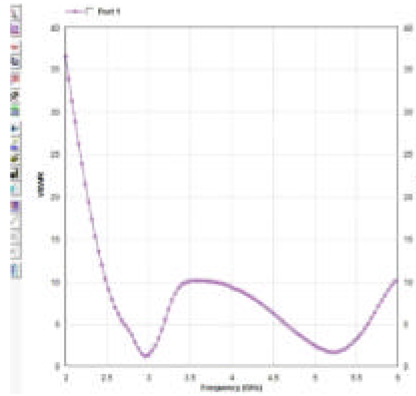

Fig. 9. VSWR.

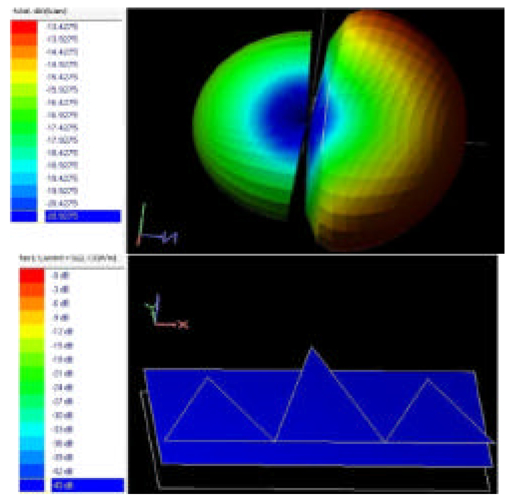

Fig. 10. Radiation pattern & current distribution.

IV. CONCLUSION

The operating frequencies of the designed patch were obtained at 2 to 6 GHz. In order to find application in the field of mobile communication the frequency range has to be within 1 to 3 GHz. So the length and the breadth of the patch can be further adjusted to reduce the resonant frequency of operation to this range. Also the use of microwave substrate with large permittivity can result in small physical antenna size at a fixed operating frequency. But while increasing the permittivity one has to be careful about the losses due to surface wave effects.

V. FUTURE SCOPE

This experiment and simulation results show the way to formulate triangular shape dual band microstrip antenna array for exploitation for fitment on SAR for remote sensing applications. A more complete study of different field solutions and simulators such as Sonnet, AWR, HFSS are required before practical usages of these antennas.

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