Design of UWB Antenna in VHF Band for Short Range Radar Applications

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***Abstract*—Short range radars like Ground Penetrating Radars (GPR),Through wall Imaging Radar(TWIR) and Foliage Penetrating Radars(Fopen) are now indispensable companions of security forces for search and rescue operations for homeland security. Detection of manmade objects under foliage and subsurface landmines have been intriguing area of research over the year's for the benefit of security forces for both war and peace time. The short range radars meant for these applications have contrary requirement of large band width for better resolution and low center frequency for better penetration. The intended platform to mount these radars either ground based or Ariel platforms puts stringent constraint on the antenna dimension. This paper illustrates the design and analysis of a compact UWB antenna in the VHF frequency range. The simulation results of the proposed antenna shows good performance in the frequency range of 64MHz to 180MHz.**

Keywords— UWB, VHF, Fopen, SAR, TWIR

I. INTRODUCTION

The ultra-wideband (UWB) radars are widely used in many applications like foliage-penetrating and landmine detection, through wall imaging etc. The requirement of low frequency for better penetration and large band width for better resolution calls for UWB radar system towards lower center frequency. Detection of vehicles, artillery and illicit human activity under foliage raises the need for Foliage Penetrating radar (Fopen). Fopen systems operate in VHF or UHF range of RF spectrum as it allows greater penetration of the signal than in the microwave frequencies and gives better range and cross-range resolution. Fig 1 shows the better ability of VHF or UHF band RADAR systems for foliage penetration and detection of tactical objects when compared higher frequency band. Also Ultra wideband (UWB) waveforms that enable high-resolution SAR images at both VHF and UHF frequencies puts forward the need of VHF or UHF band UWB antennas that can transmit the waveforms satisfactorily. The Fopen radars are mostly mounted on the air borne platform making size of the antenna another important constraint. The design of compact UWB antenna for Fopen system is a challenging problem as it requires good operating performance over the large frequency band at lower center frequency.

In this paper, a microstrip fed planar UWB monopole antenna with a plane reflector is proposed. The antenna is designed by combing the conventional bowtie antenna into a monopole with an arc edged radiator. The directional characteristics of the antenna is improved by employing a reflector. The return loss in the desired frequency range from 64MHz to 180MHz is less than -10dB and has a fractional bandwidth of 95%.

II. THE ANTENNA DESIGN

The geometry of the proposed antenna is shown in Fig.2. The antenna is fabricated on a RT Duroid substrate with a thickness of 1.58 mm and relative permittivity of 2.2. The antenna radiator fed by a micro strip feed of characteristic impedance 50-ohm, the size of the substrate is made to be 1.5m × 1.5m. The other dimensions of antennas are given in Figure. 2.

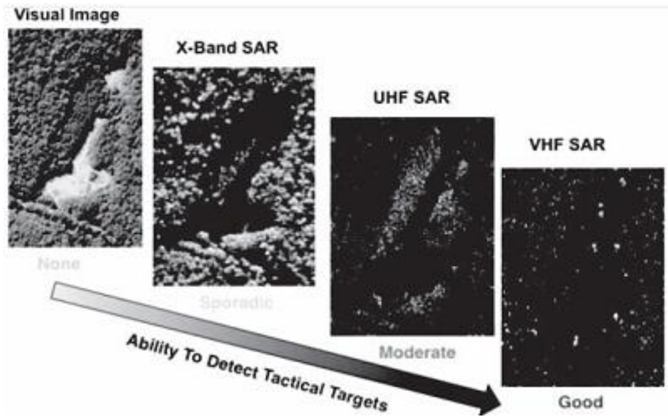

Fig 1: Comparison of optical image and RADAR image sources [1]

The monopole modified at the edge into an arc increases the current path through a smoother edge which avoids the splitting of beam towards the higher frequency. The presence of a reflector of dimension 150cm x 132.5cm at a distance 43cm below the patch makes the pattern unidirectional for the entire bandwidth. The edge feed length 9cm and the feed line 9.75cm is selected in such a way that the input impedance of the antenna gets matched to the feed impedance of 50ohm. The ground plane of 17.5cm for the edge feed and feed line from the edge allows better return loss in the bandwidth.

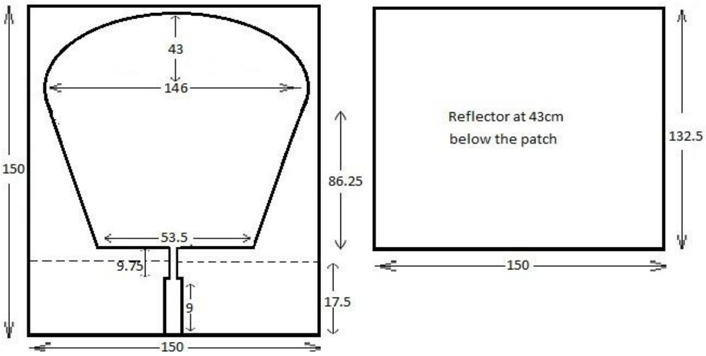

Figure 2: Antenna Dimension

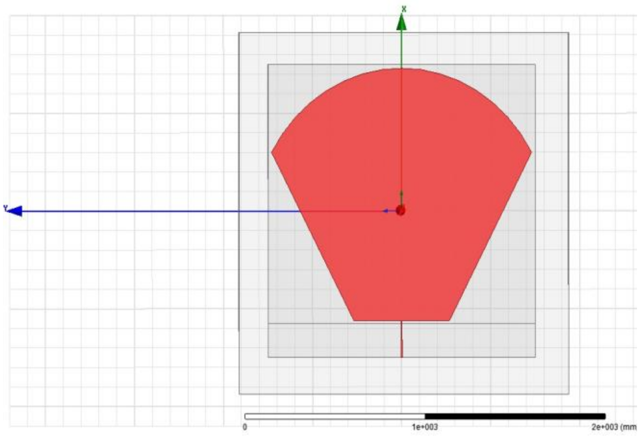
Figure 3: Antenna Model

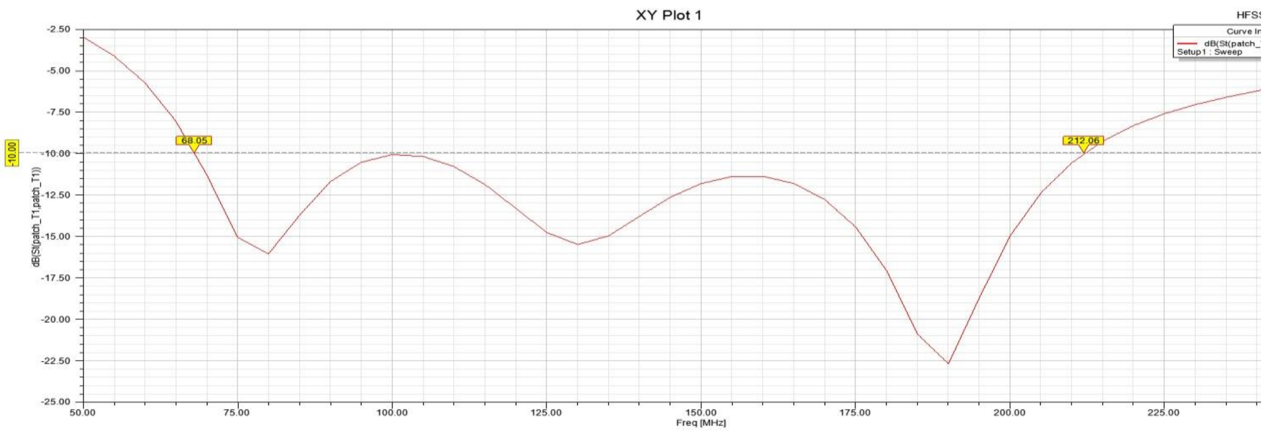

Figure 3: Return loss(dB) Vs Frequency(MHz)

III. The Antenna Performance

The antenna structure was analyzed and optimized using 3D solver using HFSS 16.0 package which utilizes the finite integration technique for electromagnetic computation. The bow tie profile was augmented into a monopole to limit the size of the antenna for a comparatively lower frequency. The important antenna parameters optimized are:

A. Bandwidth

Even though the return loss of antenna is below -10dB for the frequency range 64MHz to 212MHz the need of proper unidirectional pattern without beam splitting restricts the bandwidth from 64 MHz to 180MHz. The return loss of the proposed antenna is shown in Fig 3.

B. Conducting Reflector effect

The reflector below the patch exhibited the best performance at 43cm and was designed to give unidirectional pattern in the desired frequency range. The electric field intensity pattern of the proposed antenna at 130 MHz is shown in Fig 4.

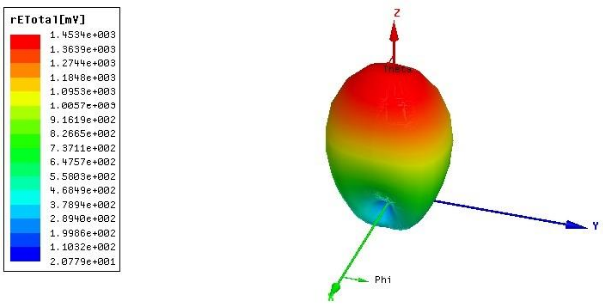

Figure 4: Electric field intensity pattern at 130 MHz

C. Radiation pattern

The radiation pattern at 150 MHz is shown in Figure 5. It can be seen that the maximum gain is 4dB in the desired direction.

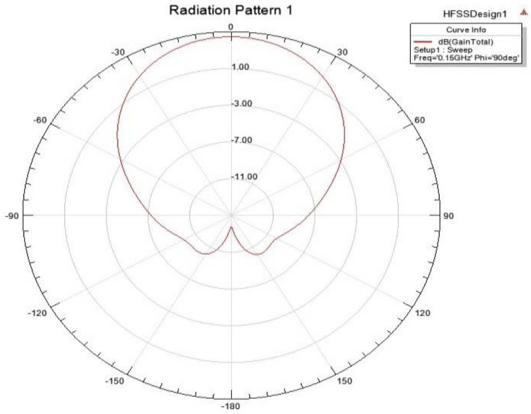

Figure 5: Gain pattern at 150MHz

A compact UWB monopole antenna with micro strip feed has been designed and analyzed. The proposed antenna performance exhibits a return loss smaller than -10 dB across a frequency range from 64MHz and 180MHz and is able to produce uni-directional radiation patterns over the entire bandwidth. The above simulation results makes the proposed antenna, a good choice for Foliage penetrating radars.

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