Wideband Antenna for Portable Ground Penetrating Radar System

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Abstract

The wideband antenna for portable GPR application is presented. The proposed antenna has small size suitable for hand-held and portable GPR system. The wideband characteristic is required to obtain range resolution of the radar system. The Tx and Rx antenna is arranged by side with metallic strip which increases isolation between two antennas. The backed cavity is added as a reflecting plane to achieve higher gains.

Keywords : GPR fat-dipole wideband antenna

1. Introduction

Ground Penetrating Radar (GPR) is used for close-range detection and identification of buried targets below ground broadly [1]-[10]. GPR detects electromagnetic waves reflected or scattered from targets which are interested such as landmine, metallic material, cracks on the wall. The range resolution of the radar is determined by the bandwidth of the system and the propagation velocity in the medium [11]. The lager bandwidth is required to achieve the more accurate range detection for the radar system. The various types of wideband antenna has been researched and presented for GPR applications. The bow-tie and fat-monopole antennas are applied widely [3]-[6][8][10]. The antennas are used widely due to their characteristic of simple planar shapes, lightweight, cheap, easy to fabricate. The GPR system tends to use lower frequency instead of higher frequency which has larger attenuation. The bow-tie and fat-monopole antenna has size of proportion of the wavelength which is longer in lower frequency. In this paper, a small wideband antenna for portable GPR system is presented. Two symmetric antennas are placed by side and the metallic strip is added to improve the isolation characteristic of the transmitting (Tx) and receiving (Rx) antenna.

2. Configuration for the antenna

The configuration of the antenna is presented in figure 1. A single fat-dipole antenna has 77 mm length and 60 mm width. Two fat-dipoles are arranged with 70mm apart on FR-4 substrate which has 4.3 relative permittivity and 1.6mm thickness. The Backed-cavity is placed at 50 mm ($\fallingdotseq \lambda/4$ at 1.5GHz in the free space) distance from the antenna. Total volume for antenna is 200 mm × 200 mm × 50 mm. Backed-cavity takes a role as the reflecting plane to obtain higher directivity and gain of the antenna. Every simulation in this paper is performed by commercial full-wave simulator with Finite Integration Technique (FIT).

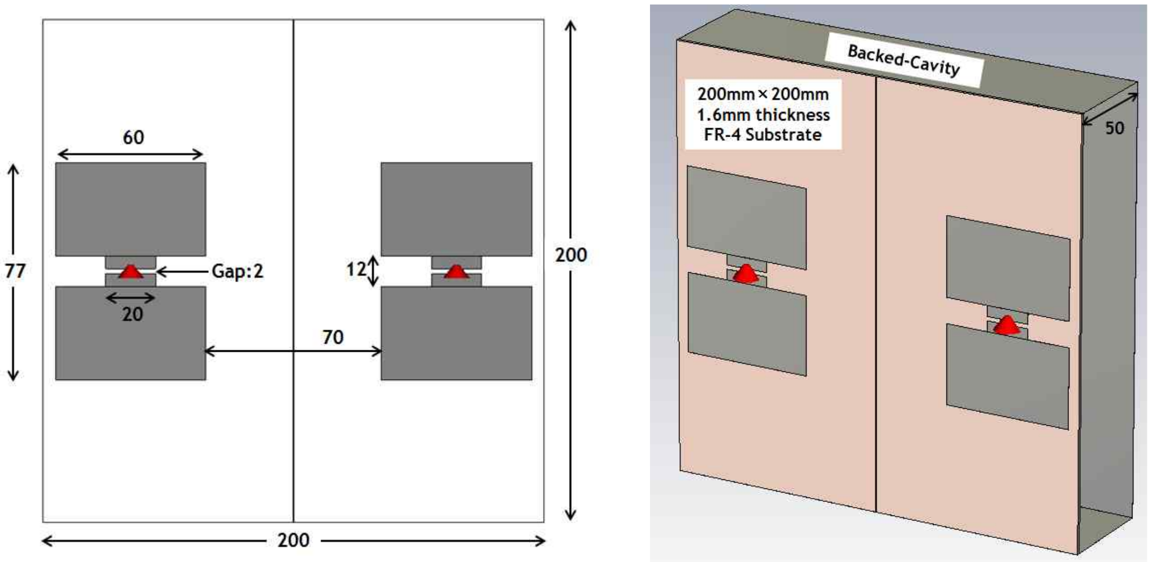
3. Characteristic of the antenna

The reflection coefficient of the antenna with and without metallic strip is shown in figure 2. The bandwidth of the bistatic antennas is 1 GHz-2.66 GHz which is 91% at the center frequency.

Isolation of the Tx and Rx antenna is shown in figure 3. 0.5 mm metal strip is inserted to acquire isolation between the Tx and Rx antennas. The normalized radiation pattern of the single antenna is presented in figure 4. Asymmetric pattern is caused due to a single antenna which is placed one side of the substrate. Total gains at each frequency are shown in the table 1.

4. Conclusions

The wideband antenna for portable GPR application is presented. The proposed antenna has small size of 200 mm × 200 mm × 50 mm and 1GHz-2.66GHz (91%) bandwidth. A pair of Tx and Rx antenna with metallic strip and backed-cavity was simulated. The antenna has less than -17dB isolation for whole bandwidth enhanced with a metallic strip. The normalized radiation pattern and total gain are also observed in various frequencies to verify performance of the antenna.



(a) (b)

Figure 1: Configuration of the antenna. (a) front view (b) perspective view (Unit : mm)

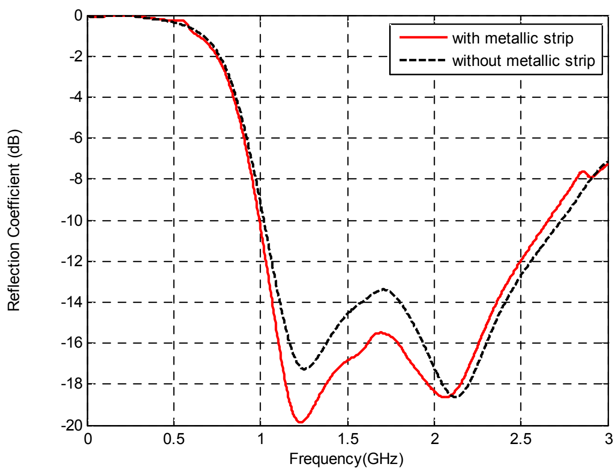


Figure 2: Reflection coefficient of the antenna.

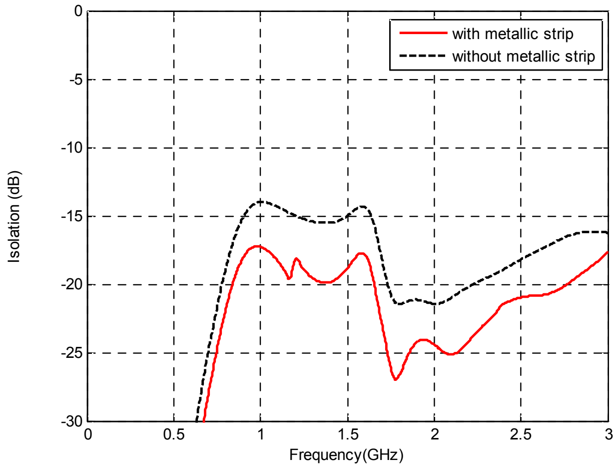
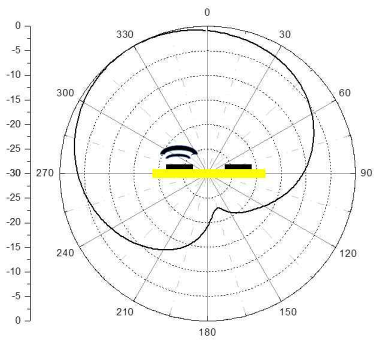
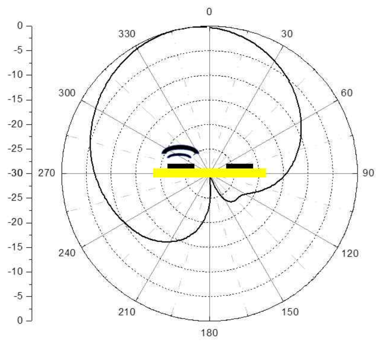


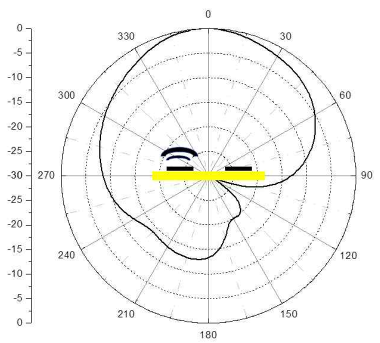
Figure 3: Isolation of between the Tx and Rx antenna.



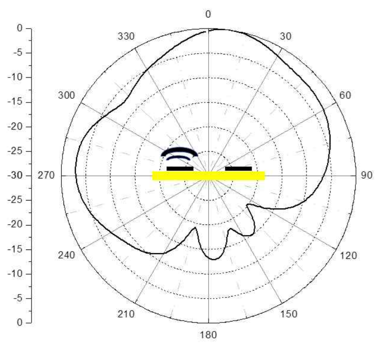
(a)



(b)



(c)



(d)

Figure 4: Normalized radiation pattern of the single antenna.
(a) 1GHz (b) 1.5GHz (c) 2GHz (d) 2.5GHz

Table 1: Total Gain of the antenna at each frequency

Frequency	1GHz	1.5GHz	2GHz	2.5GHz
Gain	6.48dBi	8.47dBi	7.24dBi	5.7dBi

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