Performance Evaluation of Ultra-Wideband Vivaldi Antennas for GPR Systems

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Abstract—. This paper focuses on the evaluating the performance of different Ultra-Wideband Vivaldi antennas for GPR systems, in the context of detection of landmines and IEDs. The antennas will be first characterized in anechoic environment, and furthermore will be installed in a 2D scanning GPR. Different survey mechanisms will be tested, including down looking GPR and forward-looking GPR. The tests will be performed over real soil containing surrogate targets and clutter.

Keywords: improvised explosive devices, Ground Penetrating Radar, Ultra-Wideband Antenna, Vivaldi Antenna

I. INTRODUCTION

Ground Penetrating Radar (GPR) systems have become an efficient solution for landmine detection, as they are able to detect both metallic and non-metallic buried targets such as improvised explosive devices (IEDs). In the last decades, different techniques have been proposed to improve the performance of GPR systems to detect IEDs [1, 2].

Depending on the antenna position, GPR systems can be classified according to the angle of illumination with respect to the soil in Forward-looking GPR systems (FLGPR) [3] and Down-looking GPR systems (DLGPR). In the first one, the transmitting antenna illuminates the soil under a given angle of incidence, trying to minimize the reflection coming back from the air-soil interface. FLGPR systems require a high dynamic range at the receiver to achieve enough sensitivity to detect the buried targets. In the Down-looking GPR systems, the incident wave hits normally the ground interface [3]. In this case, the clutter effect is greater due to the reflection of the electromagnetic waves in the ground.

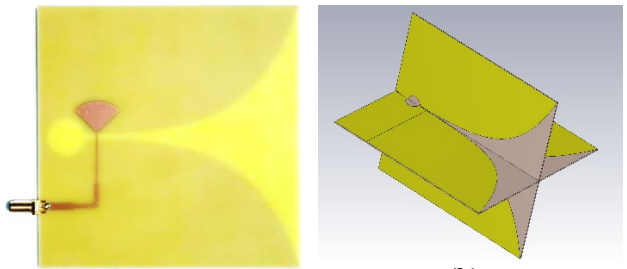
In the use of GPR for assessment, the way the measurements are taken is another important parameter that the user has control over. The method used for data acquisition can be modified to affect specific outcomes. For example, enhance the result image or to measure properties such as speed of propagation in the host medium.

GPR survey methods can be classified as the common offset (CO), common source (CS), and the common receiver (CR) surveys [3]. The CO survey is the most commonly used, where a fixed distance is maintained between the transmitting and receiving antennas. The CS and CR improved the signal-to-noise ratio and achieved a greater depth of penetration.

This contribution is focused on the analysis of different types of UWB Vivaldi antennas implemented in a 2D portable platform–based GPR, including commercial and custom-designed Vivaldi antennas.

In addition to characterizing the antennas, the purpose is to assess the effect of the angle of illumination (DL-GPR, FL-GPR) together with the variations of the types of surveys on the impact of the detection capabilities of the GPR system.

The tests will be performed over two types of real soil: high-humidity content soil and dry sandy soil. In both cases, surrogate targets and clutter will be included.



(a) **(b)**

Figure 1 Example of a Vivaldi antennas evaluated. (a) Realized single-polarization Vivaldi operating between 0.8 and 3.5 GHz, notice the feeding transmission line. (b) 3D model of dual polarization Vivaldi antenna operating between 0.65 to 4.1GHz.

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