Humanitarian detection of Landmines and Unexploded Ordnances using Airborne GPR

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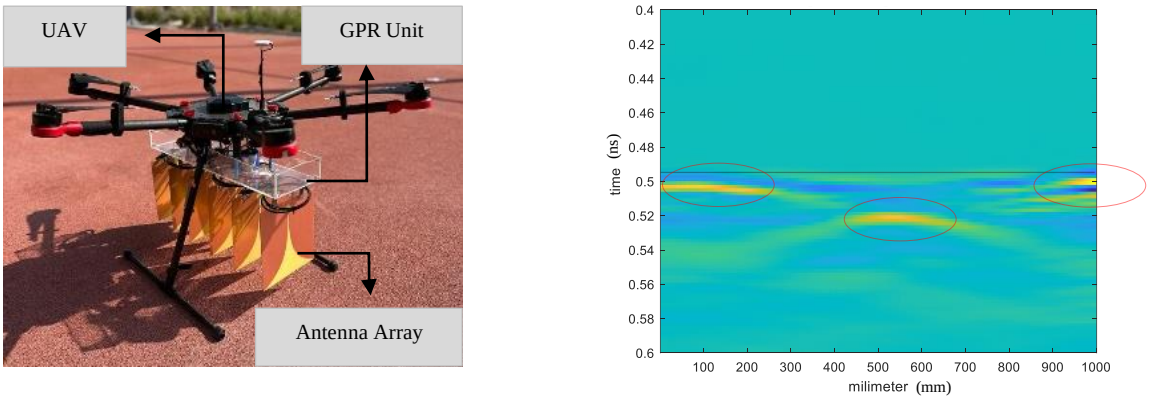
Ground Penetrating Radar (GPR) is one of the most promising tools for humanitarian demining [1]. Advantages of GPR include the leverage to distinguish between landmines and metal fragments, faster detection rate and reduction of false alarms. However, the most difficult challenge in humanitarian operations is the operator's mobility and the placement of demining tools across minefields. To overcome this challenge, we propose mounting the GPR into a remotely piloted aerial vehicle (UAV) platform, to scan the terrain.

The ultra-wideband GPR MIMO antenna system operates between start frequency of 700 MHz to end frequency of 6 GHz. A set of six, linearly co-polarized, Vivaldi antennas form a switched array, via two radio-frequency switches connected to a miniature Vector Network Analyzer. The switches are controlled by Raspberry Pi, which also reads the data from the Vector Network Analyzer. The data is sent over a wireless link to a computational platform where a Machine Learning algorithm processes the signal, discriminating the landmine and clutter [2]. The GPR is mounted on a DJI 600 UAV, with the capability of sweeping a 1x1 square meter area in 15 minutes, flying at an altitude of 6 cm above the ground. The assembly is shown in Figure 1(a).

To verify the Airborne GPR, preliminary tests were carried out to characterize the electromagnetic signature of real improvised devices (IEDs) and landmines in a controlled environment. The results of a B-Scan are presented in Figure 1(b).



(a) (b)

Figure 1. (a). Airborne GPR: Integration of GPR unit mounted on a M600 drone with six Vivaldi antennas separated.

(b). Radargram processed with background removal. The bright yellow areas represent high reflectivity, notice the buried targets shown in the scan.

References

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[2] S. Gutierrez, J. J. Pantoja, E. F. Ruiz, N. Gonzalez, F. Vega, C. Baer, J. Sachs, and C. Kasmi, "Advances on the detection of landmines and ieds in Colombia using UWB GPR and machine learning techniques," *2021 15th European Conference on Antennas and Propagation (EuCAP)*, Mar. 2021.