



Drone-Borne GPR Design: Propagation Issues

Drone GPR : Propagation des signaux

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Keywords: GPR, Wave propagation, humanitarian applications.

In this paper, we shall address the electromagnetic wave propagation issues that will critically determine the feasibility of a drone-borne ground penetrating radar sensor for humanitarian applications, particularly in the context of disaster management.

Frequency and polarization dependent scattering, attenuation and dispersion of radar signals penetrating into the sub-surface region will determine the applicability of a drone-mounted radar sensor capable of registering radar echoes for observing and monitoring sub-surface features. The functionality of the radar will thus be assessed in dependence of key radar parameters that include the central radar frequency, the modulation depth, and the mode of radar operation (pulsed FM, FM-CW), the antenna type, and the available power-budget.

In the analysis to be presented, the radar equation, together with the aforementioned propagation effects, will be used to simulate the signal strength of radar echoes under different conditions arising from the chosen key-radar parameters and the assumed physical properties of the sub-surface earth medium. The analysis to be presented will indicate whether or not drone-borne ground penetrating radar is a feasible system and if it could be constructed with the technologies available today.

The main challenges addressed in this contribution are the estimation of propagation-loss and wave-dispersion in the sub-surface medium. These features are the key constraints on the performance of a GPR system. In this regard, a realistic range of values of the electrical properties of soil and water volumes will be drawn from open literature. In the area of hardware realization, the key problem will be to have a final radar-unit weighing no more than a few kilograms that can be mounted, powered, and flown on a small copter-type-based carrier (drone) capable of autonomous operation.

The main application of the sought ground-penetrating drone-mounted radar would be to detect not only the sub-surface environment but also to possibly detect human beings buried under debris generated by landslides or the collapse of buildings. Is this mission impossible?