Conceptual Design of an Airborne GPR for Underground Pipeline Mapping

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The utility and gas pipelines buried underground throughout the U.S. and most of other countries have not been properly inventoried. Most of the past and present inventory records are limited, scattered and in different accuracies. With the recent and continuous advances in ground penetrating radar (GPR) and global positioning system (GPS) technologies, it is now possible to conduct detailed inventory with good and uniform accuracies. Indeed, ground-based GPRs have been used for this purpose in recent years. However, its applications would likely be limited to local mapping due to its limited mobility. It has become apparent that the only rapid and cost-effective means in the near future to acquire regional- to collti[lcrltt~l-scale, high-resolution inventory mapping of buried pipelines is the airborne GPRs. In addition, airborne GPRs also have the potential to provide frequent,]arge-scale heal th moni toring of the buried pipelines.

in principal, g]<ound-based GPR techniques can be used for airborne applications. However, the airborne mapping geometry makes the interpretation of data quite a bit more complicate. The complication primarily arises from unwanted clutter returns from the surface layer and the ambiguous radar returns from linear targets above the ground level, such as power lines and metallic fences. As such, the airborne GPR systems must be carefully designed in order to mini mize these anomalies and to maximi ze the detection probability.

Based on the mapping requirements, we have recently performed a system trade study on an helicopkr-based GPR for pipeline detection. In this paper, the crucial design tradeoff parameters and a strawman s ystem design for this nadir-look ing GPR will be presented. From the tradeoff between the shallow depths of the buried pipelines, platform altitude, antenna size, and penetrating capability, our study shows that 800 MHz is the optimal radar frequency for unambiguous pipeline mapping and monitoring applications. This sensor will use shml-pulse approach and a 3-m antenna to provide measurements at vertical resol ution of -20 cm and horizontal resolution of -28 m. In order to minimize tbc surface clutters, the sidelobes of the antenna radiation pattern must be controlled to about 40 dB below the peak mai nlobe level.