

Sun, Yijie, “A High-Resolution Sequential Sampling Ground Penetrating Radar System”

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Ground Penetrating Radar (GPR) is used for detecting and surveying the integrity of underground structures. The objective of this dissertation is to focus on the highway pavement thickness measurement. The present method is the core sampling method for obtaining pavement layer parameters. That method calls for drilling a hole into the highway pavement. The process is destructive, time consuming, labor intensive and provides limited coverage. GPR is a non-destructive, efficient and cost effective instrument that can measure the pavement layer parameters as accurately as the core sampling method with full coverage.

As is well known, the highway pavement usually contains rebars. For rebar-reinforced concrete pavement, the rebar's effect is an important factor that influences the determination of concrete pavement thickness from GPR data. Although some features of rebar's reflection have been studied, how to extract the rebar's scattering fields from the measured GPR data and cancel rebar's influence on pavement thickness estimation have not been reported. In this dissertation, a new algorithm for extracting the rebar's reflection fields from the measured GPR data is developed. The developed algorithm not only extracts the rebar's reflection fields, but also solves other pavement parameters.

The commercial GPR available today does not provide methods to remove the rebar's effect; therefore a professional staff is needed to interpret data. Consequently, the total operation cost is expensive. We have developed a high-resolution GPR system using a sequential sampling technique, and the rebars' effect is automatically removed by the software in real-time. Furthermore, a new type of balance-tounbalance device, “balun”, with an over 3GHz bandwidth, has been designed and proven to decrease the reflection of the antenna.

The new GPR has been designed, implemented and tested in the lab and in the field. The test results show that the tolerance of the highway pavement thickness measurement is less than 5%. The total cost of the GPR system is much lower than the present commercial version.