Enhancing Ground Penetrating Radar Signals Through Frequency Compositing

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Ground Penetrating Radar (GPR) Imaging of deeply buried targets has been a topic of study for an undocumented period of time. Multiple methods have been proposed to address this problem with varying outcomes. Methods to determine a way to choose the best signal to use at a particular depth, to methods of combining GPR scans at differing frequencies have been proposed. Combining signals is a classic method used to minimize noise effects in all types of signal processing efforts from imaging to wireless signal reception. The noise component when same frequency signals are averaged is greatly reduced if not completely removed because the noise is random and not repeatable from signal to signal. Adding differing frequencies is a bit more difficult in that the weighted gain of each frequency used in the sum has to be determined for the best outcome. Metrics for the end result are also challenging. Several methods for combining differing frequency GPR scans have been proposed over the past couple of years. None of the methods I have found use an optimization problem solver in their solution. The tutorial will review the use of an optimization problem solver routine to develop the weights for each frequency that is to be used in the compositing process as well as propose a figure of merit for the best solution measurement tool. At least three other methods will be briefly explored and result compared to the optimization problem solver method; [the Gaussian Mixture model (GMM) feature of the Expectation-Maximization Algorithm (EM)].