CFAR Processors for Detection of Land Mines

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Introduction: There are different geo-radar algorithms for object or layer detection. In the presented work we consider a known, but not widely studied and applied approach for under ground objects (targets) detection. To detect layers and targets in geo-radar profiles we propose the usage of the CFAR processing (CFAR filtering).

Our hypothesis is that after the CFAR processing the image detection of the under ground objects (pipes, land mines and soil layers) will be easier obtained.

Cell Averaging CFAR processor

\[ V = \sum_{i=1}^{N} x_i \]

\[ H_i : \begin{cases} 1 & \text{if } x_i \geq H_D \\ 0 & \text{if } x_i < H_D \end{cases} \]

The CFAR processor is a detector, which maintains a constant false alarm probability in the process of target detection. In such a detector, target detection is declared if the signal sample \( x_i \) exceeds a preliminary determined adaptive threshold \( H_D \).

Post-detection Integration CFAR processor

In a CFAR pulse train detector with non-coherent integration (CFAR PI), the noise level estimate is calculated by averaging the samples from the two-dimensional reference window.

\[ V = \sum_{i=1}^{N} x_i \]

\[ q_i = \sum_{i=1}^{N} x_i \]

\[ H_i : \begin{cases} 1 & \text{if } q_i \geq T_m V \\ 0 & \text{if } q_i < T_m V \end{cases} \]

Binary Integration CFAR Processor

In a conventional CFAR pulse train detector with binary integration, the binary integrator counts \( 'L' \), decisions (0) at the output of a CFAR pulse detector. The pulse train detection is declared if this sum exceeds the second digital threshold \( M \).

\[ H_i : \begin{cases} 1 & \text{if } \sum_{i=1}^{N} q_i \geq M \\ 0 & \text{otherwise} \end{cases} \]

These processors may use two kinds of GPR image filtering: the first one visualizes only 0 or 1 of each pixel after adaptive threshold and the second one shows the difference greater than the threshold or 0.

Results

On the figure a record from a ground penetrating radar is shown. The profile represents both a water pipe and a land mine under a thin layer of wet sand.

Conclusion

The applying of CFAR filters to detect layers and targets in geo-radar profiles is a good decision. When the threshold value increases, the background noise decreases from GPR image and the target detection is improved. CFAR processing can be used as an additional GPR processing.

Reference

