Threshold Based Algorithms for Iron Buried Objects Detection Using Magnetic Field Mapping
A. Zaoui, S. Mitt, and A. Mesloub
Military Polytechnic School of Algiers, Algeria

Abstract — Magnetic field mapping is one of the techniques that may be used during the continuation period of an on-site inspection. Iron buried objects induce anomalies in the earth’s magnetic field that appear on the surface below them and that can be measured by a magnetometer. In this work, two approaches already used in radar detection are introduced and modified to improve the buried object detection. The measurement noises, the weak value of the earth’s magnetic field and the variations due to the soil heterogeneity increase the false alarm probability. In order to reduce this last, we introduce a cell-averaging-based threshold algorithm used in radar detection. It consists of doing a comparison between each measure and a weighted average of the neighbor measures. The proposed algorithm is validated using simulation data and promising results have been obtained.

Principle
The flux lines follow the least reluctant direction. Therefore, we distinguish two regions around the buried iron object: in the first one, equipotential lines are aspirated and the magnetic field is concentrated whereas in the second one the intensity of the magnetic field decreases.

Magnetic field mapping at the CTBTO
On-site inspection techniques
the continuation period

Geomagnetic field

On-site inspection techniques

Measurement experience
An experimental magnetic mapping is released on the square region of 25m×25m using the magnetometer GSM-19 (precision of ±0.1 nT).
In first mapping without buried ferromagnetic items, we show on the figure the influence of soil heterogeneity (random variation of ±60 nT).
In the second mapping we introduce a buried iron item in the middle of the region, a variation of 400 nT is observed around the buried item. This variation depend on the volume of the item and choosing the best threshold became difficult when the item has a little volume.

Adaptive Threshold
The proposed algorithm is summarized in the figure. The main idea is to apply the cell averaging technique (CAV) used for threshold computation in radar systems. Each measure or cell under test (CUT) $\Delta B(n)$ is compared to an adaptive threshold which is computed by the sum of neighbor measures subsequently multiplied by a threshold multiplier parameter, noted $T$. The measures exceeding this adaptive threshold indicate the presence of the underground items.

The figure shows the adaptation of the threshold according to the measurement noises (artificial measure error is introduced at 14m to test the efficiency of the algorithm

Cell Averaging based threshold algorithm

Results for different parameter $T$