# Recent Advances on the Use of Kernel-based Learning-by-examples Techniques for Electromagnetic Subsurface Sensing

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To return areas contaminated with unexploded ordnance (UXO) and anti-tank/anti-personnel landmines to a civilian use, the ordnances should be obviously removed. Such a process is time-expensive and involves complex acquisition procedures. Several solutions have been proposed based on various methodological approaches, which consider different sensor modalities such as ground-sensors or synthetic aperture radars. These techniques are aimed at achieving the following goals: (a) correctly localizing a large number of dangerous targets; (b) reducing the false-alarm rate; (c) reducing the time devoted to the detection process. In such a framework, electromagnetic approaches based on learning-from-samples (LFS) techniques [1] have been proposed for the on-line (after the training phase performed off-line) detection of subsurface objects. The detection process is recast as a regression problem where the unknowns (i.e., geometric and dielectric characteristics of the target) are evaluated from the data (i.e., the value of the scattered field) by approximating the data-unknowns relation through an off-line data fitting process (training). LFS regression-based approaches demonstrated their effectiveness in dealing with detection processes where a limited number of unknowns (i.e., single object) is considered. However, because of the complexity of the underlying architecture, some difficulties occur when a larger number of unknowns (i.e., multiple objects) is taken into account. From a structural point-of-view, the regression technique does not permit one to simultaneously identify multiple positions. As a consequence, LFS regression-based approaches turn out to be very effective for the detection of a single (or few organized in a single cluster of objects) buried object. It should be pointed out that the identification of free-areas and an estimate of the concentration of subsurface objects might be enough in several situations. Then, the goal could be moved from the "*object detection*" to the "*definition of a risk map*" [2]. Consequently, a classification approach, instead of a regression one, should be employed. In this contribution, the classification approach based on a LFS technique preliminary presented in [3] for an on-line sub-surface sensing is analysed and compared to state-of-the-art classification approaches. Starting from the knowledge of the scattered field values collected above the surface, the method is aimed at defining a risk map of the domain under test. By considering a SVM-based classifier, the proposed method estimates the a-posteriori probability of the presence of subsurface dangerous objects. The advantages of the use of such an instance-based classification method can be summarized as follows: (a) no *a-priori* knowledge about the system that generated the data is required; (b) simplicity and reliability of the resolution algorithm; (c) possibility of designing optimal classifier based on the theory by *Vapnik and Chervonenkis*; (d) easy implementation in hardware for real-time applications.

**REFERENCES**

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