Mine clearance through an artificial intelligence flying drone

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Abstract. This work presents an algorithm which combines a convolutional neural network (CNN) and a symbolic data analysis (SDA) process to detect antipersonnel mines from GPR data acquisitions. The CNN is aimed at automatically detecting buried objects; the SDA reduces the probability of objects identified as mines, even though they are not.

Introduction

Landmines, heritage of the wars spreading between 1990 and 2000, are disseminated in more than 10 countries, with numbers far beyond tens of millions. Thanks to the recent progresses in increasingly performing and portable sensors, the automation of the landmine searches through autonomous robots became possible, preventing the exploitation of traditional demining techniques, which still rely on human intervention.

The present investigation focuses on the development of machine learning techniques for the identification and the localization of mines spread over an unknown territory. This is only an initial phase of a larger project, named MINOR, MINe Overall Recognition, which is aimed at generating a real-time map of the territory completed with the exact position of the mines, localised through a swarm of autonomous flying drones, equipped with a set of sensors, as Ground Penetrating Radar (GPR), infrared, thermal image camera and high sensitivity gravimeters.

Mine detection algorithm

In this paper, the analysis devoted to the data interpretation and post-processing, sets the basis to the experimental campaign performed through a GPR sensor on real antipersonnel mines. Initially, through an open source software that reproduces electromagnetic wave propagation of a GPR sensor, a vast database of radar images, as in the example inf Figure 1, has been created to simulate the presence of antipersonnel mines and other objects. The virtual simulator produces GPR responses based on position, geometry, and material properties of buried objects. A two-step strategy is consequently applied to detect the presence of a mine, distinguishing between mines and the other hidden objects. Firstly, the generated database is used to train a convolutional neural network aim at clustering data in two categories: (i) “free area”, in which no objects are detected and (ii) “no free area”, with detected, still unidentified objects. The second algorithm, whose inputs are all the images of the contaminated areas, refines the classification identifying the actual targets. Based on Symbolic Data Analysis (SDA), the unsupervised machine learning clusters the “no free area” images in two further groups: “antipersonnel mine” and “unidentified objects”, according to the features of the GPR data. The demining algorithm is eventually applied to real experimental data confirming the expected high accuracy.

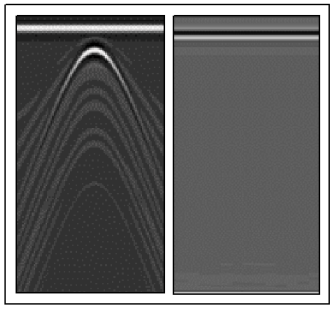

Figure 1: Example of GPR radargram simulation.

References

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