Distinguishing Buried Mines from Battlefield Clutter Using Holographic Radar

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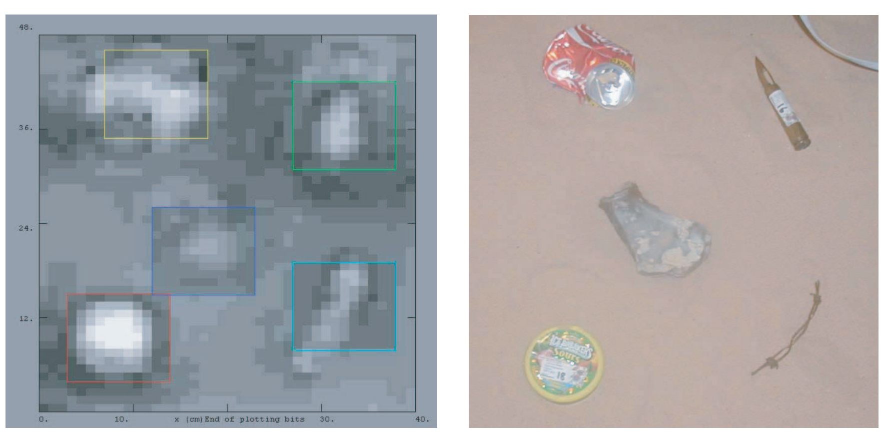
Abstract— It is said that 90% of a deminer's time is spent locating and removing harmless clutter objects. In order to address whether this situation can be improved, a series of holographic radar scans have been made using the Rascan holographic radar system of a simulated mine (a cylindrical plastic sweet container filled with sugar) and several common battlefield clutter objects: a short length of barbed wire, a small unexploded bullet, a coke tin and a large flint stone.

The raw Rascan images which consist of 5 frequencies at parallel and cross polarisations have been combined together by taking the modulus of the image amplitude less the mean background and summing over all the frequencies and two polarisations. The series consists of the same objects placed on a 400 mm × 470 mm area measured at10 mm resolution in a sand box filled with fine dry sand at about 60 mm depth. Some 15 similar images were taken with the same objects placed at different positions over the area and at different depths and orientations.

The above figure shows that the eye, armed with the knowledge of what the Rascan images represent, is readily able to identify them from a combination of their shape, their amplitude, and their "texture" or degree of un-evenness of amplitude. The question is, "Can the skills of the human eye be reproduced by an automated system?".

The image is scanned by a receptive field of a size large enough to contain the objects to be discriminated. If the amplitude above background over the receptive field exceeds some defined threshold, the position of maximum integrated amplitude is located. The part of the image within the receptive field placed optimally over the located object is saved by the system, as an example representation of that object, to be used in subsequent training. The coloured boxes in the figure show such automatically generated object images.

The series of "training" images of known objects is presented to a neural network which is able to adjust its complexity so that other "test" images are optimally classified. Finally quite new "validation" images which have not been previously presented to the network can be used to identify the classification accuracy in terms of the percentage of correctly classified objects and the percentage of false alarms.



(a) (b)

Figure 1: (a) The Rascan composite image and (b) a photograph of the corresponding objects before being buried under the sand. The coloured boxes show the areas of the image picked out by a scanned receptive field, which can be used for training a neural network.