

# 3D Integrated Imaging to Tackle Landmine Detection

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Using dual tomography imaging techniques, the University of Bath hopes to develop a new 3D subsurface camera system capable of detecting landmines underground.

The three-year research project lead by Dr. Manuchehr Soleimani at the Engineering Tomography Lab of the University of Bath aims to provide technology that can differentiate between images of plastic and metallic elements within a single explosive device, at depths of up to 10 cm underground on varied terrain.

Dr. Soleimani's lab was awarded funding from Sir Bobby Charlton's charity [Find A Better Way](#) via a competition organized by the Engineering and Physical Sciences Research Council.



**Dr. Manuchehr Soleimani demonstrates his technology that can detect an explosive device up to 10 cm underground. (Photo courtesy of the University of Bath)**

"The UN estimates that it would take more than 1,100 years to clear the estimated 110 million landmines situated in 70 countries," said Charlton. "As a charity, we are determined to find a practicable technology solution that can bring an end to this humanitarian tragedy." [1]

While ground-penetrating detection techniques such as radar or metal detectors may be more mature, anti-personnel landmines manufacturers have moved to using plastic instead of metal, both for economical and stealth reasons, which makes their detection increasingly difficult.

Having the ability to detect beyond materials has been the focus of Dr. Soleimani's recent publications on electrical and electromagnetic tomographic imaging and volumetric image reconstruction. In two separate papers, "Planar array 3D electrical capacitive tomography", and "Planar magnetic induction tomography for 3D

near subsurface imaging", Soleimani showed promising results, which he says, could be exploited to design new advanced multi-modal capacitive/inductive camera technology.

For the Electrical Capacitance Tomography part, his team used a set of 12 copper electrodes arranged in a 4x3 matrix array (250 by 250mm in total, 4mm thin) and a 12-channel capacitance measurement instrument to image the dielectric permittivity properties of objects placed in front of the sensor array. He was able to image dielectric solids at a depth of just over half the full sensor arrays length.

For the Magnetic Induction Tomography part, inductive coils and eddy currents were used to map the passive electromagnetic properties of the objects to be detected, in 3D. Here the sensors (16 air-core cylindrical coils, each 4cm in diameter) were placed in a circular shape with their axes perpendicular to the plate.

3D image reconstruction was performed based on the analysis of sequential coil excitations and responses.

"The idea is to use both imaging techniques across a range of frequencies and get a spectroscopic signature of the materials being imaged", Soleimani said. "In effect, we could build a library of material signatures so the imaging of buried dielectric materials could yield their precise compositions. This could be associated with a matching table of known landmines to speed their identification, based on their shape and composition."

Further work is required to profile the surrounding ground properties in which landmines can be buried, so the sensors can better distinguish the explosive devices. What remains is the typical trade-off between sensor array size, complexity, and imaging speed. One would want to cover a reasonable area in one scan, probably with sensor arrays

mounted on a rover robot arm.

"We aim to develop an integrated technology to detect both metallic and non-metallic landmines and to improve the speed and reliability of this process," Soleimani said.

That integrated technology includes two different types of array, so that older, metal landmines can be detected, as well as the newer plastic landmines that have begun to proliferate.

These landmines can cost little to manufacture, while the cost of finding and clearing an individual mine can cost up to \$1,000, according to the University of Bath.

"The innovative idea in this project is a combination of capacitive array and inductive array, so that both classification of electrical properties and detection of non-metallic (and metallic) landmines can be done," Dr. Soleimani told *The Engineer*.

The research project, which will take place over the next three years, aims to not only to develop a detector that will work for all landmines across all terrain, but one that can also be produced relatively cheaply, thus helping to reduce the overall cost of clearing minefields.

"We're hoping to develop a compact,

low cost version of this combined smart camera that can be deployed in landmine detection," said Dr. Soleimani.

More details on Find a Better way can be found at the following address: <http://www.findabetterway.org.uk/>

Reference:

[1] MacGregor, Alice. (2015, July 30). [3D 'smart camera' landmine detection research wins NGO funding](#). The Stack.

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