



## Demining robots technology: concepts, methods and benefits

The 5th issue we also decided to devote to demining robots. The reason for this - is the growing relevance of this topic in recent months due to the outbreak of military operations on the territory of Ukraine. Such conflicts are invariably accompanied by the widespread use of landmines by the opposing sides.

## MINE AND EXPLOSIVE DEVICE DETECTION METHODS

According to the purpose, mines are distinguished anti-tank (PTM), anti-personnel (PPM), anti-vehicle, object, and special. Anti-personnel mines are the most difficult to detect. Anti-personnel mines affect enemy personnel by the shock wave (high-explosive mines) or by shrapnel fragments in the form of balls, cylinders, arrows, or shrapnel formed prepared in advance into the body of the

mine by its crushing (fragmentation mines). The charge of a high explosive mine contains 30-200 g, and that of a fragmentation mine contains from 75 g to 0.5 kg of explosive. Fuses are used mainly by push and pull action, which can also be combined.

A reliable search for anti-personnel mines is a major challenge in humanitarian demining.

## Methods of detection

Mines and explosive devices are usually located in hiding environments. Concealment media may be:

- soils of varying composition and moisture content (the most typical case),
  - fresh water in rivers and lakes,
  - seawater,
  - vegetation,
  - snow, ice,
  - construction materials (bricks, concrete, etc.).
- Regarding the issue under consideration, their main material characteristics are density, hardness, electric conductivity, dielectric and magnetic permeability, reflection, and radiation coefficients in the visible (0.4...0.76  $\mu\text{m}$ ) and infrared (0.76...1000  $\mu\text{m}$ ) range of electromagnetic waves, etc.

### Mine detection is conducted in two directions:

- searching for individual mines (characteristic ranges here from a few centimeters to several meters),



- reconnaissance of minefields (typical ranges from tens of meters to several kilometers).

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And when detecting mines, the main problem is to recognize a useful signal (from the mine) in the background of numerous interferences from the heterogeneity of the environment and various inclusions.

The most used methods are electromagnetic (induction, radio wave, magnetometer, nonlinear), nuclear-physical, thermal-location, and mechanical (mechanical sensing). Here the main things are safety issues and reducing the cost of mines clearance. Other requirements: climatic sustainability, performance in the dark, resistance to shock, electromagnetic compatibility, and so on.

To increase the effectiveness of mine detection, it is advisable to combine different search methods into a single technical means.

One of the new promising methods of mine detection is parametric. It is based on the registration of interaction of excitation (force) and probing (information) physical fields on search objects of artificial origin (mines). The combination of these fields can be different.

Despite the advantages of this method, which consists of the description of the recognition object in a language close to the natural one, there are also disadvantages. The main ones are:



- a set of initial fuzzy rules, which is formed by a group of experts and may not be complete or inconsistent,
- subjectivity in choosing the type and parameters of the membership function, and others.

One of the ways to compensate for the latter disadvantage is the use of fully coupled artificial neural networks (ANN).

The first stage of building a neural network for tactical situation recognition consists of interviewing a group of experts, as in the previous method. The purpose of the stage is to form a fuzzy training sample. In the second stage, using the training sample, the ANN is trained. After the training procedure, the ANN is ready to work.

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## Specific features of mobile demining robots

To solve the problem of recognition of tactical situations in the application of mobile robots, it is necessary to develop a formalized apparatus for the construction of recognition systems, approaching their functional capabilities to human ones in solving recognition problems in conditions of uncertainty

and some respects - the volume, information processing time, insensitivity to emotional influences, etc., surpassing it. This circumstance makes it possible to effectively implement this apparatus in robotic complexes with artificial intelligence elements.

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## TrackReitar CleanField MD (Metal Detector) from LeoTronics

Our mobile robot is equipped with a special metal detecting sensor designed to find mines. This device can detect and provide 2D images of objects

on or under the ground. Metal detectors are considered the most reliable sensors for mine detection work.

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## Significant benefits of Demining Robots TrackReitar CleanField

- High cost-efficiency
- Ability to be repaired in the field
- Significant increase in demining speed
- Versatility - robots can be used to perform other tasks due to the possibility

of equipping with interchangeable equipment.

Don't forget to subscribe to our YouTube channel LeoTronics EU, and you will always be aware of our news.

