

Robotic Complexes of integrated systems for environmental demining of minefields

Abstract— On condition that the mines from a mine field can be laid on production line every industrial robotics team of engineers will be able to construct automated deactivation and disassembly of mines. This is attainable with the help of auxiliary means - robots – a method which has not been used by now. This is a modern mode of operation set in the Robotic Complexes. It complements the demining procedures. Robotic Complexes will be designed according to the type of mines, the type of soil, the relief and the plant cover of the minefield. The purpose is the least time to be spent clearing a minefield with minimum energy consumption.

SHORT PRESENTATION

In order demining actions to be more effective it is necessary to have complete information about each mine from the minefield: X, Y, Z coordinates, azimuth fuses of mines and three-dimensional image. This is possible with the combination of well known method for detection. At least three methods are needed to be used: explosives detector, metal detector and thermal detector (with a thermal camera), which is rejected as ineffective. X, Y coordinates of each mine will be found with the first two methods. The opportunity lies in the following. In a circle of defined dimensions above the mine, vegetation is destroyed by carrying defoliants. After the destruction of the vegetation, the zone above the mine is being poured on with chilled water. In that way an artificial distinction between the temperatures of the mine body and the soil around and above it is created because of the different heat conductivity. The needed three-dimensional image of the mine is received by the synchronized work of the two thermal cameras. This is the way to create artificial conductions for thermal scanning when it is necessary. Natural conditions for thermal scanning occur after rainfall. Low temperature difference appears in the morning after sunrise and in the evening after sunset. All methods are described in “Guidebook on Detection Technologies and Systems for Humanitarian Demining”, 2006. Technologies and systems are carried mainly by an operator or vehicle. Technologies have been improved with reduced weight by now. Based on existing and improving air drones such as quadcopters, hexacopters, etc technologies can be carried by air. Tonnage is about 1.5 kg, flight time is 70 minutes. There are experimental technologies with capacity up to 10 kg. Efficiency based on the own weight and tonnage is very high. The idea is the active use of air drones while clearing the minefield. Mines will be cleared with a "system of packing and removal of mines." Mines will be packed up together with the surrounding ground. Packed mines will be removed and stored in so-called stacks. Packing will be done by digging a solid like a tube into the ground around the minefield – “Packing Cylinder”. The digging in is done by a combination of rotary and reciprocating motion. “Packing Cylinder” is an analogy of pine crowns. There are cutting devices at the bottom of the “packing cylinder”. The digging

of the “packing cylinder” stops at a certain level under the bottom of the mine. “Packing cylinder” is able to cut the soil layers under the mine floor and to create a solid wall. "Packing cylinder" can be of poly carbonate plastic, bakelite or any other material with a small specific gravity, which have the necessary strength. It is preferable the “packing cylinder” to be disposable. There are various design solutions in addition to the logical solution or modifying it. The basis for the logical solution is a combination of mini-ML-7 with PMN, as well as other types of mines liable to destruction because they could not be disabled. The so called “packing system and removal of mines” can be developed in the following three types of shifting, positioning and usage:

- 1) By hand with the participation of engineer operator
- 2) By vehicle or auto drone
- 3) By air drone

In order to make the minefield safe from mines mini PROM, OMZ, Valmara, S mines, POMZ, M-16 before using the “packing cylinder” it is necessary to cut the cable (cord, rope, wire, etc.) used for activation. The method of cutting by air drone will be the following: The air drone has a video camera and a robot carrying cutting device. The azimuth of the cable is fixed. The air drone lands above the mine. The cable is cut as close as it is possible to the mine. Mine is ready for packing by the “packing cylinder”. Every air drone (quadcopter or hexacopter) will have a mobile platform for arrival, departure and servicing. The servicing consists in changing the storage batteries, loading and unloading – empty and full packing cylinders, etc. Mobile platforms are mounted on auto drones. With the increasing distance from the module for disable and disassembly, mobile platforms will be moved to a suitable distance from the module. Transportation of the module for disable and disassembly is done by transport trucks like auto drones. Trucks can have 3, 4, 6 or 8 wheels. Every wheel is powered by own electric motor. This allows a movement at an angle of 90° and a turn of 180° on the spot. Transport trucks will serve aero drones. They will work as a temporary storage of the empty stacks, stacks with full packing materials and devices of assistance in the demining operations. The module for disable and disassembly is an element of the Demining complex. The demining complex will have station for supplying charge for the storage batteries of the drones, photovoltaic power, communication devices, technology for destructing mines and fuses, which are not liable to disable and etc. The Complex for Robotic Demining of minefields is supposed to be integrated with INSA, SADA, SAFEDEM - Space Assets for Enhanced DEMining (SADA), IMSMA (Information Management System for Mine Action) and other technologies for detecting mines in minefields.

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