15th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2011, Prague, Czech Republic, 12-18 September 2011

FROM DESIGN CONCEPT TO PROTOTYPE OF A UXO DETECTION DEVICE

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ABSTRACT

The existence of different types of mines and explosive devices in certain parts of Kosovo's territory presents a potential threat to injury and life of the people. Therefore, one of the main tasks during last twelve years that is still ongoing is demining. Demining was carried by international specialised organisations and later on by Kosovo Security Force.

Marking the mine fields, detection of unexploded ordnances (UXO) and clearance are phases of such a very difficult process. It is very important minimisation of human role and his replacement with technical devices.

In this paper a conceptual design of a technical device for UXO detection that attempts to replace a human role on marked mine fields is presented. The prototype of a detection device remote controlled is equipped with metal detectors.

This device is initial step towards design of a device not only for mine/UXO detection, but also for clearance.

Key words: UXO, Demining, Detection Device, Clearance, Mine Fields

1. INTRODUCTION

Twelve years ago Kosovo came out the war with about 4500 sites filled with bombs, mines of various kinds and other explosive devices, fig, 1, such as cluster bombs and mines of various types, from anti-personnel to the anti-tank ones. Many specialized agencies, international and local organizations immediately started marking and cleaning.

Specialized teams of NATO forces, Kosovo Protection Corps (KPC), now the Kosovo Security Force (KSF), various international organizations and national have since reduced to 110 mined areas are cleared over 46 million 82 thousand square meters of mines.

But unfortunately the consequences were quite severe, with 114 people were killed and 446 others were seriously injured citizens or easy, many of them remaining disabled forever and many areas, fields and wells were contaminated and banned for use.

KSF units in the last year have cleared over 13 thousand square meters, but are still identified 60 high-risk areas and 50 areas as suspected unexploded ordnance and mines. As contaminated areas with various explosive devices that still pose a serious threat to the population are those in the west, east and southwest of Kosovo, Fig.2.

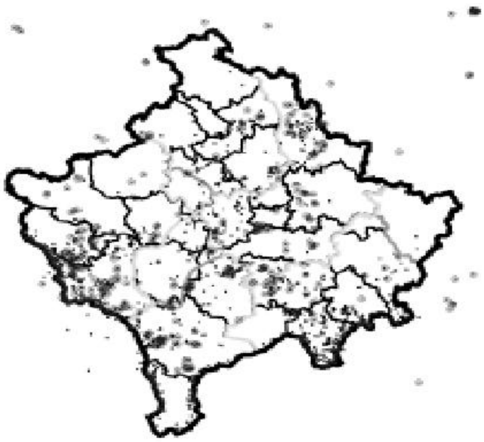

Figure1. Minefields sites in 1999 (UNMIK)

Figure 2. Minefields sites in 2011 (KSF)

Therefore, in this paper is described the process of constructing the equipment for detection of explosive devices, from initial idea to the construction of prototype at a laboratory of the Faculty of Mechanical Engineering. This came as a result of a survey conducted on existing equipment for detection and attempt to constructing a device in the circumstances and the configuration of our country.

Device or robot is design to detect the explosive devices through three metal detectors / sensors of metal placed in a 'moving hand' set in the body to move with two wheels doing independent movement run by two electric motors. The robot movement through the signed path is remotely controlled by the command table.

One of the tasks set have been to 'eliminate' the human's role during the process of explosive devices' detection, as the initial phase of humanitarian demining.

2. DESIGN PROCESS

The humanitarian demining is defined as: 'the clearance of contaminated land by the detection, removal or destruction of all mines and unexploded ordnance (UXO) hazards'.

The common methods of detection are:

- Manual, using metal detectors;
- Manual, using area excavation;
- Dogs and manual;
- Mechanical and manual.

It is easy to notice that all methods include the use of manual de-miners because, to date there is not accepted that any fully mechanised method of ground processing can find and remove mines and UXOs.

Detection is the most important and very hard part of demining process. Current methods of detection and removal of mines and UXOs are very slow and dangerous. It is estimated that one de-miner can clear 40 square meters per day.

The basic concept for design was to build a prototype that will:

- Assist and expedite the demining of areas;
- Decrease the risk for users of equipment for demining (de-miners);
- Contribute to making Kosovo a safer place for the life of its citizens;
- Enable farmers, growers and farmers work without fear in their pasture fields.

Therefore, the task was that through a constructive work, based on above mentioned data (on human role on demining process and equipment) to design a functional device that may have not only constructive/industrial purpose but also humanitarian.

For the device to be designed the following criteria have been set:

- Devise must have sensors / metal detectors;
- Construction to make the move forward, back, left and right return with a coordinated movement in contaminated areas;
- Driving of respective wheels to be independent;
- To be remotely controlled;
- To be able to pass through obstacles;
- Linkages between the details of construction to be as flexible as possible;
- To have proportionate dimensions and weight as appropriate.

The general steps of design process were:

- Concept solutions;
- To define parts;
- Find/Supply with parts;
- Modification of existing parts in laboratory;
- Construction/Manufacture of new parts.

The decision making on certain phases of design process raised much more questions and concerns on :

- Carefully definition of design problem
- Searching and generating for alternatives
- Selecting the best based on evidence
- Making sure by checking that the best has been chosen.

3. CONSTRUCTION OF A PROTOTYPE

After clearly defined idea was accepted, the needed elements were used as they are, has been modified or new elements were manufactured, the device named as "RoboDet" was constructed assembling elements in three main parts:

1. Skeleton or main frame, composed by two wheels, each formed by couple of chains that runs in four gears(two different couple) linked with steel sheet profile in which the rubber peace was mounted, fig.3;

Figure 3. Skeleton

Figure 4. 'Moving hand' set

'Moving hand' set in which three metal detector was mounted, fig.4

Figure 5. Control electronics (Receiver and Transmitter platest

2. Control electronic system, consist of receiver and transmitter plates (each containing two part – one to control movement of wheels, other to control movement of 'moving hand' set), fig.5

"RoboDet", fig.6 is driven by three electric motors 12V 30W, one of them runs 'moving hand' set and is supplied by 6V battery, while two others that drive wheels respectively are supplied by 12V 18A battery.
It has 30kg and moves with speed of 1km/h, fig.6

Figure 6. RoboDet

4. CONCLUSIONS

- The prototype of the robot for detection of unexploded devices – RoboDet designed and manufactures at the Faculty of Mechanical Engineering laboratory in Prishtina fulfills driving, detection and remote control criteria.
- Its testing in real environment with improvised 'minefield' resulted successful and satisfactory.
- Remote control system of Robodet decreases role of human.
- It is consider as a good platform for further advanced driving and control researches and developments.

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