An Integrated System Approach to Mechanized Humanitarian Demining

Introduction

It is widely known that there are 110 million landmines buried worldwide and also 100 million landmines stockpiled at 2000 year. Every year 100,000 landmines are removed. Simultaneously, 2 - 5 million landmines are planted. Every 22 minutes, one person meets this dangerous accident in the world. The purpose of our project is to establish a completely mechanized system using modified civil construction machines. This system should ensure speed and safety for the human lives while being simple and not too expensive.

Type of mines concerned in this project

Landmines are grouped into two broad categories: anti-tank (AT) and anti-personnel (AP) landmines. AT mines are designed to destroy or incapacitate tanks and other heavy vehicles, while AT mines to kill or injure human beings. Landmines are made of metallic and non-metallic materials. They have various shapes. Various kinds of explosives as like as TNT, RDX are used.

The 360 different types of anti-personnel mines are currently used around the world. The anti-personnel landmines can be grouped into:
1. Blast mines
2. Butterfly mines
3. Fragmentation mines
4. Directional mines
5. Bounding mines

Our major concern is to incapacitate these AP mines.

Method of detecting AT mines and detectors

In any demining system, the first step is to detect the mine and the next to remove it very carefully. Various detectors are being used in demining area. But there is no 100% accurate detector. Some one gives false alarm, while the other can be used only in limited area. Eventually, about 60% of deminers are doing this process manually. It is very dangerous and requires a long time to clear even a small area. Sometimes one device needs one day for clearing one square meter. The following detectors are available at the present state of arts:
1. Electromagnetic system
2. Sound wave system
3. Ground penetrating radar system
4. Infrared thermal system
5. Effluence and x-ray optics system

Table 1. Experimental results

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>25</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>△</td>
<td>△</td>
<td>△</td>
<td>x</td>
</tr>
</tbody>
</table>

O - Heavy reaction, △ - Poor, x - No

A - Steel plate, B - Steel Cylinder
C - Brass Cylinder, D - Brass door lock part
E - Aluminum plate, F - Aluminum cube
G - Aluminum ring, H - Cupper cup

Our Plan

Our objective is to develop a mechanized system, which is much faster and safer than conventional methods. We think to modify machines conventionally used at civil construction sites and to use them. Especially our concern is operator's safety. So the cabin must be covered with bulletproof glasses and steel plate. The process can be broken down in few steps, which are explained in the flowchart shown in Fig. 1.

1. Survey, marking and mapping of area, operational detailing-machine and attachments, daily work schedule
2. Cut tree and/or remove vegetation and tripwire detection
3. Check for anti-tank mines using conventional detector and beside safe lane and work
4. Remove anti-tank mine
5. Use proposed Pelican bucket system to chip away soil and/or tree roots
6. Check if mine is blasted
7. Remove dug soil to safe location L2 for disposal
8. Remove dug soil to safe location L1
9. Sieve soil and/or remove metal fragments using magnet
10. Check a gain for landmines in the dug area (50cm~1m)
11. Replace sieved and demined soil
12. Check if all area is cleared
13. Record of demining
Concluding Remarks

Our system is to look at the task from the viewpoint of the overall requirements of a demining operation instead of tackling it piecemeal. No human deminers or hand tools are to be used in the vicinity of the mines. Our method requires minimum manpower for operation and wherever it is used, it is only after ensuring complete safety of a person. It is expected that this approach, when put into practice, will revolutionize the pace of demining while ensuring 100% clearance of the minefields.

Reference:


Acknowledgements:

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Table 2. Minimum Demining Time Estimation

<table>
<thead>
<tr>
<th>Area to be Cleared</th>
<th>100 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Clearance</td>
<td>1m</td>
</tr>
<tr>
<td>Digging Soil (Using Bucket)</td>
<td>3 hrs. 47 min.</td>
</tr>
<tr>
<td>Replacing Soil (Using Wheel Loader)</td>
<td>1 hr. 15 min.</td>
</tr>
<tr>
<td>Leveling Surface</td>
<td>2hrs. 5min.</td>
</tr>
<tr>
<td>Minimum Total Time For Sequential Operation</td>
<td>7hrs. 7min.</td>
</tr>
</tbody>
</table>

Comparing with manual demining, our system is faster by 3 times and the cleared depth is deeper also by 3 times.

Equipment

We are planning to use various kinds of high-tech equipment in this project. Some equipment can be used only in particular minefield, depending on the requirements of that particular site.

The estimated total cost of demining activity is ¥104,692,640. The following is the list of main equipments, which we think to use for project, with their present prices.

- Power Shovel - 2 units - ¥22,400,000
- Wheel Loader - ¥7,200,000
- Rotation excavator - ¥6,000,000

The details will be shown at presentation.