TRENDS OF DEVELOPMENT IN UNMANNED MILITARY MOTOR VEHICLES

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Abstract
Based on an executed analysis of a current state the contents of the paper should point at trends of development in unmanned military motor vehicles of a special assignment.

Keywords: *unmanned motor vehicles, combat activity, mobility, manoeuvrability, supporting means, IEDs*

1 Introduction

Different kinds of operations conducted during military and non-military conflicts, their diversification and dissolution reflect also in a large spectrum of activities as large movements, regrouping, conduct anti-sabotage activities, fighting in siege, reconnaissance activities etc.

We can take it for granted, that dynamics of conduct of fighting activities will increase in future operations which is conditioned by an increased manoeuvrability of units and task groups. The factors enabling an increase of manoeuvrability of troops include their equipment with mobile means. These mobile assets will have to be equipped with efficient weapon systems to protect the personnel being transported, with construction provision of high manoeuvrability in terrain as well as equipment providing good conditions for an activity of a vehicle crew.

The land forces units and formations can be equipped in addition to traditional mobile assets with unmanned mobile assets on a tracked or on a wheeled chassis. Each of these kinds of chassis has its strong and weak points. High manoeuvrable assets must be taken into consideration in mechanized units and formations equipped with unmanned mobile combat and supporting means on wheeled or on tracked chassis, which can quickly meet the tasks in different directions and at the same time it will not depend on communications neither on threats to the vehicle crew.

Unmanned military (ground) motor vehicles (UGV) are robotic systems used within the army during recent ten years. The unmanned vehicles are defines as autonomous systems and all-terrain vehicle assigned for reconnaissance and combat activities instead of personnel.

Membership of the Slovak Republic to NATO and a possibility related herein to deploy the brigades and task groups of the SR Armed Forces Land Forces out off the territory of the Slovak Republic requires that a great attention is paid to a preparation and conducting a movement of troops, where the unmanned vehicles can play an extremely important role in reconnaissance and in IEDD (improvised explosive device disposal).

The basic features of each unmanned armoured vehicle include dynamics of movement, a good manoeuvrability in terrain, reconnaissance effectiveness, a defined firing power and a reliable protection of important electronic and weapon systems. There are mutual relations between these basic features; it means that improvement of one of them can have a negative impact on the others and vice versa.

The unmanned vehicles can be designed in such a way, that they excel in manoeuvrability and stability. The armour of different finish protects only an internal equipment of the vehicle against a fire by an enemy. The armour protection of the hull is not requested and therefore the unmanned vehicles can have a small total weight. A protection against visual, infrared and radar tracking by an enemy is considered at present time as an obvious, mainly through an application of electric drive systems.

In addition to these basic features and particularities of tasks, which the unmanned combat vehicle can meet in present conditions of deployment, they must be at the same time reliable in operation, with minimum demands for a preventive maintenance, even in field conditions. The design of an unmanned combat vehicle, all its groups and aggregates must enable a series production, if possible with standard technologies and at economically acceptable prices.

2 Trends in development of unmanned military motor vehicles

A present-day robots being used in practice or the ones being prepared or developed combat robots or other robots for auxiliary or special tasks can be classified in several main categories with respect to their capabilities, dimensions and weight.:

- light,
- medium-weight to heavy.

In the category of light ones we distinguish several basic groups:

a. reconnaissance- serving for a reconnaissance in a dangerous area or in urban area, where common soldiers are exposed to an increased risk of ambush or a possible threat by a well-hidden, camouflaged improvised explosive devices or remote-controlled explosive devices. These are mostly equipped with cameras, electronic sensors or electronic slots with suitable equipment for reconnaissance of a dangerous area or reconnaissance in urban streets.

b. combat – usually are equipped with various armament, e.g. a gun or a light machine-gun, mounted on an upper part of the unmanned vehicle. It can be fully stabilized and sighted by information received from electronic sensors and cameras.

c. serving for disposal – removal or deactivation of unexploded improvised explosive devices, antipersonnel mines or other unexploded ammunition.

The unmanned light ground assets include (light reconnaissance and combat assets with a weight several kilograms to several hundreds of kilograms):
PackBoat from iRobot company (versions Scout, Explorer, EOD), FoxBot, SWORDS, MAARS, Warrior X700.

The Scout version

The Scout represents a new level of an unmanned reconnaissance. It performs reconnaissance and takes part in operations as a tactical combat equipment, and namely in urban area, with is interlaced with narrow streets or other premises with hindered approach. It can pass obstacles and it moves very well in ruins of buildings. It was successfully tested by the U.S. Army in combat missions in Iraq and Afghanistan. Its advantages mainly include a small weight, relatively small dimensions (after having been assembled to a portable state) allowing the soldier to carry it as a hand-held briefcase.

It is an ideal equipment for reconnaissance of dangerous and inaccessible premises (unexamined rooms), where it is the first in assessing threats or targets and so it does not expose the lives of soldiers to any risk, who would have had to search through unknown premises themselves without its assistance, whereby the risk of surprise by an enemy would have been significantly higher, of course.

It sends these processed data to its crew, in sufficient distance for not to be threatened by a sudden and unexpected attack by an enemy. They can then plan their measures based on information as well as on image transfer in case that they detect an enemy´s position, ambush or an early detection of an improvised explosive device. The military member operating this reconnaissance robot can directly take a decision based on information gathered by a robot or to pass this information to a combat unit that can defeat an enemy with no greater problems.

PackBoat ´s clearance is 0.20 m (a telescopic arm with a camera and other sensor accessories are not engaged) and in case with a full load (and a full reconnaissance equipment) it weight is 18 kg**.** It has also five versatile open departments to place a useful load. Additional improvement and equipment with new non-combat and combat elements are possible as well.

The PackBoat Scout is supposed to resist hits equivalent to 400G that assigns it to a class of the most mechanically resistant robots. By the words of the manufacturer it can withstand a fall from stairs from the 4th floor with no serious damage, as well as a subsequent hit e.g. on a solid concrete. This feature is important mainly in a situation, when it would be performing a reconnaissance in an unknown building, where it eventually could lose stability in climbing or descending the stairs or into/from a building.

Explorer version

It can send back an image as well as a sound by a radio together with data collected by sensors in a real time. Reconnaissance of buildings, crashed houses, - rescue operations, bunkers, premises that are dangerous for men or particularly inaccessible.

Explorer contains a flexible infinitely revolving and pan tilt able head and it can expand it from a chassis and to allow an operator to have a look over an obstacle and to gain a perspective sight. It can also detect backpacks with camouflaged explosives or other improvised explosive devices (home-made also, hidden weapons and ammunition).

EOD version

It is assigned for different tasks – to secure and to remove explosive and artillery ammunition (unexploded artillery shells and other heavy ammunition, improvised explosive devices). It is similarly resistant as the Scout version, assigned to search for and to execute reconnaissance of trapped mines, grenades or very dangerous remotely controlled improvised explosive devices made by terrorists (so called road side bombs).

It meets a wide range of EOD tasks, with no threat to human life of an operator operating a robot, in particularly in case of an early explosion of ammunition. It is able to handle with various standard, as well as improvised explosive devices safely and thereafter to neutralise them.

It is equipped with a light and very resistant manipulator, ranging in any direction up to 2 m, and at this distance it can handle with an explosive and a primer. Movability is ensured in different terrains (rough stones, gravel), and it is able to move even on a challenging, as well as in a mountain terrain, also on the sand and mud. Fully loaded it weights only 24 kg. It is deployable in hardly accessible places, various corridors, shafts, chasses of the plane, train etc. The equipment has for various tasks a standard field armament for its disposal.

In the armament there are about 500 pieces of such unmanned robotic assets (in all versions). Nowadays it has been replaced by Warrior X700 (more mature PackBoat version with a similar configuration having slightly bigger dimensions than PackBoat).

In the medium-heavy to heavy category

The unmanned vehicle of this category can serve not only for a battlefield reconnaissance and areas of interest, but also for their deployment in a combat, either as main combat assets, but also as a support for own troops (a fire support) or as a support for a transportation of various cargoes, ammunition, equipment for units fighting in front lines, as well as for units, whose supply is hindered for any reason e.g. a demanding terrain or threats for commonly used ways of supply, when there is a great threat of attack on a supplying vehicle by an enemy.

This category includes vehicles with a weight from several hundreds up to about 2 - 3 tons as vehicles of types as ARV, MULE – T, MS-1 Ripsaw, Gladiator TUGV.

MULE-T

It is a supporting and supply unmanned ground infantry company vehicle – UGV (Fig. 1., Fig. 2, Fig.3). Nowadays there are about 100 pieces deployed in Iraq, from 2013 till 2015 years there should be in the U.S. Army about 2000 to 2500 pieces of such vehicles, in which at least a half in a combat version with controlled anti-tank controlled missiles (PTRS) and non-controlled anti-personnel rockets by adding a rapid fire canon of 30 mm calibre, or a heavy machine-gun of 7, 62 mm calibre up to 12, 7 mm).

One of the most surprising aspects of the MULE UGV is a combination of a hybrid electric and diesel drive unit. UGV has more chambers mounted around it, providing a vision in several modes.

Fig. 1 *Mule-T unmanned vehicle, reconnaissance version*

Fig. 2 *Combat version of Mule –T vehicle, variant A*

Fig. 3 *Combat version of UGV Crusher*

As army vehicles, the MULEs must operate almost at any terrain at any kind of weather. They must be able to perceive a wide range of objects (motor vehicles, terrain, trees, people, buildings, weapons etc.), they have a quite a number of sensors for this activity. They also must be able to receive and to understand commands and to recognize situations where they are and where they are driving to. Each UGV uses some form of Global Positioning System (GPS) and on its board there is some type of a mapping system, which identifies roads and

terrain with regard to an actual position of the vehicle with planning of a route, which it is to pass on. Guidance is carried out under Linux-clasher RT operation system. A remote station has two controlling operators (control of the vehicle, control of fire).

Tracked unmanned land vehicle MS-1 Ripsaw

An unmanned tracked vehicle designated as MS-1 Ripsaw (Fig. 4 and Fig. 5) is not a tank in a full sense of that word. It misses an armour and it is equipped only with a relatively simple firing tower, but with a light machine-gun or with a grenade launcher. So far it has been produced only a promoting prototype – one piece without armament for a demonstration of manoeuvrability and a remote control and the second one, equipped with an M-240 machine-gun for a presentation of combat capabilities.

MS-1 Ripsaw is assigned for reconnaissance operations and as a convoy protection against mines, improvised explosive devices (IED) or other unexpected surprises. It is applicable everywhere, where the lives of soldiers might be directly jeopardized.

Simplicity is a base of a concept. All parts of vehicle can be easily replaces in case they are damaged by an explosion. MS-1 Ripsaw has been developed by the Howe Howe Technologies company from Maine and total costs for its development represented only 1 million USD. A next development of a tracked vehicle will go on, especially its equipment with remote-controlled weapon systems.

Fig. 4 *Unmanned vehicle MS-1 Ripsaw – side view*

MS-1 Ripsaw is relatively light, as the weight of armour, crew and ammunition is not applied, that is why it can develop in the terrain rather high speed. The manufacturer for a testing prototype states a speed up to 90 $km \cdot hour^{-1}$ in terrain.

The vehicle having the dimensions only little bit smaller than a BMP-1, is remotely controlled through a control unit, which can be safely placed in an armoured carrier or on other vehicle (e.g. Stryker). The control is provided by a system of cameras and sensors, providing the operator being in the second vehicle with a good view on screens about movement of the "tank" being controlled. The weapon tower is remote-controlled as well by the second operator – a gunman, also through a control unit.

MS-1 Ripsaw is designed in such a way, that it is able to pass different kinds of natural and manmade obstacles; it can meet on a modern battlefield. As it has no crew, in passing obstacles, it has no need to take care, whether the crew has been injured, which increases its mobility and manoeuvrability. Furthermore the designers state, that a vehicle is able to carry and to transport 1 tonne of load.

The U.S Army representatives were enthusiastic with the first testing, but there is a long way to a series production or a combat deployment of the MS-1 Ripsaw.

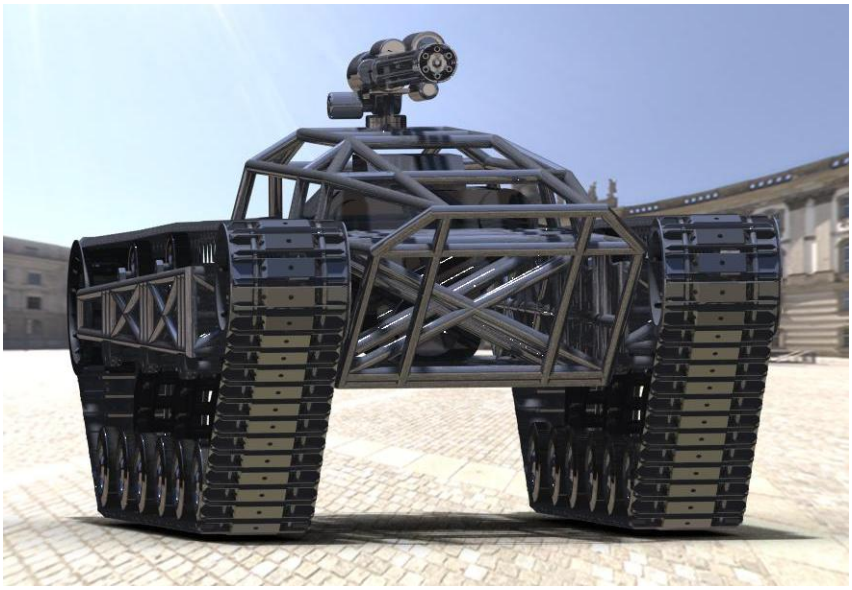

Fig.5 *Unmanned tracked vehicle MS – 1 Ripsaw, a frontal view*

Gladiator TUGV

It relates the reconnaissance as well as combat versions having been produced up to now in a number about 200 pieces. They were deployed in Iraq and Afghanistan. Till 2015 year it is planned to produces several thousands of these vehicles. A combat version of Gladiator TUGV vehicle can be seen in Fig. 6.

Fig. 6 *A combat version of Gladiator vehicle*

3 Conclusion

Striving for a protection of lives and health of the military members in conducting missions leads the highly developed states to a development of unmanned vehicles.

Basic features of each unmanned armoured combat vehicle include – dynamics of movement, good driving range in terrain, reconnaissance effectiveness, a defined firing power and a reliable protection of important electronic and weapon systems.

The armament of an unmanned combat vehicle is defined by a character and distance of targets, which are to be destroyed or neutralized by a combat vehicle. Quality of armament is assessed also by effectiveness of firing, by a quality of sighting and surveillance devices, accuracy of weapon guidance and by an available firing calibre.

Dynamics of movement is characterized mostly by a so called tactical mobility, by acceleration from a site, by a speed of driving and by an ability of an unmanned combat vehicle to pass different obstacles, not much bearing ground. The unmanned vehicles can be designed in a way to excel by their manoeuvrability and stability. The armour in different versions protects only internal equipment of an unmanned vehicle against an enemy firing. The armour protection of the hull of the vehicle is not requested and therefore the unmanned vehicles can have a low total weight.

Protection from visual, infra-red and radar surveillance by an enemy is obvious mainly by applying the electric driving systems. In addition to these basic features and varicosity of tasks, the unmanned vehicles can fulfil in present condition – the unmanned combat vehicles must be reliable in operation, with minimum demands for a preventive maintenance, even in field conditions. The design of an unmanned combat vehicle, all its groups and aggregates must enable a series production, if possible by common technologies and at economically acceptable prices.

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