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Automation of movement control for modern main tank T-90

M A Badrtdinov[1] and D V Yudincev[2, 3]

[1] JSC ‘Ural Design Bureau of Transport Engineering’, 38, Vostochnoye Chaussee, Nizhny Tagil, 622007, Russia
[2] Ural Federal University named after the First President of Russia B N Yeltsin, Nizhniy Tagil Technological Institute, 59, Krasnogvardeyskaya str., Nizhniy Tagil, 622000, Russia

E-mail: [3] yudin_dv@mail.ru

Abstract. The article discusses the option of creating an automated system for controlling the movement of a modern main T-90 tank. In order to emphasize the importance of such modernization, we turn to the history of creating domestic robotic complexes. Among them are known ‘Alisa’ on the base of T-72 tank, intended for experimental development of technologies of remote and autonomous control of objects of armored vehicles, or robot-sapper ‘Prohod-1’ on the base of armored demining machine BMR-3M ‘Vepr’. The analysis revealed the absence of a robotic complex based on the main modern tank. With the purpose of finding the ways of creating a modern unmanned model, a patent search was conducted and foreign military equipment samples were examined. The result is a proposal of modernization of the main tank T-90, which involves equipping the serial chassis with a special apparatus that ensures remote control of the model and autonomous solution of individual problems with the model. The proposed crew-free control system comprises an on-board computer, a plate with proportional electromagnetic valves, motor reduction gears, various sensors, and also the replacement of standard driver-driven controls with electronic ones.

1. Relevance of robotic complexes (RC) introduction

The problem of armaments robotization, military and special equipment has become one of the most important aspects of the development of armed forces and the means of their provision. Robotization is a package of measures aimed at mastering unmanned military and special technologies in order to reduce the military forces’ need of manpower, reduce combat losses and increase the effectiveness of combat actions and special operations. Among the problems which take robotics to do are the creation of systems and means capable of carrying out autonomous operations and solving individual combat and special tasks; the protection of human beings from the effects of adverse factors in combat conditions; reduction in the labour intensity of military and special equipment maintenance; reduction in the cost of service personnel training.

The automation of armaments control, military and special equipment implies the creation of remote control systems and the gradual transition from the simplest forms of remote control to the level of interactive supervising control. Requirements for the power drive of such automated robotic complexes: to ensure economical movement with low resistance to straight motion; to move under conditions of increased resistance to movement; hidden movement mode when the propulsion system is switched off.

Almost all developed countries are involved in establishing robotic complexes. The Ground Vehicle Systems Center (GVSC) of the United States Army has demonstrated the models of the promising machine based on the M2 Bradley [1]. Milrem Robotics (Estonia) is developing a robotic combat vehicle (RCV) with armament, similar to modern Infantry Fighting Vehicle [2]. DOG-ING (Croatia) has developed a number of remote demining and fire extinguishing machines [3]. IAI (Israel) offers the ground robotic platform ELTA's Robattle, which allows remote reconnaissance, surveillance and target detection [4]. The MAARS complex (USA) is equipped with both small arms and antitank weapons [5].

Russia can offer such RC as the specialized remote controlled robot 'Uran-6' (Figure 1), 'Platforma-M', 'Nerekhta' and other [6].

Figure 1. Robotic Demining Complex 'Uran-6'.

However, the establishment of such RC is time-consuming and resource-intensive, as it implies solution of a number of problems. These include, for example, the development of an own tracked chassis for each particular robot, and a rather weak defense against the weapons. To solve this problem, it is necessary to pay attention to existing serially produced tracked items.

The robotization of the serially produced tracked items consists in the installation of an additional apparatus set, which forms a remote control system and makes it possible to realize the unmanned sample. The crew may be accommodated in a remote control centre up to several kilometres. In this way, a modernized serial item has a number of advantages over specialized complexes:

–robotized product can be controlled either in crew mode (standard control mode) or in unmanned remote or autonomous modes;

–robotized product that is almost identical on the outside to the crew nonrobotized product, which expands the tactical possibilities of its use;

–the output time and cost of the new product are significantly reduce due to the use of serially produced chassis and the use of unified remote control equipment for a number of base chassis;

–possibility of upgrading the existing military and special equipment into unmanned products that meet the requirements of different departments;

–performance of combat tasks in an automatic mode increases the efficiency of the equipment use.

2. Examples of tank-based robotic complexes

RC 'Alisa' on the base of T-72 tank (Figure 2) was created inBauman Moscow State Technical University [7] for experimental development of remote and autonomous control for armoured weapons and vehicle facilities. The sub-system of the lower level of control, the system of technical vision, the navigation system and different modes of movement remote control and weapons have been successfully tested on this complex in the full-scale conditions. Currently, RC 'Alisa' is being used for further experimentation with hardware and software, which provide a fully autonomous movement control mode.

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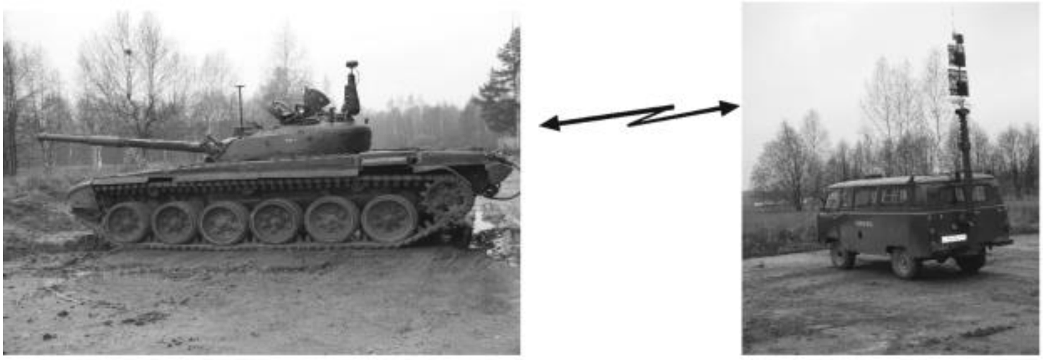

Figure 2. RC ‘Alisa’.

Further, it is advisable to consider the controlled demining RC ‘Prohod-1’ (Figure 3) created in JSC ‘High precision systems’ scientific production association [8]. The complex was created on the basis of BMR-3M ‘Vepr’ (armored demining machine). The technical capabilities of the complex allow to trawl mines installed on the ground or in snow, to neutralize mines lying on the surface as well as having radio breakers. RC ‘Prohod-1’ is equipped with a trawl with rollers (for contact action mines), cutters (cut wires of remotely controlled landmines) and a system of radio-electronic interference for radio-controlledlandmines. The complex is able to create passages up to 4.5 meters wide in combat conditions for military columns on mined areas both with crew and unmanned (remote and automatic) modes of operation.

Figure 3. Controlled robotic demining complex ‘Prohod-1’.

The automatic control mode ensures the execution of the combat mission along the specified route without the intervention of the operator. The peculiarity of RC ‘Prohod-1’ is the presence of three modes of work: with the crew inside, under operator’s control (remotely), and also in automatic mode with predetermined parameters of movement (without operator’s intervention).

3. Implementation option

As mentioned earlier, it is most advantageous to use a serially produced tracked chassis and to provide it with a set of specialized equipment which forms a crew-free control system, provides remote control and autonomous solving of individual problems.

The task can be broken down into two main development parts:

1. System of unmanned remote control.
2. System of autonomous solution of individual tasks.

The system of unmanned remote control of the sample (Figure 4) implies installation in a serial sample of such equipment as to enable the control of movement under any conditions from a safe distance and preclude the mandatory presence of the crew inside the machine. At the same time, it is

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still possible to control the machine with the aid of classical controls at the driver-mechanic's place. In general, such equipment can include various servo drives, electromagnetic valves, motor reduction gears, sensors, on-board computers, etc.

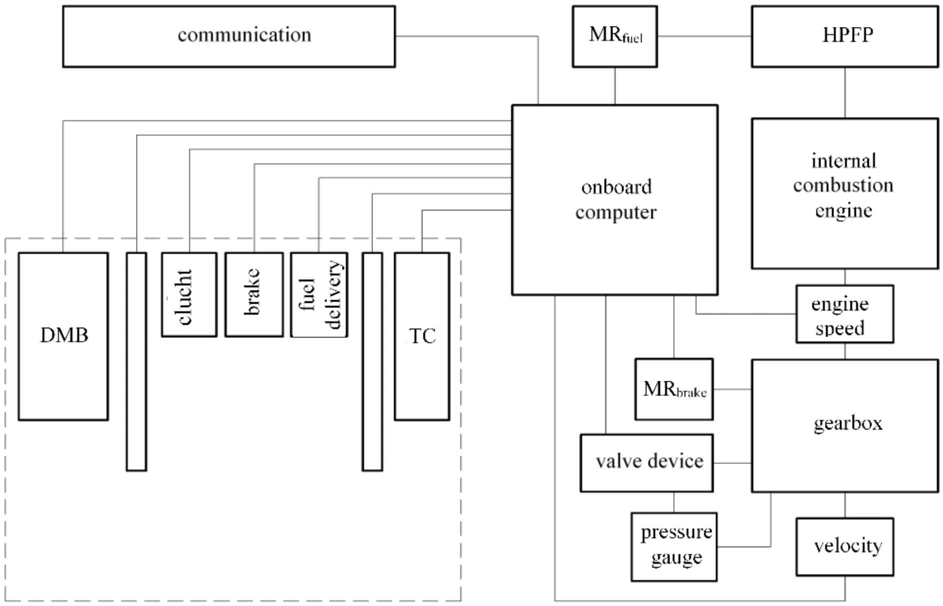

Figure 4. Implementation option of unmanned control system.

In the proposed variant for implementing theunmanned control system, the standard driver-mechanic position is maintained, but the controls are replaced by electronic control units: driver mechanics board (DMB), turn levers (can be used instead of steering levers), electronic clutch, brake and fuel delivery pedals, electronic Transmission Constituent (TC).

The signals from the controls and sensors (engine speed and actual speed of the vehicle) are received in the on-board computer, where all necessary calculations are made. Furthermore, the on-board computer generates control signals for the motor-reduction gear of the high-pressure fuel pump (HPFP), the motor-reduction gear of the brake (MR_{brake}) and the valve device of the on-board gearbox (the valve device is a plate with proportional electromagnetic valves).

The feature of this modernization is the presence of two gearboxes and therefore, the need to install two valves. In this case the possibility of realization of such transmission mode as «in-place turn» that under the standard control system it was impossible to execute. It should be noted that the absence of the 'in-place turn' mode was a disadvantage of the chosen chassis, especially when considering the use of the item in modern combat conditions, which are often carried out in populated areas and in cramped conditions.

The remote control transmits signals similar to the signals from the driver's control point or the traffic route information to the on-board computer. Then in the on-board computer this information is transformed into control signals for the actuating mechanisms and the machine moves along a predetermined route.

4. Conclusion

An analysis of the existing variants showed the absence of RC based on the modern main tank.

In this paper scheme for the execution of an automated system which provides for remote control of the model and also autonomous solution of individual problems with the model are proposed.

The selected scheme will be used to develop design documentation for the modernization of the products based on T-90 tank.

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