The Unmanned Ground Vehicles to be used in future military operations

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Abstract—Unmanned ground vehicles are fast developing because of advances in other relevant technologies like artificial intelligence and telecommunications. These machines provide new possibilities and liberate both resources and personnel from different tasks. Because of this, the time is ripe for militaries around the world to start developing this type of machines for military use. The militaries have had interest in this technology for decades. However, there are not any recent written articles which would gather and provide information about this type of machines, even though there is plenty of discussion around the development of these types of robots and the morality of their use. Therefore, the purpose of this article is to gather available information and technical data about current models under development for the militaries, as well as provide insight to these machines and their current capabilities and limitations. In addition, the goal is to provide insight on lethal autonomous weapon systems and their ethical morality. This article will also focus only on Unmanned Ground Vehicles which cannot be manned and are meant for combat and/or combat-support.

Keywords— Unmanned ground vehicle, Lethal autonomous weapon systems, UGV, LAWS, robot, autonomous, track, wheeled, Uran-9, weapon.

I. Introduction

Unmanned Ground Vehicles have been developing at fast pace during the last decade. The possible development is possible because of advance developments in artificial intelligence (AI), sensors and telecommunications. This huge development can be seen in industrial- and everyday use. With this understanding, the military has always been interested in the latest technologies. As a result of this kind of interests, the militaries around the world have been also developing their own Unmanned Ground Vehicle (UGV) for combat use.

The militaries see a lot of potential in these machines, especially after the drones have proved themselves in combat and other military operations. The airspace has been easier to conquer because of the wide available space and fewer obstructions, in signal transmission and movement, compared to the ground element. Thanks to developments in stated technologies, it is now possible to build efficient UGV's for military use.

Even though it is now possible, does a country need these systems, and where should the line be drawn for automation to avoid rogue "killer robots"? However, have these questions already fallen behind the progress and become obsolete if other actors have made the leap and made progress beyond reach? What is the current state in development of this UGV's in different countries? What we may see on future battlefields?

II. Methods

A. Search strategy

Search was focused on mapping the state of contemporary military UGV development. The data was search from IEEE Xplore database, ProQuest Military database, IntechOpen, SAE Mobilus, Worldwide science. Due to scarcity of available high-quality scientific literature, a secondary search was conducted using National Defence Universities and Tampere University's library databases, manufacturers websites, newspaper articles and even blogs. The information in the secondary search results were cross verified. Languages used for the search were: English, Finnish, Russian, Italian, Chinese.

B. Screening and eligibility criteria

The search results were screened for relevance based on their title and abstract. Publications were excluded if did not report on 1) military use 2) terrain based 3) wheels or tracks 4) technical details. The full text versions of all articles which did not clearly meet exclusion criteria were read. Finally, publications were included if they reported on UGV's which 1) could be armed or weaponized for combat use, 2) utilized artificial intelligence and/or were radio controlled, 3) had technical information available and 4) were under active development or had been accepted for military service. Data extracted from the articles included technical details, such as dimensions, weight, operational range, top speed, type of chassis, pay load capacity, level of automation, use of AI, weaponry, control method, sensors and optics.

The main limitation of the study is the unavailability of high-quality public reports. Most up to date reports are kept classified and thus unavailable for public use. In the event a report does give out specific information, it has often become irrelevant, as is the case with the most recent review published in 2013[1]. As a result of major advances in UGV technology most details in the reports have to be revised.

III. Ethical debate

The trend in modern war technology has been developing robots for use in battle and other similar hostile environments. Innovation in this field has been fueled by the tremendous utility military robots potentially offer. [1] For example, they can save one's own solders, keep them away from major danger and inflict major casualties on the enemy side with little or no casualties. [1;2] However, weaponizing robots has sparked doubt and stark criticism as well, as their employment is also fraught with peril. [1;3;4;5]

Developing war technologies gone awry is a recurrent theme in futuristic sci-fi movies and books as the story feeds to a common miss-belief of all war technologies being inherently harmful. In fact, many modern technologies in everyday use, like the computer and encoding algorithms, have initially been developed for military use. The major issue most people have with autonomous, weaponized robots is with who will be making the decision of killing a human being, a robot or a human operator. Currently all developers of these systems are stating that they still want a human to be the one to "pull the trigger". [1;4;7;8] These kinds of legal issues need to be solved regarding utilizing these kinds of machines in operational use, however the development will not stop nevertheless.

Unfortunately, the weapon systems of individual countries are inevitably becoming more and more autonomous with the development of computer technologies [4]. An arms race is already visible between Russia, China and the US as they are developing robots for use in future conflicts and wars. [4;6;9;10] At the same time other countries have also started developing their own unmanned ground vehicles (UGV's) and other unmanned platforms. A country not being able to keep up with current weapon development tempo, has historically suffered major losses in the next crisis or war.

So, to keep up with the major countries arms race and to make up for the decline in population birthrate, Finland does not have a choice except to develop autonomous defense systems - if we want to be capable of protecting our people and borders with a believable force and deterrence.

IV. Lethal Unmanned Ground vehicles in different parts of the world

The leading developers of military UGV's are Russia, Israel and the US. Their UGV models, as well as other models showing comparable potential, are discussed in detail in the following text. These models have most information available, and they have been shown to a public. In addition, numerous countries have their own UGV programs of varying degree. The descriptions and available technical data of these current UGV models are gathered in appendix 1.

A. Russian UGV's

The Russians versions of the UGV's already have several models in operational test use with their armed forces. The first model which has been shown the most to the public would be the Uran-9, as shown in the picture 1. The Uran-9 is a track based unmanned armored vehicle to be used against other armored forces and to support Russian infantry [11;12]. The tank is not yet fully autonomous and the AI is still in development, however it can be operated remotely with a simple game pad. [13;14;15]

Picture 1. Uran-9. With full armament [12]

The reason for why this vehicle can be considered to be state of the art is simple: It is capable to carry a huge load of different weapon systems. As can be seen in the picture, the turret is equipped with a 2A72 30mm automatic gun, which is capable of shooting normal or explosive rounds and automatically switching between the two, and a 7,62mm machine gun to target infantry. In addition to these standard Russian infantry tank armaments, this tank has several extra weaponries to make it even stronger opponent. For example, spotting targets is supported by optical lasers equipped with heat vision, which means this vehicle is more than capable to operate during the night and in difficult weather conditions. The cameras are equipped with AI to help the operator distinguish enemy units from friendly ones. These lasers and optical cameras/optics are used to target either armored vehicles with its "Attaka"-missiles or to target air units with its "Igla"-missiles. Also, it has six RPO-A Shmel Rocket-propelled Infantry Flamethrower-A units attached to it. [11;12] These RPO-A Shmel weapon units are classified as flamethrowers even though they are considered to be rocket launchers.

This unit has been used in the Syrian Civil War, and according to Russian sources, it has performed poorly. However, Russian forces acquired enough information to further develop it and after Vostok 2018 exercise it has entered military service in January 2019.[16] They are still developing the AI for tanks, the connection range, response time and data bind width.[14] This is first UGV of this caliber to enter military service and might be a game changer. It may shape the way future military UGV's are developed and used.

The second most developed Russian UGV would be the Marker as shown in picture 2. Russia's Foundation for Advanced Studies (FPI) has unveiled an updated version of the Marker unmanned ground vehicle (UGV) with a different track configuration as well as a larger body, potentially with the intention to mount larger caliber weapons.

Picture 2. The updated Marker with light armament [17]

The updated Marker UGV was shown with five road wheels, an idler, a drive sprocket, and two roller returns. A large payload bay area is featured in the rear of the platform with the engine and cooling units to the front. The updated unit can launch a group of small reconnaissance unmanned aerial vehicles (UAVs) to perform tasks individually or together as a group via a cluster launch module. This module was tested on 17 October 2019.[17]

The Markers autonomous operations are supported by a modular multispectral vision and data processing system, featuring neural network algorithms. Other mission systems include a laser warning system, thermal sensors, day/night infrared (IR) cameras, laser rangefinder, target detection, early warning system, identification, and tracking equipment.[17]

Five versions of Marker UGVs are believed to be in development. Two platforms in a tracked configuration have been tested and a wheeled version is also in development. Two experimental prototypes of the Marker UGV were tested on 9 July 2019. The project's first stage, which included trials in coastal areas, was successfully completed on the tracked chassis on 25 July 2019 with tests carried out at the Magnitogorsk test site of robotic systems and complexes (MIP RSK).[17]

The UGV demonstrated automatic routing in urban areas and rough terrain in its first phase of testing. The second stage involved maneuver operations, as well as targeting and firing trials, and commenced at the end of July 2019. Further weapon testing is expected to be conducted in the first quarter of 2020 with the UGV engaging targets in "automatic mode". [17;18]

B. Middle-Eastern UGV's

The Israeli have been developing a semi-autonomous UGV Guardium [19], in picture 3. It was designed to perform routine missions, such as force protection, route proving, combat logistic support and routine missions like programmed patrols along border routes, also autonomously react in line with set parameters [19]. The Guardium consist of command and control application, a custom-tailored communication system, a modular selection of payloads and a comprehensive logistic support package. This solution can be applied to different vehicles as a kit solution [19]. The Guardium differs from the Russian UGV's especially in regards of the AI, which has been developed much further, as well as the structure designed for the terrain at the border of Israel. Overall, the Guardium is geared towards border patrolling and the Russian UGV's toward performing in front line combat.

Picture 3. Israeli Guardium on patrol.[20]

Iranian forces have also been busy developing their own UGV's which would be much cheaper and more effective at destroying tanks, by exploding underneath them. In doing so they target tanks weakest point, its belly. The Iranian UGV is called Heidar-1 and it is shown in picture 4.

Picture 4. Heidar-1 family, UGV's equipped with Ak-47 machine gun or with explosives.[21]

Heidar-1 is remotely controlled UGV with a simple AI to help recognize targets and to help aim the riffle. It can carry enough explosive ordinance to cause significant damage or destroy its target [21;22]. The UGV can be guided to the target by using a drone from a far.[22] It is a small, cheaply producible kamikaze vehicle with tremendous explosive power.

C. The US

On the American continent we have one of the greatest military might's, the US has also been developing their unmanned vehicles and autonomous systems for a while now. Several of the most well-known projects are the walking robots like Spot and Atlas designed by Boston Dynamics, however they do not classify exactly as UGV. They have also developed wheeled UGV's like MULE (Multifunctional Utility/Logistic and Equipment) and Crusher. On July 29 2011, the development of the MULE system came to a halt [23] when funding was cut from all unmanned vehicle programs due to decisions Pentagons decision. These UGV projects were almost completely buried after the Russian operations in Syria, where Russia used their UGV's in war operations. Recently the attitude toward UGV's has shifted again and the US has been detailing their use in strategic planning for future conflicts and operations in their booklet: The U.S. Army: Robotics and Autonomous systems strategy [25].

One of the few projects to survive and continue to be developed is the Crusher. It uses the data collected from the MULE project and is now the most developed UGV in the US. The Crusher is shown in picture 5. The reason for the survival of the Crusher was that, unlike others, it is funded by DARPA and not developed by major companies like Lock-head and Martin.

Picture 5. The crusher with weapon 50cal. armament [24]

The Crusher was designed primarily for reconnaissance and support roles. Because it doesn't carry a human crew, new design approaches could be explored to create a rugged, flexible vehicle capable of carrying huge payloads. For instance, Crusher can forego armor under certain circumstances so it can carry more supplies. Ultimately, Crusher will be able to navigate autonomously over extreme terrain complete with ditches, rock barriers and man-made obstacles. Crusher can run on battery power alone, allowing for nearly silent operation. It can also carry weapons, so it can take on combat roles and offer fire support.[26]

There are four primary focus areas in Crusher's development:

- Ruggedness to withstand extreme terrain without losing speed, even when carrying 3 600kg of cargo.
- -Quiet motion on the battlefield to make it a viable reconnaissance asset, because of its hybrid-diesel-electric setup allowing nearly silent operations.
- Autonomous operation to allow for scouting, reconnaissance and even combat roles without risking a single human life.
- Skid-steer ability with six wheel-drive, with each wheel powered independently.

Crusher's skeleton is made of aluminum and titanium. Its hull is an aluminum space frame (an open structure of connecting rods) with ultra-sturdy titanium nodes joining the rods for added strength in the likely event of collisions with large, hard objects. Immediately below the hull is a skid plate – basically a suspended, shock-mounted steel "bumper" which stands as a first-defense, protecting the hull from initial contact with the likes of boulders, tree stumps and steps.[24;26;27]

When it comes to its sensor arrays and computing power it is stated that Crusher has IMU (Inertial measurement Unit), GPS (Global Positioning System), cameras and LADAR (Laser Detection and Ranging)-units. LADAR is attached on top of a 5.5m telescopic mast. The crushers on board CPU (700-MHZ Pentium 3) combines the data from the LADAR and the cameras to create a 3D-picture of the landscape affront of it. The same on-board computer controls and runs all the Crushers mechanical duties with co-operation of navigational data and sensor data. [26;27]

V. Conclusions

In addition to the previously listed countries, many more are developing their own UGV systems. One country worth mentioning is Estonia with their Milrem UGV [28] currently being tested with their army forces.

There are as many different systems and solutions as there are individual countries as they are designed to suit individual operational requirements. However, similarities can be seen between the systems.

Information gathered about the UGV's in different countries, is summarized in Appendix 1 and in the table 1. The table 1 shows the essential information about the different models. The models were chosen based on their realistic potential to be truly used in future military operations in one way or another. In addition, these models had most information available to the public. The table also shows the development of UGV's in different countries, because a few of these models are further developed than others and a portion is already in use or are basis for the development of future UGV models.

A few conclusions can be made based on current available data. First of all, the wheeled systems are mainly designed to be six wheeled with skid-steering or the whole system is built on tracks to offer better maneuverability in roughest terrain. Secondly, all are designed to carry various kinds of weaponry or load. Thirdly, there are always more than one sensory system to help the UGV navigate the terrain and help the operator to make decisions on how to control the vehicle. Fourthly, all these systems have AI developed for military use; however, their level of sophistication in quality and capabilities vary.

For obvious reasons, an AI is a national secret for each county involved in development of theirs UGV's and so the data regarding the AI's will not be available for free use. However, looking at each systems requirement, sensors, construction and way of working (viewed from videos available on the internet) it is possible to make assumptions, use logical deduction and come to rough conclusions and estimations on how the AI is built and how it works. As can be seen from table 1, most of these UGV's are remotely controlled and do not have the full capability to perform completely autonomous operations on a battlefield. Most advanced models are capable of autonomous navigation and target recognition; however, they are not still good enough to be used fully in a battle.

In conclusion, these UGV's are mostly a way of showing force and military capability. Still they should not be taken lightly. Even though these systems are not completely ready, they do show just how much individual countries are willing to invest in development of these systems and how they are planning to integrate them as a part of their military force. In addition, by looking at the weaponry and payload capabilities of each UGV, it can be seen which UGVs are planned to be used in supportive- and logistic-roles and which are to be used in ways more aggressive ways. The decisions and individual designs seem to follow each countries war-doctrines.

VI. discussion

The automation should always include a human in the loop, especially when deciding of firing a weapon or destroying a target. The final decision should be left to a human operator, to avoid mistargeting, recognition errors and misfire.

While it is easy to critique the abstract idea of "killer robots", closer observation of existing UGV's highlights the necessity of such devices to be develop for national defense purposes. UGV's in general can save resources and personnel, at the same time bringing new possibilities and options to the future battlefields. Because of this, several nations are investing resources and founds to develop their own UGV's for military use. Although they show a lot of promise, it is hard to tell at the moment how well these UGV's will work in a real battle situation. Only time will tell.

VII. Future work

The operational UGVs appear to be able to sufficiently perform given tasks in homogeneous conditions where interferences are minimized. As the state of military UGV development seems to be limited by the ability of artificial intelligence to operate in inconsistent terrain, new solutions are widely pursued. The following work shall aim to develop a new kind of AI using neural networks and evolutionary computing. The next article will focus on the development methods of the AI and in the final article the performance of this AI will be tested on a UGV test platform in diverse environments. It is intended to investigate weather neural-networks can efficiently be fostered together into a single, evolved AI, if it functional in a desired way and if it is capable of recognizing targets while autonomously operating in combat situations.

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Appendix 1

This appendix hold the information about different types of lethal UGV's , the information is gathered in table 1.

TABLE I
THE COMPARISON TABLE OF UGV'S

Picture	**UGV name/ Country of origin/ Weight/ Dimensions**	**Type of chassis/ Type of power train/ Top speed/ Operatinal range/ Operating time**	**Weaponry/ Payload capability**	**Control method/ Electronics and optics**	**Has the UGV been used in combat and when/ State of production or use**	**Sources**
	**Uran-9** / Russia/ 10000 kg / 512 cm x 253 cm x 250cm	Track/ Diesel electric motor/ 35km/h/ 3 km/ N/A.	1x 30 mm 2A72 autocannon ABM M30-M3 modification; 1 × 7.62mm PKT/PKTM; 4 × 9M120 Ataka anti-tank missiles; 6 or 12 x Shmel-M thermobaric rocket launchers/ N/A	Automus or radio controlled; Autonomus target recognicion and target lock/ Laser warning system; cam IR sensors; Laser rangefinder; Electro-optic and thermal imaging cameras	YES, combat tested in Syria 2018/ Entered military service 2019	(11-16; 29-31)
	**Marker**/ Russia/ N/A/ N/A/ N/A, aprox. as PLATFORMA-M	Track/ N/A/ N/A/ N/A/ N/A	1 × 7.62mm PKT/PKTM; grenade launcher module and/or 120 mm mortars; 2x Anti-tank missiles / N/A	Automatic routing in urban areas and rough terrain; engaging targets in "automatic mode"/ Laser warning system, thermal sensors, laser rangefinder, target detection, early warning system, identification, and tracking equipment. ; day/night infrared (IR) cameras	No/ Demostrator and testing platform	(17;18;32)
	**Nerehta**/ Russia/ 2000kg/ 260 cm x 160 cm x 90 cm	Track/ N/A/ 32 km/h / Up to 3km / N/A	1x 12,7 mm machine gun, or 7.62 anti-tank machine gun or ? ?-30? automatic granade launcher/ Payload 500kg	Radio controlled/ GLONASS positioning system; IMU; Aiming stabilizer; Laser range finder; Laser targeting system; Heat vision camera	No/ In testing	(33;)
	**BAS-01G Soratnik**/ Russia/ 7000 kg/ N/A , aprox. as Uran-9	Track/ N/A/ 45 km/h / 10km/ N/A	1x1 × 7.62mm PKT/PKTM; 1x 12,7mm NSV heavy machine gun, 1x AGS-17 automatic granade launcher or Kornet ATGMs/ N/A	Radio controlled/ Laser range finder; Laser targeting system; Heat vision camera	No/ Demostrator and a testing platform	(34;)
	**PLATFORMA-M** / Russia/ 800kg/ 160 cm x 120 cm x 120 cm	Track/ N/A/ 12 km/h / 1km/ 10h	1x 7.62 Machine gun; 4x RPG-26 Aglen rocket-proppeled grenade launchers/ N/A	Radio controlled/ Radio reconnaissance locators; Rangefinder; Optical-electronic; Heat-vision camera	YES, combat tested in Syria 2017/ In testing	(35;36)
	**Guardium**/ Israel/ 1700 kg/ 295cm x180 cm x 220cm	Wheeled; 2WD/ N/A/ 50km/h / N/A/ 24h+	N/A/ N/A	Autonomus driving capabilities, waypoint based; Autonomus patrol capabilities/ IR camera, Radar, Remotely Operated Weapon Systems, Non-lethal Weapon Systems, Electronic Counter Measures, Hostile Fire Indicator (HFI), two-way audio link	Yes, Israel borders, since 2008/ Still in developing	(19;20)

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	**RoBattle LR-3**/ Israel/ 7000kg / N/A	6x Wheels drive, skid steer/ N/A	Pitbull AD remotely operated Weapon system with 7.62 mm machinegun/ Payload 3000 kg;	Real-time mapping and autonomy; Autonomus: Preplanned route, with obstacle avoidance/ N/A	No/ Demostrator and testing platform	(37:)
	**RAMBOW**/ Israel / 4500 kg / 370 cm x 220 cm x N/A	6x Wheels drive, in-hub electric motors, skid steer/ Hybrid with diesel engine/ 35km/h/ 50km on batteries-300km with diesel engine/ N/A	1 x12,7mm machine gun; 6x Marlow loitering missiles/ 1000 kg payload	Autonomus,Preplanned route, with obstacle avoidance/ Telescopic camera system	No/ Demostrator	(38-40)
	**Crusher**/ USA/ 6000kg / 500cm x 260 cm x 152 cm	6x Wheels drive; skid steer/ Hybrid electric, with 60 Kw tubo-diesel engine/ 45 km/h / 16km/ N/A/	50 cal SAW / N/A	Semi-autonomus; Remote control; Waypoint-based navigation full autonomy/ LADAR; IMU, GPS; Cameras; 6xstereo vision cameras;	No / Still in development and testing platform	(24-27;41;42)
	**Crusher mini**/ USA/ 57 kg / 79cm x 53cm x38cm	6x Wheels drive, skid steer/ Electric motors/ 24 km/h/ Line of sight/ N/A	N/A/ Payload capacity 45 kg	Radio controlled/ Stabilized camera	No/ Testing platform	(43;44)
	**Ripsaw M5**/ USA/ 4500kg/ 472cmx 253cmx170cm	Track/ 600hp Diesel engine / 110km/h/ N/A	Kongsberg MCT-30 Protector ; 30-millimeter Mk. 44 Bushmaster II autocannon; CROWS-J remote controlled missile launcher armed with Javelin anti-tank missiles/ N/A	N/A/ TacFLIR 280-HD sensor turret	No/ Demostrator and testing platform	(45;46)
	**Heidar-1**/ Iran/ N/A/ N/A , aprox as Crusher mini	6x Wheels drive, skid steer/ In-hub electric motors/ N/A	1x 7,62 AK 47, explosive ordinance / N/A	Radio controlled/ Visual camera	No/ Demostrator	(21;22)

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	**AlRobot**/ Iraq/ N/A/ N/A , aprox as Guardium	Wheeled; 2WD/ N/A/ N/A/ 1km / N/A	12.7 mm cannon; 2x 70 mm rockets models "ATAKA"/ N/A	Radio controlled, requires 2 people to operate – one mans the gun while the other drives the vehicle/ Thermal cameras	Yes, Mosoul 2016 / N/A	(47-49)
	**Milrem THeMIS**/ Estonia/ 1630 kg/ 250 cm x215 cm x115cm	Track/ Diesel electric drive/ 25km/h / Line of sight up to 1,5km/ 8h	RWS ADDER weapon station is compatible with weapons including 7.62mm general-purpose machine gun, 12.7mm machine gun, 40mm automatic grenade launcher (CIS 40 AGL), and CIS 50MG machine gun. / Payload 750 kg	Radio controlled/ LiDARs; cameras come with the ADDER system; wich includes thermal cameras, video and audio recording, IR (MIL-STD-810G), Thermal, HDR	Yes, Mali 2019 / In production	(28;50-52)
	**The IRONCLAD**/ Ukraine / 1100 kg/ 257cm x170,5cmx96 cm	Wheeled 4WD/ Diesel Power Train (15 kW) generators provide electricity to 4 electric engines (12 kW)/ 20km/h / 20km/ 10h	Shablya RWS with possible choise of 7.62/.308 and 12.7/.50 machine guns or or a 40 mm automatic grenade launcher, or two antitank missiles, as well as up to eight smoke grenade launchers/ N/A	Radio controlled; MESH network cabalities and control/ 3x full HD near-IR CMOS cameras	No/ Demostrator and testing platform	(53;54)
	**Milos**/ Serbia/ 680kg/ 172cm x 70 cm x95 cm	Track/ electric propulsion/ 12 km/h / 1km/ 2-8h	1xM86 7.62mm; RBG 40mm grenade launcher/ N/A	Radio controlled/ Meteorological sensor; a daylight charge-coupled device (CCD) camera with a continuous zoom of up to 30x, a night vision-thermal camera with a digital zoom of up to 4x, and a laser range finder with a range of up to 2,000m.	No/ Entered production in 2019	(55;56)
	**Rheinmetall Mission Master/** Germany-(Canada)/ 1100kg/ 290cm x 155cm x 170-350cm	8x Wheels drive, skid steer/ Electric motors or Hybrid diesel/30 km/h/ Amphibious 5km/h/ 8h- 30h	Modular plarform with possible choise of 7.62mm machine gun/50mm weapon systems or 0.50 calibre machine guns/70 mm (14 rockets) rocket launcher /40mm grenade launchers/ Payload 600kg, 300kg Amphibious	Semi-autonomus; Remote control; Waypoint-based navigation full autonomy/ GPS/SLAM-navigation/ Ladars, three of them 2-D and one 3-D/ front and a rear camera and a 360° optronic system	No/ Demostrator and testing platform	(57-61)