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# UGVs: Robots to the Rescue



UGVs have long been a vital and highly advanced class of equipment used to help keep soldiers, law enforcement and public safety personnel out of harm's way as they go about their dangerous work in both theatre and civilian operations.

During the past ten years UGV utility has focused upon EOD, and their roles in reducing the exposure of troops to dirty and dangerous tasks is a growing feature of modern Armed Forces. From small 2kg robots used to disrupt IEDs to big 200kg vehicles that can haul other vehicles, the UGV story is one of military technological excellence and their capabilities will continue to grow in the coming years. Unmanned vehicles are now being used in surveillance and reconnaissance missions, with more advanced communications, camera systems, thermal and explosive sensors, and other hazmat (hazardous material) sensors. An assessment by Visiongain estimates global spending on military UGVs amounted to almost \$580 million in 2013.

Director of combat manoeuvre systems in Lockheed Martin's missiles and fire control division, Joe Zinecker, envisages long-duration, persistent surveillance UGVs that do not require refuelling for months - carrying out advanced, hidden, constant 24/7 surveillance missions, such as on chemical-weapons storage sites or other sensitive facilities.

From exclusive use in EOD and for mine and IED route clearing in Afghanistan as the main military theatre and in civilian operations, smaller, lighter ground robots are emerging that will be able to carry extra ammunition and supplies, lengthening the duration of missions, while keeping the soldier at a safer distance.

## Tactical Control

UGVs are also increasingly vital for complete operational and tactical control, overall mission management, and enhanced force co-ordination. Deployed as logistics carriers, SAR transporters, they are an essential tactical logistic platform for indoor and outdoor operations and to enhance the capabilities and effectiveness of special and light ground tactical forces. They provide a way to carry supply, equipment or materials creating a lighter and more effective ground force.

RUAG's envisioned UGV-communication system will be directed and powerful, and will work over great distances without quality degradation. One of the system's main layout parameters will be the "continuity of safe function," because an almost uninterrupted communication is the prerequisite, that a UGV doesn't become a "run-away robot," which could injure people. The aim for the first fielded generation of UGVs is, to apply "supervised autonomy" as standard mode of operation. This mode offers the ability, that "a man in the loop" can intervene via remote control, if an UGV doesn't continue correctly with its programmed actions or when surrounding conditions make it necessary, to deviate from the programmed sequence of actions. Shown, RUAG's GECKO UGV with SKY-WATCH UAV.

(Photo: Mönch / DPM)

The TERRAMAX system by Oshkosh Defense can expand the capabilities of existing ground vehicles used by Special Forces, while reducing their exposure to RPGs and small-arms fire as well as IEDs.

Lockheed Martin (LM) is developing very long duration, persistent-surveillance UGVs that can remain in one location without the need for maintenance or refuelling for weeks per mission. LM recently conducted a successful UGV demonstration

with the Army Tank-Automotive Research, Development and Engineering Center, which showcased vehicles driving in a fully autonomous mode.

An example of a tactical logistical UGV for performing semi-autonomous missions is the PROBOT (Professional Robot) from Roboteam, which can carry heavy payloads - up to 250kg - while maintaining high speed and manoeuvrability over many types of obstacles. With different payloads available, the PROBOT can lift and carry, climb stairs and manoeuvre directly to a point of interest - including in confined areas, which is essential for urban operations, which are increasingly common in modern warfare and COIN. Its tracing and imaging sensors enable hands-free navigation in urban, indoors and open spaces.

## Getting Lighter

JIEDDO (US Joint IED Defeat Organization) has conducted FRC (First Look Reconnaissance) Ultra-Light Reconnaissance Robots - evaluated four ground robot systems to wrap up operational assessments in Afghanistan and desperately meet commanders' urgent battlefield requests for smaller, lighter robots for EOD and to give dismounted troops better situational awareness. The iRobot 110 FIRSTLOOK weighs just over 2kg - a throwable robot that can survive 3m drops onto concrete. It is waterproof to 1m and can overcome curbs and other obstacles and right itself when flipped over. Operated using an intuitive, lightweight operator control unit, FIRSTLOOK provides the user with 360° of situational awareness and optional thermal imaging capabilities for day, night and all weather operations. An optional tripod deployment mechanism and high-back camera provides greater situational awareness, the ability to perform under vehicle inspections, mark drop markers or charges at a specific location.

Recently, iRobot outfitted FIRSTLOOK with a small, lightweight manipulator, allowing the robot to interact with its environment and provide the operator with an awareness of what is happening while being able to mediate a potentially dangerous situation from a safe distance. It can be integrated with various CBRN sensors already being used by troops and HazMat teams, which are integrated onto the robot without adding weight.

Much depends on the development of sensors effective enough to meet the demands on smaller robots operating in rugged terrain. The value





*EOD robot pulls the wire of an suspect IED found by the Iraqi Police at the height of the insurgency. Controlled by soldiers assigned to 731st Ordnance Company, the robot safely surveys the device at a safe distance with its two on-board cameras and mechanical arm. (Photo: US Navy / 1st Class Jeremy L. Wood)*

need greater manipulation capability; only larger UGVs have had manipulator arms – and manoeuvrability as a whole is a major challenge for negotiating multiple obstacles.

iRobot is integrating the control of multiple robots onto a single, unified controller, and is also integrating robot control into the existing tactical network special operators. One 'master' UGV can be driven to the entrance of a cave by an operator, which will send a second machine to penetrate the cave, with the master robot sending communications and video from the robot inside the cave back to the user. The aim is also to build on the interoperability of robotic equipment with the equipment special operators already use – by taking existing accessories such as thermal cameras and adapting them to the UGV rather than having to produce custom-made advanced equipment.

## Patrols and Cargo Supply

UGVs are also increasingly used for patrol missions. The USMC is experimenting with a new UGV, the Mobile Detection Assessment Response System (MDARS) that is designed to patrol installations and detect intruders or potential enemy forces nearly 2km away. The MDARS was used in late January 2014 to successfully secure an air base during their final pre-deployment Integrated Training Exercise conducted at the USMC Air Ground Combat Center at Twentynine Palms, CA/USA.

According to its developers, San Diego-based Space and Naval Warfare Systems Center Pacific, the MDARS UGV could be headed to Afghanistan, following a field demonstration in January at the combat centre's Camp Wilson, where Marine Aircraft Group 13 and Marine Wing Support Squadron 374 were tasked with patrolling the area immediately surrounding their airfield as a mock enemy force tried to probe their defences. On the first night the UGV autonomously navigated the base by heading to pre-determined waypoints and guards in one tower detected two potential enemy soldiers. MDARS programme manager Pat Culliton said: "We were operating between two towers and one of the towers reported some activity. From the operator control station you just click a button and say go there."

The versatility of UGVs extends to casualty evacuation and cargo resupply, most notably in Afghanistan. The Mission Planning and Management System (MPMS), which was developed by Neya Systems for tactical mission management with UGVs, has been extended to include VERTI, developed by Neya with LM. VERTI allows for pre-mission planning using an interface that is familiar to mission planners who are already familiar with Air Tasking Orders and existing planning tactics, techniques, and procedures. The pre-mission planning phase is intended to allow an in-field medic or other soldier to rapidly call up a desired mission such as cargo resupply.

Rather than traditional 'functional' user interfaces, which focus on direct control of specific payloads, platforms, and sensors, VERTI presents a context-aware, mission-specific interface that walks the user through the steps

required for a particular mission, while allowing him to make changes to critical parameters as the tactical situation changes in real time. According to LM Engineering Fellow Dr. Jeffrey Poulin, demonstrating the system on the unmanned LM K-MAX power lift helicopter "provides a framework for integrating and maturing next-generation control systems and technologies to rapidly deploy capability in a cost-efficient manner."

## EOD and Mine-Clearing

In conflict areas troops need equipment to remove UXO or IEDs from patrol routes, breach through minefields and in some instances remove hazardous or unstable munitions from inhabited areas. The Generation IV TALON EOD/CBRNE robot is a classic example, equipped with three high-resolution, IR-assisted cameras, a 300:1 pan/tilt/zoom camera mounted on a power mast, and two-way comms. CBRNE sensors can be monitored from the safe zone.

For reconnaissance inside buildings, sewers, and drainpipes, UGVs can reach into threat areas under and inside vehicles and can clear roadside IEDs out of harm's way. They can survey and analyse the device before and after the RSP (render-safe procedure) is applied. Portable X-ray systems on the UGV are used to produce radiographs of the bomb before intervention with the UGV then capturing, collating, and relaying information back to the ICP (Incident Control Point). Primarily designed as track vehicles with retractable arm claws and cameras, the bot has multiple disruptors to 'shoot' into the innards of the IED and prevent the main charge from being detonated.

Israel Aerospace Industries' (IAI) Ramta's Division is developing an unmanned ground penetrating radar sensor designed to detect deep buried and surface-laid mines and IEDs. The IAI Mines and IED Detection System (MIDS) has completed the last phase of engineering testing, with a tech-

*The IAI Mines and IED Detection System (MIDS) EO payload manufactured by IAI has day/night cameras to provide remote operators with situational awareness and to enable visual surveillance from a safe distance. (Photo: IAI)*



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nology demonstrator set to be ready for field testing by the end of 2014. The MIDS electro-optic payload manufactured by IAI has day/night cameras to provide remote operators with situational awareness and to enable visual surveillance from a safe distance. On-board navigation systems allow the vehicle to travel along a precise series of pre-programmed or operator designated waypoints and record and transmit the exact location of discovered threats.

MIDS will carry a remotely-operated weapon system slaved to the EO payload for self defence against enemy combatants or for detonating threats on the operator's command. The system will also be equipped with a small dozer blade able to clear obstructions, and a lane-painting-marking system for designating both a safe path for following vehicles and troops and for outlining the location of discovered threats.

## Small is Beautiful

The SIRE from Tactical Electronics is an example of a highly advanced, small multi-functional wireless robot ideal for surveillance, payload delivery, search and inspection, and IED RSPs. Designed for rapid deployment, the SIRE integrates detachable wheels, a removable camera head, and weighs barely 2kg – providing an ultra-thin, lightweight and stowage in a backpack. The robot's detachable all-terrain rubber tyres are accommodated in its own payload hold and the camera head can be attached to the base unit; the wireless video can be viewed on any tactical electronics monitor. The small remote is designed for single-hand operation through a reusable RF controller and has a transmission distance of 300 m.

ReconRobotics has developed a personal sensor system that is extremely lightweight, durable, and easy to operate. The 0.5-kg THROW-BOT XT (TXT) can be carried in a small pouch, deployed in five seconds, thrown up to 4 m through a window, onto a rooftop or over a wall - and with minimal training. Operating at very low frequencies, transmissions to and from the robot can propagate through walls and doors. An operator can direct the robot to move deep into a structure while receiving real-time video and audio signals on the handheld operator control unit. More than 4,000 TXTs have now been battle-tested and deployed by several foreign militaries, providing immediate situational awareness during high-risk operations.

## ... And so are Larger UGVs

Larger UGVs are needed to move and grab heavy items such as vehicle-borne IEDs. The iRobot WARRIOR has been developed with the US Army Tank Automotive Research, Development and Engineering Center (TARDEC) to offer greater lifting, carrying, and grabbing power, and for better dexterity to open and close doors. It combines a TARDEC-developed map-based navigation and can haul a payload of 68kg – often a PACKBOT to approach, investigate and neutralize IEDs – and lift up to 159 kilograms. It features a dual-track system with articulated flippers for enhanced mobility in aggressive terrain as well as urban environments.

However, slow-moving vehicles can be easily out-maneuvred and disabled by an enemy. The RIPSAN Military Spec 1 (MS1) unmanned tracked vehicle from Howe & Howe (H&H) for perimeter defence, surveillance, EOD, rescue, border patrol, and crowd control is designed to move rapidly alongside a convoy without obstructing its movement to secure suspected IEDs sites or respond to enemy ambush fire, and to tow immobilized vehicles out of the line of fire. Its multiple cameras provide continuous 360° coverage,



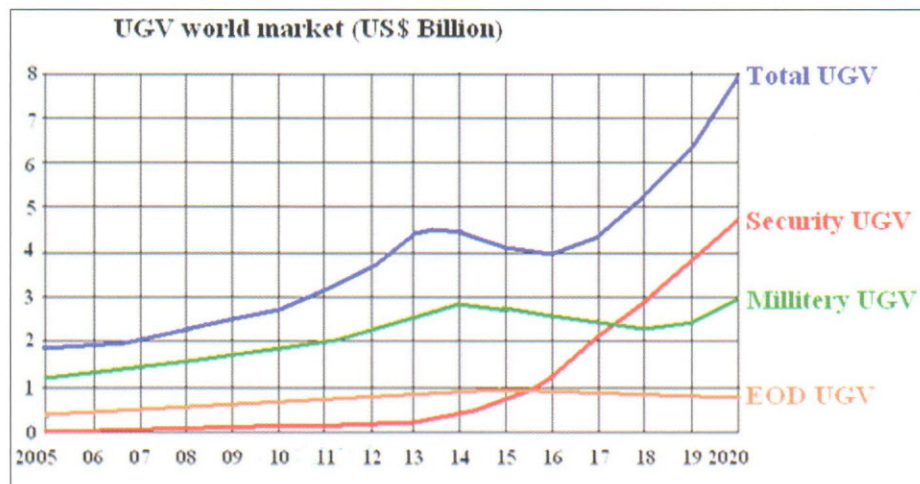
Designed for rapid deployment; the SIRE small UGV integrates detachable wheels, a removable camera head, and weighs under 2 kilograms. (Photo: Tactical Electronics)

providing the operator with constant situational awareness, and it can support an effective perimeter defence system. As a weaponised UGV for use in crowd riot control the RIPSAN can be integrated with multiple IED Modular Crowd Control Munitions (MCCM) charges mounted on a belt around the vehicle.

The Frontline Robotics TUGV (Tele-Operated Unmanned Ground Vehicle) has a 795kg towing capacity, sufficient to tow the largest IED 'battle wagons.' A 450kg payload capacity in the rear cargo bed provides the capability to carry mission-critical equipment to remote sites, and a 45kg payload capacity on the front deck enables the TUGV to carry optional CBRNE sensors and equipment.

For SWAT Teams, public safety, military law enforcement, and fire fighter reinforcement, and to explore dangerous areas relaying intelligence and reconnaissance information in real time, the Roboteam IRIS (Individual Robot Intelligence System) ultra-light weight, hand-deployable, extremely ruggedized hand-carried unmanned system can support several users entering above-ground and underground areas and confined spaces. Using cameras and a microphone, the IRIS operators are able to quickly access the hazards of dangerous

Market research has shown that the fear of terrorism is becoming the driving force behind the demand for UGVs while military commitment to unmanned ground systems appears to be slowing. (Graphs analysed from Wintergreen, Tactical Group and SIBAT)





situations from a safe distance in day and night operations. As with EOD robots, this makes the IRIS the first line of defence ahead of human or canine forces. The hand-carried system is controlled by the ROCU (Ruggedized Operator Control Unit) – a high resolution, handheld, touch-screen operator console with gamepad controllers.

## Further Developments

Nexter Robotics, a subsidiary wholly-owned by the Nexter Group, provides new solutions for the needs expressed both by France's Armed Forces and friendly forces abroad for small-scale robots capable of performing reconnaissance and C-IED missions for route clearance, while also offering new applications for civil security units. Both in France and abroad, working directly with customers and through its network of partners, Nexter Robotics is primarily focusing its activities on design, development, industrialisation, production, commercialisation, and technical support for both land-based and air/land hybrid robotic systems, together with all the associated components and mission modules. Nexter can also provide tailor-made engineering solutions to incorporate robots in existing weapon systems and infrastructures, and is developing licensing agreements as part of its activities. The first product in the Nexter Robotics line, the NERVA LG robot, was unveiled at EUROSATORY 2012 and IDEX 2013.

Oto Melara is focussing its Robotics R&D activities on designing original robotic systems able to perform routinely surveillance and patrolling tactical operations. Oto Melara is proud to offer a family of highly mobile robotic vehicles, both tracked and wheeled, which offer excellent performance in terms of their load capacity, speed, precision, and controllability. The UGVs, which are constructed around a precise modular architecture, can take on-board a range of actuators and sensors, which make the vehicles capable of the efficient undertaking of different missions. The family consists of a complete series of robotic platforms starting to the smallest 3kg 4-wheels TRP 3 – NEC to the biggest 200kg 6x6 PRAETOR passing through the EOD specialised TRP 1, the mines-detector light tracked dual-use platform both TRP 2 in military version and TRP 7 – HS supporting the Home Land Security Forces. Oto Melara's OTO TRP2 is the military enhanced version of OTO TRP7 – HS, it has been designed in order to be easily packed in three military back-packs and then reassembled within a couple of minutes. Its total weight is 60kg, 25 of them sensors or mission payloads. It can reach a maximum speed of 35km/h and its endurance is longer than four hours. The Control Ground Station, which is unique for all the vehicles, derives directly from Oto Melara's lengthy experience in the field of the Remote Control and ruggedisation of arms systems. The TRP 3 – NEC is a small, lightweight UGV equipped with six day/night cameras that

*The PIAP TRM can be thrown into a building or to an open area and steered by remote control in order to perform an inspection from a safe distance. The TRM's construction is designed to withstand the impact produced by a fall from up to 9 metres.*

*Shown: TRM robot and control panel.*

*(Photo: PIAP)*



*The Mobile Detection Assessment Response System (MDARS) surveys the area around the expeditionary airfield at Marine Corps Air Ground Combat Center Twentynine Palms, Calif.*

*(Photo: USMC / Cpl. D.J. Wu)*

fulfil ISR goals in order to enhance the operator's SA increasing his/hers safety. The robot can be employed for stealth recce missions, and is very rugged.

PIAP TRM is a small robotic device designed to deliver support for operations in difficult to access and dangerous places. PIAP TRM has been designed in response to the threats faced by forces responsible for public safety during area and objects reconnaissance. The small robot measures at 205x167x190mm, with 1.4kg + 0.16kg additional load weight, and can withstand the impact of a 9m fall.

## UGVs - A Highly Promising Technology of the Future

RUAG is researching, developing and investing in the UGV technology with the aim of gradually becoming a UGV competence centre for the Swiss Army and other security forces. RUAG is developing and delivering most of the UGV component groups in kit form. The kit is designed in such a way that it can be used with almost any vehicle. RUAG and General Dynamics Land Systems-Mowag (GDELS-Mowag) have teamed on a project to expand the mission capabilities of the EAGLE IV vehicle by introducing the retrofittable robotics vehicle kit. The kit enables vehicle tele-operation and provides operators with the capability to conduct either manned or unmanned operations, depending on the situation and threat. The system includes a Multi Purpose Sensor (MPS) head from Sagem, which provide day and night reconnaissance and surveillance capabilities while manned or unmanned.

## Science Fiction?

Can UGVs be used as fighting machines? Other than disruptive weapons for EOD, putting machine guns or missiles on a UGV has been controversial. The semi-autonomous 1-77-m-high Ripsaw MS2 is tele-operated from a nearby M113, with computer-assisted 'drive by wire' controls. It was weaponised by the US Army's Armament Research, Development and Engineering Center (ARDEC) and includes a remotely controlled M240 machine gun operated from a separate console installed in the control vehicle.

The long-held notion of ground robots as the 'war machines of the future' replacing some military personnel looms closer as military planners reduce force numbers, and as the robots become even more advanced. But it is also widely believed that the safety requirements and technology of autonomous UGVs are not yet mature enough for them to replace tank battalions or infantry brigades, or perform vital operations which only humans can do - decision making, diverse missions, obstacle avoidance, navigation, communication, and rapid adaptation to ever-changing combat situations.