

Robotics

Robot Wars

Many armies, and police forces, have long used unmanned ground vehicles to conduct hazardous explosive ordnance disposal (EOD) missions, but did not require the robot to be fast or particularly robust. This is soon to change as a new generation of fast, agile robots will be entrusted with a range of demanding missions such as surveillance, reconnaissance, attack and logistics support.

Ian Kemp

Whereas the EOD robot is typically deployed as close to the threat device as safety permits and is directly controlled by an operator the true military robot will have a certain degree of automation and will take the war to the enemy.

FCS Robots

The US Army's ambitious, multibillion dollar Future Combat Systems (FCS) project includes manned ground vehicles, unmanned air vehicles and large, medium and small unmanned ground vehicles (UGV). In September 2003 United Defense Ground Systems was selected by the FCS integrator team of Boeing and Science Applications International (SAIC) for the Phase 1 engineering study effort to design and develop the Armed Robotic Vehicle, the largest of the FCS robots. There will be two variants: the ARV-RSTA (also abbreviated as ARV-R) that will perform reconnaissance, surveillance and target acquisition (RSTA) missions, and the ARV-Assault (ARV-A) variant that will undertake direct and indirect fire missions under remote control in support of mounted and dismounted operations. The contract included a Phase 2 option to enter into Systems Development and Demonstration. Work on the latter phase will be performed at the company's facility in Santa Clara, California.

The ARVs will share a common 6 x 6 chassis powered by a four-cycle, six-cylinder diesel engine developing 217 hp. An electric drive hybrid motor can be fitted as an



French DGA's rendition of robots at work

[Home](#) | [Contents](#)

alternative. The ARV will be capable of accelerating from 0 to 48 kph in ten seconds, achieve a top road speed of 90 kph and have a range exceeding 400 km. On the vehicles a similar turret capable of traversing 180 degrees will be mounted. The target weight of 8.5 tonnes will enable two vehicles to be carried by a C-130 Hercules tactical transport aircraft or one inside a CH-47 medium transport helicopter. The vehicles will be constructed of titanium and protected by ceramic armour.

It is intended that the ARV will operate ahead of manned FCS vehicles, such as the Reconnaissance and Surveillance Vehicle, which will act as control platforms. Dismounted troops will also be able to direct ARVs. According to an army statement the ARV-R will remotely provide reconnaissance capability in urban military operations and other battlespace, deploy sensors, direct fire weapons, and special munitions into buildings, bunkers, tunnels and other urban features, act as a communications relay and assess battle damage. The ARV-R will have a five-metre telescopic mast mounting an electro-optical/infrared/laser sensor package, a multi-function Ka-band radar and a nuclear, biological and chemical warfare sensor. The ARV-R will be able to deploy unattended ground sensors from a launcher mounted on the turret roof. The vehicle will be armed with the XM307 25 mm Advanced Crew Served Weapon being developed by General Dynamics and carry 150 to 250 rounds of ammunition.

The AVR-A will “remotely provide reconnaissance capability, deploy sensors, direct-fire weapons, and special munitions into buildings, bunkers, and other urban features, locate or by-pass threat obstacles in buildings, bunkers, and tunnels, and other urban features, assess battle damage, act as a communications relay, support the mounted and dismounted forces in the assault with direct fire and anti-tank weapons and occupy key terrain and provide over-watching fires”, according to an army statement. The vehicle will be armed with an ATK Gun Systems Mk 44 30 mm cannon and a pod of four beyond-line-of-sight Common Missiles. The missile pod can be retracted into the turret for protection.

The company will deliver the first prototypes in 2010 with fielding to the first FCS-equipped brigade-sized Units of Action scheduled for 2012-2014. A typical unit will operate approximately 45 ARVs.



United Defense Ground Systems is developing the assault (left) and reconnaissance (right) variants of the Armed Robotic Vehicle for the US Army's Future Combat Systems. This is purportedly the world's largest UGV project. (United Defense)

In April 2005 United Defense received a \$ 30.9 million ARV contract from the US Army's Tank-Automotive Research, Development and Engineering Center (Tardec). The contract requires the company to integrate state-of-the-art unmanned platform technologies leveraged from army and commercial developments. The demonstrators will be used as a step toward transitioning technologies into the FCS ARV System Development and Demonstration effort.

Lockheed Martin is developing the 6 x 6 Multifunction Utility/Logistics and Equipment (Mule), a 2.5-tonne UGV that will provide support to FCS infantry units. The study phase, now underway, is anticipated to be worth \$ 200 million-plus. Three Mule variants based on a common chassis are being developed, the Transport Mule designed to carry equipment and supplies to support two dismounted infantry squads. It will also be suitable for casualty evacuation, the Armed Robotic Vehicle – Assault (Light) will be armed with a small calibre gun and four missiles to support dismounted infantry soldiers and the Countermine variant is designed to detect and neutralise mines and mark cleared lanes through minefields.

The Mule will have an advanced 6 x 6 independent articulated suspension coupled to in-hub motors powering each wheel. This technology will allow it to climb a 1.5-metre step, cross a 1.5-metre gap, traverse slopes greater than 40 per cent, ford water to a depth of 1.25 metres and cross obstacles as high as 0.5 metres while compensating for varying payload weights.

The smallest platform in the FCS family will be the man-portable Small Unmanned Ground Vehicle (Sugv) capable of operating in urban terrain tunnels, sewers and caves to conduct RSTA missions. The Sugv target weight is less than 30 pounds (13.6 kg)

with a modular 'plug-and-play' payload of up to six pounds (2.72 kg). It is intended to have an endurance of six hours and operate up to 1000 metres from the operator above ground and up to 200 metres away in tunnels.



US forces are using iRobot's manpackable PackBot UGVs in Iraq and Afghanistan for reconnaissance and EOD missions. (US Army)

iRobot had its funding boosted from \$ 37.3 million to \$ 51.4 earlier this year to expedite Sugv development. The Sugv will be a smaller, lighter successor to iRobot's PackBots that are in US service and consists of the Explorer, Scout and EOD models and have proven invaluable on the battlefield in Iraq and Afghanistan.

Marines Enlist Gladiator

In February 2005 Carnegie Mellon University's National Robotics Engineering Consortium, in partnership with United Defense, was awarded a \$ 26.4 million contract to develop the Gladiator Tactical Unmanned Ground Vehicle (Tugv) for the US Marine Corps. Six Gladiators are to be delivered by July 2007 for evaluation. A prototype delivered in 2004 has already undergone testing. The Corps could eventually buy as many as 200 Gladiators for a range of missions including RSTA, direct fire, obstacle breaching, nuclear, biological and chemical (NBC) reconnaissance, employment of non-lethal weapons and resupply. Planned weapon fits for the Gladiator include the Anti-Personnel/Obstacle Breaching System, the 7.62 mm M240G medium machine gun, the 5.56 mm M249 light machine-gun and the Shoulder-launched Multipurpose Assault Weapon. The 6 x 6 robot will be small enough to be carried by a Humvee allowing several to be carried inside an MV-22 tiltrotor, a CH-53 helicopter and the Marine Expeditionary Fighting Vehicle. In a press release Donald Smith, director of economic development for Carnegie Mellon and the University of Pittsburgh, noted "The United States Congress mandated that one third of all military vehicles be unmanned by 2015."



Lockheed Martin is developing a light assault (left), a countermine (centre) and a transport (right) variant of the Multifunction Utility/Logistics and Equipment (Mule) for the US Army's Future Combat Systems project. (Lockheed Martin)

Carnegie Mellon, in conjunction with the US Marine Corps Warfighting Laboratory, has developed the lightweight Dragon Runner Mobile Ground Sensor System that has undergone field trials in Iraq over the past several months. Weighing about four kg and measuring 39.4 cm long, 28.6 cm wide and 12.7 cm high the Dragon Runner has been designed to fit inside a marine's pack along with its handheld controller that incorporates a small screen. The robot's suspension system enables the Dragon Runner to be thrown through windows, up stairs or over walls. It also has a 'sentry mode' using its several on-board sensors to provide real-time imagery and audio alerts. It is intended for use at the squad, platoon and company level primarily for operations in an urban or desert environment.

French and German

The French Army's Bulle Opérationnelle Aéroterrestre (Boa) network enabled warfare concept includes the employment of UGVs and French industry has already gained experience with remote operation of armoured fighting vehicles. Giat received a contract from the DGA in August 2001 to develop the AMX 30B2DT (DT for Démineur Télé opérable) system that allows the remote ground operation of the AMX30B2 tank for mine clearance operations and has since supplied ten systems to the army. The remote control kit can be installed by the crew in less than ten minutes and allows them to direct the tank's mobility functions and the mine clearance tools from up to 1000 metres away. Giat has since developed an improved system that allows three operators in a wheeled VAB armoured personnel carrier to control three mine clearance vehicles up to three km away by day and night. Other improvements include the radio control link having been hardened against electronic warfare, the equipping the tanks with a navigation/location system intended to prevent collisions in the remote controlled mode and the adjusting the controls to allow the mine clearance tank to travel at speeds up to 28 kph. Giat is offering the system for installation in other vehicles.



The smallest platform in the Future Combat System family will be the 13.6 kg Small Unmanned Ground Vehicle (SUGV) now being developed by iRobot. (US Army)

Giat is teamed with Sagem and Cap Gemini on project Syrano (SYstème de Reconnaissance et d'Acquisition de cibles pour Neutralisation d'Objectifs) to develop a UGV that can be used for reconnaissance missions primarily in an urban environment. It will have an operating range of ten km and it will be capable of acquiring and designating targets for manned platforms. This project serves as a logical base for developing the capability planned for the Boa. The Boa graphics developed by the DGA illustrate a small reconnaissance robot working in conjunction with the manned 6 x 6 EBRC armoured reconnaissance vehicle that is being developed as the first element of the Boa system. The Army also intends to field at a future stage of the Felin project (see Computer Soldiers Byte In within this issue) a Hobot (HOMme – roBOT) to support dismounted infantry squads.



Giat's AMX30B2 remotely controlled tank is in service with the French Army for mine clearance operations. (Giat)

Eads-Dornier is conducting the Primus (Programme of Intelligent Mobile Unmanned Systems) technology demonstration project for the German defence procurement agency. The aim of the project is to develop and integrate advanced technologies for the operation of partially autonomous UGVs. A demonstrator has been running for more than two years based on the Rheinmetall Landsysteme Wiesel 2. To identify and avoid obstacles or dangerous areas a Dornier 3D laser scanner is mounted on the vehicle to scan the terrain in front and for the vehicle's computer to generate an obstacle map in real time, calculate the most appropriate route and guide the vehicle to that point. The Primus Wiesel is able to reach a speed of 30 kph cross-country and 50 kph on roads in autonomous operation mode. The vehicle can also be driven by a soldier.



Carnegie Mellon University, in partnership with United Defense, is developing the Gladiator Tactical Unmanned Ground Vehicle for the US Marine Corps. Six Gladiators are to be delivered by July 2007 for evaluation. (United Defense)

Israeli Security Missions

The Lahav Division of Israel Aircraft Industries (IAI) developed the Guardium autonomous security system for a wide range of military and civilian applications. Linked to a Main Control Center (MCC) the M-Guard vehicle is design to continuously patrol the perimeter of airfields, ports, military bases, pipelines and other facilities that require security monitoring. An unspecified number of systems are in service with the Israeli Ministry of Defence and officials have suggested these could be use to patrol the Gaza strip.



The Dragon Runner Mobile Ground Sensor System developed by Carnegie Mellon University for the US Marine Corps Warfighting Laboratory is the smallest military UGV in service with a weight of four kg. The robot has been optimised for use in urban environments. (US Department of Defense)

The first M-Guard configuration is based on the 4 x 4 Tomcar light all-terrain vehicle that is already used by the Israeli Defence Force and Border Police. The chassis can operate on and off roads and achieve speeds of up to 80 kph. It can carry a payload of up to 500 kg including a light armour shield to protect sensitive components. The M-Guard vehicle can be fitted with a range of sensors such as video and thermal cameras, a sensitive microphone, loudspeakers and radio. It can be armed with a variety of light weapons including machine-guns and grenade launchers for both lethal and non-lethal munitions. The MCC would typically control several vehicles and co-ordinate the response to an intrusion using M-Guards until a rapid response force could be

unmapped and rugged terrain.



Initially known as the Robot Wiesel 2, the Primus is an Eads Dornier technology demonstrator developed for the German defence procurement agency. Its 'eyes' are a three-dimensional laser scanner. (Eads)

In recognition of the wide applications and growing roles for UGVs QinetiQ, in November 2004, bought for \$ 163 million Foster-Miller in America, which specialises in the development of EOD robots. The two companies have been collaborating in the development of the Special Weapons Observation Reconnaissance Detection System (Swords) variant of Foster-Miller's Talon.

The tracked Talon was originally designed for EOD/IED missions and weighs less than 45 kg making it man-portable. It can be remotely operated up to 1000 metres distant. Since first being deployed with US forces in Bosnia in 2000 the Talon EOD/IED robot has performed more than 20,000 missions in Iraq and Afghanistan.

The Talon reconnaissance variant is lighter, at 27 kg, because it does not have an arm or gripper. It can be fitted with a variety of day/night sensors and listening devices. The Talon Swords can be armed with an M240 7.62 mm or an M249 5.56 mm machine gun, the Barrett 12.7 mm sniper rifle and other light weapons. Four Swords prototypes were used for evaluations in 2003 and 2004. A further 18 were shipped to Iraq earlier this year. In 2004 a Talon configured for chemical, gas, temperature and radiation monitoring was delivered to the US Army's Armament Research, Development and Engineering Center (Ardec) Fire Department for testing and evaluation.

[Home](#) | [To the top](#)

[Contents](#)

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