Increasing Unmanned Presence

Advancements in technology and wartime requirements are driving the demand for unmanned ground vehicles.

By Paul Broussard
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Unmanned ground vehicle (UGV) technology is being shaped by a confluence of events. While enhancements to these vehicles are being driven by technological innovation, these systems are also evolving through their expanding role in two combat theaters of operation providing invaluable lessons learned for the government/industry development teams and system operators.

'Robots in combat is the norm and they continue to proliferate.'

U.S. ground forces in Afghanistan and Iraq continue to face a long list of daily operational challenges including long and dangerous missions over varying terrain in hostile environments. While the department continues to invest billions of dollars to provide add-on armor kits for legacy ground vehicles, and deliver new and upgraded models of MRAPs to the two theaters, improvised explosive devices (IEDs) and other asymmetric threats continue to inflict significant numbers of deaths and injuries to vehicle crews and their passengers.

UGVs capable of supporting missions throughout the spectrum of ground operations, are seen as one way to selectively remove crews and passengers from vehicles on the battlefield, and thereby reducing injury and loss of life. The DoD/industry team is making incremental progress in delivering these vehicles to the operators.

Lt Col Dave Thompson, USMC

Marine Corps Lieutenant Colonel Dave Thompson, project manager, Robotic Systems Joint Project Office, told A&M that the department s growing fleets of UGVs are primarily being used in the maneuver and maneuver support roles by the Army and Marine engineer teams, and all of the services and coalition partners EOD teams. While the sizes vary from around 30 pounds for the Mini-EOD to over a ton for the MV-4, the services demand for unmanned systems is increasing as their benefits are proven over and over again, he added.

The employment of these UGVs in the two war zones has produced important lessons learned including the call for more power, lighter weight, better lifting capacity and greater quantities. We re working on improvements for the currently fielded robots and have other robots in the wings that will satisfy a lot of these demands in the near term and all of them in the long term, he added.

While Thompson was unable to discuss specific UGV limitations that U.S. forces have experienced, he pointed out the terrain in Afghanistan has presented many new challenges for the robot operators lessons that the industry team is responding to as will be described later.

The first of which is getting the robots to where they need to be, he said. While Iraq s road systems are well established and usually allow an easy approach to the robot s objective area, Afghanistan s terrain has demanded that the department field robots that the soldiers and Marines can carry with them on dismounted patrol. They have that now and are using it to great success (but they want more, of course). The line-of-sight issue is exacerbated by the variety of terrain in Operation Enduring Freedom, but some of our radio technology improvements have mitigated the impact. We are doing our best to react to the warfighters needs and incorporating the lessons learned from OIF and OEF into the robots we re planning to buy in the near term and long term, he said.

One important takeaway for industry from the department s UGV employment in Iraq and Afghanistan is the systems lessons learned are specific to those two theaters and should serve as only one data point along the development roadmap. Thompson

cautioned, However, we can never forget that our robots may eventually be used in a jungle environment or in the surf zone, so that makes our job in the acquisition community that much more interesting.

And it is the expanded use of UGVs which is helping to integrate them into the culture, and tactics, techniques and procedures of ground operations. Thompson pointed out, The greatest benefit from the lessons learned in theater that I m seeing is the day-to-day comfort with robotics that is being built. While it used to be the exception to find someone who had interacted with a robot on the battlefield, it is now becoming common. He concluded, The benefits are clearly evident to everyone from the man on point to the commander in the chain-of-command. Having robots in combat is now the norm and they continue to proliferate.

Larger Platforms

Oshkosh Defense, John Deere, and RC Rover are among the industry teams eyeing the department s insatiable appetite for UGVs

While Oshkosh Defense s UGV applications are still in developmental stages, the company has successfully demonstrated fully autonomous capabilities with its TerraMax autonomous vehicle system since 2003. A key design strategy allows the Terramax to be a kit that could be applied to any military vehicle. John Beck, chief engineer of unmanned systems for Oshkosh Corporation s Advanced Products Engineering division, pointed out that Oshkosh vehicles such as the USMC Medium Tactical Vehicle Replacement (MTVR) and U.S. Army Palletized Load System (PLS) enabled with the TerraMax system have performed countless test missions without human intervention, constituting thousands of miles in varying terrain and weather conditions.

TerraMax-equipped unmanned ground vehicles (UGV) have attained average speeds in off-road environments of greater than 20 mph (peaks up to 53 mph) on many of the longer missions. We have received financial rewards for the development of leading UGV technologies through the DARPA demonstrations and performed under contract for feasibility studies, Beck noted.

For its part, John Deere does not have a UGV program of record but its heritage product portfolio is incrementally gaining the capabilities of these vehicle systems. Some of the UGV technology building blocks have been refined for more than a decade and originate in agriculture and other business areas. When you look at the agricultural, construction and forestry-type environments, we ve been involved in robotics for 15-plus years, pointed out Mark Bodwell, group manager for business development, Military Affairs, John Deere. Specific competencies gained through the company s diverse customer base include auto-steering and other basic robotic skills, and GPS correction and placement of materials.

Mark Bodwell
John Deere

The company is blending these technology advancements with lessons learned from U.S. operations in Iraq and Afghanistan, into the R-Gator utility vehicle which was introduced in 2005. The R-Gator evolved from the company s proven M-Gator military vehicle platform which, on its own merits, has been prominently fielded throughout the department.

In late 2009, the latest R-Gator model was introduced. The vehicle design integrated the ground warfare community s lessons learned from the Afghan theater including how to transit on very rudimentary roads and trails. This R-Gator was fielded with an independent, 4-wheel suspension, improved ground clearance (11 inches), higher ground speed in manual operation (up to 35mph) and other enhancements.

The vehicle s curbside weight (approximately 1,600 lbs) and other characteristics make this a much more agile vehicle for off-road missions when compared to different MRAP and other DoD vehicles.

In addition to the man-drivable feature, the R-Gator has three other options: teach and playback (to record and follow up to six paths); tele-operational (similar to operating a remote control car); and fully autonomous. This last option is where you can set GPS waypoints and the machine will go off and execute autonomously, said Bodwell.

Squad-level Support

Lockheed Martin Missiles and Fire Control is developing its new Squad Mission Support System (SMSS), leveraging robotic technologies for future robotic weapons systems. SMSS has successfully participated in two U.S. Army evaluations at Fort Benning. The first was Army Expeditionary Warrior Experiment, Spiral E in November December of 2008. The second was a Military Utility Assessment conducted in August 2009. As part of these two efforts, the SMSS was awarded three government safety releases to be operated by and around soldiers, in both remote control and autonomous modes. The SMSS is scheduled for advanced user testing in Afghanistan in 2010.

Funded entirely by Lockheed Martin as an independent research and development project, SMSS will provide manned and unmanned transport and logistical support light and early entry forces, in particular of the U.S. Army and U.S. Marine Corps.

The SMSS is a robotic platform based on a turbo-diesel powered, high mobility six wheel all-terrain vehicle (ATV) capable of carrying 1,000 pounds (453 kg) of payload. Current platforms are utilizing a commercial platform converted for a surrogate SMSS vehicle. Future versions will utilize specially designed platforms, optimized for the SMSS mission.

The SMSS will decrease the amount of time a warfighter has to spend in controlling robotic systems by providing vehicles with a greater perception of their surroundings on the battlefield, said James Gribschaw, director - Combat Maneuver Systems at Lockheed Martin Missiles and Fire Control. Combining perception with extraordinary mobility will allow vehicles to follow the warfighter, without remote control commands, across any terrain, ensuring the payload the robotic system is carrying is available.

SMSS was first developed in 2006 to support a TARDEC contract. The first versions possessed primitive waypoint following, had no navigation sensors and required a human operator onboard for safety purposes. Over time, successive SMSS variants eliminated the need for a human onboard, and have been given enhanced capabilities for autonomous navigation, behaviors and obstacle avoidance without direct remote control. SMSS is also being evaluated for firefighting, first responder, power generation, and logistic duties which can take advantage of its ever growing autonomous capabilities.

In all modes, SMSS autonomously avoids obstacles and people, said Gribschaw. If confused, SMSS sends a message to the operator, requesting assistance. Control hand- over between controller units is easily accomplished, permitting units to send the SMSS back and forth for resupply missions, for example, he added.

The SMSS operator control unit consists of a vest containing the computer, batteries and antenna, and a control/display unit. As desired, the unit may be carried in the standard modular lightweight load-carrying equipment (MOLLE) system.

Solving Technology Hurdles

Some of the vexing challenges of operating a UGV in an autonomous, and even a tele-operational mode, are obstacle detection and obstacle avoidance.

Oshkosh and John Deere are actively engaged in developing solutions to these and other technology hurdles.

Oshkosh is extending developed capabilities with respect to perception and autonomous behaviors required to operate safely in a tactical environment for applications such as convoy/logistics missions and route clearance.

A convoy consisting of unmanned vehicles can serve as a force multiplier, enabling a single operator riding in a protected escort vehicle at safe standoff distance, to supervise the operation of multiple vehicles in a coordinated manner. In this scenario, Beck pointed out These unmanned logistics vehicles have the capability of maintaining an established vehicle separation, effectively eliminating the slinky affect when accelerating or decelerating, enabling tighter formation for greater security, improved efficiency and reduced accidents. They also have the capability to operate for extended periods of time, day or night, and in dust-laden environments without fatigue or loss of awareness, but most importantly if the UGV is destroyed by an IED, our warfighter lives to see another day.

To overcome the challenges of obstacle detection and obstacle avoidance, John Deere mounted two forward looking and one rear-looking laser range sensors on R-Gator to help avoid positive obstacles (person, vehicles and other material) and negative obstacles (ditch, cliff or other feature). We have the ability to read obstacles as small as a brick or as large as a building, added Bodwell. These and other on-board sensors help the autonomous vehicle think about options when it encounters an obstacle: slow down, go around or over the obstacle, or take other actions.

Man Portable Systems

Man portable UGVs have been the U.S. DoDs platform of choice to keep operators out of harms way during mine countermeasures operations, IED tasks, close quarter surveillance, and other missions. RC Rover s Rev9 family of UGVs represents one group of state-of-the art vehicles in this class.

The Rev9 vehicle line ranges between 35-52 lbs in weight including payload and in the ready- for-operation mode. Anything lighter than 30 lbs has proven unstable for severe tactical usage, while heavier than 60 lbs has proven to be an excess burden for man-portability and limiting maneuverability, Amir Sepahban, founder and CEO, told A&M.

While lighter than other unmanned UGV siblings in the departments growing inventory, the Rev9 is no lightweight in an operational mode. The vehicle can be field-upgraded to reach speeds of up to 38 miles/hr while slowing to maneuverable accuracy of one linear inch per minute at the same time. This is a first in the industry, said Sepahban.

Expanding the Mission Envelope for Small and Large Vehicles

RC Rover is also completing some cutting edge work in exploring the frontiers of UGV size and utility.

One internal R&D project consisted of a Rev9-18 carrying a micro-Rev9 (5-in x 4-in x 1-in). The micro-Rev9 was operated by the Rev9 Commander software but was limited to Bluetooth connectivity. Sepahban explained the command and control of the micro-Rev9. The micro-Rev9 was carried under the belly of full-scale cousin, the Rev9-18 and was released when access to tighter space was required. A micro-wireless cam was installed onboard the micro-Rev9 and both Bluetooth operation and visual tasks were bridged through full-scale Rev9 through the micro-version. In this manner we were able to launch a tiny product at a distance of over 500 ft to allow for further surveillance of tight spaces ahead.

RC Rover has also demonstrated the versatility and utility of man-portable UGVs in evolving missions. In one project the company designed a dock-station and custom built a four propeller, self-leveling UAV to launch from the UGV. The initial UAV had a slightly larger footprint than the Rev9 and was suspended five inches atop the UGV. A testing regimen, which included 7 out of 10 successful landings, encouraged RC Rover to scale down the size of its UAV to improve the landing features and the overall UGV/UAV footprint.

Based on its efforts, Sepahban concluded that size holds no barriers when it comes to UGV or UAV usability. He added, While the smaller UGVs are limited to overcoming obstacles, they serve great purpose for site survey on manageable terrain.

The R-Gators progress also continues to expand the mission envelope of UGVs. At the 2010 AUSA winter symposium, the company introduced the EZY-Lift capability allowing the vehicle to embark, transport and debark smaller EOD UGVs and similar loads. We can take the smaller ground robots up to our tray, lift it autonomously into the back of the R-Gator, it has a 1,400 lb capacity. We can take the smaller bots and deliver those to an urban site to where they want to clear buildings with them. They can then extend their communications range using the R-Gator to clear the buildings. We ll do a perimeter security [tour] around the village, go back, pick them up and return to homebase, explained Bodwell.

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