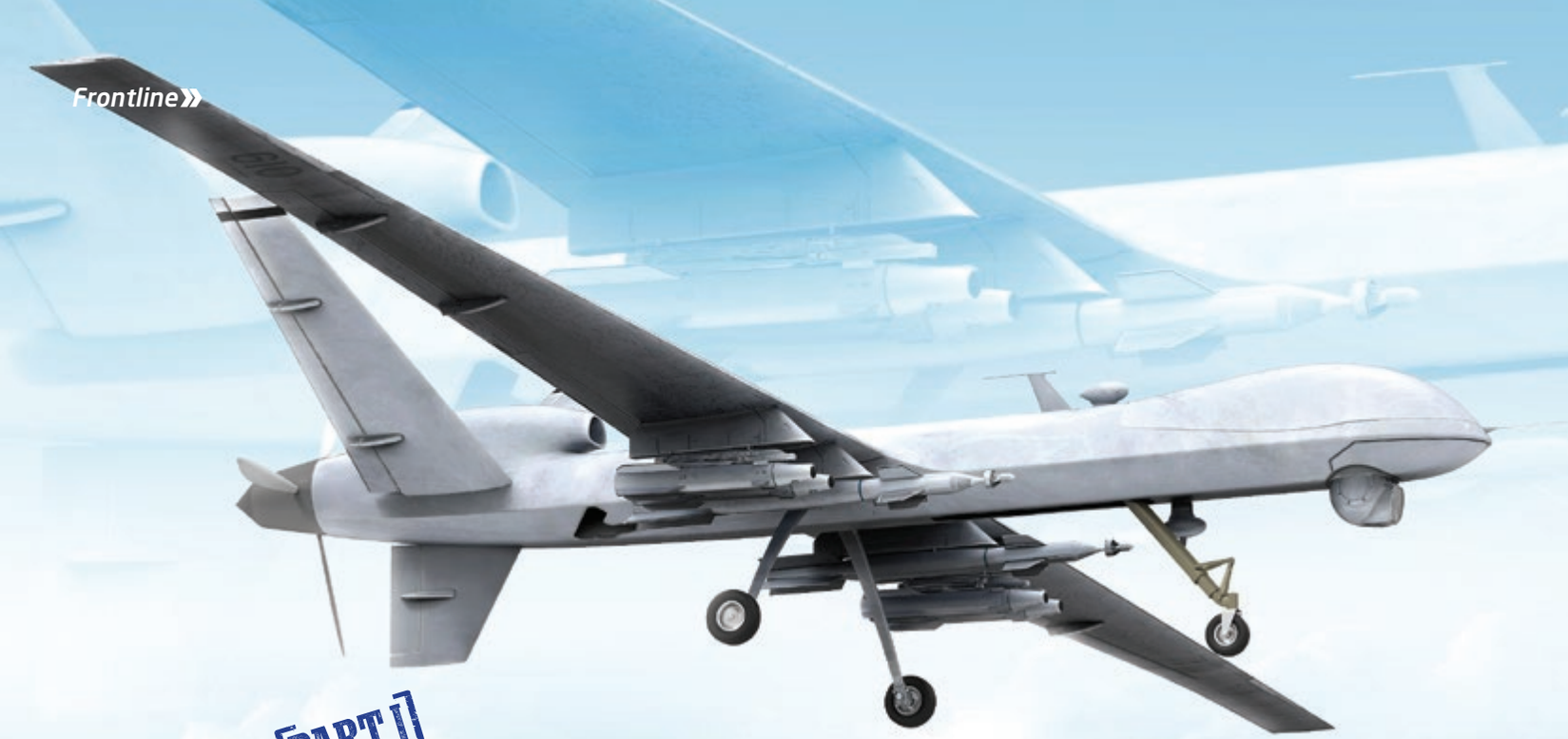

[PART I]

Unmanned vehicles: Enhancing security, rescue and natural disaster management capability

Unmanned ground (UGV), maritime (UMV) and aerial (UAV) vehicles offer increased capability in security missions, rescue operations, and the management of natural disasters. State border protection demands monitoring very large areas during an extended period of time. The US Customs and Border Protection (CBP) agency uses six Predator UAVs to patrol the southwestern and northern borders of the US. In Europe, the FRONTEX agency responsible for border security of Schengen member States supports the relentless monitoring of the northern coasts of the Mediterranean using unmanned aircraft in view of the current political climate in North Africa.

By
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Instead of sending first responders directly to the potentially hazardous site of a disaster, unmanned vehicles can explore the area and collect valuable information without risking the lives of rescuers. Furthermore, vehicles equipped with sophisticated sensor systems detect hazards earlier and much more reliably than humans. By combining the capabilities of an experienced rescuer with those of a remotely operated vehicle, a powerful system is created that can deal with a large variety of security threats and dangers.

In the aftermath of severe natural disasters such as earthquakes, hurricanes, and tsunamis, soldiers and rescue teams are deployed to provide humanitarian assistance. Rescue teams benefit from rapid intelligence and analysis of the situation, which is best provided by robotic platforms that are versatile, have long endurance and provide live imagery essential for the movement of rescue teams and the safe transportation of vital equipment, food, drinking water and medical supplies.

In this article, we review the current capability of robotic UGVs, the need for integration of UMVs into current manned operations, and the critical role of UAVs to increase security and rescue efforts, and conduct effective surveillance of large geographical areas.

Adaptation of robotic UGVs to increase security and rescue efforts

There is an ever-increasing threat and need to improve security methods to prevent Improvised Explosive Devices (IEDs), suicide bombers, car bombs, and nuclear/biological/chemical devices being used against both military personnel and civilian targets. As the techniques being used to emplace IEDs are constantly evolving, there is emerging a growing need for a system capable of remotely removing rubble, which might be covering/concealing these devices, and clearing paths to reach these devices, which might otherwise be inaccessible. In addition, when severe natural disasters such as earthquakes, hurricanes, and tsunamis occur, soldiers and rescue teams are often called upon to provide humanitarian assistance. Thus, soldiers and rescue teams need a mobile robotic platform that is simple, versatile, and easy to transport. To support these needs, unmanned ground vehicle platforms must be quickly adapted to support a wide range of uses; specifically generator power, lights, powered tools, security sensors, camera systems, debris removal, and other.

Robotic systems assist security teams

Currently addressing this need, soldiers and civilian security teams are using on-site roadblocks, vehicle inspections, and inspecting rubble and debris piles for concealed IEDs. Unfortunately, with the ease that IEDs can be placed in a car, hidden adjacent to the road, or on insurgents themselves, these soldiers and security teams are easy targets, thus the potential is great to lose many personnel. With the increasing threat there is a need to put into place a robotic system to remove soldiers and rescue teams from this threat and provide a physical and visual deterrent to the insurgents that also allows the insurgents to be easily and safely captured. Adapting a robotic multi-task ground vehicle that remotely uncovers potential explosive hazards will allow the application of other systems and techniques to perform neutralisation of such improvised weapon systems. In addition, such robotic vehicles will be able to clear small rubble/debris from a route after determining whether it contains an explosive hazard, to avoid impeding the movement of ground forces or leaving a location suitable for concealing an explosive hazard. Such designs can be controlled with a series of manual, robotic, or autonomous control systems.

Search and rescue UGVs

There is a constant world threat of dangerous and damaging storms, earthquakes, tsunamis, hurricanes, tornados and other natural disasters. Compounding this is the disastrous situation to the population after the initial event. Such problems often include lack of water, food, communication, transportation, medical assistance, and much more. When these events happen there is a call for international support, which military and first responder teams immediately mobilise to help. Such events occurred recently in 2013, in the Philippines and the USA. Therefore, having a series of multi-task ground vehicles can quickly support a wide range of needs. In addition, such vehicles can provide psychological support to the rescue teams and local population, plus augment security to help prevent looting. Other disasters, such as underground fires and mine accidents, can also benefit from a versatile multi-task vehicle; for there is a need in the world to support miner safety, mine rescue teams, and the addition of escape vehicles to rescue trapped miners. In addition, there is a need to support the removal of landmines from abandoned war zones. Current estimates place the number of landmines scattered around ex-conflict zones at more than 100 million. These landmines are deadly to the local population. A multi-task vehicle design must be able to support detection, marking, and removal of such devices. The vehicle should also have the means to be used as a construction tool to support local rebuilding. In addition, such designs should help wounded soldiers who have lost legs and arms due to IEDs. Specifically, with both manual and robotic controls the commercial vehicle should be used as a construction tool that will help these soldiers regain community re-integration and quality back into their lives.

Robotic and manually controlled fire fighting vehicle to support first responders (ARGUS Robotics, USA)

Robotic and manually controlled underground vehicle to support mine rescue and escape teams (ARGUS Robotics, USA)

The ARGUS robotic vehicles

Modifying a current Commercial on the Shelf (COTS) vehicle and developing the necessary unmanned system control capabilities, presents the quickest and least expensive method of meeting such needs. Multi-task ground vehicles

Robotic and manually controlled ground vehicle equipped with a landmine detection wand to support humanitarian demining (ARGUS Robotics, USA)

"With the need to support miner safety and the poor performance of existing rescue systems, these UGV design components and techniques make a viable system. The vehicle can be used for mine rescue, and includes a series of indicator lights that are set to warn of dangerous levels of gases such as oxygen, methane, carbon-dioxide, carbon-monoxide or others."

have been designed by ARGUS Robotics (USA) to support military use, rescue, transport, and explosives detection and removal. These multi-task motorised vehicles include a vehicle body with a rigid frame on a wheeled platform. The vehicle includes a rotary mounting platform on top of the vehicle configured to interchangeably mount and remove various secondary systems or components, thereby permitting the multi-task motorised vehicle to change functions. The secondary systems include at least one of a high performance gun platform, a missile platform, a speaker platform, a multi-light platform, a UAV launch platform, a robot arm, a multiple imaging platform, or a multiple gun platform, for military applications. Secondary components may also include a robot arm, an imaging platform, a camera, a waterspout, or an oxygen tank for use in mine rescue and firefighting situations. The vehicle includes a jib crane for mounting and demounting the secondary systems to and from the vehicle. Other features and configurations of the multi-task vehicle concept include a front end loading bucket; backhoe bucket mounted to the rear; a set of controls for manual operation of the vehicle; indicator lights that warn about dangerous levels of toxic gases; a tandem set of levers to recover the vehicle when the vehicle has flipped over due to terrain or an explosion; a plurality of modular internal compartments including oil system, fuel system, drive system, or engine compartments; and a multiplicity of upstanding threaded mounting studs.

With the need to support miner safety and the poor performance of existing rescue systems, these UGV design components and techniques make a viable system. The vehicle can be used for mine rescue, and includes a series of indicator lights that are set to warn of dangerous levels of gases such as oxygen, methane, carbon-dioxide, carbon-monoxide or others. The ARGUS design supports performance components and designs from other industries, such as dust containment chambers for electronic functions that could be applied to dust problems with military vehicles. The design can advance wireless communication systems to support underground mine use for personnel location during a mine accident, as well as advance the design of maintenance systems that support other engineering industries.

To support humanitarian demining, a standard commercial vehicle has been converted into a fully robotic control vehicle. With a dual set of controls, manual and robotic, the vehicle can be used as a true construction device to help with the general needs of the region, and then quickly adapted to assist technicians to find, mark and remove buried explosives or similar devices. The vehicle is small compared to a bulldozer, it can be easily transported to remote geographical regions, and with the ease of operation and repair, it requires no specialised technicians. This capability increases the amount of land that can be cleared of landmines per day. To support wounded soldiers the ARGUS backhoe loader is a fully functional construction vehicle that was modified at the request of the US Department of Defense (US-DoD). One of the Key Point Parameters (KPP) is that such a design has operator controls that can quickly be switched between robotic and manual, in less than ten seconds. The major benefit is that an amputee soldier can control the vehicle's function from his or her wheelchair or from the operator's seat within the vehicle. Once trained, such operators can become private contractors and offer services to support general construction and earthwork.

An important feature of the ARGUS designs is the interchangeability of vehicle components between industries to support changing needs. Such interchangeability increases performance. One example is adapting the electrical control system to meet the required standards for underground mine vehicles so as to eliminate dust damage. In addition, the ARGUS design serves as an educational platform presented to engineering and technical colleges to teach students the functions and operations of hydraulics, electro-hydraulic control systems, robotics, steering systems, and wheeled vehicle design. The most important aspect of the ARGUS design philosophy is to support imagination, creativity, and innovation to meet ever changing needs in a wide range of security, rescue and humanitarian applications. ■

In our next issue (Apr/May 2014) we bring you Part 2 of this article, commencing from: Integration of UMVs into current manned maritime security and surveillance operations.

About the Authors

John Cunningham is the Owner and Founder of Area Reconnaissance Ground and Urban Support Robotics (ARGUS), USA. John received his BS degree from West Virginia University in Mining Engineering and MS Degree from Marshall University in Technology Management-Manufacturing. For 24 years John oversaw design and manufacturing of thousands of wheeled and tracked commercial construction vehicles for domestic and international markets. The US Department of Defense approached John requesting commercial vehicles to be made in both manual and robotic functions for anti-IED efforts. Such vehicles were quickly made and exceeded all key point parameters. From this request a series of vehicles have been designed on a common platform to meet a wide range of security and humanitarian needs around the world.

Dr Pascual Marqués is the Owner and Executive Director at Marques Aviation Ltd (UK) and the International Director (United Kingdom) of Unmanned Vehicle University. Dr Marqués is an expert in Aerodynamics and Flight Stability. At Marques Aviation Ltd he oversees the design and manufacture of novel fixed-wing and rotor unmanned aircraft developed by the company. Dr Marqués acts as the Chair for the World Congress on Unmanned Systems Engineering (WCUSEng) and the International Aerospace Engineering Conference (IAEC). He is also the Editor-in-Chief of the International Journal of Unmanned Systems Engineering (IJUSEng). Dr Marqués regularly lectures in Aerodynamics and Numerical Analysis at Unmanned Vehicle University where he is a member of Faculty.