Fiber Optics and Robotics: **Saving Lives on Hazardous Missions**

Ruggedized, tactical-grade fiber-optic cable provides control and monitoring of robotic UGV equipment, enabling life-saving functions over surprising distances.

While the UAV—unmanned aerial vehicle—has been much in the news for its use in military operations, much less attention has been given to its Earth-bound counterpart, the unmanned ground vehicle or UGV. The device allows front-line military troops and civilian first-responders to operate at a safe distance when dealing with hazards ranging from roadside bombs to toxic mishaps—often via fiber-optic cable-controlled robotic equipment. In a growing number of applications where secure communications and full-motion, real-time video are concerned, engineers and manufacturers of advanced robotics are incorporating another sophisticated technology—ruggedized fiber-optic cable.

With proven capabilities in broadcasting and remote controls of mechanical equipment, fiber-optic cable is used in diverse applications ranging from the "flying" TV camera to mile-deep mining operations where robots perform jobs that are too risky, time-consuming or difficult for humans to perform.

Photo courtesy Dept. of Defense

A robotic systems engineer conducts a systems check of a robotic UGV before making it available for test training with US Marine Corps infantrymen.

"We are trying to apply technology so that people who are in the front lines of dangerous occupations have a way to do their jobs in a safer manner," explains David Timian, vice president at Applied Research Associates (ARA; Albuquerque, NM). ARA provides advanced research, engineering, and technical support for military, research, homeland security, commercial and industrial markets. Among the more sophisticated products the firm designs and manufactures are specialized robotic vehicles.

Mission-Critical Operational Requirements

Serving markets such as transportation, military, homeland security and aerospace, ARA products incorporate multiple advanced technologies. For example, ARA is currently testing a new demining system called the Nemesis, a remotely operated rubber-tracked, skid-steer loader with onboard sensors and equipment designed to detect, discriminate, and mark antitank land mines. ARA developed Nemesis in conjunction with the US Army's RDECOM CERDEC Night Vision and Electronic Sensors Directorate (NVESD) in Fort Belvoir, VA, and earned high marks during an initial operational test in Cambodia.

The Nemesis detection system includes an electromagnetic induction metal detector array combined with a ground-penetrating synthetic aperture radar array that is capable of detecting low-metal antitank land mines and some antipersonnel land mines. The Nemesis modular robotic control system provides independent command and control of the demining payloads, such as ordnance clearing or area preparation tools.

ARA's other innovative tactical systems include an 8000-pound-class (3600-kg) UGV for handling unexploded ordinance. This includes land mines, IEDs (improvised explosive devices) car bombs and sub-munitions such as the cluster-type explosives that military aircraft drop on airfields.

"Our vehicles are used by the US Air Force and Marines to clean up unexploded sub-munitions and other ordinance," Timian says. "For a number of reasons we need to be able to use an FCCS [Fiber Communications and Control System] to control the vehicles and to also provide for on-board, remote video monitoring of the environment from the command post."

These fiber-controlled unmanned systems are a solution for situations where radio frequency (RF) connections are not viable due to non-line-of-sight conditions, local RF jamming, or when security conditions call for closed communications whereby information is transmitted directly from the operator to the robot and back.

These ARA vehicles are equipped with a reel-like system containing ruggedized fiber-optic cable produced by Optical Cable Corporation (OCC; Roanoke, VA), a manufacturer of advanced fiber cable. OCC's line includes extremely strong yet lightweight tight-buffered cables designed for military tactical field use and commercial applications.

"Our FCCS features a unique tension system that allows the cable to be paid out and retrieved smoothly and automatically," Timian says. "So, the operator doesn't have to pay particular attention to the path of the cable, except they have to follow the direction of the fiber cable when bringing the robot

Photo courtesy ARA

The Nemesis Demining System.

home. Our vehicles have up to two miles of cable on them, so they can be operated at a long distance away from a hazard and still have full operational capabilities."

Timian adds that due to the resiliency and flexibility of the fiber cable, an ARA robotic vehicle can travel over rough terrain, around bends and even navigate overlapping ramps of a multi-story parking garage. This ability is also facilitated by the cable system, which automatically maintains practically zero tension in the cable.

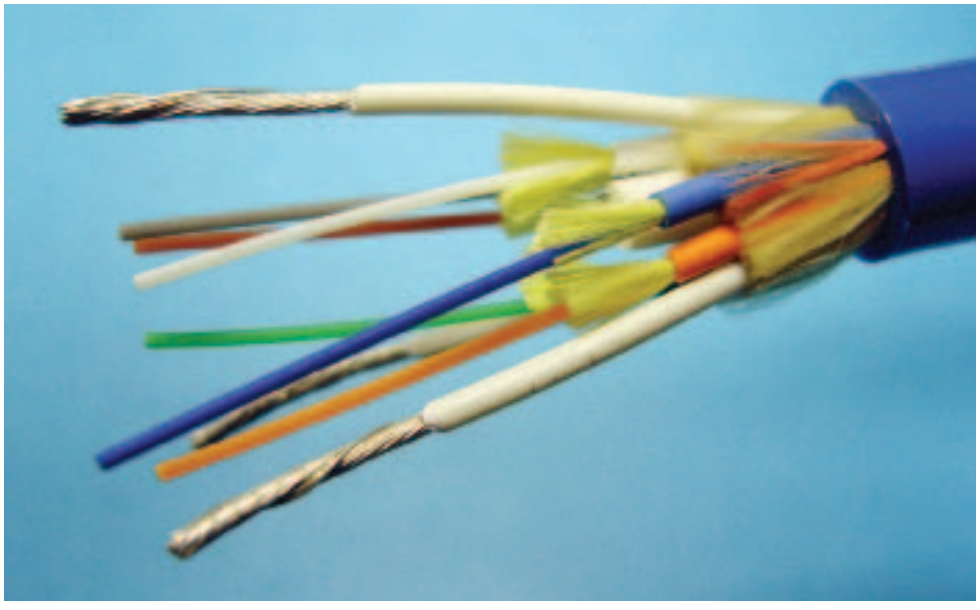
These vehicles are equipped with various tools needed to locate and dismantle unexploded ordinance. Multiple, multiplexed cameras are mounted on top of the robots, allowing the base station operator a variety of views from which to steer and perform dismantling operations.

Going Where No One Should Go

The use of ruggedized fiber-optic cable to operate robotic equipment in harsh environments originated with the development of armored, tactical-grade fiber cable developed by OCC for battlefield applications. This cable can survive not only rough handling by installers and operators, but will also withstand the crushing weight and abrasion of heavy equipment such as battle tanks running over it.

"Once I got started with robotic applications, I quickly saw that many of them share requirements and characteristics that were best served by ruggedized fiber cable," says Don McEvoy of Allied Data Communications (Portsmouth, NH), which serves the fiber cable needs of ARA and several major defense contractors. "The distance, multiplexing capabilities and ruggedness of the fiber are critical in the various arenas where robots are operated."

"This type of cable is ideal for use in hazardous or harsh environments as well as where deployment and retrieval for reuse is required," McEvoy explains. "A specially formulated sheath combined with advanced fiber core buffering allows OCC's product the ability to withstand crush, abrasion, cut and chemical damage, which are attributes needed in a wide variety of robotic applications."



A sheath combined with fiber core buffering allows the cable to withstand crush, abrasion, cut and chemical damage.

McEvoy adds that tight-buffered construction is also a significant feature of this ruggedized cable. OCC pioneered the development of tight-buffered cables for the most demanding military field applications in the early 1980s. Much easier to work with than its counterpart, "loose tube" cable, OCC's plenum-rated tight-buffered cable is designed for use indoors and outdoors, and overcomes the need to make splices, thereby enabling a much cleaner and quicker installation. When installed, this cable design eliminates the need for build-up or break-out kits and reduces optical splice loss and potential link failures.

"The **multiplexing capabilities and ruggedness** of the fiber are critical."

The markets and applications include aerospace, deep-sea exploration, military, security, law enforcement and a growing range of industrial and commercial applications. Most of these applications depend on the superior survivability and communications features of ruggedized and robust fiber-optic cable.

"When it comes to robotic applications, ruggedized, tactical cable is our number-one product," McEvoy says. "It gives you a mission-critical direct connection, with the ability to unleash large amounts of bandwidth to engage a robot into complex mechanical operations, instrument readings, high-quality sound and high-definition full-motion video." ✈