RIRAK Whitepaper Short

Executive Summary

By utilizing Rapidly Installable, Robotic Appliqué Kits (RIRAK) as the initial volume-deployed unmanned ground vehicle system, the U.S. government can immediately achieve the 2001 Congressional mandate of 1/3 operational ground combat vehicles unmanned by 2015. Nearly a decade and a half after the mandate, soldiers are still being killed / injured performing tasks that could have been done by a robot. The Kairos Autonomi Pronto4 Uomo (a RIRAK) exists right now and would allow commanders to remove Soldiers from harm's way through a 10 minute installation within an already deployed wheeled vehicle. The current RIRAK can be improved over time through dedicated R&D from TARDEC, MCWL or other DoD agencies. This white paper presents the case for the RIRAK approach and its near immediate availability for usage in achievement of the 2001 mandate while providing a viable choice for removing a soldier from harm's way.

It's 2015

Back in 2001 Congress mandated that 1/3 of ground combat vehicles be unmanned by 2015. It wasn't a passing fad as the request was refreshed in 2006 and 2008. A congressional report was required in 2006. All of this detail is available through a quick web search. DARPA responded to the mandate through the novel usage of a national competition series called the Grand and Urban Challenges. These challenges provided a means of rallying men and women around a common focused goal and clearly reduced the liability of unmanned ground vehicle operation in life-like scenarios. Effectively DARPA jump started the unmanned ground vehicle industry by providing real scenarios where the best of autonomous operations could be exercised – they controlled the environment and the technology flourished.

The basis of the goal is rooted in the simple desire to take Warfighters out of harm's way, improve efficiency and reduce manpower. Tasks that are dangerous, tedious, or requiring less than 100% focus of a Warfighter are prime candidates for robotic replacement or assistance.

The primary challenge is such that any system deployed has a significant potential risk that it will hurt or kill innocent people because the system cannot recognize them. There is no effective people sensor. Visually there is no effective scene comprehension or dynamic intent determination.

Technology Advance

There are a significant number of institutions, domestic and military, moving the unmanned ground vehicle technology forward. There will be and are hundreds of millions of dollars and man hours dedicated to the development of autonomous systems in the commercial and industrial world. Surviving standards will be those embraced by industry. The U.S. Military will benefit greatly from the massive industrial effort underway. In fact, it is very challenging for the U.S. military to fund and direct that development because of its small market size and available funding levels. The focus today should be on rapidly fielding systems that can be immediately used to remove a Soldier from harm's way.

The technology is in a high state of flux. Any desired robotic system will be outdated before it is tested and fielded because of the rate of advancement in the field. Many approaches for a solution to similar problems are in play. Since the correct approach, because of fielded system experience, is not known prior to fielding, competing approaches will be assessed based upon cost, achievement and politics.

Additionally, since large vehicle robots have never been fielded in any number, the actual usage and utilization of these systems by Warfighters is unknown. So what is designed and developed at the base of the sword will most likely undergo significant requirement change at the tip of the sword.

The actual percentage of time that an optionally unmanned ground vehicle is performing robotic operations is very small. Eight hours of operation in a week is less than 5%. The cost of committing an existing vehicle, implementing standard unmanned ground vehicle (UGV) capability and delivering that vehicle to the point of need and usage can be staggering for 5% of its usage.

Installation

It is very clear that the cost of deploying new vehicles, designed from the ground up as robots is far too costly because of all the unknowns associated with robotic operations.

Drive-By-Mechanics, as opposed to Drive-By-Wire are still the most reliable and forensically deterministic method for the operation of ground vehicles. The U.S. military relies heavily on domestic vehicle manufacturing technology for the creation and production of its tactical military vehicles. It's about cost, supply and reliability. If the domestic market can absorb the cost of high volume vehicle manufacture, the military must leverage the domestic approach when tactical vehicle decisions are made.

The best approach is an appliqué kit that attaches to an existing vehicle platform and utilizes as much of that vehicle's DOTMLPF (Doctrine, Organization, Training, Materiel, Leadership & Education, Personnel, and Facilities) as possible. This assures continued support and deployment of the baseline vehicle system.

A further challenge comes in the form of the installation of the appliqué kit in the vehicle. Installations that require tight integration with the vehicle take time and expertise to achieve. Therefore, installations that take time must commit the vehicle to be a UGV. Once a vehicle is committed to be a UGV, it then must be managed as a UGV. It must be positioned where it can be most effective. Since its effective usage has many locations it must be positioned in a number of places at once; many copies of the appliqué based UGV must be made available and delivered. Furthermore, it is highly likely that a tightly integrated appliqué kit enabled UGV will NOT be in the right place at the right time because of installation time.

The focus of the Rapidly Installed Robotic Appliqué Kit approach for a UGV is to place a robotic asset in the seat where a man sits to operate a vehicle. This RIRAK operates controls and senses the world in similar fashion as a human driver of the vehicle. Its initial complexity is low because it is a tele-operated system requiring a remote human operator. Simple automations help improve efficiency of the system.

Entry operation includes proper operation of throttle, brake, steering and transmission. Advanced operations grow with the evolution of the kit and not the vehicle. Internally facing cameras read gauges and present that information to a remote operator. Externally facing non-mechanical cameras with inherent pan, tilt and zoom capability provide visual feedback for vehicle operation.

The initial goal of the RIRAK approach is to provide a platform for a man to operate a vehicle without being placed in harm's way. This is a Soldier-In-The-Loop approach where various levels of supervised autonomy can be directed by the Soldier through decisions based upon real time information fed back from the vehicle and the RIRAK. Simple automated behaviors such as speed control, heading control, retro-traverse, and others lighten the workload of the remote operator.

Rapidly Installed Robotic Appliqué Kit Exists Today

The Pronto4 Uomo, designed and manufactured by Kairos Autonomi is a RIRAK. It weighs less than 50 lbs after removal from a rucksack or carrying case. A short 10 minute install in the selected vehicle converts that vehicle into a tele-

operated unmanned ground vehicle system. The system attaches to vehicle power of 12 or 24 VDC and can operate from common BB5590 military batteries. It is delivered in a case with everything required to tele-operate a vehicle at distances up to 1 mile based upon the radio environment.

The Pronto4 Uomo operates a vehicle like a Soldier would, which is entirely mechanically. It steers, brakes, accelerates, and shifts mechanically. This is a different approach, mechanical only, than is taken by some appliqué kit approaches, but it does provide a truly universal way to operate most vehicles and yields a rapid installation. Automations are applied to ease the soldiers work load and improve cognition of the environment.

Common controls of brake, throttle, steering and transmission are firmly attached. A camera is mounted to the windshield or roof. The Pronto4 Uomo includes connections to internal vehicle controls for auto/manual operation and an internal E-Stop for training operations. All attachments are temporary and require no modifications of the host vehicle.

A supplied single handheld SafetyDirect controller has a built in wireless E-Stop and industry common 'gamepad style' controls. A multi-function display reports vehicle status. The robust SafetyDirect has an on-board Wireless Access Point for displaying video on any devices such as a tablet, head mounted display, 1st or 3rd person views, etc.

Tactical Migration & Training

The Pronto4 Uomo would be the basis of the first RIRAK. Through efforts by TARDEC, MCWL, DARPA and others, the concept can be improved significantly but incrementally, adapting it to the rigors of tactical military usage. The following are but a few of the improvements that can be provided:

- Implementation of other features deemed important for the conversion of the Pronto4 Uomo into a deployable RIRAK system. These could include visual instrument cluster reading systems, flexible remote starting system, more complex transmission attachments, ultra wide band localization, and many others.
- Addition of a manipulator arm to the RIRAK for manipulation of vehicle and payload assets from within the vehicle. This arm is attached to the RIRAK, and would allow the operator to initiate internal vehicle borne actions such as surveying, jamming, relaying, disruption, etc.
- Couple the RIRAK with a Rapid Install External Manipulator Arm (RIEMA) similar or identical to those on EOD robots. This provides the ability to affect its environment by cutting wires, removing obstacles, lifting containers, excavation, route clearing, IED detection, vehicle extraction, equipment loading, etc.
- Use-case adjustments. Kairos has participated in the SOCOM TE and received valuable feedback from the SF community. That invaluable feedback was implemented. There needs to be a continued collaborative effort to enhance the utility of the system.
- Adherence to various military standards as required such as MIL-STD-810G (Environmental), MIL-STD-882E (Soldier Safety), MIL-STD-461E (RF Management), MIL-STD-1472G (Design) , IOP Compliance

A road map exists from the current Pronto4 Uomo through an initial RIRAK deployment and then continued RIRAK development and evolution.

Training requirements are minimal and can be performed through multiple media means (video, audio, flip- charts, etc.). Since a RIRAK installs in 10 minutes, it is possible to view an installation in 10 minutes and then perform that installation. Training can be done in the field, near or at the point of use. A person, having never seen a RIRAK, can watch the training video, use flip charts, etc. then perform several installations and qualifications in a 1 hour period, becoming an instructor, then provide that block of instructions to others.

Summary

Proper focus on the RIRAK concept will yield near term (<9 months) volume deployment of a RIRAK Block 1.

Army: Equipping every maneuver company in the US Army (396 on active duty) with a Pronto4 Uomo based RIRAK, gives the company commander the ability to issue the RIRAK to the platoon with the most dangerous task.

Marines: Equipping the Ground Combat Element (GCE) of each Marine Corp Expeditionary Unit with one or more Pronto4 Uomo based RIRAKs, gives the battalion commander the ability to issue the RIRAK to the platoon with the most dangerous task.

The battalion/company commander or platoon leader (based on mission analysis) determines which vehicle should be converted to unmanned. The unmanned vehicle is sent forward on a specific task (route recon, deliver supplies, route clearance, etc) and human operators observe from a safe position up to 1000 meters away or more.

This achieves and exceeds the 2001 Congressional mandate, lays the foundation for further ground vehicle automation, and most importantly provides a ubiquitous tool to remove the Soldier from harm's way…NOW!