Robotics and Unmanned Systems – "Game Changers" for Combat Medical Missions

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ABSTRACT

Introduction/Relevance to the Symposium

The development and deployment of unmanned systems throughout the military forces of the world is rapid, accelerating and 'game changing.' This paper describes the current and planned research and development of robotics/unmanned systems being designed specifically for combat medical missions such as critical item resupply, casualty extraction, and casualty evacuation. These systems will also be applicable to logistics delivery, combat search and rescue, and special operations team insertion/ extraction.

Rationale

Combat medical missions such as resupply and casualty evacuation are dangerous missions. This is especially true for the 'high demand/low density' helicopter flightcrews bringing in the supplies and evacuating the wounded and the medical personnel on the ground who have to rescue and treat the wounded. Medical 'first responders' often become casualties themselves while trying to rescue or treat their comrades. This has been true since the beginning of armed conflict and perhaps there is a better way. Fielding robotics and unmanned systems which can perform these missions and tasks will: (1) Provide tactical commanders with increased tactical and operational flexibility; (2) Allow the execution of these missions in conditions manned platforms cannot (should not) operate in such as 'zero-zero' weather or a contaminated environment; (3) Husband critical medical 'first responder' resources; and (4) Act as a force multiplier of scarce medical evacuation systems.

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The development and deployment of unmanned systems throughout the military forces of the world is rapid, accelerating and game changing. This paper describes the current and planned research and development of robotics/unmanned systems being designed specifically for combat medical missions such as critical item resupply, casualty extraction, and casualty evacuation. These systems will also be applicable to logistics delivery, combat search and rescue, and special operations team insertion/ extraction.

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Description of Methods Employed and Results Obtained

This paper will describe current research and development projects, and technology and operational demonstrations being conducted by the U.S. Army and other U.S. Department of Defense organizations, in the field of robotics/unmanned systems for combat medical missions. It will discuss robots, unmanned aircraft systems (UAV), unmanned ground vehicles (UGV), and integrated UAS/UGV systems. The paper will provide insights and lessons-learned from these demonstrations. Further, it will briefly outline current relevant doctrine, concepts-of-operations, and desired system and subsystem capabilities and requirements. Finally, this paper will identify challenges – technical, doctrinal, philosophical and cultural that must be addressed before robotic/unmanned systems can attain the "game changing" impacts they are capable of.

Conclusions

Robotics and unmanned systems are developed and fielded in rapidly increasing numbers. Their numbers and rate of deployment will continue to accelerate as missions on than the traditional intelligence, surveillance and reconnaissance and explosive ordnance disposal missions are addressed. One such mission area is combat medical resupply and casualty extraction. Employing unmanned systems for these missions will provide additional operational flexibility and will be truly 'game changing' on the battlefield of the 21st century.

1.0 INTRODUCTION

The development and deployment of unmanned systems throughout the military forces of the world is rapid, accelerating and 'game-changing.' The U.S. Army Medical Research and Materiel Command Telemedicine and Advanced Technology Research Center (TATRC) is conducting research and development of robotic/unmanned systems designed for combat medical missions such as critical item resupply, casualty extraction, casualty evacuation, and contaminated human remains recovery. These systems will also be applicable to logistics delivery, combat search and rescue, special operations team insertion/extraction, and civilian 'first responder' missions.

Combat medical missions such as resupply and casualty evacuation are dangerous missions. This is especially true for the 'high demand/low density' helicopter flightcrews bringing in the supplies and evacuating the wounded and the medical personnel on the ground who have to rescue and treat the wounded. Medical 'first responders' often become casualties themselves while trying to rescue or treat their comrades. This has been true since the beginning of armed conflict and perhaps there is a better way. Fielding robotics and unmanned systems which can perform these missions and tasks will: (1) Provide tactical commanders with increased tactical and operational flexibility; (2) Allow the execution of these missions in conditions manned platforms cannot (should not) operate in such as 'zero-zero' weather or a contaminated environment; (3) Husband critical medical 'first responder' resources; and (4) Act as a force multiplier of scarce 'high demand/low density' medical evacuation systems.

The U.S. Department of Defense, the various Combatant Commands Services are awakening to the revolutionary possibilities offered by unmanned systems, not just for the traditional Intelligence, Surveillance and Reconnaissance missions, but for logistics delivery, combat search and rescue, special operations team insertion/extraction, and casualty movement. It should be noted that TATRC is focusing its efforts on Medical Resupply, Casualty Extraction[1] and Casualty Evacuation (CASEVAC) or Tactical Evacuation (TACEVAC).[2] Unmanned Medical Evacuation (MEDEVAC) is currently beyond TATRC's scope, but will be addressed in the future ad enabling technologies mature.

[1] Casualty Extraction : Casualty movement from the point-of-injury to a relatively safe location where initial medical care can be provided, i.e., self-aid, buddy-aid, or Combat Life Saver aid; and prior to First Responder care, i.e., medic, corpsman or physician. NOTE this is a non-standard DoD term.

[2] Casualty Evacuation: The unregulated movement of casualties that can include movement to and between medical treatment facilities (DoD Joint Publication JP 1-02).

2.0 CAPABILITY GAPS & DOCUMENTATION OF NEED

The U.S. Services are looking into the future and identifying ‘placeholders’ for Medical Mission Unmanned Air Systems (UAS) by documenting capability gaps. For example, the Navy, in its Maritime Forces 2030 Free Form Medical Deterrent System states:

- Advanced battlefield transport will make use of unmanned autonomous Vehicles
- Advanced life support systems such as the Army’s Life Support for Trauma and Transport (LSTAT) will improve enroute care
- Telemedicine, including robotics-enhanced surgery, will serve as a force multiplier

The Marine Corps Concept of Operations for Unmanned Aircraft System Family of Systems describes *“…a CASEVAC system (which) will relieve the reliance on manned platforms to evacuate casualties from combat zones. The systems will move a wounded Marines or soldier from the site of his injury within the “golden hour” immediately following the trauma. This system will transport one to two stabilized, wounded Marines to an appropriate medical facility in an environmentally controlled atmosphere to eliminate exposure to the elements and variances in temperature.”*

The U.S. Army Training and Doctrine Pamphlet (TRADOC) PAM 525-66, Future Operating Capability 09-06, Health Services Support says, *“Future Soldiers will utilize unmanned vehicles, robotics and standoff equipment to recover wounded and injured Soldiers from high-risk areas, with minimal exposure.”* Further, the U.S. Army Capability Concept Plan for Army Aviation Operations 2015-2024’

TRADOC PAM 525-7-15 says, *“Army aviation capabilities will contribute to achieving the future Modular Force sustain capability requirements…… the capability of UAS to provide rapid movement of planned logistics support that enables precise delivery of supplies to forward battlefield locations..... Unmanned aircraft will ....also be capable of extraction of wounded .“* And finally, the Army’s Initial Capabilities Document for Unmanned Systems states *“Force health protection capability gaps include the inability to safely diagnose, recover, and transport casualties with enroute care from areas where manned systems are denied entry or unavailable.”*

Even the U.S. Congress is getting on board, having set a Congressionally Directed Goal of 1/3 of ground combat vehicles should be unmanned by 2015 and 1/3 of deep strike aircraft should be unmanned by 2020. Also, Public Law 109-364 SEC 941 – Enacted 17 Oct 06, (John Warner National Defense Authorization Act for Fiscal Year 2007) requires a preference for unmanned systems in acquisition programs for new systems, including a requirement under any such program for the development of a manned system for a certification that an unmanned system is incapable of meeting program requirements.

3.0 RESEARCH STRATEGIES

The U.S. Army Telemedicine and Advanced Technology Research Center (TATRC), part of the U.S. Army Medical Research and Materiel Command (MRMC) has established a technology development strategy contributing to the attainment of a long term Autonomous Combat Casualty Care vision. TATRC is implementing this strategy by leveraging Department of Defense (DoD) Science and Technology funding programs such a the Small Business Innovative Research (SBIR) and Science and Small Business Technology Transfer Program (STTR). TATRC also guides and manages applicable Congressionally Directed Research Programs. Close collaboration is maintained with the various DoD and Service organizations, for example – The Robotics Systems Joint Project Office, the Army Maneuver Battle Lab, The Marine Corps Warfighting Laboratory, the Office of Naval Research, the Air Force Surgeon General’s office for modernization, and the U.S. Special Forces Command Command Surgeon. Great emphasis is placed on developing transition paths that will take the products of these R&D efforts and move them into fielded systems or commercial products.

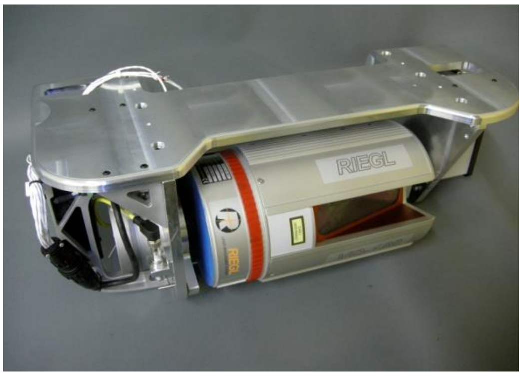
3.1 Combat Medic UAS for Medical Resupply and Evacuation SBIR Projects

One project looking exclusively at the employment of unmanned aircraft systems (UAS) for medical resupply, casualty extraction, and CASEVAC missions is the Combat Medic UAS Small Business Innovative Research (SBIR) Project. This project is in the final year of its Phase II effort. Two companies – Dragonfly Pictures and Piasecki Aircraft (and their partners) will be conducting flight demonstrations with a representative UAS this summer. Combat Medic UAS is focusing on UAS autonomous navigation, flight, landing zone selection, takeoff and landing; and on UAS/medical personnel C^2/interaction. A notional concept of operations for these missions is included below (figure 1).

A vital enabling component of unmanned medical transport missions is the development, certification and fielding of a portable, closed loop, critical care capability. Three systems are in development: (1) LS-1 (formerly LSTAT-Lite); (2) Lightweight Trauma Module (LTM); and (4) Monitoring Oxygen Ventilation and External Suction Device (MOVES). This capability should include Electro Cardiogram (ECG), invasive pressure monitoring, non-invasive blood pressure monitoring, temperature, pulse rate, blood oxygen saturation, heart rate, infusion pumps, fluid warmer, ventilator and oxygen. Additionally, a closed-loop capability is desired whereby the critical care system, coupled with the UAS communications system, transmits patient status to the awaiting medical personnel, who in turn can use this same communications path to adjust critical care system settings.

Both companies Dragonfly Pictures and Piasecki Aircraft are using similar technical approaches, and are integrating commercial-off-the-shelf laser imaging detection and ranging systems (LIDAR), with their respective Unmanned Air Vehicle (UAV) flight control and mission management systems. The LIDARs, mounted under the chin of the each vehicle, scans in both the horizontal and vertical planes, looking for flight path and landing zone obstacles. Coupling this LIDAR/autopilot system with digital terrain maps allows the UAS to takeoff, navigate, transit, select a landing site, and land – all autonomously. Both companies will demonstrate this capability during their upcoming flight demonstrations later this year.

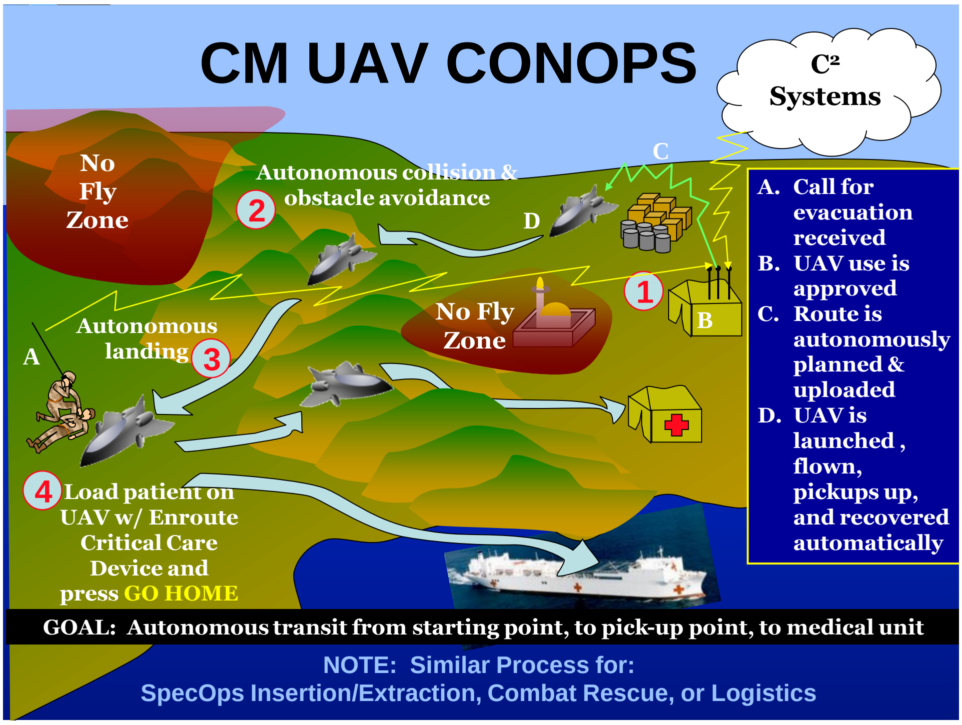
Dragonfly Pictures 100m SICK LD-LRS LIDAR and Servo.



Piasecki Aircraft RIEGL VQ-180 LIDAR.

3.2 Joint Medical Distance Support & Evacuation (JMDSE) Joint Capabilities Technology Demonstration (JCTD)

TATRC is also the Deputy Technical Manager for the U.S. Joint Forces Command Joint Medical Distance Support and Evacuation (JMDSE) Joint Capability Technology Demonstration (JCTD). One component of JMDSE is the Joint Unmanned Casualty Evacuation (JUMC) effort. JUMC is developing a baseline concept of operations document for combatant commander, Service and individual UAS program managers. It will describe the potential use of cargo capable, unmanned aircraft systems to provide medical re-supply, casualty extraction, casualty evacuation, and the transport of personnel with suspected or actual chemical, biological, radiological or nuclear contamination.



Combat Medic UAS SBIR Notional Concept of Operations.

3.3 U.S. Marine Corps Limited Objective Experiments (LOE)

The U.S. Marine Corps is aggressively pursuing an Air Cargo UAS capability to meet real world mission requirements. Medical resupply and CASEVAC are of course, subsets of the larger logistics mission. The Marines hope to deploy a basic Air Cargo UAS system into the Afghanistan area of operations this summer. To support this fielding effort the Marine Corps Warfighting Laboratory (MCWL) has conducted three flight demonstrations. The first – Limited Objective Experiment 3.3 – Enhanced Company Operations, in May 2009, employed a Boeing Unmanned Little Bird UAS to delivery supplies (water, food) and evacuate a casualty (weighted mannequin), carried in an outboard cargo pod. The results were encouraging and *"validated both the unmanned resupply and CASEVAC concepts…CASEVAC and resupply TTPs (tactics, techniques and procedures) require further experimentation for refinement, (and) has potential, but requires technical improvement before undergoing further experimentation."* The MCWL recommends integrated this unmanned capability into their Sea Basing Concept.

The next flight demonstration took place in January 2010, at the Dugway Proving Grounds in Utah. The first demonstration employed the Kaman/Lockheed Martin K-Max UAS and successfully demonstrated autonomous and teleoperated takeoffs, flight, delivery of sling loaded cargo, and landing. At the time of this writing the final report wasn't available, but the Marines seemed pleased with the overall results. The third and last flight demonstration will take place in March 2010, again at Dugway, employing the Boeing A-160 Hummingbird UAS.

Boeing Unmanned Little Bird UAV at the Marine Corps MountainWarfare Training Center.

Boeing A-160 Hummingbird UAV.

Kaman/Lockheed Martin K-Max UAV.

3.4 Congressionally Directed Research

Congress has identified the use of unmanned systems for medical missions as a topic of interest and is funding the Advanced Multi-Missions and CASEVAC project, as a Congressional Special Interest program. This effort will build and fly/drive an integrated unmanned aircraft and unmanned ground vehicle system demonstrator capable of delivering medical supplies and extracting and/or evacuating a casualty. TATRC is managing this program on Congress's behalf.

3.5 Unmanned Ground & Air System for CBRNE Contaminated Personnel Recovery SBIR Project

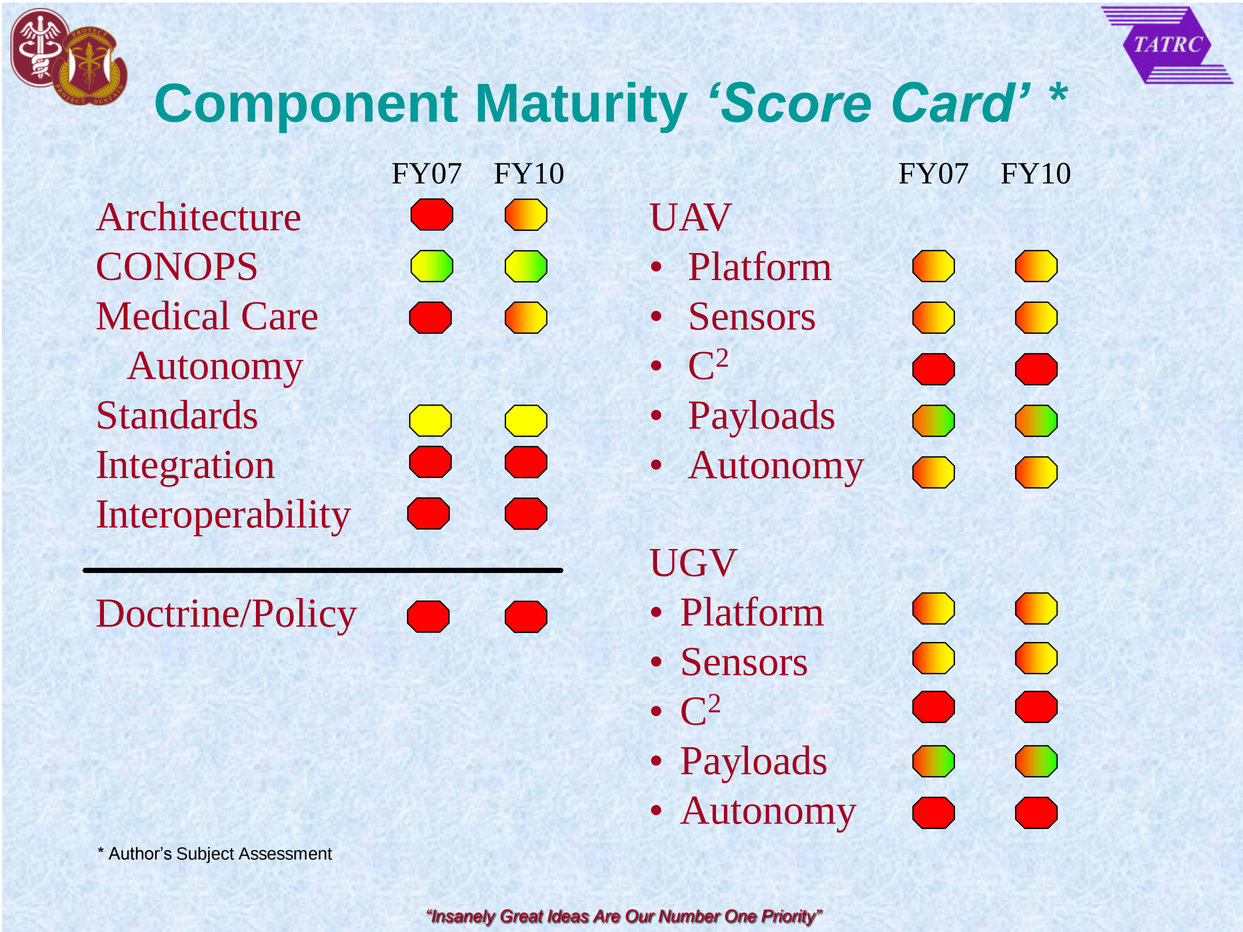
TATRC is also conducting the Unmanned Ground & Air System for Chemical Biological Radiological Nuclear and Explosives (CBRNE) Contaminated Personnel Recovery SBIR. This two-year effort will demonstrate a UAS and a ground robot working in coordination to recover and transport simulated contaminated human remains. This capability would greatly reduce risk to personnel who would otherwise have to perform this grizzly and difficult task. This capability has senior DoD attention.

4.0 CHALLENGES

There are significant technical and non-technical issues that must be addressed before a viable unmanned medical resupply and patient movement capability can be fielded. These include:

- Autonomous navigation and operations
- Robust command and control
- Standoff casualty assessment and triage
- Autonomous or extremely rapid tele-operations for casualty handling
- Tactile feedback for unmanned casualty handling systems so additional harm isn't inflicted
- Closed-loop, portable critical care systems (as discussed above)
- Unmanned systems sensors
- Medical standards for transporting casualties on unmanned systems
- International Treaties and individual nation doctrine and policies
- Power

Below is a subjective, but informed assessment of the maturity of the various technical components necessary to field an unmanned medical resupply and casualty movement capability.



5.0 SUMMARY

Robotic and unmanned systems are being developed and fielded in rapidly increasing numbers. Their numbers and rate of deployment will continue to accelerate as missions other than the traditional intelligence, surveillance and reconnaissance, and explosive ordnance disposal missions are addressed. One such mission area is combat medical resupply and casualty evacuation. Employing unmanned systems – unmanned aircraft, unmanned ground vehicles, and unmanned air/ground systems for these missions will provide additional operational flexibility, protect critical medical assets and personnel, and will be truly 'game changing' in the operational space of the 21st century.