The U.S. Army's Strategic Vision for Robots and Autonomous Systems

military-Earth thinking notebook

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This general document essentially describes the research and acquisition actions to be carried out in order to unify the efforts to integrate robots and autonomous systems (RAS) in the US Army. This integration is intended to preserve a capability and therefore a manoeuvre lead time in the face of potential adversaries developing and implementing a wide range of RAS that also enable them to defeat the US Army's assets or exploit its weaknesses [1]. It is the first publication in a series on the same subject. Other militaries and the Ministry of Defense are also beginning to publish strategic visions on the subject [2]. Describing the way the US Army views the massive arrival of robots at the conceptual and strategic levels, this document had its place in the central theme of this issue of the Cahiers.

1] US Army's Robotic and Autonomous Systems (RAS) Strategy of **September 30, 2016 from TRADOC/ARCIC, approved for distribution.**

2] In the article DOD preparing to release new 25-year unmanned systems roadmap, (**Jordana Mishory,** Inside Defense**, October** 27**, 2016), the Department of Defense announces a similar document at the attached level** in **early 2017.**

Today's investment in SARs should enable the US Army to respond to three major challenges. First, the ever-increasing rate of modernization of the adversary, including stand-off capabilities.[1] The first is the ever-increasing and innovative use of RAS by the adversary, and finally the constraint of the future environment, particularly in ultra-dense urban areas in which the means of communication will work at the limit of their potential.[2]. The research and acquisition strategy is divided into three phases, in the short, medium and long term.

The idea of developing a strategy for SARs should enable the US Army to improve its effectiveness in the future, with an emphasis on man-machine interface and collaboration.

This will allow forces to "learn, adapt, fight and win" in a complex world and uncertain environment. The contribution of RAS and integrated man-machine teams should save time and tactical and operational space for commanders at all levels.

This article will describe the need expressed by the US Army interms of R AS, before setting out the priorities for the short, medium and long term, and then looking at how this strategy can be implemented and incorporated into current concepts and doctrines.

Why does the Army need SARs?

To meet the three identified challenges of the adversarial race to modernize, the US Army has identified five objectives guiding research, development, and employment of land (SKU[3]) and air (SAU[4]) systems.

- Increase knowledge of one's environment and situationalawareness: the complexity of the terrain and environment, as well as the countermeasures implemented by the enemy limit the soldier's possibilities to see, understand and fight below the battalion level (inclusive). In view of this, the development of SARs should allow for increased surveillance of the environment of immediate and future interest, which is still often inaccessible today by guided means.This will facilitate more frequent remote security measures (i.e. better protection through superior anticipation on the part of the tactical commander).

- Lighten the physical and cognitive load of the combatantThe **use** of equipment designed to deal with multiple situations can lead to an excessive load (protection, coercion and "Big Data"),reducing the soldier's endurance and capacity for action. Autonomous systems can take on some of the burden and the ever-increasing mass of data, slowing down movement on one side and decision making on the other. SAR will have to facilitate the mission by enabling the collection, organization and prioritization of information, reducing electromagnetic and cyber signatures, while improving decision making and tactical mobility.
- Supporting the levels with more efficient and well-distributed forward logisticsLogistical support**:** Logistical support is resource-intensive; it exposes units (sustaining and supported) during resupply and along ever-expanding chains. Optimized and robotically based SKUs and AGS will be required to improve logistics action at every stage, for example, by better prioritizing deliveries based on operational urgency.

- Facilitating movement and manoeuvringCombat in the twenty-first century, as described in US doctrine, requires a land force capable of overtaking the enemy in physical and cognitive manoeuvre**.** The enemy will be able to be engaged as far away as possible, with greater power, overcoming obstacles, in all areas that will be put in place by the adversary to limit movement, protect his means and inflict the maximum possible damage to the deployed force.

- Protect the force: This is somewhat the purpose of the other objectives described above. The congestion and the complexity of the action area will expose the soldier to many perilous situations, possibly still unknown today, and for which the parry will require improved protection due to a massive use of RAS (deception, detection, counterfire, jamming, etc...).

Achieving these goals and integrating the SAR into Army formations will take time and a change in mentality. In short, the SAR will have to minimize exposure to danger to

combatants, speed up decision making, and execute missions that cannot be accomplished by humans.

The short, medium and long term stages

Of the five objectives above, the highest priority for the USArmy is the reduction of the load and the better knowledge of the environment for the combatant, in order to facilitate the movement and manoeuvre of the landed units. Thus, this institution has divided its current strategy into three phases: firstly, short-term, realistic and achievable objectives partly included in the current budgets (2016-2020), then a possible medium-term one for which budget lines have been proposed (2021-2030), and finally a long-term one (2031-2040) concerning foresight and for which a fund limited to research has been programmed in the budget.

For the next 25 years, three technological breakthroughs are essential for an effective and efficient SAR: autonomy, artificial intelligence and common control. These will, of course, have to be made within a framework of cyber development and a fully protected backbone network in order to take full advantage of the SAR to accomplish the mission received.

Autonomy will be the level of independence authorized by humans to a system in order to make it perform a certain task in a given environment. This technology will rely on a set of sensors and navigational computers, with sufficient software sophistication to enable the machine to make decisions. This process will reduce the number of fighters used to control robots, especially when they are assigned to dangerous tasks. This technology will make it possible to delegate, under minimum control, missions of deep fire away from the control centres, thus ensuring the preservation of the human factor, or any other long-term surveillance mission, for example, thus allowing, in total, humans to remain focused on missions that are inaccessible to machines, or for which they are better suited.

Linked to this autonomy, **artificial intelligence (AI) is the** ability of a machine to perform functions that are usually the exclusive domain of human intelligence (e.g. understanding, conversation, decision-making). Technological advances in AI should enable the machine to perform tasks long and exclusively considered to be the exclusive domain of humans. Likewise, AI will make it possible to further develop the analysis of the need for RAS, thus closing a loop. In addition to autonomy, it will allow, for example, land vehicles to move off-axis (off-road) or to analyze very quickly a considerable mass of information to facilitate human decision-making. With each improvement, AI will have to facilitate the consideration of factors such as mission parameters, rules of engagement, fine terrain analysis, and enable faster decision making in five areas:

- the identification of strategic risk indicators,
- operational and counter-propaganda information,
- support for decision-making at the operational level,
- the use of mixed combat formations between humans and machines,
- increasing the conduct of specific defensive operations during which the management of information flow, the ability to propose reactions and the synchronisation of efforts could exceed the capabilities of a human-planning process. However, the USArmy intends to maintain strict human control over these actions through the human-in-the-loop [5] or human-on-the-loop [6] concepts.

Finally, **common control is** the creation of a system to manage a group of SKUs or SAUs

or mixed, with the use by a single soldier ofone and the same control device by also reducing, through autonomy and AI, the physical and cognitive burden of the controller. This common control will ensure interoperability of systems through data sharing, single coding, range or transfer of control to another platform.

- In the **short term:** the priority is therefore to reduce the physical and cognitive burden on the combatant. Concepts will continue to be developed and programmes implemented to improve the five objectives described above as quickly as possible, especially for landed combatants. The idea is to provide the soldier as quickly as possible with small, easily transportable and usable SKUs or SAUs, which already possess all the AI and autonomy or joint control capabilities available on the scientific market today. Some of them will quickly be destined to lighten the combatant, while waiting for an exoskeleton [7].

The US Army is also currently investing in remote-controlled (captive) or radio-controlled systems for the benefit of on-board troops.

Finally, possible changes in the command system (delegation and subsidiarity, responsibility and autonomy of subordinate levels) are being taken into account and studied concomitantly.

- In the **medium term:** the main aim will be to miniaturise the first SARs supplied so that they can be used in swarms in terms of environmental knowledge, but also to develop a first reliable and operational exoskeleton and to implement fully autonomous supply and convoy missions. Finally, the means will be needed to increase manoeuvre capabilities with robotic combat vehicles and larger payloads.

Greater integration and human-ASU/ASU interaction is planned with fixed or captive, radio-controlled, remote-controlled or autonomous vehicles. A new fleet may be produced, which may include firing platforms that can go to areas that are very difficult or too perilous to access. Medical evacuation systems will also be developed to further reduce the time required to care for the wounded.

- In the **long term: a** new generation will replace the initial generation in the areas already described and will further increase the acquired capabilities. There will be a permanent availability of air combat assets with greater endurance and reduced signature, for example with systematic swarming, as well as fully autonomous air delivery and radio-controlled and autonomously supported combat vehicles, reducing the human footprint to a minimum. The ultimate goal is to enable the commander to retain the initiative in a high-intensity combat with decentralised actions. Easily deployable SARs immediately incorporated into control systems will enable a high rate of manoeuvre to be maintained by immediately updating environmental and situational awareness and accelerating implementation accordingly. Finally, the systematic use of RAS, which have become more commonplace, will facilitate greater and easier risk-taking in operations, while providing a greater range of effects from a single unit to commanders.

Implementation

To carry out this strategy aimed at achieving tactical and technical superiority in joint combat, the US Army must prioritize itsobjectives and innovate.

- The method: Thus, to achieve its five capability goals, the US Army has designated its essential points of effort: autonomy, AI and joint control. The development of these capabilities will underpin all research and advances in this strategy. Of the three, land vehicle autonomy will be the most important because it is the hallmark of land forces.

Second aspect, innovation, as defined by the Army OperatingConcept [8], is based on the significant enhancement of existing equipment, or the creation of new ones, through critical thinking, research, processes, internal practices, and also marketing methods [9]. 9] Innovation, as imagined, is therefore no longer just a technological matter, but more a systemic problem aimed at both stimulating creativity and supporting creation through more flexible processes at the service of the operative-tactical requirement. It will be supported by coherent concepts and doctrines, and will be based on the laboratories of the Research, Development and Engineering Command (RDECOM), with tactical testing and experimentation being carried out by centres of excellence. The ability to propose improvements will be offered to all users by reducing hierarchical and administrative chains.

- The means: To maintain its superiority, the US Army must use emerging technologies and develop new concepts of acquisition methods, often building on existing ones, or using a necessary increase in resources. The current acquisition process is a time-consuming investment. It will require the combined efforts of the four main agencies[10] in the Army robotics community to focus on pooling their efforts, with milestones (which is why the SIR is planned to progress in phases), and to capture and exploit any technological breakthroughs.

The budget will have to take account of these crucial needs very quickly, as the current Strategic Portfolio Analysis Review is perfectly positioned to set priorities and allocate resources to this strategy.

Finally, the organizations belonging to the robotics community have all the capacities to carry out this strategy. The most important ones are RDECOM, TRADOC, military research laboratories, academia and civilian industry. The U.S.Army will always have to ensure that spending is contained and that the best equipment is obtained. Collaboration in all its forms with civilian industry is encouraged, just as participation with other militaries in the Joint Concept and Autonomous Systems must be maintained. The latter makes it possible to reduce costs and increase interoperability. 11] Finally, the US defence budget commits $18 billion over the next three years to support SAR research and development.

In order to ensure coherence of modes of action and means, the Army has set up a five-stage development process (SIDRA)[12]:

- maintain the current one (at the level, by upgrading the old one),
- modernise it (by adding a common or universal controller, developing autonomy),
- develop new capabilities (off-road capabilities, swarm employment, AI),
- replace the old one (as it becomes obsolete, by increasing autonomous systems),
- evaluate new developments (maintain a constant and high level of research, identify versatile technologies that can be applied to several fields of employment).

Conclusion

This RAS strategy is part of the 2014 WCA[13] through the intermediate solutions it offers

to ten of the Army Warfighting Challenges (AWFC), dealing with the understanding of hension, maintaining links, reconnaissance operations, area control or even the integration of manoeuvre and fire.

Its implementation will require immense time and resources forthe US Army to meet the three challenges presented by future operational environments:

- Increasing the speed of execution on the battlefield,
- increased enemy use of RAS,
- the increasing complexity of the battlefields.

It is certainly bound to evolve over time, but it will keep as a denominator to go faster than the adversary in the search and acquisition and always seek the protection of the combatant. Finally, the SAR seems to be at the heart of all concerns today and is the subject of many high-level interventions, such as, recently, that of the Deputy US CEMAT, General Allyn, who took up and explained the five objectives of the SAR strategy[14].

14] Following this publication, an execution order will be issued, followed by a concept of operation and a concept of employment.

1] The ability to fire from a distance that will keep the target out of immediate replica range.

2] See studies and essays on the Megacities.

[3] Unmanned Ground Systems

[4] Unmanned Aircraft Systems

5] The final decision will be made by a human operator (e.g. for firing systems).

6] The human retains a possibility of intervention in a process (e.g. the choice of a logistic route).

7] A wide range of capabilities is envisaged, from individual or group lightering vehicles to logistics provision through autonomous parachute drops, regulated by coordinates.7] A wide range of capabilities is envisaged, from individual or group lightering vehicles to logistics supply through autonomous airdrops, regulated on coordinates provided by transport robots according to consumption from other SARs, via electromagnetic or visual "lighting" of the battlefield or the detection and neutralisation of explosives.

8] Army Operating Concept: Win in a Complex World, 2020-2040 edition of 31 October 2014.

9] Directly related to the TRADOC's desire to no longer require a certain type of vehicle (the "Big Five" era), but rather tomeet a capacity requirement ("Big -Eight" then "6 + 1").

10] RDECOM, TRADOC, US Army Staff andthe Assistant Secretary of the Army forProcurement , Logistics and Technology - ASA/ALT.

11] The USArmy has , for example, shared the burden of developing a common controller with the US Navy. With the USMC, in addition to its participation in the controller, the JAAR system - Joint Automated Aerial Resuply - a UAS capable of projecting a 150 kg payload. Over a distance of 120 km.

[12] Sustain, Improve, Develop, Replace, Assess

13] Ibid.

14] Army vice chief touts focus on unmanned systems , article by Courtney McBride,Inside Defense, October 26, 2016.

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