Executive Summary

The future of teams

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Introduction

Robotic and Autonomous Systems (RAS) are experiencing significant growth in both usage and scope of application. But how do defence leaders gain team acceptance of such systems, make certain they are deployed appropriately, and, most importantly, ensure they meet mission-critical goals safely, securely and legally?

Unlike Vehicle (UxV) Ground Control Stations where the system is controlled remotely by a human operative, an autonomous system is capable of understanding higher-level intent and direction – and deciding a suitable course of action – without relying on human oversight and control.

As RAS become increasingly sophisticated, developing user trust and ensuring operator confidence is even more vital. Although human operatives may still be present, at the higher end of the autonomy spectrum, where artificial intelligence and machine learning combine, AS are designed to perform mission-critical tasks as independent team members.

Failure and reversionary mode situations are the exception. In this instance, human operators need to be involved in the control loop, requiring them to maintain the necessary Situation Awareness (SA) to ensure their understanding of the circumstances is sufficient to inform any necessary intervention.

Teaming humans and machines

Longer term, as the scope and scale of autonomy rises, AS becomes a member of a high performing collaborative human team, and the development and maintenance of trust becomes essential to ensure effective performance during mission-critical situations. Here, the training focus shifts to the implementation of design features and functionality to enable a symbiotic collaborative relationship between the human element and an AS that could be capable of intelligent thought.

Further into the future, there is an aspiration among engineers for fully autonomous systems, where there are no humans in the loop. However, there are potential ethical and legal implications when removing human intervention completely, particularly where the use of lethal effects could lead to loss of life.

An alternative approach is adaptable / adaptive autonomy where the level of autonomy varies, depending on the circumstances. In the former, the human operative can tailor the level of automation and initiate the switch between human and RAS; in the latter there is an automatic re-balancing of tasks. Having explored this approach in our studies and experimental investigations, we found that maintaining control of triggering shifts in autonomy was preferred by human users and engendered a greater reported level of trust.

The growing number of AS generate vast amounts of data which need to be received, handled, managed, processed, analysed and exploited – allowing the human user to assimilate, understand and make effective decisions. In addition to the clear need for automatic data processing to create more manageable data sets, there are legal and ethical considerations for data collection and analysis, such as how long different types of data should be stored, dependent on sensitivity, or whether data can be stored at all, as may be the case with people's faces.

Enhancing trust through design

Based on its recent work QinetiQ has developed a construct, which identifies the design features that should be incorporated within RAS to establish and extend trust. The construct's two approaches are compatible: Anthropomorphism – an inference process involving the attribution of human related characteristics to machine equipment, such as the ability for rational thought and conscious feeling – coupled with a three-layered model covering 'dispositional trust', 'situational trust' and 'learned trust'.

QinetiQ's trials with UxVs suggest that higher levels of anthropomorphism, applied in conjunction with five critical areas of design, can engender a higher degree of trust. These five areas are:

1. Transparency:

Allowing users to understand how the logic works, what the algorithms are doing and how they are arriving at their decisions, coupled with an ability to interrogate the functionality, traceability and explanations for any errors that may arise.

2. Appearance:

A well-designed, aesthetically pleasing interface with anthropomorphic features – including name, gender and appropriate essential characteristics. For example, an AS intended for lethal action should appear menacing and sinister.

3. Ease of use:

Enhanced system usability, visual clarity of data and ongoing salient feedback on aspects such as progress re task execution, system state, and potential hazards – but avoiding distracting layers of tote pages or pull-down windows that may reduce SA for the operator.

4. Communication style.

Verbal communication/interrogation and response by human voice rather than synthetic speech or text, incorporating individual users' accents to increase impact. It is also important to demonstrate good etiquette and politeness.

5. Level of operator-control.

Keeping the operator in the loop – even with high-level AS – can be useful in building confidence. For example, if the operator gleans information that the AS does not have, they can still influence the AS to achieve tasks, auto-destruct or auto-home.

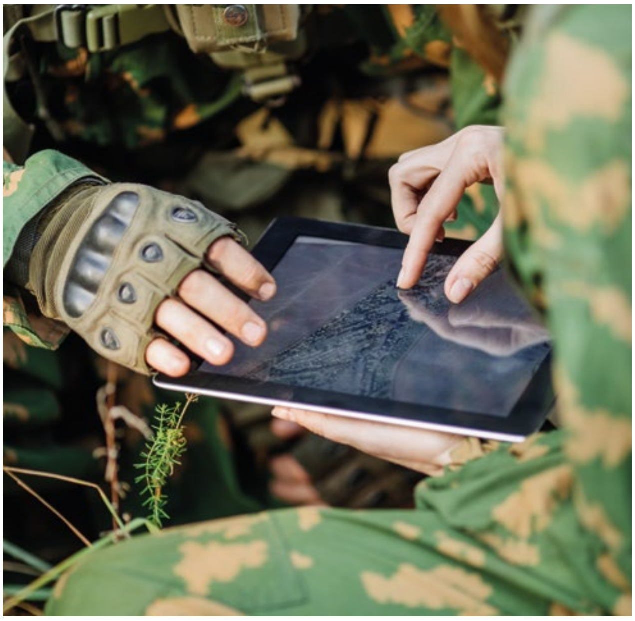
Building trust through training

In a military context, full autonomy implementation is currently limited to specific aspects of task execution – putting the training emphasis on easing the operators' challenge of managing multiple heterogenous systems or vehicles. The domain environment also influences the level of autonomy. For example, sub-surface vehicles can operate in a higher mode of autonomy due to fewer constraints and rules within that domain.

The potential of emerging training technologies such as Virtual Reality (VR) and Augmented Reality (AR) can be harnessed to increase user comprehension, build confidence and establish trust in RAS. Training gaps in relation to different UxV types can be addressed as on-the-job knowledge acquisition in the same way as capabilities and limitations are learned with respect to a new Rigid Inflatable Boat (RIB) or helicopter.

For more sophisticated AS, human operators will need to develop a solid understanding of how systems work before they can be expected to have faith in them. Then, as long as AS function as expected, user acceptance and trust are likely to increase with enhanced functionality and more frequent use.

However, once autonomous functionality is successfully enabled and deemed predictable and reliable, there may be a tendency to 'over-trust' the system. This results in a different set of complications requiring mitigation. For example, a user may be disinclined to maintain SA and in a critical situation would not be in a position to intervene if required.



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