The Role of Artificial Intelligence in Cross-Platform Tailoring of AR Data

Vadym Slyusar

November 15, 2020

Slyusar Vadym, DSc, Prof
MOD of Ukraine

The role of Artificial Intelligence in cross-platform tailoring of AR data

Because Artificial Intelligence (AI) will form the basis of future control networks, the incorporation of AI is an important trend in the development of battlefield and weapons control systems.

NATO experts have few alternative definitions of AI, but in the context of AR can be recommended the definition from NIAG Study Group SG-238 “GBAD Operations against the 21st Century Peer Nation Cruise Missile and Unmanned Aerial Systems (UAS)”: “AI refers to systems designed by humans that, given a complex goal, act in the physical or digital world by perceiving their environment, interpreting the collected structured or unstructured data, reasoning on the knowledge derived from this data and deciding the best action(s) to take (according to pre-defined parameters) to achieve the given goal. AI systems can also be designed to learn to adapt their behavior by analyzing how the environment is affected by their previous actions” [1].

AI is useful in particular with respect to making heterogeneous AR systems work together; to improve AR data exchange and target allocation (also between nations); to working with fewer resources of AR data; to making coordination of sensors and effectors, threat detection and identification, semi-autonomous weapon allocation [1]. AI is a mean to improving responce speed (fast threat, pop up, numerous threats), derivation of intents, situational awareness and debrief with help of AR. On the other hand, AR is a communication bridge and feedback mechanism from AI to a Human for the support of decisions making.

The main benefits of AI and ML are to enhance C2 (with AR), Communications, Sensors, Integration and Interoperability [1]. On the basis of AI and ML with Microsoft Common Objects in Context (MS-COCO) [2], or other technologies, the synthesis of AR symbols can be provided (such as outline symbols of targets, fig. 1). It enables joint target acquisition, targeting of moving targets (single or swarm) and supports coordination and deconfliction of distributed Joint Fires between networked combat vehicles, tanks, helicopters, ships etc. also inside Manned and Unmanned Teams (MUM-T).

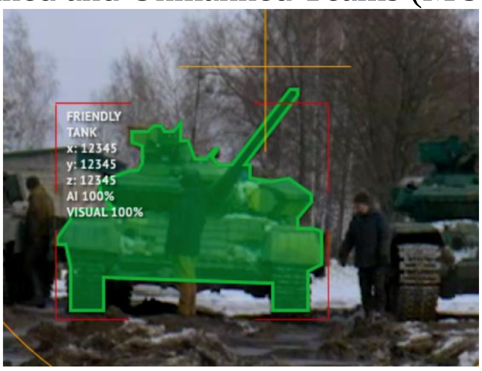

Fig. 1: The outline symbol of target as AR data

AI can be used to visually identify objects and targets on the battlefield. For this task can be used the cloud distributed or multi-platform cooperative AI algorithm, which is distributed between several vehicles and can create joint three-dimensional outlines AR symbols for the common operational picture.

AI algorithms can build (and not only outline) AR symbols of targets but also synthesis they AR vulnerability models, similar such as the German VEMAG model, Swiss RUAG model, US MILES LEAR model, and French GDI model, which use now for modeling and simulations (fig. 2) [3, 4].

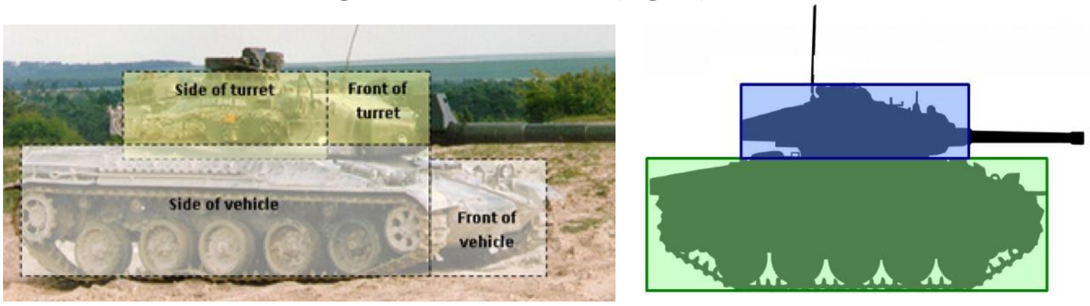

Fig. 2. AI syntheses AR symbols with a decomposition of target areas [4] for Networked Weapon Systems.

These visualized vulnerability models of target decompose enemy object into few sides and those sides into some areas for hitting, allow for a more precision and/or effectiveness regards between point of impact and specific damage effect. The information about such hitting areas can be distributed as AR symbols between networked combat vehicles inside a unit to coherent/ together destroy of difficult target. The level of decomposition of AR shape symbols can be changed dependent distance to target, and the state of such decomposition may be used as the additional information about current distance to target. This concept will increase effectiveness of the combat engagement if use unmanned platforms as forward observers for produce vulnerability areas symbols of targets.

The color of the target’s outline symbol obtained from other vehicles via BMS can be updated using the AI algorithm to solve occlusion problems and optimize its visual perception against the background of the scene.

Neither vulnerability models nor the associated vulnerability calculation mechanisms need to be standardized in order to achieve technical interoperability, as opposed to a standardized vulnerability model that can be used to create a reference model. Still, the entry into the vulnerability model and the exit of the AR model should be standardized to achieve technical compatibility, while the mechanism for calculating the underlying vulnerability model using AI can be considered a “black box”.

In the future, after increasing the autonomy of robotic UGV and the integration of human perception analogues, such in the physical vision, into robotics, the part of AR data from BMS should be transferred to UGV for use by its autopilot for orientation and support of mission. For this it is possible to preload the necessary volumes of AR data before the start of the UGV mission, as well as quickly update them on board the UGV during the execution of the task.

In case of the Remotely Controlled UGV the overlaying of preloaded AR symbols to the video stream from the UGV on-board cameras should be make in the UGV equipment with the next transmission a full ready combination preloaded AR and video stream to the UGV's operator. Such solution decrease navigation errors and exclude additional mistakes such as operator localization in the placing AR symbols in correct position on the terrain image. This improves the accuracy of targeting acquisition and situation awareness.

At the same time, AR outline symbols of targets will be synthesized as AR data on the base of Point Cloud from UGV on-board vision sensors by use AI algorithms. Also AI can perform the following functions: warnings about the possibility of capsizing, determining a safe path, detecting suddenly emerging threats that impede movement, visual warning for marking areas requiring special attention, the analysis of hyperspectral images of the soil to identify changes in its surface, which is a sign of artificial camouflage of improvised explosive devices or mines, camouflage identification against the backdrop of a natural landscape. All results of such identification will be present as AR symbols. Such synthesized AR symbols can be sending to the operator of Command post or other vehicle inside MUM-T without video stream for minimization of traffic or incorporate to full video stream in the combination with preloaded AR symbols as well. In this case, it is necessary to solve the problem of integrating the on-board AR data generation tools with the UGV architecture, as well as to find a compromise in the level of centralization of their connection to the BMS. It is very important also inside MUM-T.

References

1. Slyusar V.I. Artificial intelligence as the basis of future control networks. //Coordination problems of military technical and defensive industrial policy in Ukraine. Weapons and military equipment development perspectives/ VII International Scientific and Practical Conference. Abstracts of reports. - October 8–10, 2019. - Kyiv. - DOI: 10.13140/RG.2.2.30247.50087. - https://www.researchgate.net/publication/334573170_Artificial_intelligence_as_the_basis_of_future_control_networks.

2. Lin TY. et al. (2014). Microsoft COCO: Common Objects in Context. In: Fleet D., Pajdla T., Schiele B., Tuytelaars T. (eds). Computer Vision – ECCV 2014. Lecture Notes in Computer Science, vol. 8693. Springer, Cham. - https://doi.org/10.1007/978-3-319-10602-1_48.

3. Technical Report STO-TR-MSG-063. Urban Combat Advanced Training Technology. Annex F. - July, 2015. - ISBN 978-92-837-2011-9. – 176 p. https://www.sto.nato.int/publications/STO%20Technical%20Reports/STO-TR-MSG-063/$$TR-MSG-063-ALL.pdf.

4. Technical Report STO-TR-MSG-140. Urban Combat Advanced Training Technology Live Simulation Standards. Annex A. - May, 2020. - DOI: 10.14339/STO-TR-MSG-140. - ISBN 978-92-837-2270-0. – 398 p. - https://www.sto.nato.int/publications/STO%20Technical%20Reports/STO-TR-MSG-140/$$TR-MSG-140-ALL.pdf.