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APPLICATIONS OF AUGMENTED REALITY TECHNOLOGY IN THE MILITARY EDUCATIONAL FIELD

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ABSTRACT

The aim of this paper is to present practical applications of augmented reality technology AR, corroborated with facilities of VR virtual reality technology, made using existing equipment in the Academy of Land Forces, by the authors of the paper and with the involvement of passionate academics. of this direction of scientific research. Augmented reality technology is part of the field of emerging technologies and along with disruptive technologies, are areas that are currently being addressed intensively in terms of research and their use in civilian and military applications. The research methodology was based on the creation of scenarios in which AR equipment was used, and with the help of the Ada Viewer software application, operator-specific information was augmented. The behavior of the operators was then evaluated by comparative analysis with the classical scenarios. The obtained results highlight the advantages of augmented reality technology, allowing the efficiency of the activities and actions of the operators. The range of practical applications with AR technology can be developed for many disciplines of education and training of military students in the academy, and the combination of AR technology and virtual reality facilities will allow modeling and simulation of operator training scenarios and more active involvement.

KEYWORDS: Ada Viewer, augmented reality, emerging and disruptive technologies, military education, virtual reality

1. Introduction

Emerging and disruptive technologies are in different stages: existing, in manufacturing, of conception, experimentation and analysis of their purpose and the effects they can determine on different environments, such as the military, economic, social and even political. The typology of these technologies is defined in many specialized works or

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strategies, doctrines or reports (Christensen, McDonald, Altman & Palmer, 2018) and includes in the civil field new technologies usually or in progress (artificial intelligence AI, hypersonic weapons, direct-directed weapons, quantum computers, clean energy technologies, biotechnologies, nanotechnologies, 5G communications, etc.), as well as older technologies (gene therapy, preimplantation genetic diagnosis, etc.). In the military field, emerging and disruptive technologies are at the same stage of conceptual research and development and present the same interest from political and military decision-makers (Bassler, Kouretsos & Schramm, 2020; Reding & Eaton, 2020). In this field, too, artificial intelligence is already used in various applications, such as C4 ISR systems, cyber operations, autonomous vehicles, intelligent logistics (Payal, Dixit & Sairam, 2021; Mallick, 2018) and, in a new higher stage, the emergence of these applications will determine their functional integration or interconnection. Other types of technologies: directed energy weapons systems, autonomous lethal weapons, hypersonic weapons, robotic technologies, quantum technologies, biotechnologies, etc. (Chyba, 2020; Sayler, 2020) are in advanced stages of research determined by the competition for military supremacy between world military powers.

Last but not least, augmented reality AR and VR virtual reality technologies are part of the category of emerging and disruptive technologies due to the possibilities of modeling-simulation of military actions and their management using instantaneous spatial and temporal landmarks, which could produce essential changes as a result of confrontations between combat forces.

It is estimated that emerging and disruptive technologies are the product of specific transformations of the fourth industrial revolution, caused by the fusion of the third generation technologies (Martinelli, Mina & Moggi, 2021; Lee & Lee, 2021) and that they will influence the conduct of military confrontations, international security and implicitly international relations.

2. Resources and Research Methodology

Depending on the resources or on the augmented reality equipment available, each team of specialists can plan or design their research in different directions. For example, the authors (Amaguaña, Collaguazo, Tituaña & Aguilar, 2018, pp. 394-403) *"developed an AR system that was developed using the Unity – Vuforia application. The system simulates a war environment using three-dimensional objects and audio-visual resources to create a real conflict. The Vuforia application uses the database to create the target image and, together with the resources of the Unity video game engine, animation algorithms are also developed and implemented in 3D objects"*. So, the operator can interact with the physical field and the digital objects.

In order to achieve the objectives of this paper, the following hardware and software resources of the AR (augmented reality) type were used, existing in the endowment of the Center for modelling-simulation of military actions within the "Nicolae Bălcescu" Land Forces Academy in Sibiu:

a) augmented reality glasses, HoloLens brand with the following characteristics: resolution: 2K 3: 2 light motors in each eye; holographic density: > 2.5K radians (points of light on the radian); processor: Qualcomm Snapdragon 850; holographic unit: second generation; 8 MP photos, 1080p video; microphones: 5 channels.



Figure no. 1: *Holographic glasses, Hololens brand*
(Source: Authors)

The holographic glasses, HoloLens brand (Figure no. 1), can be easily transported, have small dimensions, and their operation is independent of the existence of any power supply, having built-in batteries.

b) the Ada Viewer software application for creating AR presentations, with instructor and user licenses (Figure no. 2).



Figure no. 2: *Ada Viewer application menu*
(Source: Authors)

The functions of the Ada Viewer application are as follows (Ada Platform, n.d.):

– uses maps and geographical locations (Figure no. 3);

– enlarges geographical maps and locates characteristic points;

– measures distances and areas between the characteristic points of the map;

– places indicators/markers that can signify different locations on the digital map;

– allows online meetings in real time.

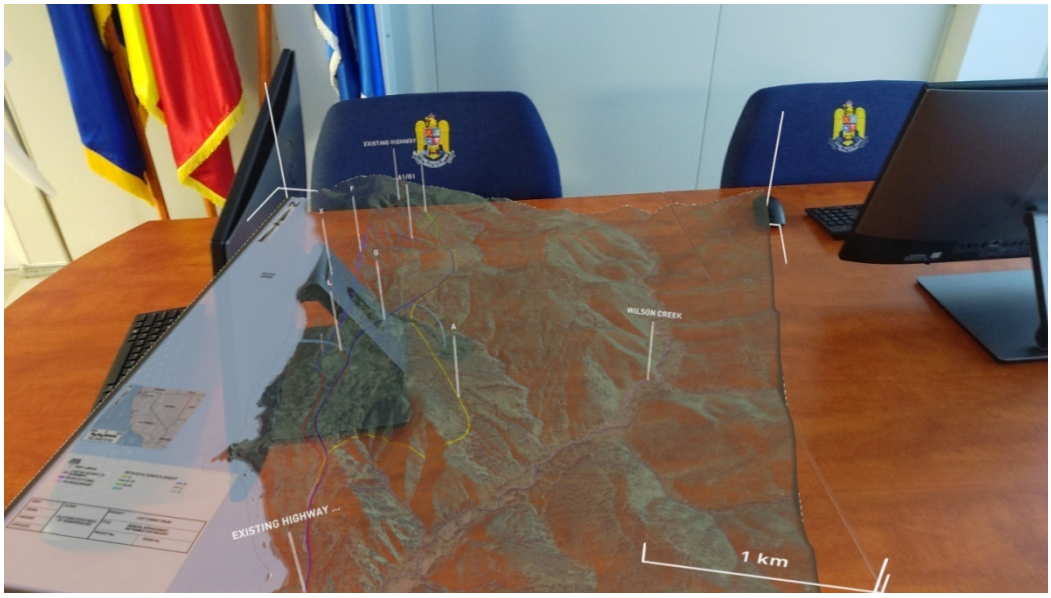


Figure no. 3: *Using digital maps with Ada Viewer*
(Source: Authors)

The Ada Viewer application is available for HoloLens and iOS glasses (iPhone and iPad), which allow the holographic views of 3D data to be brought into the physical or real space of the operator (Research Report, n.d.). All this construction of holograms is possible through the Ada Cloud platform, which is an end-to-end solution, i.e. a complete solution that follows a project throughout the period of its realization (Ada Platform, n.d.).

c) PC or laptop computer for the coordination and transmission of actions between a center/command point and executors.

d) HP VR Backpack Workstation, HP Reverb G2, plug-in and virtual reality kits.

2.1. Execution of Marching Missions by Military Teams

In order to demonstrate the usefulness of using augmented reality in the training process, a marching exercise was held in the Perii Dăii training ground with the second-year military students specializing in Military Leadership and Organization Management. The students were divided into two teams of four military students in each team.

An order of operations was sent by the platoon commander to the team commanders regarding the execution of a team-level research patrol in order to ensure the freedom of movement of their own forces on the route Perii Dăii firing range – Daia locality – Agnita locality, using, on the one hand, the classical methods of data transmission – travel course, marking of risk areas, (radio means, printed map of the area) and, on the other hand, data transmission using augmented digital maps (with voice command and touch options), with the itinerary travel. During the execution of the mission, the students were sent in real time the coordinates of the travel.

2.2. Conducting Briefings and Meetings by the Command Structures

In the current military actions and activities, command structures can conduct briefings and meetings online, using applications such as Teams, meet, zoom, Moodle, etc., for briefings and meetings without classification level.

This variant involves the physical presence of the commander or head of the structure in front of the monitor placed in a fixed space and with internet access (Figure no. 4).

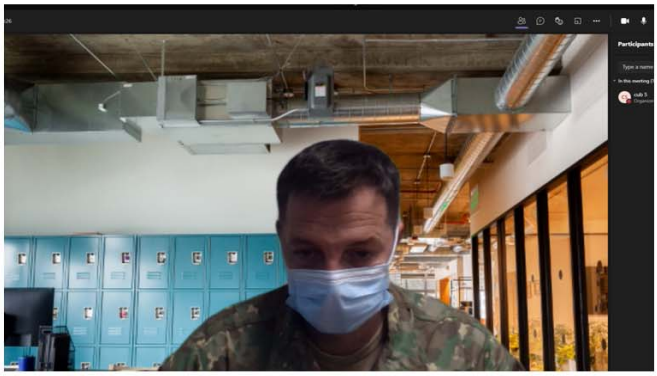


Figure no. 4: *The physical presence of a person at a briefing*
(Source: Authors)



Figure no. 5: *AR Immersion – the perception of being in a particular space or place*
(Source: Authors)

In the AR version (Figure no. 5), a briefing or meeting can take place from any location where there is internet access, without the need for a physical presence in front of a monitor, which considerably reduces the time of transmission of information to subordinates. Through the holographic glasses, the leader of the briefing conducts his activity using all the functions of the application menu.

For the proposed experiment, the Teams platform was used (Figure no. 6) with which the platoon commander managed to transmit to the group commanders data on the instruction for the execution of a shooting/instruction session, from his location (Figure no. 7).

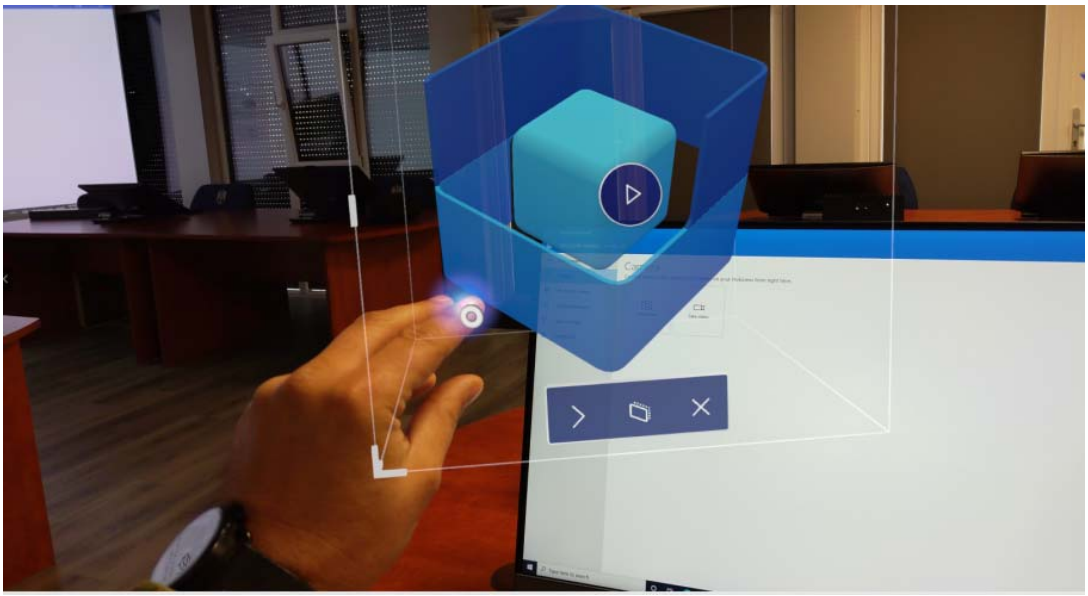


Figure no. 6: *Access button on the Teams platform*
(Source: Authors)



Figure no. 7: *Platoon commander's location*
(Source: Authors)

On the other hand, the group commanders appropriated the orders and the data received (Figure no. 8), which they then transmitted to their subordinates. All this could be increased by developing the capacity for synthesis and analysis using these modern and efficient methods of preparing packages of forces.



Figure no. 8: *Mastery of data by a group commander*
(Source: Authors)

2.3. Shooting Instruction with Individual Weapons

Figure no. 9 shows both AR and VR technology (virtual reality) equipment with which the military shooter carried out training activities in the execution of firing sessions with the individual weapons provided. To practice and learn the shooting operations (handling the gun and aiming at the target), the soldier visualized the real target and, at the same time, watched the augmented shooting operations on the Hololens glasses, which he performed repeatedly.



Figure no. 9: *Mastery of firing operations by the military*
(Source: Authors)

After mastering them, the soldier practiced the shooting session in a virtual firing range (Figure no. 10), the VR equipment being represented in Figure no. 9 by the pistol and the portable workstation placed on the back of the soldier.



Figure no. 10: *Virtual firing range*
(Source: Authors)

The virtual range provided the following data on the execution of the shooting, as follows:

a) ammunition consumed;

b) the number of hit objectives;

c) the accuracy of the hit objectives.

3. Results and Discussions

3.1. Execution of Marching Missions by Military Teams

After the execution of the march, everyone was asked a number of 3 questions, to be answered by awarding points on the scale from 1-5. The obtained results are materialized in Table no. 1.

Table no. 1

Answers of team commanders

No. students	Questions	Total score answers	
		Classical methods	AR elements
8 students (2 team commanders, 3 militaries in each team)	To what extent have you identified the probable course of your own forces?	38	42
	How did you identify the risk areas on the travel itinerary?	34	40
	How do you assess the efficiency of the mission execution variant?	36	41

From the analysis of the resulting scores, it is highlighted that AR technology determines a better mastery of the mission elements, due to the supplementation of the mission content with complementary elements (characteristic points, critical points, instructions, restrictions). Also, compared to the variant of transmitting information by radio and map, communication through RA favours the analysis of the mission and the evaluation of its course by displaying in real time the characteristic data.

3.2. Conducting Briefings and Meetings by the Command Structures

Table no. 2

Characteristics of the two variants of conducting briefings and meetings

Characteristic	Microsoft Teams	Microsoft Teams + AR
Content	Chat enriched with text, audio and video components, and file sharing	Chat enriched with text, audio and video components, as well as on-screen file sharing, + the emergence of projects of holographic visualizations of 3D data in physical space
Goal	A private chat to develop an idea, then shared with the entire organization	A private chat to develop an idea, then shared with the entire organization + the possibility of touch commands, built-in voice commands, eye tracking, spatial mapping and projection of the visual field to normal dimensions
Storage	Storing all files, documents, etc. in one place	Storing all files, documents, etc., in one place + predefined holographic icons for their recognizing

3.3. Shooting Instruction with Individual Weapons

The results shown in Figure no. 10 highlights one of the first attempts to execute the shooting session in the virtual range. Following the repetition of the shooting session, the results were improved (Figure no. 11).

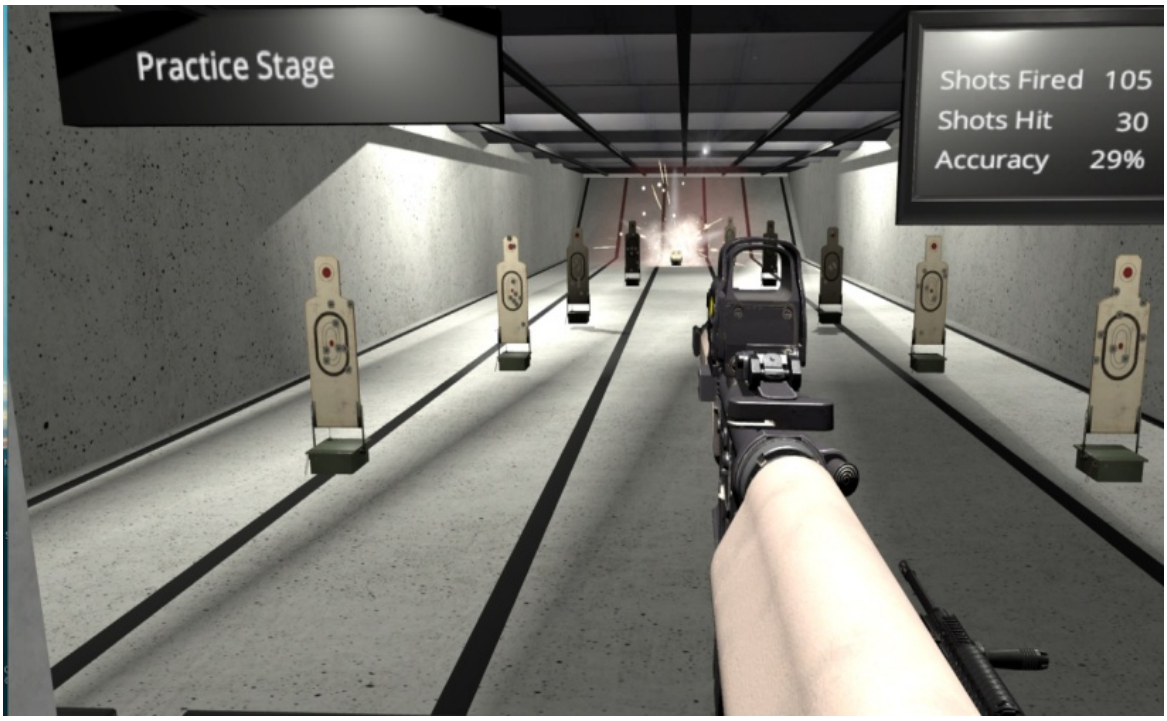


Figure no. 11: *The results obtained when shooting in the virtual range*
(Source: Authors)

Thus, it is observed from the analysis of the two figures, 10 and 11, an increase of the shooting accuracy from 22 % to 29 %, which demonstrates the effectiveness of the training method in the virtual firing range, with efficiency on the shots in the real range.

Thus, the following advantages of the training method in the virtual firing range arise:

- elimination of risks and incidents happening in a real firing range;
- allows the improvement of military shooting skills;
- allows the military to self-train;
- elimination of the consumption of real ammunition;
- the system displays the consumed virtual ammunition, the number of hit targets, the accuracy or precision of the hit targets;
- the disassembly operations of the armament can be transmitted on the AR glasses.

4. Conclusions and Perspectives

Conclusions on the applications created:

- effectively complement the real didactic and instructional activities;
- significantly reduce the costs associated with all actions involved in a training activity;
- the combination of the two technologies, AR and VR, allowed the realization of a complete virtual application in terms of the entire instructional content;

- initiation and development of skills to use the two types of technologies by students;
- active involvement of students in the applications created.

Perspectives on the development of augmented reality applications in the Land Forces Academy:

- development of virtual applications using the combination of the two technologies;
- transposition of training exercises and tactical scenarios from the classical format into a virtual format and their use in the educational process with all students;
- involvement of as many students as possible in the scientific circle activities of the Modeling-Simulation Center of the Land Forces Academy and participation in scientific events;
- the interconnection between the Modeling-Simulation Center and the Instruction Firing Ranges.

Acknowledgements

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