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THE USE OF AUGMENTED REALITY TECHNOLOGY IN THE TRAINING OF SPECIALISTS IN THE OPERATION AND REPAIR OF MULTI-PURPOSE ARMORED MILITARY VEHICLES

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One of the promising trends in modern training is the maximum immersion of students in educational material in order to ensure the immersiveness of education. To increase the efficiency of the educational process, new information technologies are being actively introduced. Such technology is augmented reality (AR). Augmented reality allows you to implement this approach using smartphones, tablets and computers. Currently, two approaches are used: marker and marker-free technology. The use of augmented reality is possible both online and offline. Materials for the implementation of this technology in the educational process are usually prepared by IT companies using languages and programming tools of their own development, which somewhat reduces the availability of technology for ordinary users (both teachers and students). The purpose of this study is to analyze the reasons that limit the spread of augmented reality technology in the educational process and to offer own solution to this issue. On the example of using the Aurasma platform, an option of introducing augmented reality technology into process of training of operators of multi-purpose armored military vehicles is proposed. The proposed option of using public software and devices for the development and application of the information system allows students to study the device, the principle of its operation, features of diagnostics and maintenance of systems, units and components of the military vehicle. The proposed technology of augmented reality allows to increase the level of remote learning of information material by 8.2%, as well as to ensure the formation of highly qualified bachelors, masters or doctors of philosophy upon implementation of remote learning technologies in higher education. With the development of information transmission technology 5G and above, the need for such information systems will grow. The decrease in the cost of smartphones, tablets and other devices, such as augmented reality glasses, will also give an additional impetus to the development of this technology.

Key words: AR - augmented reality; VR - virtual reality; Higher education; Automotive equipment; Motor vehicles

Introduction

American didactics and philosopher John Dewey said "If we teach today in the same way as we were taught yesterday, we will steal tomorrow from our children"[1]. This is still relevant today, despite this phrase nearly a centenary celebration. In order to interest the student in educational material and increase his motivation to master the quality of information material, it is necessary to find a new approach that would correspond to the information space of today. It is known that modern smartphones and tablets in terms of performance and capabilities far exceed the functionality of personal computers of the last decade, and the ability to connect them to high-speed mobile Internet allows implementing new approaches to providing real-time information. The availability of additional sensors and digital cameras also increases the capabilities of portable mobile devices that are used in education. The use of augmented and virtual reality technologies, as well as their combination in the form of mixed (hybrid) reality, is an important promising area for the use of mobile devices in the educational process not only in high school, but also during study of school material in remote learning. Development and use of these technologies depends on the complexity of their application. The easier their use is for the average user, the more dynamic is the growth of such equipment per unit of population, so the mass use of augmented or virtual reality technology is the main trend in their development.

The analysis of the last studies and publications

Augmented reality technology in education and industry was first proposed by Professors Codell, Thomas, and David W. Mizell. However, twenty-eight years have passed since the publication of this work, which is a very long period for information technology. At that time, considering cost and bulkiness of the equipment, this area has not become widespread, and the concept of augmented reality has been developed in the work of

Ronald Azum [3]: real environment, interactive and real-time, and connects virtual objects with physical objects.

The development of information technologies, both in software and technology, has made it possible to integrate the achievements of virtual and augmented realities into a new trend of immersive education. The approach of full immersion in the process of studying the subject using virtual and augmented realities is actively used in commercial companies that have the opportunity to invest in this promising area. Acumen Research and Consulting's latest industry forecast [4] quantifies the revenue of hybrid reality and its sectors, including AR, VR, and the corporate and consumer segments of each of then, as shown in Figure 1. According to Acumen Research and Consulting [4], augmented reality market will reach USD 451.5 billion in 2030.

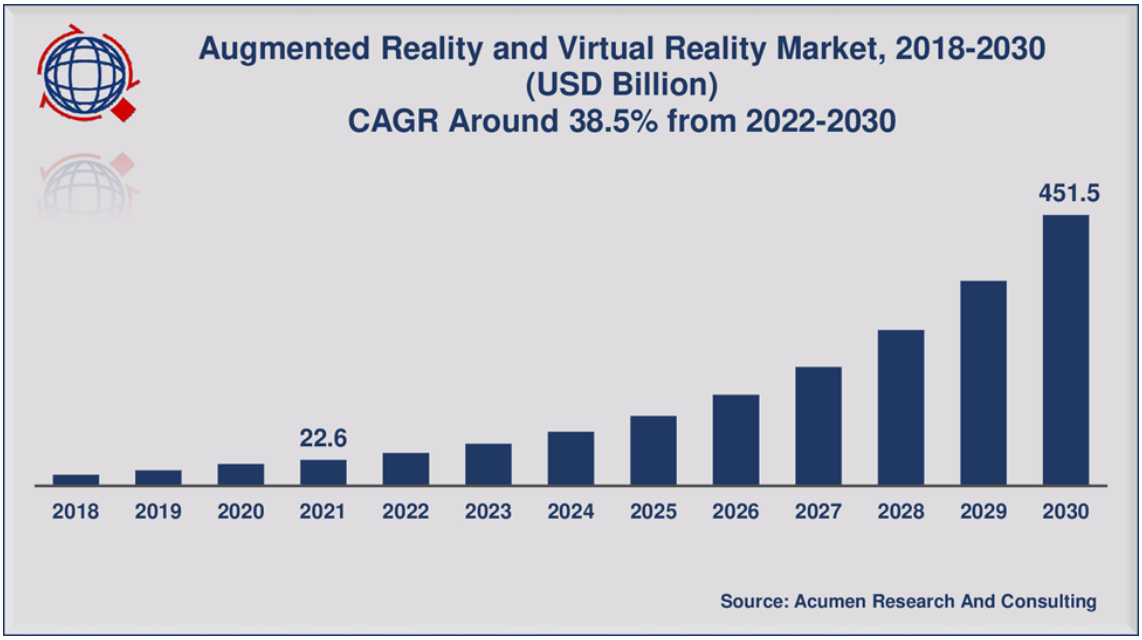
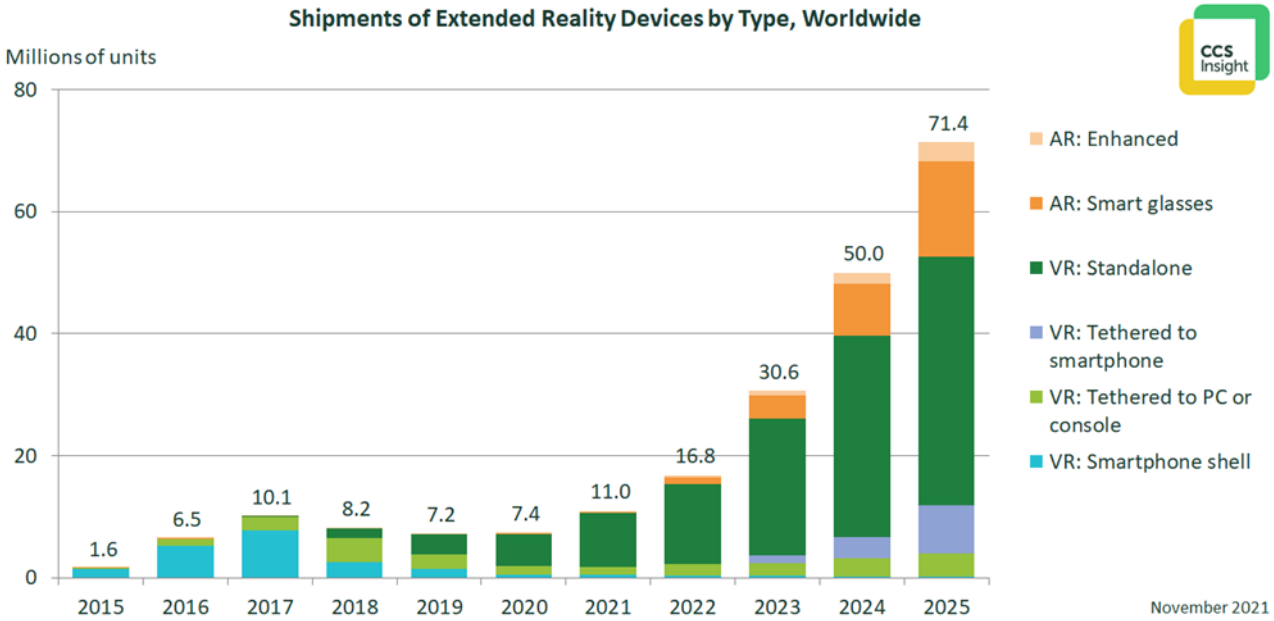


Fig. 1. The revenue of the world market of virtual and augmented realities in 2018 – 2030

According to CCS Insight [5], which provides market information and analytics for companies in the mobile and wireless sectors, the virtual reality has technological advantages (see Figure 2). According to analysts, the pandemic gave a needed boost to consumer demand for XR, which helped relieve people's boredom in lockdown. But thair forecast was always based on the assumption that growth over the next decade will not come from gaming alone, but also from integrating the technology with other forms of visual entertainment including video, education, web browsing, remote events and socializing.



Fig, 2. Dynamics of changes in the volume of the equipment market for virtual and augmented reality, CCS Insight data

Analysis of scientific and technical literature [6, 7, 8, 9] showed that there are no mush analytical works devoted to augmented reality technology in the educational environment for today. One of these works belongs to the author V. Heroimenko, however he considers learning during the game with immersion in the virtual reality in disregard for quality of education.

Considering above-mentioned facts, the aim of this article is to explore the possibility of using augmented reality technology on the Aurasma web browser platform in the preparation of bachelors, masters or doctors of philosophy capable of performing skilled work during operation, repair or creation of new automotive vehicles.

Theoretical basis of study

There are two approaches to using augmented reality technology in the higher education process:

– use of special marker;

– without special marker.

The first approach provides for the use of special marker, created by special programs, such as ATK marker system, IGD marker system, SCR marker system and others [10]. The type of marker, as a rule, does provide visual or understandable information, and consists of a chaotic set of simple figures: rectangles, triangles, polygons or circles (Figure 3).

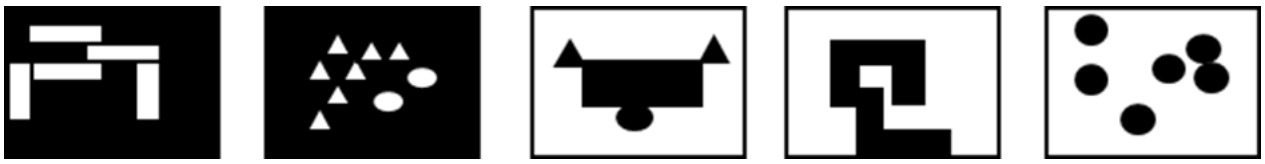


Fig. 3. Example of augmented reality markers

The following components are required for the operation of such a system: markers; trigger image of real models; camera and augmented reality program. The program can work both on the Internet and without it offline. Markers are identified by comparing markers with software database of augmented reality technology. Marker scanning allows you to track the movement of the camera relative to the marker, thus creating the effect of synchronous movement of the object of study on the screen of the user's personal device (Figure 4).

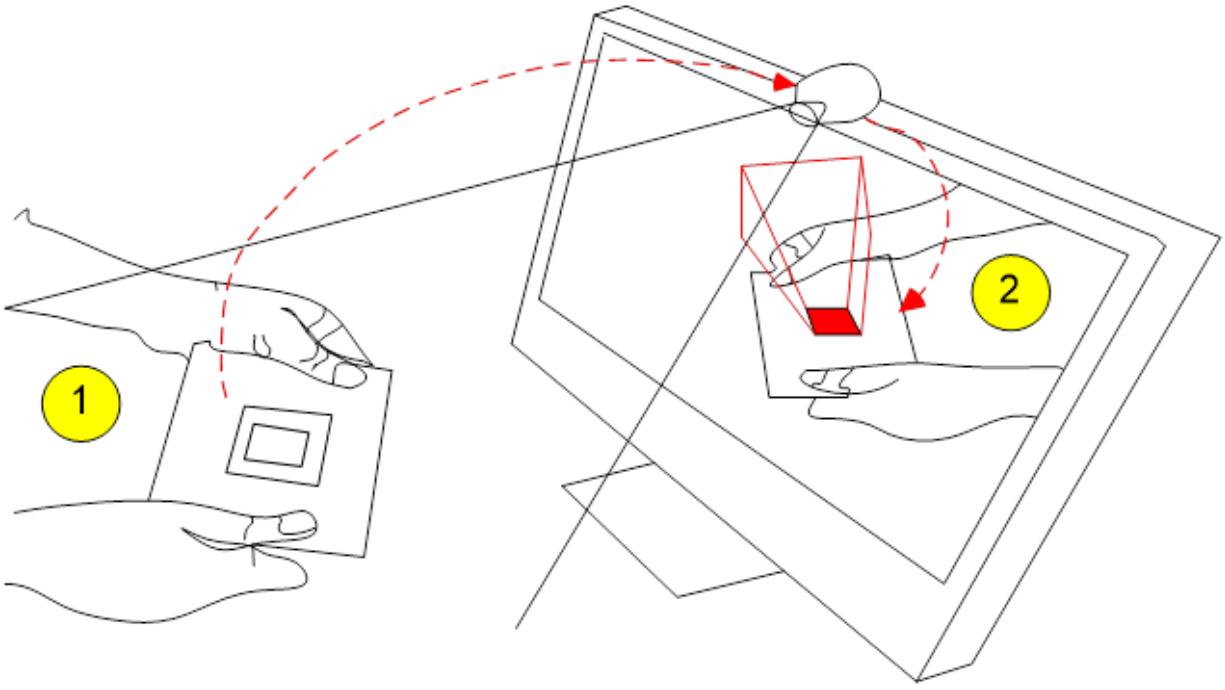


Fig. 4. Layout of marker-based system (1 - marker, 2 - image trigger)

The second approach involves the use of technology that provides recognition based on algorithms for comparing the surrounding environment with a special virtual grid. Software algorithms based on a virtual grid find different reference points, which determine the exact location to which the virtual model will be "tied" (Figure 5). The advantage of this technology is that the markers are real-world objects for which you do not need to create special visual identifiers.

Fig. 5. Mode of operation of system using a browser and a real image

The following platforms can be used as a browser: Layar, Acrossair, Wikitude, Blipbar and Aurasma. This work is based on the example of the latter platform to create an information system for the study of automotive vehicles.

This study focuses on solution of problem of supplementing the real space with interactive digital content, which has a special technical data. The used platform allowed to create special content on the structure, principle of operation and diagnostics of units, mechanisms and automotive vehicle system.

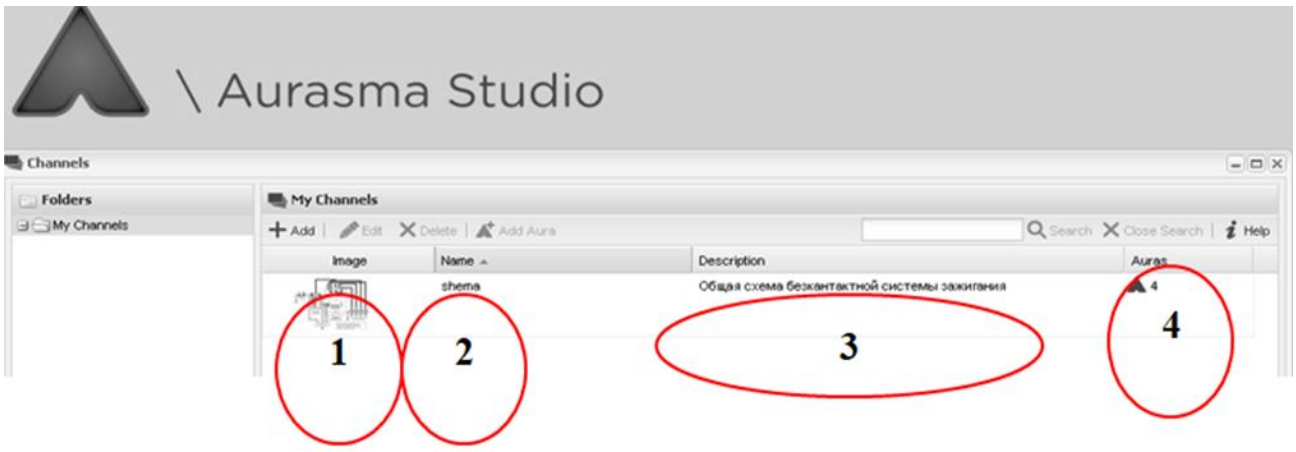
Information channels have been created for high-quality content. These channels group basic elements of learning into so-called "auras" (video content). The formation of auras was based on the online resource Studio-Aurasma. For the proposed approach, Shema and Galmo information channels were created [11 – 14]. These channels can be closed to restrict access (professional) or open (public) in order to organize access to information on special permission, for example for military or special services during study of features of a structure and operation of special equipment. Shema and Galmo information channels may contain textual and/or graphic information in addition to video content.

As an example, we give the open content of information channels (Figure 6), in which grouped "auras" (video content) relate to:

- ignition system of the vehicle [15], where the following elements are formed: the general scheme of the pointless ignition system; information on the features of inspection and regulation of the ignition system; structure of ignition system elements;

- brake system of the vehicle [16, 17, 18], where the following elements are formed: the general layout of the brake system; the procedure for troubleshooting brake system; gap adjustment after replacement of brake pads; replacement of brake cylinders.

The work identifies reasons that limit the spread of augmented reality technology in the educational process. On the example of the use of the Aurasma platform, the option of introducing augmented reality technology into the educational process of training specialists in the operation and repair of automotive equipment, light armored special-purpose vehicles, and multi-purpose armored military equipment is proposed. The authors proposed the option of using publicly available software tools and devices for the development and application of an information system for studying the structure, principles of operation, diagnostics and maintenance and repair of a car (armored car) of a specific brand. A version of the developed channels for the ignition system and braking system of the car is provided. The advantages of using a markerless version of augmented reality in comparison with marker are shown. The proposed technology of using augmented reality allows to increase the motivation and quality of training of students both in the process of studying modern automotive technology and in the process of familiarization with its promising models. It was determined that the prospects for the further development of augmented reality technology are related to the availability and development of the mobile Internet market and devices that allow using it. The obtained research results can be used for the training of specialists not only in the operation and repair of automobile equipment, but also in the field of other applied sciences, natural sciences, or humanities.



1 - trigger image; 2 - channel name; 3 - channel description; 4- the number of "auras" connected to the channel

Fig. 6. Shema information channel in Studio-Aurasma application

To ensure convenience for higher education student, each of the elements of the channel has been assigned a separate trigger image, which is connected to the corresponding "aura" (Figure 7) associated with the content of virtual reality.

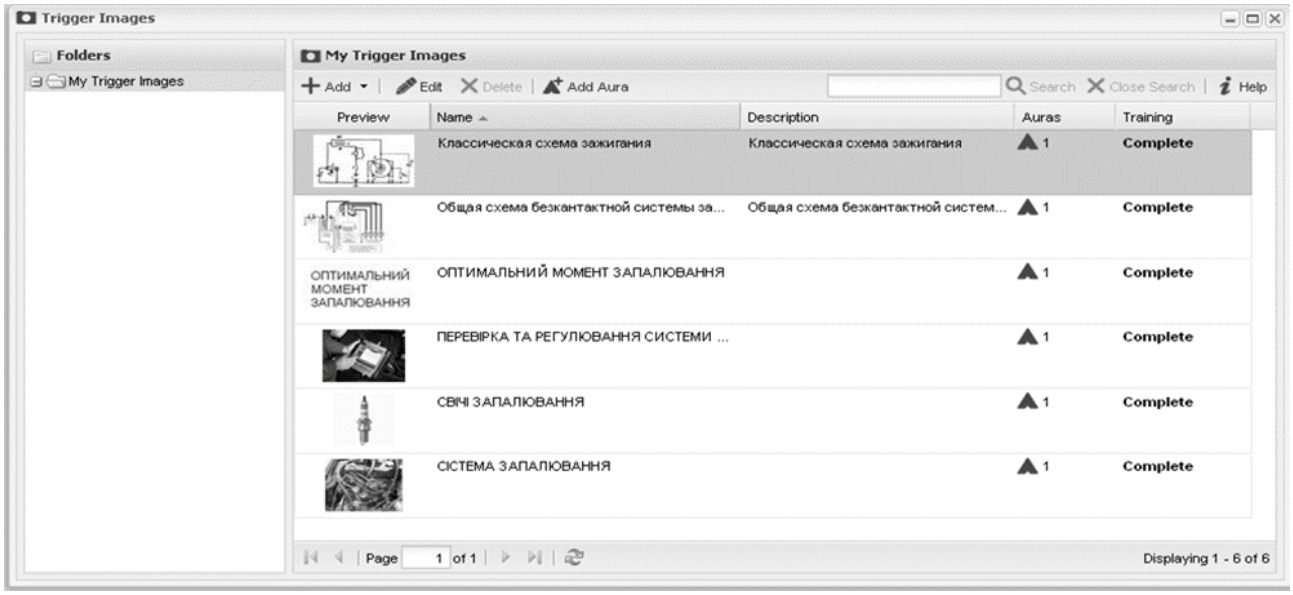


Fig. 7. Shema channel elements in Studio-Aurasma

To use the specified information system, as shown in Figure 8, it is necessary to perform the following actions:

1. Download the free Aurasma application depending on the mobile device platform, used on the Android Marketplace or Apple itunes Appstore on a smartphone or tablet.
2. Turn on the Shema or Galmo channel search.
3. Connect the Shema or Galmo channel.
4. Connect the field of view of the device's front camera and after some time (up to two minutes) point the smartphone or tablet at the selected trigger image.
5. If all actions are performed correctly, then depending on the selected trigger image, the corresponding video content will be connected.

It should be noted that mobile equipment must have access to the Internet either through a built-in modem or via Wi-Fi.

The technical result that can be obtained when using this information system consists in increasing the efficiency and convenience when using the information system for diagnosing the braking and ignition systems of the KrAZ-Cougar armored car. This information system reduces the time of obtaining the necessary information for diagnosis and repair of the braking and ignition system of the KrAZ-Cougar car, and also increases the clarity of information.

Fig. 8. Content preparation in the Camtasia Studio environment

The elements of the information channel, for example for the ignition system of the internal combustion engine, and its trigger image are shown as diagram on Figure 10.

To use this information system, the student should perform the following steps:

1. Download the free Aurasma app depending on mobile platform.

2. Connect the appropriate "auras", depending on the level of education and access.

3. Connect the field of view of the front camera of the device and select the appropriate trigger image to start training.

It should be noted that in order to access special information, mobile equipment should have access to the Internet and special access rights.

In the case of access to open content, the Internet is not a prerequisite for the use of augmented reality in learning.

Study results

Augmented reality enables the learner to interact with real images and orients him/her to an interactive individual study of information at the appropriate level of higher education. Visual search for information on real objects allows a person to focus on the specifics of the material being studied, and thus provides the necessary competencies during training.

The technical result that can be obtained by using the above information system is to increase the efficiency and ease of access to information related to the construction, repair or maintenance of the multi-purpose armored military vehicles. This approach allows student to reduce the time of learning of the necessary information by focusing his/her attention on the material, as well as increases student's competence in the performance of professional duties during work.

To fill the content, information channels are created, in which auras (video content) are grouped. Channels are formed using the Studio-Aurasma online resource. For the operation of the proposed system, information channels Shema and Galmo were created in the Studio-Aurasma application.

The channel can be closed to restrict access or open (public). In order to be able to access the content of a closed channel, you need to subscribe to it.

In the information system, public channels Shema and Galmo were created, which allow, using text or graphic information, to provide video and audio information on the structure, principles of operation,

diagnostics and maintenance of systems and units of the KrAZ-Cougar car. At this time, the content is filled with information on the ignition system and braking system [11, 12, 14].

In addition, the use of augmented reality technology in the operation and repair of multi-purpose armored military equipment, as well as automobile equipment of the National Guard of Ukraine, theoretically described in scientific works [13, 14], will allow to significantly increase the efficiency of operational activities and repair work.

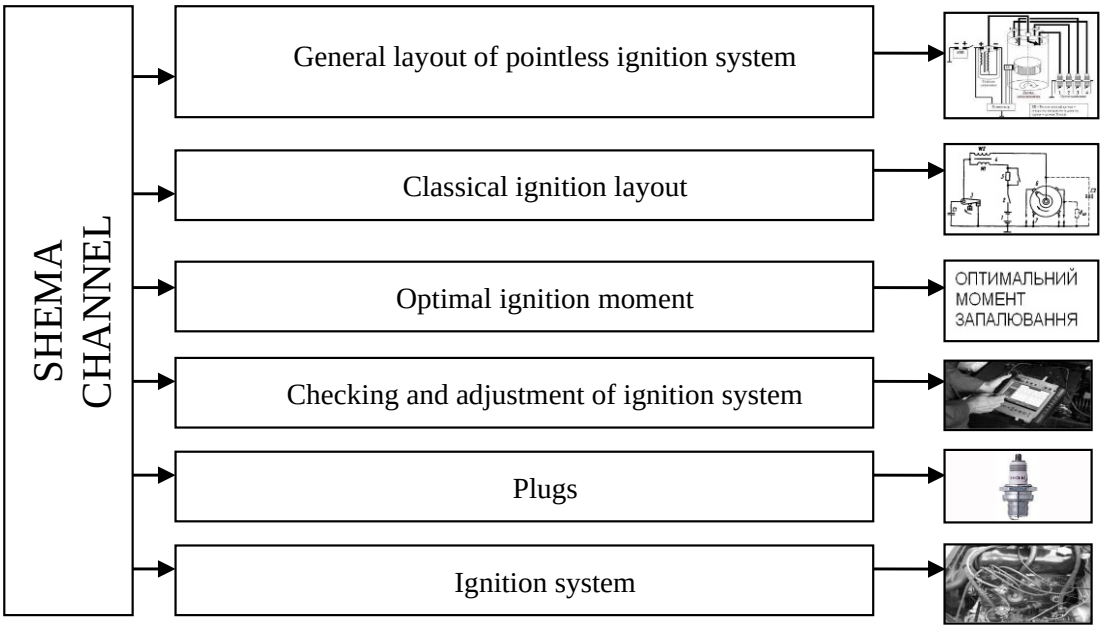


Fig. 9. Shema channel elements and their trigger image

Used approach was tested in two study groups: the material was provided without the use of augmented reality technology in the first group while augmented reality technology was used in the second group. This test, showing achievements in these groups, was carried out after training. Obtained results are presented in table 1 and shown graphically on Figure 9.

Table 1

The results of the test in two study groups.

Log No.	Received point (max-110)			
	Group 1 (without AR technology)		Group 2 (with AR technology)	
	Received point (max-110)	Knowledge acquisition rate (efficiency of study)	Received point (max-110)	Knowledge acquisition rate (efficiency of study)
1	75	68.2	91	82.7
2	60	54.5	59	53.6
3	74	67.3	80	72.7
4	81	73.6	83	75.5
5	51	46.4	75	68.2
6	62	56.4	81	73.6
7	83	75.5	92	83.6
8	90	81.8	69	62.7
9	81	73.6	84	76.4
10	62	56.4	87	79.1
11	58	52.7	79	71.8
12	64	58.2	88	80.0
13	77	70.0	95	86.4
14	59	53.6	89	80.9
15	45	40.9	92	83.6
Mean point	68.1	61.9	82.9	75.4
Absolute gain		14.8		
Relative gain %		8.2		

Study results show that the use of augmented reality technology increases knowledge acquisition by of 8.2% in average, which suggests thigh quality of use of this technology during remote learning of higher education.

Knowledge acquisition rate (assessment or learning performance) in this study was calculated by the ratio

$$O = (F / P) \cdot 100\%,$$

where O is an assessment of success (learning, productivity), F is actual amount of acquired knowledge, skills; P is full amount of knowledge and skills offered for acquisition.

Knowledge acquisition rate varies between 100% (complete acquisition of information) and 0% (completely unlearned material).

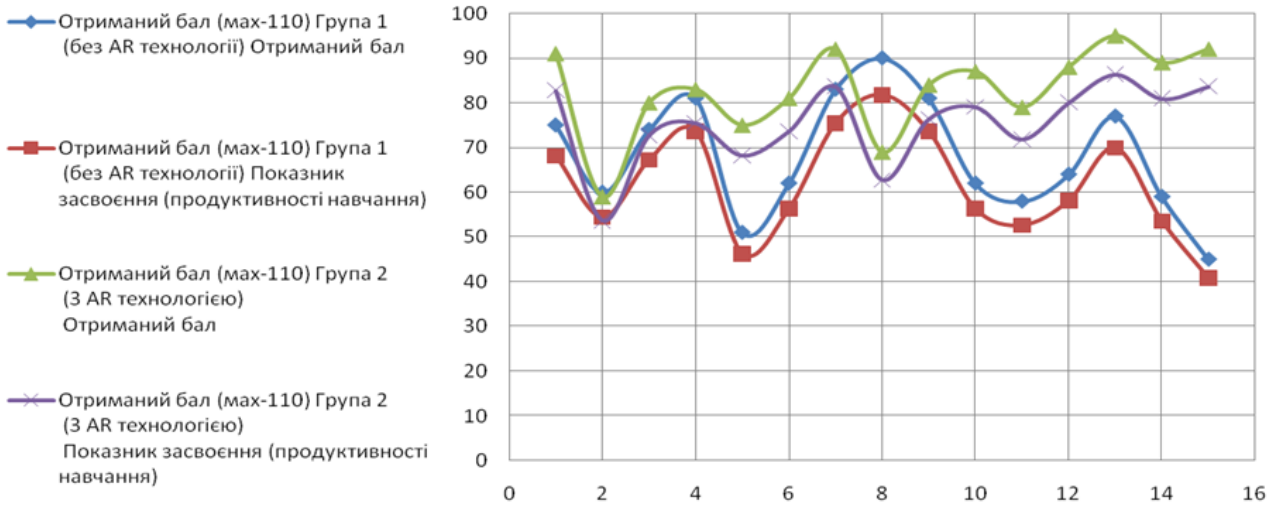


Fig. 10. The results of the test on the topic in two research groups.

Conclusions and prospects of further research

The use of augmented reality technology in the training of students during remote learning or learning to use an individual environment, allows increasing knowledge acquisition rate by 8.2%.

Information system for studying the design of elements, units and systems of multi-purpose armored military vehicles, as well as acquainting military higher education students with the peculiarities of its operation, allows significant increase of their motivation to obtain information during studying of complex technical issues in the field of military equipment and weapons through the use of visual effects of information, as shown by results of studies performed in certain groups of students.

The article presents one of the options for the use of augmented reality technology during the training of specialists in the operation of automotive equipment. As studies have shown, the use of this technology can increase the average score and the rate of assimilation (learning productivity) by 8.2%. The advantages of the proposed technology are the ease of preparation of the necessary material without the use of programming tools. The creation of three-dimensional images is still associated with the use of software code, although some companies have announced their projects that combine virtual and augmented reality. For example, Intel introduced a device with which they enter the world of immersive entertainment. 3D cameras in the lenses receive data input from the user's hand, which makes it possible to interact with a virtual scenario or introduce elements of the real world into a digital environment. The information system due to the use of visual effects of information presentation, as practice has shown, significantly increases the motivation of education seekers, simplifies the consideration of complex technical issues related to the study of the structure and operation of automotive equipment. The proposed technology makes it possible to expand the information system to the required size at the request of its developers and users. Unfortunately, so far the technology of augmented reality is used more in the commercial sector and requires significant financial costs. However, taking into account the interest of both the middle and higher education segments and the growth dynamics of the mixed reality market, we can hope for the emergence of new platforms and state support for this direction. With the development of information transmission technology 5G and above, the need for such information systems will grow. The decrease in the cost of smartphones, tablets and other devices, such as augmented reality glasses, will also give an additional impetus to the development of this technology.

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Використання технології доповненої реальності у підготовці фахівців з експлуатації та ремонту багатоцільової броньованої військової техніки

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Одним із перспективних напрямів сучасної підготовки є максимальне занурення студентів у навчальний матеріал з метою забезпечення заглибленості навчання. Для підвищення ефективності навчального процесу активно впроваджуються нові інформаційні технології. Такою технологією є доповнена реальність (AR). Доповнена реальність дозволяє реалізувати цей підхід за допомогою смартфонів, планшетів і комп'ютерів. Зараз використовуються два підходи: маркерна та безмаркерна технологія. Використання доповненої реальності можливо як онлайн, так і офлайн. Матеріали для впровадження цієї технології в навчальний процес зазвичай готують IT-компанії з використанням мов і засобів програмування власної розробки, що дещо знижує доступність технології для звичайних користувачів (як викладачів, так і студентів). Мета даного дослідження – проаналізувати причини, що стримують поширення технології доповненої реальності в освітньому процесі, та запропонувати власне вирішення цієї проблеми. На прикладі використання платформи Aurasma запропоновано варіант впровадження технології доповненої реальності в процес підготовки операторів багатоцільової броньованої військової техніки. Запропонований варіант використання загальнодоступного програмного забезпечення та пристроїв для розробки та застосування інформаційної системи дозволяє студентам вивчити пристрій, принцип його роботи, особливості діагностики та обслуговування систем, агрегатів та вузлів військової машини. Запропонована технологія доповненої реальності дозволяє підвищити рівень дистанційного вивчення інформаційного матеріалу на 8,2%, а також забезпечити формування висококваліфікованих кадрів бакалаврів, магістрів або докторів філософії при впровадженні технологій дистанційного навчання у вищій школі. З розвитком технології передачі інформації 5G і вище потреба в таких інформаційних системах зростатиме. Здешевлення смартфонів, планшетів та інших пристроїв, таких як окуляри доповненої реальності, також дасть додатковий поштовх розвитку цієї технології.

Ключові слова: AR – augmented reality; VR – virtual reality; доповнена реальність; віртуальна реальність; освіта; автобронетанкова техніка.

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