Possibilities of application of augmented reality in different branches of education

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Abstract. Augmented reality has a great impact on the student in the presentation of educational material: objects of augmented reality affect the development of facial expressions, attention, stimulate thinking, and increase the level of understanding of information. Its implementation in various spheres has indisputable advantages: realism, clarity, application in many industries, information completeness and interactivity. That is why the study presents the possibilities of using augmented reality in the study of mathematics, anatomy, physics, chemistry, architecture, as well as in other fields. The comparison of domestic and foreign proposals for augmented reality is presented. The use of augmented reality in various fields (technology, entertainment, science and medicine, education, games, etc.) should be well thought out and pedagogically appropriate. That is why in the future it is planned to conduct research on the feasibility of using augmented reality and to develop elements of augmented reality accordingly.

Keywords: augmented reality, medicine, education, technology, application.

1 Introduction

The modern world is a very rapid development of technology that contributes to the facilitation of human life. Augmented reality is one of these technologies. It is a combination of computer graphics and the real world. Important benefits of augmented reality are its use of in various fields:

— technology: enrich and improve life experience;
— entertainment: the ability to make the leisure activities of the users more diverse, colorful and fun;
— science and medicine: not only examination or consultation but also serious things, such as remote surgery;
— interactive layouts: visualization of planning of apartments, houses, shopping complexes;

− printing: live flyers, magazines, and newspapers with animation, visualization of advertising products;
− arcade games: flying a plane, driving a car;
− animated technological processes, etc.

Augmented reality (AR) is a technology that aims to complement the real world any elements created graphics or models (and this includes text, audio, and video). This is possible by pointing the smartphone's camera at the special label on which the object is displayed.

The founder of the idea of using AR in the industry is Thomas Preston Caudell. An engineer working at the Boeing Aviation Company in 1990 created an AR helmet that displayed information on the windshield. This invention has become widespread in use [2].

AR has a great impact on the student or student in the presentation of educational material: AR beats influence the development of facial expressions, attention, stimulating thinking, and increase the level of understanding of information.

Many AREdu 2019 authors have addressed various aspects of AR technology, in particular: Ihor O. Arkhypov [8], Volodymyr O. Artemchuk [5], Zhanna I. Bilyk [22; 23; 24], Anzhela P. Boiko [6], Stanislav L. Bondarevskyi [13], Oleksandr Yu. Burov [5], Iryna I. Deinega [5], Andrii V. Iatsyshyn [5], Anna V. Iatsyshyn [5], Valeriia O. Kovach [5], Yaroslav M. Krainyk [6], Tetiana H. Kramarenko [7], Ivan V. Kravets [11], Olexander I. Kuchma [8], Yulii G. Kutsan [5], Olga V. Kuzyshyn [11], Olena O. Lavrentieva [8], Victor M. Lutsyshyn [11], Svitlana H. Lytvynova [5], Maiia V. Marienko [20; 25], Oksana M. Markova [13; 16; 28], Anna P. Megalinska [23], Lilia Ya. Midak [11], Yevhenii O. Modlo [13; 16; 26], Natalia V. Morkun [14], Vladimir S. Morkun [14], Ivan O. Muzyka [18; 23], Pavlo P. Nechypurenko [13; 15; 16], Jurij D. Pahomov [11], Liubov F. Panchenko [18], Andrey V. Pikilnyak [4; 14; 30], Dmytro A. Poltavskyi [6], Oleksandr O. Popov [5], Olha S. Pylypenko [7], Yevhen O. Romanenko [5], Tetiana V. Selivanova [15; 16], Serhiy O. Semerikov [13; 26], Viktor B. Shapovalov [22; 23; 24], Yevhenii B. Shapovalov [22; 23; 24], Ekaterina O. Shmeltser [16], Mariya P. Shyshkina [20; 25], Tetiana V. Starova [15; 16], Viktoriia G. Stoliarenko [16], Stanislav T. Tolmachev [13], Aleksandr D. Uchitel [8; 11; 15; 22; 24], Vladimir I. Zaselskiy [6; 7] etc.

2 Results

To distinguish between AR, one must understand the following: AR is a view of virtual objects and reality, at the same time, where virtual information is added and integrated into the physical world. AR ranges from reality to virtual reality, which is absolute immersion. Figure 1 illustrated a range of mixed reality from the real to the virtual environment.

In virtual reality a man completely immersed in the virtual world, with absolute no does not interact with the real. Special virtual reality glasses are used to fully reflect the virtual environment.

Therefore, understanding the difference, you can present a scheme of AR (Fig. 2).
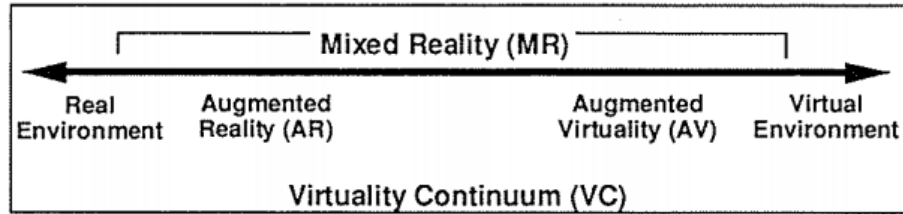
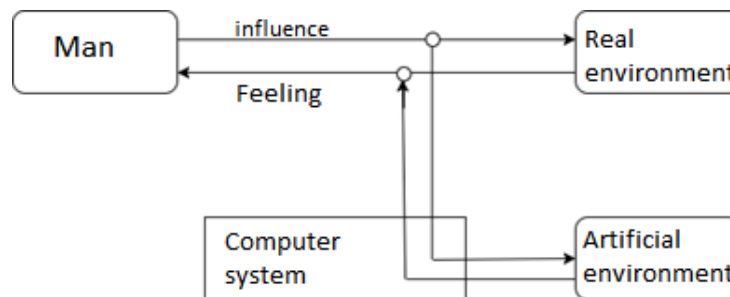**Fig. 1.** The range of mixed reality technologies [12]

Fig. 2. Schematic of the AR environment

Referring to Ronald Azuma's [1], we can distinguish the main features of AR:

- Combination of the real and virtual world;
- Real-time interaction;
- Represent objects in 3D.

How AR works:

1. The camera finds a real-world marker and then transmits information about it to a computer or smartphone.
2. Computer program replace marker by virtual object (text, music, video, 3D model, etc.) and displays it on the screen.
3. The camera then tracks the movements of the marker, and the program allows you to control the objects.

The possibilities of using AR technologies are almost endless and can be applied in almost every aspect of our lives. They will qualitatively change the ways we communicate, consume information and do business. The following are areas of their use in real life:

— *Education*. The Google Expeditions app can make learning more interactive through special tours where students can view a variety of objects while the teacher talks about them.

─ *Medicine*. Viper has proposed a solution that combines telemedicine with AR. With Google Glass and Vipaar, surgeons can assist their colleagues remotely by projecting their hands on the surgeon who performs the surgery.

─ *Aviation*. Military pilots have long used AR. Special displays and helmets display information about fighter systems and assist in aiming. AR is also beginning to penetrate civil aviation. For example, Aero Glass has developed special augmented reality goggles that help the pilot navigate space, follow the route, and receive additional information while flying.

─ *Marketing*. With AR technology, brands can conduct more creative online advertising campaigns, there by drawing additional attention to their products. For example, to advertise the series "Walking Dead", at the bus stop installed an AR system that displays the characters both in the real and zombie' world [27].

─ *Tourism*. For new generations, it is inherent to know the world through direct interaction. For example, the Catalan National Museum of Art has begun to actively use AR to better navigate the intricate corridors and interactively view the exhibits [9].

─ *Design*. It is much easier to set up an apartment because, instead of imagining whether a particular item will suit you, you can simply put furniture in your interior virtually – using the Furniture Dropping AR application.

─ *Shopping*. While you will be in the Supermarket, AR applications will help you navigate a large number of rows and find the shortest route to the right product. It will also be possible to get more information about discounts and great deals.

─ *Games*. A prime example is Pokemon Go. However, the most interesting game implementations will come after the official release of iOS 11, which will run ARKit.

Ukrainian AR projects.

Live Animations is an international IT company specializing in the development of innovative AR products for children [10].

At present, there is a mass application of AR in Ukraine. In any supermarket come to life drawings on the floor, when buying ice cream is a bonus viewing the cartoon, and buying a notebook, you can see a realistic animation. The following is a detailed overview of these projects.

1. Mobile application "Wonderland AR" based on the book "Alice's Adventures in Wonderland". After recognizing the marker, the camera displays an animation of the characters accompanied by music (Fig. 3-5). With this application, you can interact with fairy-tale characters: shoot videos, take photos and write to social networks.

2. Live Photo mobile application. In 2014, Live Animations, together with Hatber (stationery manufacturer), released the first Live Notebooks in Ukraine. When you point the camera at this stationery, the picture depicted on it comes to life; animation starts (Fig. 6-7).

Fig. 3. Wonderland AR example 1

Fig. 4. Wonderland AR example 2

Fig. 5. Wonderland AR example 3

3. Mobile application with AR "My Yeti". The company developed this project for Gourmet Ice Cream. On 5 types of ice cream were placed 20 different markers (stars), when pointing at them, a cartoon will appear (Fig. 8-9).

Fig. 6. Live Photo example 1

Fig. 7. Live Photo example 2

Trinetix was a company that develops mobile applications, augmented reality and integrated internet solutions [29]. "Architectural monuments of Kiev" is a mobile application that works together with a travel directory "Kyiv is my love". When you point the camera at a photo of a monument in the catalog, its 3D model is displayed.

Fig. 8. My Yeti example 1

Fig. 9. My Yeti example 2

The main components of the project:

— object markers are photos from the catalog;
— 3D models of Kyiv monuments;
— mobile application with AR module that demonstrates famous architectural monuments.

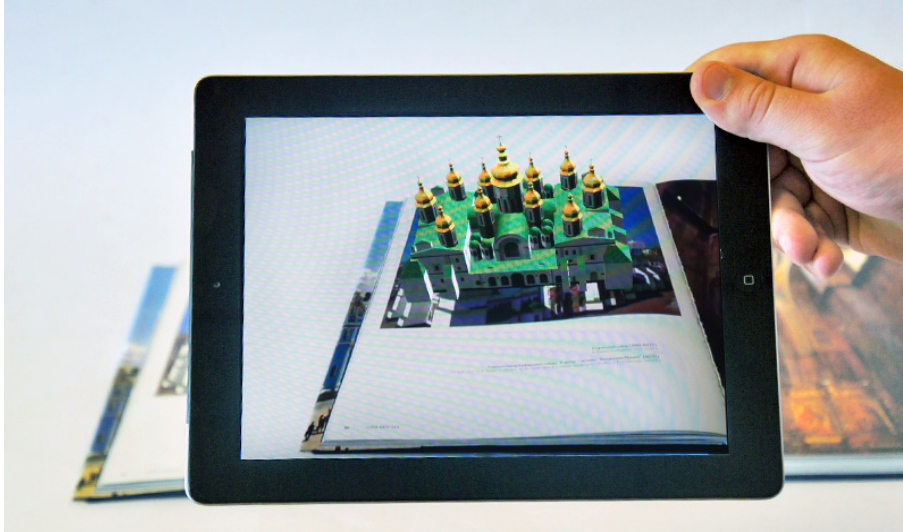In Fig. 10 to 11 are photos of augmented reality presentation.

Fig. 10. Mobile application "Architectural monuments of Kyiv" (example 1)

Fig. 11. Mobile application "Architectural monuments of Kyiv" (example 2)

Non-Ukrainian AR projects.

1. Housecraft.

Company Sirvo LLC (USA) has developed a mobile application Housecraft, which runs on iOS 11. The great advantage of this application is that it does not belong to one store, unlike the application IKEA [3]. At Housecraft, you can see a large

selection of interior items that can be used in your home with your smartphone or tablet. You can also resize objects and lighting (Fig. 12).

Fig. 12. Housecraft mobile application operation

2. Night Sky.

This mobile application by iCandi Apps run under iOS 11 was developed for those who enjoy astronomy (Fig. 13). Application includes the following features [17]:

─ constellations that shine like glass are displayed;
─ easy choice of the 8 bright light spectra;
─ pollution simulator – it is possible to increase or decrease the star brightness, it simulates different variants of environmental pollution;
─ animated planets and the Sun.

Fig. 13. Night Sky

3. Blippar.

A mobile application created by Blippar to recognize any objects in the real world. To get information about the subject, you need to point to your smartphone camera. Works even when pointing the camera at the sky (you can find the weather forecast) (Fig. 14).
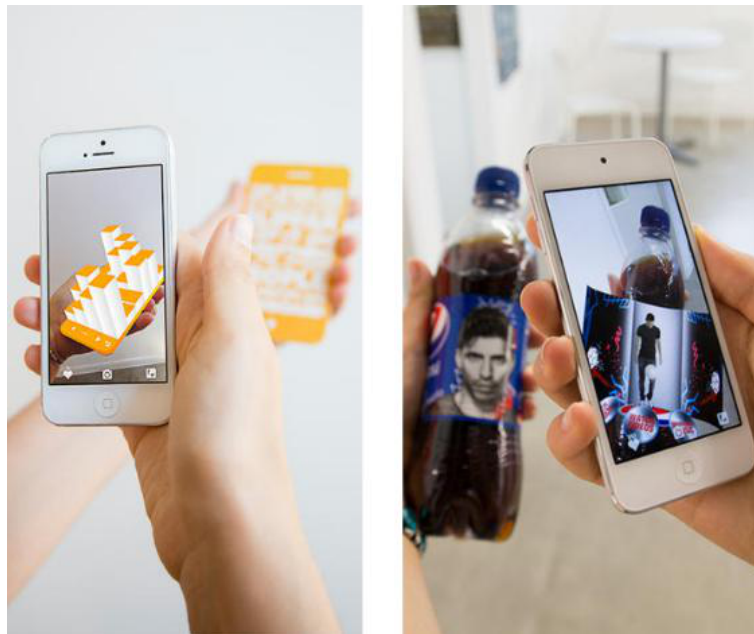

Fig. 14. Blippar

In the field of education augmented reality systems can be widely used in many fields, such as history, mathematics, physics, chemistry, astronomy, etc. You can create books and guidelines on AR technology; simulate the experiments; modeling work with some equipment.

AR widely used in medicine. For example, a laparoscopic operation image on the endoscope complemented the image obtained at the time intraoperative angiography. This information allows the surgeon to locate formation within the body and reduce to a minimum loss of healthy tissue organ of a patient during surgery with removal of formation.

AR can facilitate the study of anatomy by visual effects and information on the organs and bones. You can see the result of the impact of surgical intervention or medicinal preparation as in one body, so also in the group of, not causing harm to a living organism. An educational technology company Visible Body is develop the Human Anatomy Atlas AR application (Fig. 15), which improves the study of the human body. This application provides a detailed 3D model of human anatomy, allowing students to see tissues and organs and virtually dissect the body.

Fig. 15. Human Anatomy Atlas AR Application

Using 3D models with AR in mathematical education can help students to understand math deeply. For example, with Photomath application [19] it is possible to put the camera on the written task and get answer with solving steps (Fig. 16). Features of Photomath: scan textbook (print) and handwritten problems, scientific calculator, step-by-step explanations for every solution, multiple solving methods, no internet connection required to use, 30+ languages supported.
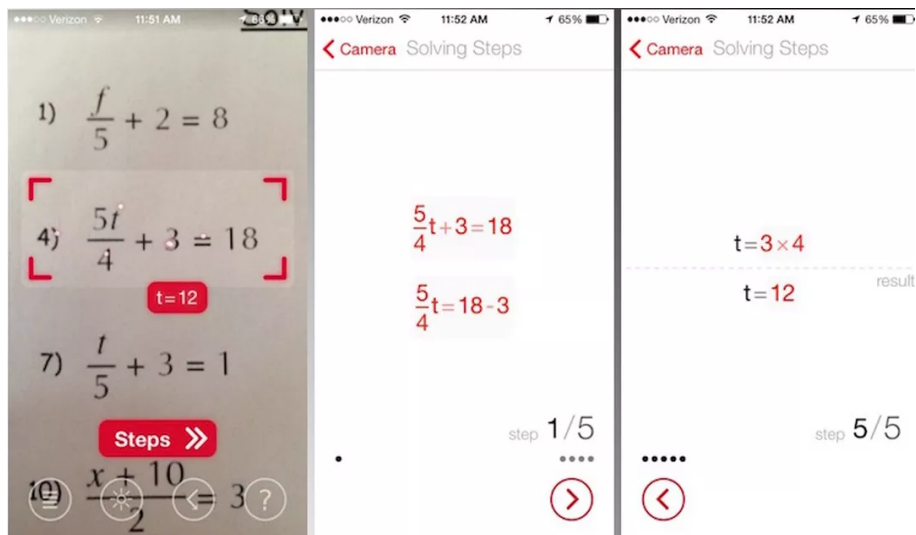

Fig. 16. Photomath

Photomath supports: Basic Math/Pre-Algebra (arithmetic, integers, fractions, decimal numbers, powers, roots, factors), Algebra (linear equations/inequalities, quadratic equations, systems of equations, logarithms, functions, matrices, graphing, polynomials), Trigonometry/Precalculus (identities, conic sections, vectors, matrices, complex numbers, sequences and series, logarithmic functions), Calculus (limits, derivatives, integrals, curve sketching), Statistics (combinations, factorials).

In science education, AR can be used to virtual experimentation. For example, the "Interesting chemistry AR" application (Fig. 17) of SIKE Software allow studying the chemical reactions [21].
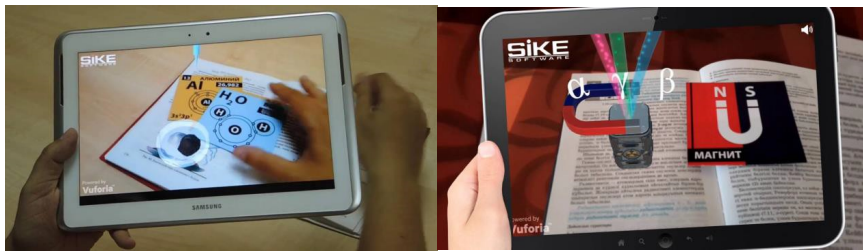

Fig. 17. AR applications "Interesting chemistry AR" and "Interesting physics AR" by SIKE Software

In architectural education, AR can be used, for example, to architectural visualisation. For example, the ARki application (Fig. 18) is a real-time AR visualisation service for architectural models. Darf Design produce each architectural visualisation in-house and provide bespoke AR apps that are unique for each project. By incorporating AR technology within the design process, ARki is able to visualise 3D models for both design and presentation purposes, helping to create an immersive visualisation technique with on-site visualisation and interactivity.

Fig. 18. ARki

3 Conclusions

AR implementation in various spheres has many advantages: realism, clarity, information completeness, interactivity etc. The use of AR in various fields (technology, entertainment, science and medicine, education, games, etc.) should be well thought out and appropriate. In particular, the use of AR in the education involves the development of appropriate applications and methods of their use in the higher educational institutions, which is a prospect for further research.

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