The Use of Augmented Reality Technology in the Educational Process

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Abstract

Today's education system is heavily focused on digitalization of the educational environment. Almost every educational institution is equipped with computes, has access to the Internet, utilizes electronic educational resources, projectors, etc., but the full capabilities of this technology are rarely used. Students' attention is focused on printed educational literature. Therefore, it is sometimes difficult for students to imagine any process described in the book, which is why some students lose interest in learning. In recent decades, computer technologies have been developing rapidly. This led to the fact that the equipment of schools and Universities lagged behind the technologies used by students at home. Until now, paper textbooks limited the tactile and visual styles of learning. Thanks to the technology of augmented reality, the process of perception and memorization of educational material can be simplified. Augmented reality technology will enhance the learning process with bright three-dimensional images, game elements, activate the interaction and participation, development of spatial thinking [Wu13]. Thanks to augmented reality, students have endless opportunities to learn new things. It is worth noting that it is becoming more popular to use electronic textbooks, but they are only digitized copies of textbooks in paper form. There is little use of computer visualization. Unfortunately, the introduction of any innovation into the education system requires a lot of time. However, there are many clubs and extracurricular schools, where such systems and technologies as augmented reality and the Internet of things have been widely used for a long time, and they are gaining popularity every year [Bol13].
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tice, virtual space, interactive teaching methods, creative projects in the education system

1 Introduction

Computer technologies are used actively in educational process in almost every part of the world. Disputes between teachers about the benefits and harms of computer games still continue. Nevertheless, the creation of educational computer games is one of the key areas in modern education. The combination of emotional appeal, audiovisual, computational and informational capabilities of computer technology great didactic potential, which could be realized in educational practice [Sal13]. The teacher stops being the primary source of information. Students receive new material mostly not from the teacher, but from their surroundings – experiences, friends and gadgets. The modern world is hard to imagine without electronic devices; therefore, educational games play an important role in the educational program for those teachers who want not only to give students new knowledge, but also to attract them to their subject. Information technology in education can keep the attention of students [Zil15]. As a result, they show a greater interest in the learning process and the development of technological skills necessary for an academic and professional career.

The education system should always be up to date with modern levels of technology, intelligence, software and other achievements. Therefore, the use of information and communication technologies in the educational process should not lag behind. After all, a student's result depends mostly on the adequate meeting of the need for knowledge, the quality of measures to deepen this knowledge and on how informative and interesting the process acquiring knowledge is. One of the latest achievements in field information technology is augmented reality, which aims to supplement our reality with virtual objects. This technology is widely used in computer games, architecture, marketing and military. We have reviewed, studied and analyzed research and development in the field of augmented reality, such as: "a Survey of Augmented Reality", "Semapedia", "ARTag", " Layar", "Arget", where in one way or another a video stream is further digitally processed and overlaid with computer graphics.

Many of the mentioned technologies use computer vision through a camera. The analysis of educational and scientific literature on this topic allowed us to conclude that applicability of this technology in the educational process is low.

Currently, there is a rapid process of integration of information technology in almost all areas of human activity. People produce a great number of various technological developments and software solutions designed for educational use, and an urgent task facing teachers is the introduction of these technologies into the educational process for daily use by both teachers and students.

The introduction of any technology is associated with certain advantages and disadvantages. In regards to augmented reality, it allows you to expand the possibilities of the educational process.

The technology of augmented reality in education increase its role every year: schools, technical schools and universities around the world are moving from traditional methods to more advanced methods. Paper textbooks and manuals are replaced by e-books, whiteboards are replaced by displays and tablets. Studies show that mixed reality (MR) will be a real breakthrough in the field of education. MR allows students to better assimilate and memorize a lot of information as in primary school as in secondary and high school. Scientists conducted a test with two groups of students. The first group of students studying new material with the help of AR, and the other with classical schemes and manuals. The tests demonstrated that participants from the first group got almost 90% of the total volume of the material, also trey showed discipline and interest in learning, whereas the classical approach showed three times less efficiency.

The essential advantages of mixed reality:

- Visibility. A typical example is 3D modeling. The three-dimensional approach is highly useful for manufacturing; the future specialist can assess all the details of a machine, understand its structure, realize various improvements and changes via AR/MR headsets.

- Visualization. This technique is often used in teaching children. Visualization of the educational material with the help of augmented reality, improves the process of memorization and assimilation.

- Interest. Reading black and white pages of a textbook is not a very exciting process for a child. You can show the content of these pages in another format - MR gives an opportunity to explain difficult moments in a way that is easy even for primary school children. This approach is much more interesting, more pleasant and clearer.

The use of augmented reality devices in teaching is becoming more diverse every year. A very popular interpretation being applications for smartphones.

Augmented reality is the result of applying any sensory data in the field of perception in order to supplement data about the environment and improve the understanding of information.

2 Task

The introduction of modern virtual learning tools into the education system is the most important condition for enhancing the learning effect. The most promising features seem to be interactive 3D-modeling and the use of augmented reality [Vis15].

Having at hand only a set of paper markers, we can present an educational object in three dimensions and do a number of manipulations with it, look at it from the inside or in-slice. The relevance of the introduction of augmented reality technology in the educational process is that the use of such an innovative tool will undoubtedly increase the motivation of students in the study of various disciplines, as well as increase the level of assimilation of the subject, synthesizing various forms of its representation. A huge advantage of the use of augmented reality technology is its visibility, information completeness and interactivity.

The effectiveness of the educational process depends entirely on the level of its organization. The required level can be achieved with a clear, consistent, logically linked construction roles, activities and interactions between student and teacher.

It should be noted that the application of these technologies in education within the framework of psycho-pedagogical, techno-economic aspects are controversial. This is due to the following reasons:

1) incorrect assessment and lack of understanding of the possibilities of using virtual reality in education;

2) misconception about the ergonomic characteristics of modern virtual and augmented reality hardware;

3) poor elaboration of psychological and pedagogical base of design, implementation and application of teaching tools using virtual and augmented reality.

These problems cause us to pay more attention to the empowerment of virtual and augmented reality technology in the organization of the educational process.

The relevance of the application of these technologies in training is due to the fact that they can improve the efficiency of this process, while providing convenience and accessibility for almost everyone. In addition, they allow you to easily organize a remote lesson or test. Another important fact is that the tendency of the last decades is the constant complication of various technical systems and, as a result, an increase in time and increasing requirements for the level of training of specialists for working with them. Moreover, the use of real production systems in training is often expensive and can carry a high degree of danger to life. One of the ways to improve engineering education technologies is the use of virtual and augmented reality systems, 3D electronic learning systems. This will significantly reduce training time, improve the quality of training and enhance the practical orientation of the educational process [Kam13]. However, such training tools are also complex systems, the developers of which must have specialized training and competence in various technical and humanitarian fields.

The prospects and pace of implementation of virtual and augmented reality technologies show that learning tools developed on their basis will become an integral part of education at all levels of education, and their role will significantly increase both in the framework of traditional full-time training and in the framework of e-education [Zhu14]. Realizing this, it was decided to conduct a pedagogical research in order to identify and test the experimental set of pedagogical conditions, providing, on the one hand, the willingness of students to develop applications with virtual and augmented reality, and on the other – to effectively use these technologies for the organization of the educational process at all levels.

To date, the following areas of work have been identified. The first is related to the study of virtual and augmented reality technologies as a new direction of the information technology industry, the basics of creating virtual and augmented reality applications (VR, AR) [Bla13]. The second direction is pedagogical design of teaching aids based on virtual and augmented reality technologies. The third – definition and experimental check of organizational and pedagogical conditions of effective use of such means of training in educational process [Kat16].

In the first of these areas, which, in our opinion, should be implemented at three levels, today is actively working in the field of additional education: the course "Fundamentals of creating applications with augmented reality" to prepare students to create applications with augmented reality. The aim of the course is to introduce students to the technologies of augmented reality, the development of interest and motivation in this area, to

teach how to apply these technologies in practice and create applications of augmented reality. After studying the course, students will know the applications of augmented reality, types of augmented reality, the technology of working on the creation of applications with augmented reality, the differences between augmented reality and virtual reality.

And they will be able to apply the technology of augmented reality, create images for work, create their own 3D models, use augmented reality glasses, use AR-applications, develop AR-applications, and also have skills in using AR development tools.

The second direction of our research also finds practical solutions. The purpose of the work in this direction is to determine and test the experimental set of pedagogical conditions that provide effective training of university students to the organization of the educational process with the use of teaching tools created on the basis of virtual and augmented reality technologies. Efficiency of preparation of university students to the organization of educational process with use of the means of training created on the basis of technologies of virtual and augmented reality is reached by realization of a complex of the following pedagogical conditions:

1) design of means of training on the basis of virtual and augmented reality technologies, taking into account the principles of modular and competence approaches;

2) application of means occupational training on the basis of VR and AR tech;

3) presentation of the content and students' self-study in the framework of the modular program with three levels of complexity of diagnostic, educational, cognitive, search and creative tasks [Blu12].

Note that the formulated tasks, in fact, provide a starting point for the implementation of the third direction of our research. It is planned to attract graduate students in studies such as "Applied computer science «and "Mathematical and information support of economics" Students conduct master classes on augmented reality at secondary general education institutions. Further work should be organized in the indicated areas.

3 Development Of Methodology

There are several methods of using augmented reality technology to support the educational process [Yen13]:

- methods of using the QR-code system in the applied activity of an educational institution;
- methods of using augmented reality and virtual media objects;
- method of use in CAD.

Let us give some examples:

1. Use QR-codes with links to multimedia sources and resources that help to solve a particular problem. After printing out the codes, they can be pasted directly into the manuals or notebooks of students;

2. With project management you can create collections of links, news items, comments, etc. QR codes can be published on pages of sites to support the project posters.

3. When used in the library, when QR-codes can be placed on information stands with information such as video or multimedia comment (in the form of links) to the announcement of the announcement or other material.

4. Placing the code in the catalogues of the University library literature search: the code is automatically displayed to summarize key information, table of contents, author and location on the shelf.

5. Adding codes to the automated learning environment information system. These codes contain an indication of the URL - page of a particular training course, a link to the schedule of classes, the availability of classrooms.

6. Visual demonstration of complex processes.

The review and analysis of augmented reality technology shows how this technology opens new horizons in the field of education, providing the opportunity to Supplement the real objects of contextual information and visualization of educational material. The marketing analysis of the market and identified the economic benefits of the implementation of the development, developed a software package consisting of two parts – a scanner application and a web interface [Bov15]. The introduction of augmented reality technology will motivate students to self-study, to interest the audience, to develop the desire to learn new features and technologies, to replace expensive manuals and laboratory equipment with multimedia computer models [Ale14].

The main purpose of the development of educational systems and virtual simulators with augmented reality is to transfer the methodology of studying any subject discipline or familiarity with some device, product, or unit.

The proposed system is designed for rapid visual training of specialists in methods of operation, maintenance and repair of complex equipment and equipment, directly on this technique, with the use of mobile multimedia devices, without the participation of training personnel. It consists of a software part that uses the technology of computer image recognition and mobile hardware – a tablet computer (or multimedia augmented reality glasses, or a virtual reality helmet) [Cho13].

To start the training, the user must be located in front of the device being studied. On a tablet computer (augmented reality glasses, or virtual reality helmet), you must run the appropriate application, and then point the camera of the mobile device to the labels located on the device. The tracking system recognizes the specified part (or specialized label on this part) and runs the appropriate educational program.

Interactive educational program demonstrates directly on the device the order of actions, accompanied by visual and voice prompts, which must be carried out to perform a particular technological operation.

The training is individual and takes place through the demonstration on the screen of the user's mobile device of additional information layers, including 3D models, tips, animation, text and graphic elements, positioned on the coordinates of the structural elements of the studied device [Mur16]. Combining the coordinates of virtual and real objects is achieved through augmented reality technology, which allows you to track their changes in space by recognizing real objects in the video stream coming from the camera of a mobile device.

Training step by step. Each stage is accompanied by a corresponding demonstration showing through 3D models and additional visual elements the necessary information. Steps that demonstrate the sequence of certain actions are accompanied by voice prompts. Managing demonstration of using voice commands and an additional input device and positioning (touch panels, controllers, hardware positioning). Functional feature

- Familiarity of the user with the basic elements of the device under study; - Visual training of the user of a certain technological procedure with reference to the coordinates of the elements of the device or device;

- Visual training of the user of a certain technological procedure without reference to the coordinates of the elements of the device (or device) on its 3D model (for students who are at a distance);

- Voice control

- Voice guidance and tips

The system allows an untrained specialist to get acquainted with the technological procedure in 1-2 minutes and perform this procedure directly on the device (or device).

3.1 Hardware part

To ensure versatility and additional redundancy of the hardware component, the software can be run on a mobile device running Android or iOS and equipped with a video camera. It can be almost any modern tablet computer or smartphone. To improve the stability of recognition of the device position in space, the objects next to it, or he himself, is pre-marked with visual or infrared marks, which help the tracking system and increase the accuracy of the positioning of virtual objects [Yue11].

3.2 Program part

The organization of the visual learning system is implemented on the basis of a specially designed mobile application. This mobile application contains the following main functional modules:

- The augmented reality system module, which captures video stream from the camera of a mobile device, searches for a marker by key points on the video image and determines the coordinates of the real object.

- Educational process logic model, which receives information about the location of real objects, substitutes them with additional information layers and 3D models, and applies to them the conditions of the current stage of training.

- Module for generating the final combined image and displaying it on the screen of the display device.

- Voice recognition and voice control module.

- User interaction and user interface display module.

- Training scenario

The training program is a visual step-by-step instruction that demonstrates the basic steps and the necessary tools to perform a specific technological procedure.

To run the program, the user must select the appropriate application in the mobile device and run it. After the launch, the video will start broadcasting on the screen of the mobile device. The program supports several operating modes:

- Mode 1 - "augmented reality" to display visual elements on a real device.

- Mode 2 - "no augmented reality" to display visual elements on a virtual 3D model of the device, without reference to real objects.

By default, the program will start in the "augmented reality" mode, for which the user needs to be located in front of the marked device and point the camera of the mobile device directly at it. Switching to the "no

augmented reality" mode for distance education from the combat vehicle or in the classroom, is made using special controls in the application interface, or a specific voice command.

When the tracking system recognizes the specified part (or a specialized label on this part), the visual instruction steps that demonstrate the operations to be performed by the user will be displayed [Lee12].

The demonstration consists of a set of stages (training steps). Each stage is accompanied by a corresponding demonstration. During the demonstration, the desired element of the device with which the operation is performed is highlighted in color to attract the user's attention. The animation shows the user the action that he needs to perform. Text information is displayed and a voice prompt about the action to be performed is played. If the operation is dangerous or unpredictable, the system displays appropriate warnings accompanied by an indication and an audible signal. During the training, the user is an active participant of the demonstration and can control its process with the help of voice commands and navigation elements of the user interface.

4 Results

The use of vivid and memorable visualization in explaining various topics that can be done within basic knowledge and in various training formats — in a lesson, lecture, seminar, or excursion — can significantly increase the degree of selection of useful information, as well as improve the process of perception.

We are convinced that AR is a huge breakthrough in the way of providing educational material, as well as in the assimilation of information by schoolchildren and students. Bright and significant results indicate the effectiveness of the AR and MR technology. Several experiments were conducted in this group.

The result of the experiment: the level of perception - 95%, the attention of the audience at the level of 98%, while in the second group with standard conditions these characteristics were 45% less.

In addition to the fact that in three-dimensional image mental processes are stimulated, motor skills, facial expressions, attention and the degree of assimilation, memorization and, most importantly, understanding of permissible information are developed [Koh10]. As part of our AR integration effort, we have adapted RealEye, which is an electronic application based on augmented reality technology, providing a wide range of functionality for both the teacher and the student.

Using this technology, the teacher can convey the necessary material in a more interesting and accessible form for students by basing classes on exciting games, demonstrations and workshops. The ease of use of virtual 3D objects simplifies the process of explaining new material. At the same time, mastering the technology of augmented reality, increases the level of information literacy of the teacher and student.

"RealEye" consists of a software environment – the interface, and a device – the AR controller. The core of the application is a Flash module based in the Flash Develop programming environment, which combines the following files:

- .3ds file extension – a three-dimensional model an object or phenomenon created in 3dsmax;
- .ipg file extension – a texture for a model made in Photoshop;
- .png file extension – a token implemented in CorelDraw;

In addition, the platform Alternativa3D is connected and FLAR Manager tracker is used. Alternativa3D provides graphics support, and FLAR Manager tracks the marker in space and draws the 3D object.

The application has a simple and user-friendly interface, which is accessible even for a beginner without any instructions. The universal software shell for Windows was developed in the object-oriented programming environment Boorland Delphi 7.

The application interface allows you to select the mode of the program:

- The automatic mode, in which flash modules of objects are assigned to buttons.
- The start mode, in which the user can change objects by pressing just one button.
- The manual mode, in which the user must specify the path to each object. The point of this mode is that you can view newly created models that are not yet included in the automatic mode.

We found this technology useful in a "Hardware protection of information" course. The demonstration tools can be used both directly by the teacher and individually by each student. The use of this technology ensures the effectiveness of the educational process and raises interest of students in the course subject.

Thus, augmented reality technologies can and should be used in solving educational and organizational tasks in an academic environment [Aga16]. This will ensure the mastery of not only specific actions in this area, but also a system of universal educational actions. In the course of solving these problems, the student obtains the necessary knowledge and applies them in practice.

The application allows the teacher to make more visual, informative, stimulating and most importantly interesting classes for students.

Thus, using augmented reality technologies will have a positive impact both on the student (to promote better learning) and on the teacher (to help organize the educational process).

Note that the formulated tasks, in fact, provide a starting point for the implementation of the third direction of our study. It is planned to attract graduate students in the field of Applied Informatics and Mathematical and Information support of economics. To date, applications with augmented reality have been created and actively used to organize and conduct career guidance work of the Institute of information technology and telecommunications, students conduct master classes on working with augmented reality in secondary educational institutions. Further work should be organized in these areas with an emphasis on the formation of the necessary and sufficient pedagogical and technological base of the study.

5 Discussion

The introduction of modern virtual learning tools into the education system is the most important condition for enhancing the learning effect. The most promising features seem to be interactive 3D-modeling and the use of augmented reality.

Having at hand only a set of paper markers, we can present an educational object in three dimensions and do a number of manipulations with it, look at it from the inside or in-slice. The relevance of the introduction of augmented reality technology in the educational process is that the use of such an innovative tool will undoubtedly increase the motivation of students in the study of various disciplines, as well as increase the level of assimilation of the subject, synthesizing various forms of its representation. A significant advantage of the use of augmented reality technology is its visibility, information completeness and interactivity.

The effectiveness of the educational process depends entirely on the level of its organization. The required level can be achieved with a clear, consistent, logically linked construction roles, activities and interactions between student and teacher.

One of the most important reasons for the high efficiency of augmented reality in education is that AR clearly shows the interconnection between the real and the virtual worlds. The three-dimensional image allows a person to be interested and stimulates his attention and sensitivity to the information component.

Regardless of the given material, augmented reality helps to increase its attractiveness for students of different age and increases the desire for knowledge.

Also, the using of augmented reality technology is highly effective from a material point of view: costs for the manufacture of printed textbooks reduce; the need to manufacture and use visual aids reduce.

To obtain the effect of augmented reality, only a two-dimensional label and a device with a camera are needed.

Now the work of applications that use technologies of augmented reality is available on a wide range of devices from smartphones to computers with built-in cameras. Therefore, taking into account the availability of this kind of gadgets, practically everyone's technical question of using AR in education based on selection and implementation of a specific unified platform, where the process of education will be carried out. At present, there is no purposeful introduction of technologies of this kind in the educational process, and the number of such software solutions is extremely small. Nevertheless, many experts in the field of information technologies agree that the future of augmented reality in various areas of our life has rather bright prospects, and AR - technologies in education will bring the education system to a new level.

In the development of research activities of students in Russia, the main point is still the long tradition. The activities of many students are often reduced to the simplified implementation of workshops or lab work, i.e. solving problems by repeating actions of the teacher, and so on. The main goal of this activity was the preparation university applicants and the formation of young successors for research institutes. In modern conditions, when the issue of reducing the academic load of children is relevant, the meaning of the term "student research" takes on a slightly different meaning [Cas13]. There the share of the vocational guidance component, the factors of scientific novelty of research reduce, and the content associated with the understanding of research as a tool to improve not only the quality of education, but also motivation for further research, increases.

Posters are a common thing for education. Despite the large number of digital boards and other additional equipment, posters are still used in schools, often promoting outdated and irrelevant information. Perhaps, posters can solve the problem of involvement and motivation, if we apply additional visualization technologies to it with help of a phone or a tablet. The essence of visualization technology is that you can direct smartphones or

tablets with cameras and a special application to various objects, such as paintings, portraits, figures, posters, etc., and get the detailed information about them.

In fact, each object involved in the training system, caught in the camera lens of the gadget and recognized as a specific label, gives the user the path to the virtual content. Thus, students can go on a virtual tour using their favorite electronics. Attachment to electronics can turn into a student's advantage with help of technologies of augmented and virtual reality. These can be objects of both the real world and painted on special posters that provide access to pre-recorded videos, but the development of this concept is limited by the available budget.

6 Conclusion

Mankind has a rather tortuous way of understanding how the world works. After the invention of the Internet, the world divided into reality and virtuality – it became difficult for us to imagine that once people lived without the web. But it turned out, that between them, there is another stratum - augmented reality, which experts recognize as new media [Bow14].

Augmented reality is an innovative technology of superimposing virtual information on the real world. It is the most effective tool of the modern marketer. An indispensable assistant in the presentation of complex projects and designs. The best mediator between the consumer and the goods.

The basic principle of augmented reality is the combination on the screen of the live imaging and virtual information that is directly related to visible objects.

Augmented reality technology is becoming more and more popular every day and is increasingly used in various fields. This technology has great potential, and is actively developing. Experts believe that soon the addition of the real environment with digital data will gain high demand in all spheres of life.

The didactic opportunities of modern information and communication technologies and their application in education is one of the current areas of pedagogy. Today it seems promising to use augmented reality technology in educational practices.

In general, we can say that today, augmented reality technologies in education are at the stage of their formation, and, given the prospects for their development, it is necessary to conduct both foreign experience analytics and educational experiments with augmented reality in domestic schools and universities.

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