

# Augmented Reality as a Modern Learning Tool

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## Abstract

This article describes the need to apply augmented reality technologies in training, as well as technologies of augmented reality application development in the educational process in engineering and IT areas. The definition of the augmented reality is given, the directions of studying the augmented reality technologies are analyzed, such as: studying the augmented reality technologies as means of designing and developing applications, application of pedagogical technologies for visualization of laboratory training workshops, definition and experimental testing of organizational and pedagogical conditions for effective use of such means of education in the educational process. Areas of application are considered, and types of visualization such as scientific visualization, software visualization, and information visualization are distinguished. Description of problems associated with the poorly developed skills of students to create images by verbal description, for instance, visualize information. It is substantiated the use of AR-applications to solve two tasks: to obtain sustainable knowledge, skills, and abilities in the use of finished products AR-applications, mastering the technology of designing AR-applications, and independent creation of projects of augmented reality for educational purposes and in general development. There is also a scheme of methods for designing AR-applications.

## Keywords <sup>1</sup>

Augmented reality, AR-applications, information visualization, augmented reality application design, modeling, 3D-object model, quality of knowledge, learning process efficiency.

## 1. Introduction

Constantly accelerating the development of information and communication technologies in the modern world assumes mastering of new interactive skills, first of all, the faculty to maintain a high level of professionalism, which leads to the mastering of new pedagogical and technological methods and techniques of teaching, which in turn increases the quality of learning and mastering of new knowledge and competences of students. At the same time, one step behind in technical terms threatens to put both the user and the specialist off for the whole epoch of mastering new skills, capabilities, means, and software and hardware implementations [1].

The process of ubiquitous digitalization inevitably changes the structure of employment and the education system as a supplier of highly professional staff. The digital transformation of the modern society puts on the agenda the questions about innovative forms of teaching and forms of education of students, adequate to the current state of society and tasks of economic development [2]. In the coming years, education will be further adapted to the needs of people born in the digital age, with an emphasis on technology [3]. The use of information and communication technologies in learning is since there is an opportunity to improve the efficiency of this process, while making it convenient and accessible to almost everyone, as well as making it easy to organize a remote session or to conduct testing on the material studied [4].

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The functions and roles of the teacher and, consequently, his professional training are transformed. From a knowledge carrier and their supervisor, a teacher becomes a mentor, mentor-consultant, guide in the world of information, moderator, initiating and directing active independent work, organizing various types of interaction of students, becomes an expert and developer of electronic learning materials [5].

Information and communication technologies have become an integral part of the modern man. They are especially widely used by young people, using their gadgets to play, communicate, search for information, navigate, and choose a route in new places and cities, etc. [6]. A modern schoolboy, student, or trainee in retraining programs is practically free to master computer technology at the level of intuition and trial methods, using all kinds of technical means such as smartphones, tablets, laptops, and computers, as well as software platforms and social networks. To use these skills is the task of a modern teacher who can counteract wasted time in the network with interesting and visual stories aimed not only to present information but also with the effect of learning [7]. The purpose of the teacher's work is not just to enclose a set of knowledge (knowledge, as well as information, is now widely available on the Internet, it is only necessary to make a correction request), but the main thing - to direct the student to the comprehension of the studied information, its generalization and obtaining subsequent conclusions.

As a learning effect or stimulus and motivation to learn can become an augmented reality, which is used in the skillful combination of technical, software, and didactic means of education as schoolchildren and students of various specialties and directions. Thus, the rational use of information resources in the implementation of educational programs has become the main trend of modern education [8]. The effective functioning of the information and educational environment and the application of new digital technologies require an appropriate level of qualification from the employees it uses and supports and imposes new requirements to the education system as a whole and teacher training in particular [3].

## **2. Purposes and Objectives of the Research**

The purpose of this research is to analyze the technologies of augmented reality and to study the ways of introducing these technologies into the educational process, including the training of technical professions and training directions.

Justification of the choice of augmented reality application development methods and design algorithms for educational purposes will allow us to generalize the experience of using augmented reality technologies and will increase the interest in the process of education, namely, in the process of design of the students themselves, as well as teachers.

The use of augmented reality application development technologies in training in technical areas involves a deep study of graphic design methods (drawings, drawings, color schemes, etc.), as well as software design applications, which increases the overall professional training of students in the direction of information technology.

As smartphones, tablets, and other mobile devices continue to dominate our digital ecosystem, there are many industries using mobile or wearable devices to perform augmented reality (AR) functions in their workplaces to increase productivity and reduce unnecessary workloads [9].

## **3. The Definition of Augmented Reality and Methods of the Use of the Applications for Learning**

Let's consider the concept of augmented reality. For the first time, the definition of augmented reality was formulated by Ronald Azuma in "The Augmented Reality Study".

Augmented reality (AR) is a system that combines the virtual with the real, interacts in real-time, and is in 3D space [10].

According to [9Thi18] Augmented Reality (AR), a technology for seamlessly augmenting the physical world with digital content, can be the answer to help bridge this gap and bring the two worlds closer, both digitally and physically. In other words, by overlaying additional information on

the image of the real world, Augmented Reality Technology implements a fundamentally new type of user interface that is responsive to the environment.

As Bova V.V., Lezhebokov A.A., Nuzhnov E.V. indicates. "... AR-interfaces allow users to see in the real world embedded virtual objects and manipulate them in real-time" [11].

Augmented Reality is a new interactive technology that allows superimposing computer graphics or text information on real-time objects, it is a combination on the screen of two originally independent spaces: the world of real objects around a person and the virtual world created on a computer [12].

As noted by the authors in [4] Augmented Reality is an innovative technology of superimposing virtual information on the real world. It is an indispensable assistant in the presentation of complex projects and designs, the best intermediary between consumer and product. The main principle of Augmented Reality is a combination of live images on the screen and virtual information directly related to visible objects. Speaking of augmented reality (AR), we usually define the addition of the real world some virtual generated digital information to make the combination of the two worlds as seamless as possible, requiring the integration of interdisciplinary knowledge from many areas, such as computer vision, signal processing, touch network, Internet of Things (IoT), three-dimensional computer graphics, human interaction with the computer and hardware and software design [9Thi19]. The teacher, using e-learning, should be a teacher in the field of education. The process of informatization of society and the intensive development of programming languages allows a new look at many phenomena of the world around, including those related to the use of modern information and communication technologies and supercomputer technologies [13].

It is possible to define the following directions of Augmented Reality Technology research. First of all, the study of augmented reality technologies as a means of designing and developing applications that allow overlaying digital images on the surrounding reality, i.e. visualize information, thus complementing texts, graphics, video, and audio. Secondly, study the application of pedagogical technologies for visualization of laboratory training workshops to improve the learning of the material under study. Third, the definition and experimental validation of organizational and pedagogical conditions for the effective use of such learning tools in the learning process [4] by processing the results of the survey in real-time and storing these results in a database of trainees for further analysis of the success of learning material and application of selected learning technologies.

#### **4. Methodology for using augmented reality in teaching**

The main objective of the teacher - to prepare pupils for life in the modern information society in which the main values are knowledge and information and also ability is competent to work with them as [5]. It is possible to claim that when training IT specialists classical lecture fades into the background due to the lack of visualization of representation of results of design and means of display of the program code. As a rule, the presentations allowing the teacher to show difficult elements of lecture character, and also computing or project, supported with the visual image hardware and the software, etc. [6] are in that case applied. There passed those times when during lecture showed PowerPoint and called it technology integration. Today's teachers and students look for interactive and oriented to pupils' immersive technologies [14].

For drawing attention and its deduction, it is required to include elements of interactivity or practical activities in training activity that will allow cultivating interest in the subject, which will increase the desire trained to gain new knowledge, deepening already available. This purpose is answered by the technology of augmented reality, allowing to interest, realize the creative potential, to motivate independent actions and self-training [15].

It is well-known that the best digestion of new material happens at the visual sensation of information, and fixing – at the direct accomplishment of the certain, strictly regulated repeating actions. So that to apprehend and comprehend new knowledge, it is desirable to see the object of study, and for complete immersion in the knowledge of the object, it is necessary to learn them to manipulate. Therefore, when studying physics, it was very much allocated for time for laboratory works when trained could take a small weight or the amperemeter in hands and learn by own experience that there is friction force, the body is affected by the pushing-out force – Archimedes

force, at the parallel connection of the bulb, burn more brightly than at consecutive. Modern technologies allow us to make the same experiments but are now virtual. Visualization at the same time is present, and the accomplishment of some actions consolidating the effect of knowledge remains an unclaimed process. Visualization in combination with the manipulation, i.e. fixing at the muscular level, at the level of the response to an action, is possible when using augmented reality as training aids and representations of knowledge.

On the scope select the following types of visualization:

- scientific visualization;
- visualization of the software;
- information visualization [11].

Scientific visualization can include the representation of static and dynamic objects from the point of view of their studying. It can be the visual image of the blood system of the person or work of heart, and also a demonstration of the moving difficult mechanism and the parts making it, demonstration of scientific inventions, the facts, opening, effects and influence of results rash or, on the contrary, the considered actions and the made decisions.

Visualization of the software can represent some graphic objects showing how the described environment depending on the change of the code and the entered data changes as the software product reacts to the operations performed by the person – so-called simulators and exercise machines which are most often intended for working off of abilities to manage the acquired information.

Information visualization – the simple or combined image which does not possess the training function and is not obligatory to storing and acquisition of skills of management of this information.

The modern child in two years can successfully use the offered smartphone for viewing animated films or children's videos. It leads to the fact that growing, he gets used to perceiving information visually, occasionally without pondering upon its essence and without being able to conclude. Till a certain time, it does not prevent studying at school since it is enough to remember the offered material to receive good marks. But over time it is necessary to analyze fiction, historical events, to get acquainted with theoretical material on natural disciplines when simple reproduction of the facts already insufficiently. It is necessary to find relationships between cause and effect. Here lack of skills and abilities to watch deep into events, to look for the actual reason, to assume possible effects for what occasion it is necessary to represent mentally events through rather extended periods as in the future, and in elapsed time affects.

For visualization of change of events and their course during such temporary intervals, the same can serve the technology of augmented reality.

Still, there is a wish to touch on one issue trained, got used to perceive only "information - in - pictures", i.e. without pondering upon basic data, without comparing them, and without drawing at the same time independent conclusions. Acquaintance to any new subject begins with determinations and rules. The teacher often faces that the question asked upside-down nonpluses even the good pupil who several times spoke determination or the formulation of the new concept. It means that trained according to (read) phrase apprehended aurally or written cannot independently visualize this concept, provide it, transfer to the facts, forms, examples already known to it. Trained gets used to working with ready images, at the same time it becomes difficult for it to generate independently such images or it is impossible. The augmented reality can at rational use supplement understanding of terms and determinations, showing as inaccuracies in determination change the essence of object or process about which there is a speech.

So, it is offered to use technologies of augmented reality when training to engineer and IT to the directions at the higher school, proceeding from two tasks: first, to receive resistant concepts when using ready-made products of AR-applications, secondly, to master technologies of design of AR-applications and to independently create projects of augmented reality in the training purposes and all-developing.

Let's stop on the second task. For the creation of AR-applications special knowledge and application of technologies, not only design but also design skills are required.

First, it is necessary to study the data domain for which the AR-application will be created. It can represent the graphics image, static or dynamic. It can be studying any patterns of change of object, its

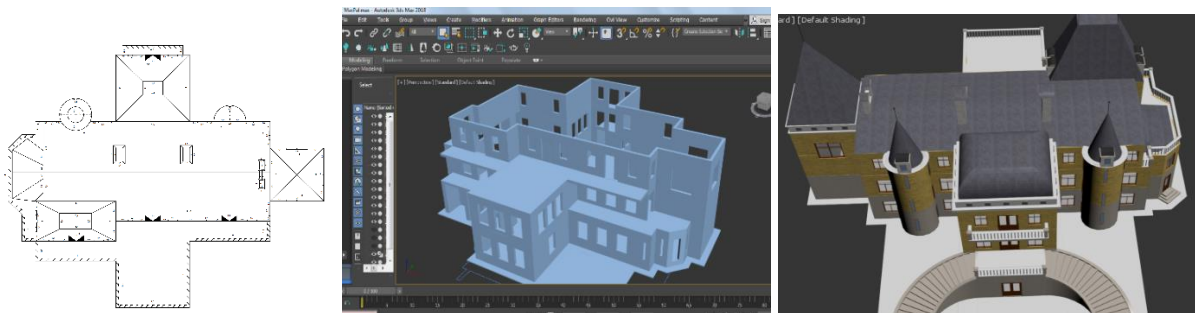
basic functions, and assignment, the related historical events of its features proceeding in its processes.

Secondly, choice of representation of object or process: the freeze or dynamic frame image (video series), schematically or full-color, transparent or opaque, with transitions or without them, reacting to change of provision of the gadget or ignoring it, etc.

Thirdly, the choice of design and color gamma of the AR-application. The monochrome type or full-color is possible. Bright tone or pastel. The tone in one gamma or contrast selecting certain image details.

Fourthly, the choice of technologies of design, i.e. the environment of drawing (drawing), modeling, development, and storage of libraries and databases to the application.

Only later above the described preliminary stages, it is possible to begin to develop the AR-application. For this purpose, at first, the corresponding pictures images of the object are selected. It defined what image or its part will serve as the marker for the initialization of the AR-application (or the QR code is created). According to the selected pictures, the scheme of the object is drawn, its three-dimensional image is modeled, textures for the covering are selected, additional elements of the roof, the ladder, etc. (an example of Figure 1) are created.



**Figure 1:** Modeling a three-dimensional image of Massandra Palace

Only after that, you can start creating the AR application itself. As a rule, it is the Unity environment that is used to develop AR-applications for Android, as well as the Vuforia engine for storing a database of images and markers. Adjust the characteristics of the image and with the help of special scripts creates a working project (an example of Figure 1).



**Figure 2:** Augmented reality application to visualize Massandra Palace

## 5. AR Applications Development Framework

For a more clear description of the above-mentioned method of AR-application development, the algorithm described above can be represented as a scheme (Figure 1).

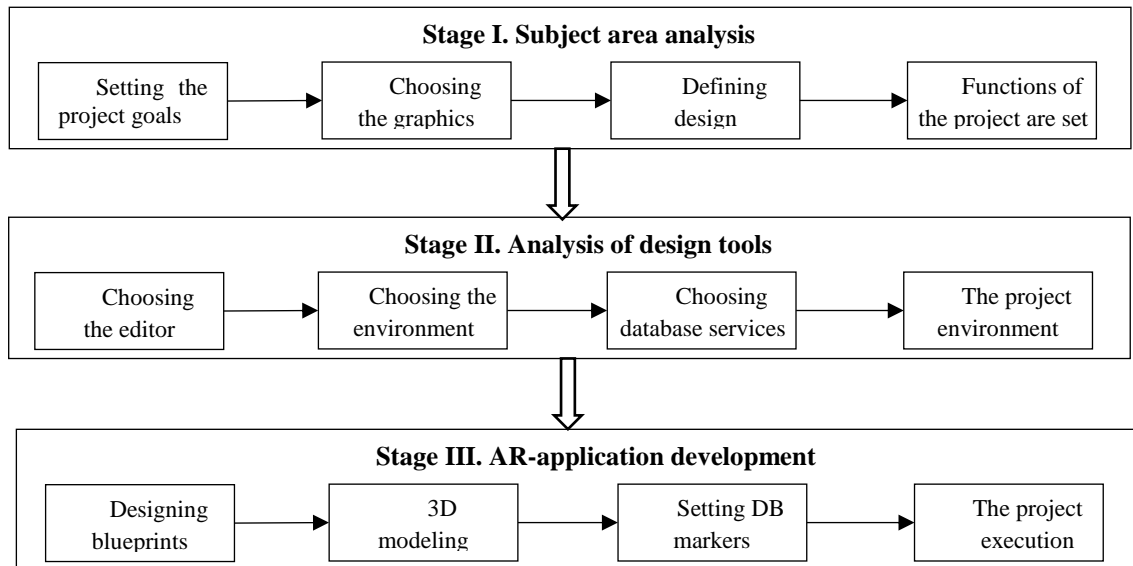


Figure 3: Augmented reality application development scheme

## 6. Problematic Discussion on the Integration of AR Applications into the Educational Process

Augmented reality or AR applications allow you to visualize information that is difficult to perceive, thus allowing more effective training processes that require memorization of large amounts of material and its deep perception, due to the visibility and actual actions performed with the information being studied. Also, the development of augmented reality applications by students of engineering and IT areas allows to interest and involve young people in self-development and self-education, which guarantees the training of highly professional staff in this field.

Currently, there are two significant problems with the use of augmented reality applications. The first is the work of applications in real-time, which is influenced by the technical capabilities of gadgets (cell phones, tablets, additional reality glasses, etc.), using AR-applications and superimposing on top of the real picture of the augmented image, which entails the need to process graphics in real-time on portable platforms. Thus, the computing capabilities of the hardware are the main limitation of the AR-applications. The second problem is the quality of the received data (graphics, video, or sound). The AR application in the classical variant processes the initial information, received from the camera, processes it, finding and recognizing special markers or QR codes, and adds to it virtual data (an image, another video, 3D model, or just text), which are stored in special libraries. In this case, the place where the additional information will appear at the display is determined by the developer [16].

It should be noted that regional universities have a huge shortage of resources (information, personnel, financial, hardware, etc.), without which it is impossible to create special educational conditions for students [17]. Also, it is possible to result in one more problem which is connected with the training of personnel of the higher school, i.e. because of the novelty of technologies of the augmented reality the overwhelming majority of teachers do not possess sufficient knowledge and methods of training to the development of these applications, and, hence, they do not apply them in

the educational process. The students turn out to be limited by the classical traditional methods of education, which makes the process of obtaining knowledge routine and boring.

On the other hand, working with augmented reality applications involves individual sessions and the development of projects and tasks, which affects the separation of students from each other and the disruption of communication and social ties between them. Thus, the abuse of information and communication technologies and development technologies including AR-applications can lead to personal isolation of students from their peers [18].

## 7. Conclusion

Thus, the introduction of augmented reality (AR) technology will improve the quality of learning by motivating students to self-study, increasing the interest of the audience in the presented and studied material, developing the desire to use modern interactive technical capabilities and technologies, replacing manuals and laboratory equipment with multimedia computer models [6]. Besides, it will allow the modern teacher to use technologies of the augmented reality to receive higher educational effects and moral satisfaction from the professional activity.

For students, these advantages can be summarized as follows: the attractiveness of the courses, reduced cognitive load, increased motivation and interest in the course, increased ability to ask questions, increased interaction between students, new opportunities for individual learning, the concretization of abstract concepts, increased success [19].

Modern enterprises are in urgent need of an influx of young mobile employees, which is explained by the new course of the country on implementation of the National Technological Initiative as one of the priorities of the state policy, which gives rise to the task of creating conditions for the preparation of future personnel, corresponding to the state priorities for the development of science and technology, capable of developing at home. Thus they increase their economic potential [20]. Within the educational processes, the augmented reality will allow students to work, increasing their creative potential without fear of production risks and costs [18].

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