

Применение дополненной реальности при изучении начертательной геометрии

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Аннотация

В статье анализируются проблемы развития пространственного мышления студентов при освоении дисциплины «Начертательная геометрия», решении проекционных задач и предлагается их решение с использованием технологии дополненной реальности. Рассмотрены понятие и технология дополненной реальности, технологии трекинга. Дано обоснование актуальности и своевременности использования технологии дополненной реальности для поддержки образовательных процессов, а также выявлена цель работы. В статье исследуется использование технологий дополненной реальности в обучении студентов пространственному мышлению, что позволяет сэкономить время на передачу и усвоение информации, полученной студентами в рамках данной дисциплины. Проведен анализ существующих исследований в области применения технологии дополненной реальности при преподавании дисциплины «Начертательная геометрия». Показана возможность использования технологии дополненной реальности в образовании с целью наглядного представления учебного материала. Рассмотрен проект разработки мобильного AR-приложения для визуализации задач учебно-методического пособия по начертательной геометрии на базе платформы Vuforia. Предлагаемый программный продукт реализован на мобильной платформе с операционной системой Android. При разработке программного обеспечения используется язык программирования C# для написания скриптов для реализации требуемого функционала, в частности интерактивного взаимодействия с трехмерными объектами.

Ключевые слова

Дополненная реальность, 3D - моделирование, пространственное мышление, начертательная геометрия, маркер, трекинг

Application of augmented reality to study descriptive geometry

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Abstract

This article analyzes the problems of the development of spatial thinking of students in the development of the discipline "Descriptive geometry", solving projection problems and proposes their solution using the technology of augmented reality. The concept and technology of augmented reality, tracking technologies are considered. The substantiation of the relevance and timeliness of its use to support educational processes is given. The article explores the use of augmented reality technologies in teaching students' spatial thinking, which saves time on the transfer and assimilation of information received by students within the framework of this discipline. The analysis of existing research in the field of application of augmented reality technology in teaching the discipline "Descriptive geometry" is carried out. The possibility of using augmented reality technology in education for the purpose of

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visual presentation of educational material is shown. A project for the development of a mobile AR application for visualizing the tasks of a textbook on descriptive geometry based on the Vuforia platform is considered. The proposed software product is implemented on a mobile platform with the Android operating system. When developing software, the C# programming language is used to write scripts to implement the required functionality, in particular, interactive interaction with three-dimensional objects.

Key words

Augmented reality, 3D modeling, spatial thinking, descriptive geometry, marker, tracking

1. Introduction

Currently, there is a rapid growth of software products that use the latest modern technologies, including augmented reality technologies, for various fields of human activity: medicine, education, entertainment and tourism, engineering, etc. Such popularity of this technology can be explained by human interaction with three-dimensional objects in three-dimensional space. This article discusses the problems of the development of spatial thinking of students in the study of the discipline "Descriptive geometry", and offers their solution using the technology of augmented reality.

The development of spatial thinking is an urgent problem of modern engineering education. The process of studying the discipline "Descriptive Geometry" is significantly difficult, some topics are especially difficult for students to master. This is due to the fundamental difference between the drawings of Euclidean geometry and descriptive geometry, as well as insufficient training of students. Teachers do not always have layouts at their disposal, with the help of which they can visually show a particular task. Often even layouts do not allow you to fully understand the essence of projection mapping tasks. With the use of the proposed application with augmented reality, the student can always comprehend the task in a calm atmosphere, in contrast to the use of the layout, which can be considered for a limited time in the classroom, because the 3D model is always nearby, since almost everyone has a mobile device.

The purpose of the work is to develop a mobile application using augmented reality technology for visualizing the tasks of descriptive geometry based on a teaching aid, and thereby to demonstrate the possibility of developing students' spatial thinking skills.

2. Marker and markerless augmented reality technologies

Augmented reality is currently an advanced technology, and one of the most promising areas of modern projects in the IT industry.

Augmented reality (AR - "augmented reality") is a technology that allows you to superimpose various information, for example, text, graphics, audio and other virtual objects on real objects in real time. The use of AR technology in many spheres of human life provides an opportunity to interact with virtual and real objects, which makes it possible to build the processes of studying disciplines in a more visual and interesting way, and makes it possible to automate the process of obtaining the necessary information for specialists in many industries.

The development of modern AR applications is based on the use of marker, "markerless" or spatial tracking technology. The most popular is marker technology, which involves the use of an image - a template within a frame. Each such template is associated with its own specific three-dimensional object. When the camera of a mobile device is pointed at a template, it is recognized and the corresponding model is reproduced, which is tied to this template within the software product.

On the other hand, tags are not required for markerless technology to work. The application scans the surrounding landscape with the camera and imposes a specific grid on which software algorithms calculate the control points, to which, in turn, three-dimensional objects will be snapped. Spatial tracking technology is based on the spatial location of certain objects. This technology is based on the

use of GPS / GLONASS data and compass, which are built into the mobile device. The coordinates determine the location of the three-dimensional object in space. As soon as the user's coordinates match the coordinates set in the augmented reality program, the application will be activated.

Undoubtedly, the using of augmented reality technology contributes to the development of a student's spatial thinking. Spatial thinking is a type of human mental activity that provides the creation of spatial images and their operation in solving practical and theoretical problems in the educational process. Spatial thinking implies constant re-coding of images, i.e. constant transition from three-dimensional images to two-dimensional, and vice versa [1]. Thanks to the use of elements of augmented reality in educational processes, the user gets the opportunity to interactively interact with three-dimensional objects - move them, rotate, scale, view from different angles. Such a principle of work, definitely, gives a great impetus to the development of spatial thinking, allows a deeper study of the subject of research.

The absence or minimally developed spatial representations of a person are an obstacle, overcoming which, one can solve the problem of the formation of spatial thinking. In order for the student to be able to independently read and draw a drawing, to solve projection problems, it is necessary to develop his spatial imagination. The study of many engineering disciplines, including descriptive geometry, is one of the most important means of developing human thinking [2].

The use of AR technology in teaching various disciplines should lead to the next stage of the student's development, stimulate the transition from concrete-figurative thinking to abstract thinking. Using AR allows you to apply graphics, animation and audio in an interactive way, which allows you to expand the scope of the principle of visibility. This makes it possible to transmit information to the student in the most understandable and logical way, allows to increase the amount of information received, contributes to the development of spatial thinking and intuition [3]. With the help of AR learning technologies, invisible objects and phenomena, particles, sound, abstract theoretical concepts can be visualized, i.e. a didactic image was created.

3. Development of a mobile application for studying descriptive geometry

Many educational institutions still use various techniques and warm-ups that develop spatial "vigilance" in students, modeling (making paper models of various objects), etc. Despite the rapidly growing popularity of augmented reality technology, the use of this technology in training systems is still not widespread enough, and the introduction of any innovation requires a fairly large amount of time.

At the same time, in educational processes, it is important to ensure a consistent transition from physical volumetric models to digital three-dimensional objects, and from digital to images that students can independently depict on paper, while developing their spatial thinking. After that, gradually complicate the actions themselves with volumetric figures - from the formation and accumulation of spatial images, the ability to operate them to the activation of mental activity when performing various projects [4].

After analyzing the problems of the development of students' spatial thinking in solving educational problems, in order to achieve the set goal of the work, a solution is presented using the use of augmented reality technology. As a result, a mobile application was developed on OC Android with elements of augmented reality for visualizing the tasks of the educational-methodological manual "Descriptive geometry", prepared by the teachers of the Nizhny Novgorod State Technical University named after R.E. Alekseeva I.Yu. Skobeleva, I.A. Shirshova and M.L. Mukhina. Mobile application development is based on the following technologies and tools:

- tracking marker technology was used;
- a mobile device (Android smartphone or tablet) is used as a display device.

The following stack of software products was chosen to develop the application. The most optimal platform for the development of this training system is the Vuforia SDK. Vuforia SDK is a free library that is constantly being modernized and allows you to create cross-platform applications using a special

game engine Unity [5], has good documentation and many instructions for working with it. Modeling and animation of three-dimensional objects are performed in Autodesk Maya software. It is in this software product that the bulk of the work is created. Also one of the advantages of this program is an easy way to export models to Unity using the .fbx format.

An example of capturing a single label in Unity based on the model from the figure of the tutorial is shown in Figure 1.

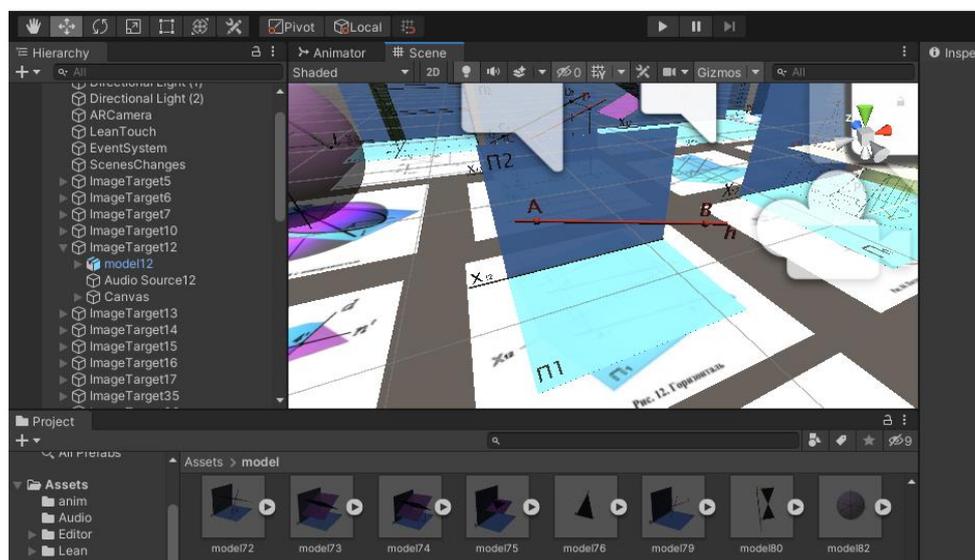


Рисунок 1: Application Scene in Unity

It is also worth adding that the use of such applications in educational institutions is offered only as an auxiliary tool in solving problems of projection display, and is in no way aimed at excluding the teacher from educational processes, modeling or replacing drawing tools, etc.

Figure 2 shows an abstract example of rendering a model when the camera of a mobile device is hovering over a tag.

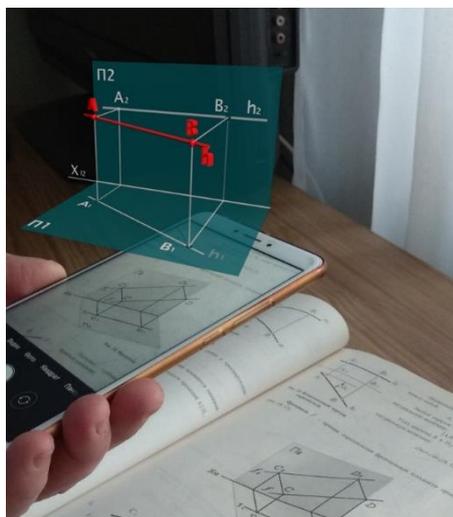


Рисунок 2: Visualization of the tutorial illustration

4. Conclusion

In such a way, the main advantage of using augmented reality technology in teaching processes is the development of spatial thinking in students. Based on the developed prototype of the application, we can already say that students will be able to easily see three-dimensional objects, which usually had

to be represented, calculated and built using traditional methods on paper. With the help of virtual controls, you can animate 3D objects. Also, the three-dimensional model is accompanied by a sound explanation of a particular task. In this case, the sound can be turned off if only a visual representation of the object is required.

Ultimately, this kind of mobile applications using augmented reality technology can be used as an auxiliary tool in solving problems within the framework of a cognitive-visual approach to teaching descriptive geometry and other engineering disciplines.

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