Informational Training System Mindgate

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***Abstract*—The question about distance learning systems and their modernization is discussed in this work. Modern systems do not give the opportunity of interactive integration into the studying and design/user interface/possibilities are not required. It was the cause of low study efficiency. The lack of online platform does not allow getting the homework centrally (relatively to the specialization of students). Nowadays in 2nd and 3rd world countries distance educational systems do not provide competently work about giving the learning materials. The system that will allow solving these problems is described below.**

Keywords—ITS; Unreal Engine 4 (UE4); game engine; application; system;

I. INTRODUCTION TO PROBLEM

Nowadays self-development is the main direction and aspiration of a person. Also it is time of innovative technologies and systems of studying. In many cases, theoretical knowledge is not enough to obtain proper skills in professional areas. Students should not be mere listeners and passive observers. Students of technical faculties especially need practice and hand-on experience in their areas. Through interaction, like Virtual Reality (hereinafter referred to as the VR), Augmented Reality (hereinafter referred to as AR) features could help perform a virtual practice – with augmented tutorials, digital modeling and simulations, and acquire some experience in the end [1]. This article provide a new way of collecting knowledge with the help of simple schematic.

The large number of students does not understand the meaning of being a professional at some field of activity. It's a great problem of nowadays. Through some studying months they begin to think about infallibility of their decision. Students usually see the top layer of the specialty and they appreciate it, but they know nothing about filling, because there is no one to give them proper understanding. If students were able to compare different specialties and specializations in the university, they would get better look of what is going on inside them. With the technology of ITS, everyone will be able to see pitfalls of specialty and to come up with the more constructive decision of their choice.

It will allow understand the educational structure easier and this system is intended for simplification of the process of choosing the specialty and gathering the data and knowledge in one single place. It will increase the number of graduated students and workable staff, but decreasing the cost for education and giving the opportunity to study through gadgets like PC, smartphone, tablet etc.

II. PRINCIPLE OF OPERATION

A. What is Unreal Engine 4

Unreal Engine 4 (hereinafter referred to as UE4) is a game engine that is usually used to build anything about the gaming industry: user interface elements, models, animations, visual effects, textures, materials, etc. [2]. All this allows developers to achieve the required result and the option of creating training video materials and applications will be considered within the framework of this article.

B. Why Unreal Engine 4

UE4 was chosen for Informational-Training System(hereinafter referred to as the ITS) development as a user-friendly program that allows developer to create simple programming elements with the help of the node system (Fig. 1), which facilitates its study and application in practice. It can be easier to achieve goals with the help of great software community which not only answers the particular questions, but also contains a large number of lessons as a huge advantage in learning this program.

The game engine in authors' understanding is a relevant decision regarding the further development of ITS. Due to it you cannot just stop at the video, but also create an application in which it will be possible to manage it depending on the object of study, go to the detailed help, getting VR control over the studied. The application itself will be flexible enough in terms of internal changes. UE4 has enough capabilities to create accurate and demonstrative processes of something [2]. This applies more to the industrial sphere, but it is possible not to be limited and to be continued with the

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visualization of other disciplines like math, languages and more.

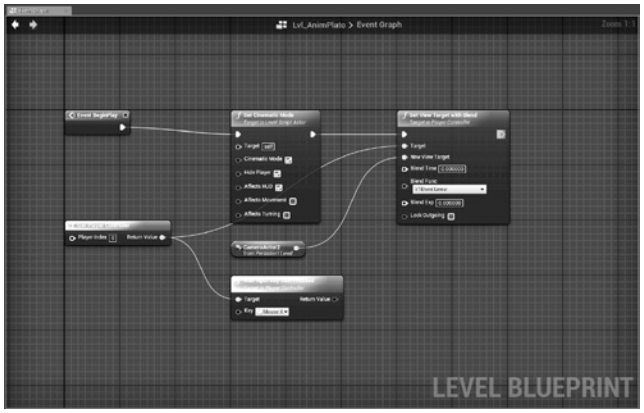

Fig. 1. Example of a node system in mode Level Blueprint in Unreal Engine 4.

III. FEATURES FROM ANALOGUES

This approach does not allow getting the range of possibilities that were described above, in comparison with typical video editing with 2D animation or characters and object rendering.

Video lectures could be seen as a possible alternative, but lecturers often do not have required equipment, which can support in describing different features [3].

There are different AR applications in the world and many of them have a great variety of purposes. AR technology has an ability to render objects that are hard to imagine and turn them into 3D models, thus making it easier to grasp abstract and difficult content. This is especially good for visual learners and practically anyone to translate theoretical material into a real concept. For example, Polytechnic Institute of Leiria in Portugal integrates AR into math lessons and students report it as helpful, easy and interesting [1]. Authors' idea is the same, but the range of its use is centralized with the special online platform where users can find any knowledge they want to get. By the words "any knowledge" authors mean all those disciplines and subjects which are supposed to be included to the platform from universities and colleges.

The main analogue is Nvidia Holodeck, whose technology allows people to remotely work together in VR, develop design, assembly lines, technological processes and much more, having their 3D counterparts in a virtual environment [4]. The main difference is that this technology will be available (it is under development) for technological giants, in which they will work and create. This proposed ITS will provide training and presentation of various knowledge. The rest of the possibilities in the form of VR technologies and possibly co-education can be added later, with the development of the project and the availability of this technology to users. The field of updates and improvements is unlocked, so it can be everything that users and creators want it to be.

The idea of video tutorials or lectures requires considerable expenses to obtain all the necessary advantages. It is necessary to create a platform, with which the whole idea will be available not for users only, but for training employees too. There is a team at Stanford University that created project called "Strivr". It started as a VR training tool in sports, spun out of work done at Stanford with its football team. But after discovering that there are only so many football teams, it pivoted to retail and works with companies like Walmart [5]. United Rentals (hereinafter referred to as UR) trains outside sales reps (hereinafter referred to as OSRs) to rent construction equipment to job sites. However, during training and onboarding it is near impossible to have OSRs learn a consistent approach to job sites. Using photos or videos in formal classroom training falls short in replicating the actual jobsite experience. UR and STRIVR used VR to bring construction sites into the classroom. UR utilized STRIVR's immersive training platform to create a next-gen learning program for OSRs that utilizes VR technology. UR recreated the 5 phases of construction in VR so that new OSRs are able to learn while feeling like they are actually on a site, but without actually being there [6]. In this way they achieved increasing effectiveness while decreasing time in training by 40% [6].

This example is what authors need to fill their platform up and unite such trainings, tutorials, lessons, classes etc. together so it would become easier to look for such technologies and opportunities.

IV. BRIEF DESCRIPTION OF RELATED WORKS FOR ESTABLISHING ITS

To create ITS, it's not enough to get by only the game engine. It just provides an opportunity for interaction of all created in third-party programs in the idea necessary framework. The block diagram of the creation of the training course is shown in Fig. 2.

A. Creation of the training part and the beginning of the technical part

The course begins to be created from the receipt of the task for the course. The terms of reference are agreed upon, training priorities are set and training approaches are clarified: what references, models, animations should be, whether the lecturer wants to be visualized, distance learning of employees, or creating a course for university students and other subtleties. Once all the terms of reference have been agreed with the customer, the creation of the ITS begins.

During the creation of the training part, an interface to this course is being thought out, as each customer has completely different requirements for design and functionality. The user interface will be created friendly, so as not to scare off the consumer.

A soundtrack is recorded, according to which all the animation will fit later.

At the same time, 3D models and their animations are created in separated sets, which after the completion of the scoring are transferred to the game engine UE4 and are reduced together. The application contains an interactive assistant for more comfortable and easy learning process. An example of such arrangement is shown in Fig. 3.

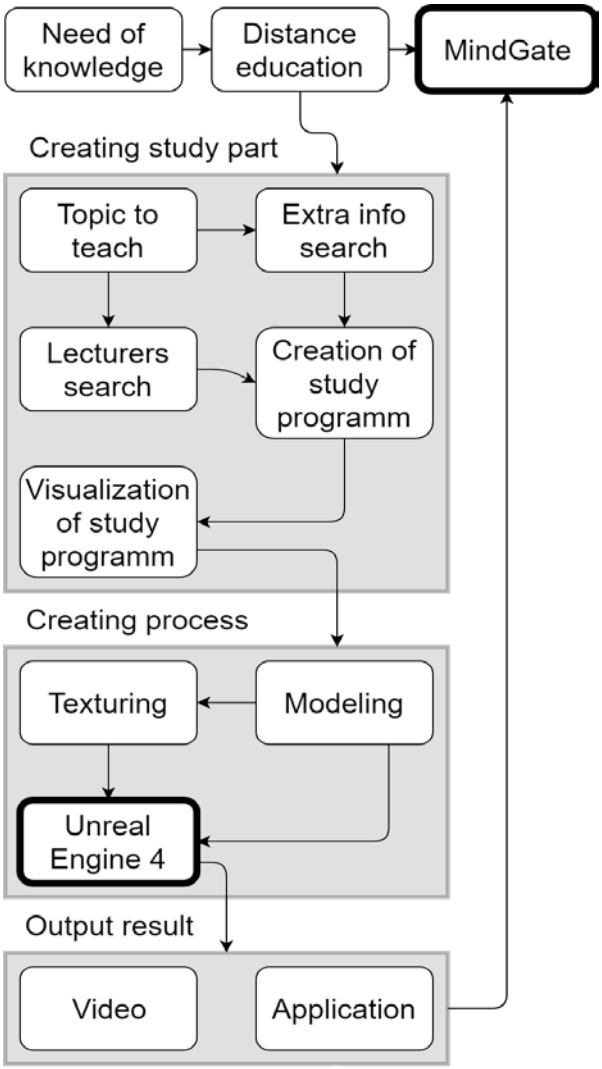

Fig. 2. Block diagram of course's creating process.

B. Modeling

In that case, Fusion 360 and 3DsMax were used. The first is a CAD program that has the ability to polygon modeling, in which one of the characters for this idea was created. It was exported to 3DsMax, where further manipulations were made. By them are meant:

- Retopology of the imported model from Fusion360;
- Splitting the mesh into material groups;
- Modeling low-poly models;
- Rigging and animation.

The second program was also useful for creating another character with which the same postprocesses were produced.

C. Baking texture maps

To bake texture maps was used Substance Painter. They (maps) allow you to increase performance in the game engine UE4. This is due to the fact that the original models are Highpoly (that is, they have a huge number of triangles and polygons that create the surface of the model), and to calculate that one frame leaves a lot of computer resources.

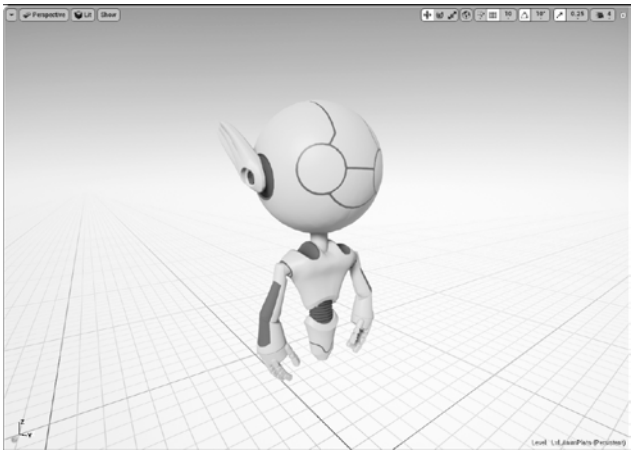
Fig. 3. Example of a character which was inserted into Unreal Engine 4 with its rig, animations, mesh, and other stuff which defines it as a finished model.

Baking technology, which is used in the gaming industry, allows you to convey the properties of Highpoly model to Lowpoly model - the surface relief, the feeling that it is created from millions of polygons, rather than from thousands.

Also, for example, there is no need to create joints of metal sheets, because the whole relief will be transferred to the Lowpoly model with the help of the normal map, which is presented above on Fig. 4.

D. Unreal Engine 4

Combination, realtime rendering. These terms describe one of the main functions that allow you to export video and software products from the program. All the processes that were presented in the block diagram Fig. 2, are combined in the game engine UE4, which combines all the elements created before: models, animations, materials, textures, audio tracks, rigs, lighting, shaders and others that generate a complete picture ready to be presented to the consumer.

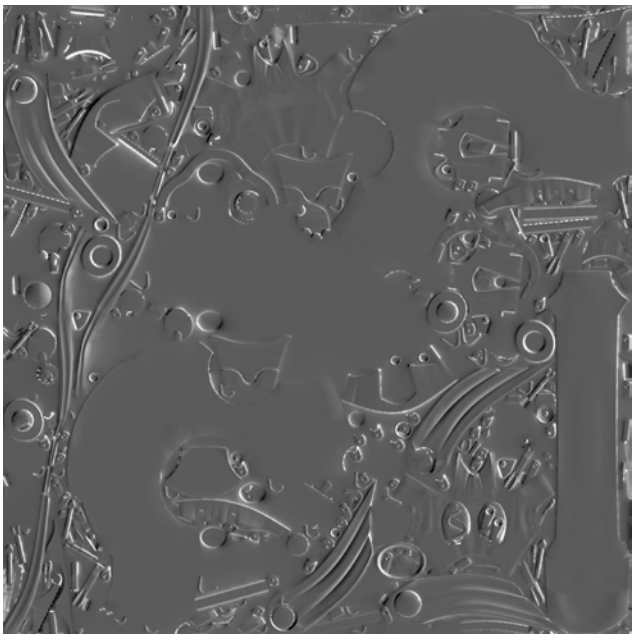
Fig. 4. Example of one of the four normal maps, which were used in the lowpoly model of robot on the fig. 1.

At the end of the course, the entire course is exported from the game engine UE4. At first, an application will be created, which will be one of the engines. Video footage of the courses for viewing and using by consumers will also be placed in it

V. FUTURE WORK ABOUT APPLICATION

On the authors' opinion, the globalization through online platform is one of the most convenient ways to share different study materials. It allows students to get an access to a whole library of various tutorials from different universities. Using this platform will give an opportunity to create kind of virtual classes where users would be able to accept knowledge through videos or applications. ITS contains all brief introductions from each university disciplines in country, so student, who uses this platform, have a great possibility to choose the correct place.

The chance to select the most suitable type of lessons will be given to educational institutions. Also, they will be able to create lessons by themselves, being moderated before publishing, or with the help of MindGate team.

The great step further and one of the main goals is to create lessons with the ability to control the studied subject. As an instance, it is about rotating it, looking at the special details, changing the materials and their features, seeing the simulations etc. Such tutorials can be created as VR, AR or simple desktop editions. It depends on the required tasks. Example of how it can look is shown on the Fig. 5. It was taken from UE4 channel on YouTube website. UE4 team was demonstrating and discussing game engine possibilities in VR.

The main idea is to collect different AR/VR/MR/XR and standard lessons and bring them together to the one platform. The latter can become the united base for the whole content of distance learning, offering its own schematic of students educating through the simple lessons.

Fig. 5. Screenshot from video webinar "VR and AR for Design Review" on UE4 YouTube channel.

VI. WORK OF AN APPLICATION

The structure of the application is the same for all courses. The difference in the interface is present only directly in the course itself.

When users (students) open the application they enter the start page, where five buttons are placed: continue the course, the new course, search for new courses, store and sign into the account. The algorithm of the proposed ITS application is shown below in the flowchart Fig. 6.

Let's consider all the buttons:

- Clicking "Continue the course" opens a new page where user is offered a course that was viewed last time.
- "New course" – redirect user to his personal library of courses that were purchased or submitted to him initially. He chooses the course he needs and it opens at the last moment of the passage.
- "Look for new course" – opens a page with all nearly added courses, their prices and topics. User can use filters by date, by relevance and any sphere. There is a possibility of searching. Once the course was selected, user is redirected to a page where he is offered different payment methods.
- "Shop" – page where you can create course for and order, after which customer contact us and the process which is represented in diagram Fig.2 takes place. There displays products which has a valid discount, as well as the opportunity to buy a premium account, which allows user to get certain privileges, that is still in development.
- "Enter account" – offers to enter the user's account, which will open the library of courses. Log in is possible with basic accounts (Google, Facebook, MindGate account). In the absence of an account, you can register through the application with the transition to the site.

Authors' opinion about future work is based on the globalization on the online platform. The main idea is to collect different AR/VR/MR/XR and standard lessons and bring them together to the one platform. The latter can become the united base for the whole content of distance learning offering its own schematic of educating students through the simple lessons.

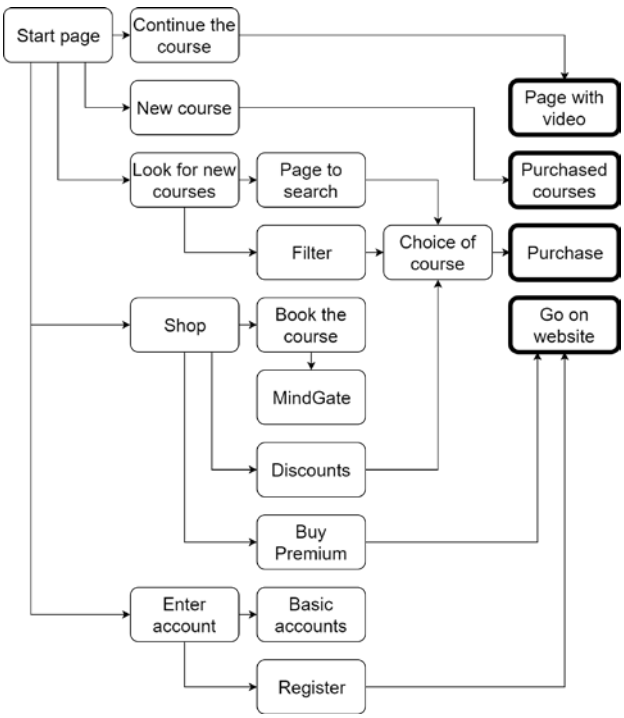

Fig. 6. Block diagram of supposed application structure.

It will allow to understand the educational structure easier and to compare different specialties and specializations in the university.

This system is intended for simplification of the process of choosing the specialty and gathering the data and knowledge in one single place. It will increase the number of graduated students and workable staff, but decreasing the cost for education and giving the opportunity to study through gadgets like PC, smartphone, tablet etc.

VII. PRINCIPLE OF TRAINING

When the user has installed the program, authorized in it and received for use a training or trial course (the latter is attached to each course), he opens it and can view it in video format.

The video shows 3D animation, which was created in accordance with the customer and voiced by the lecturer, who dictates the teaching materials. There will be a link, which appears for each new term or key information. If user clicks on it, the second window with video of necessary fragment will be shown. At the end, the system returns to the original video, from where the playback continues.

The user will be able to view the information he is interested in outside the video course. For example, a lesson is devoted to the engine and explaining the work of its details, their combinations and the physical / chemical processes that occur inside it. All this is created in 3D and transferred to video, where, according to the speech of the lecturer, the object moves and rotates to show the details in question.

The user can go into a mode where he can manipulate the model. For example, he wants to consider in more detail how the pistons move. In the list of all components, he selects the crankshaft, and all the details that limit the visual contact are shifted from him. The user can click on the item of interest and select "Play" from the menu, where the movement of all components together with crankshaft will be shown. Also, he will be able to lose physical / chemical processes, which occur due to movement, or view a reference on the details, the properties of its materials, drawings, simulation of workpiece processing. And so about all the main components.

This will allow the user to have a clear idea of what he is studying and not to think out all the processes, because the latter can lead to errors in the perception of the topic from the very beginning.

Thus, training can take place in a distance form, which allows you to train cadres or students outside the office or university. This type of training can completely replace lectures and practices, which will provide autonomy in training and knowledge acquisition by consumers, like STRIVR did [6].

VIII. CONCLUSION

Nowadays some programs exist and they use Augmented Reality technology to show information to user through devices which have cameras and support the AR (smartphone and tablet). This way, galleries, children programs, education programs for medical students and so on [4] are able to work. But only STRIVR [6] and Nvidia Holodeck [4] can be enough global to be compared with idea of this article. However, as it was written earlier, the latter is intended for work, not for training and the first one is about to create its own projects not including other ones. It creates borders for both ones in getting the whole data. In the future, these systems could perfectly complement each other with the similarity of ideas.

This ITS was presented at the regional SpringUp startup contest in Odessa, Ukraine, with a fully-fledged business plan, income and payback calculations.

An experimental course (on Fig. 7) was created on the basis of the proposed software for the subject "Design systems" at the Odessa National Polytechnic University. It was considered the design of mechanical nodes, the creation of their three-dimensional models and obtaining design documentation. This course assumed the lack of knowledge of the drawing documentation by the students, and explained the types of drawings, how to correctly read the drawings and what the design documentation is. All this was considered using the example of creating a 3D model of assembling a mechanical node.

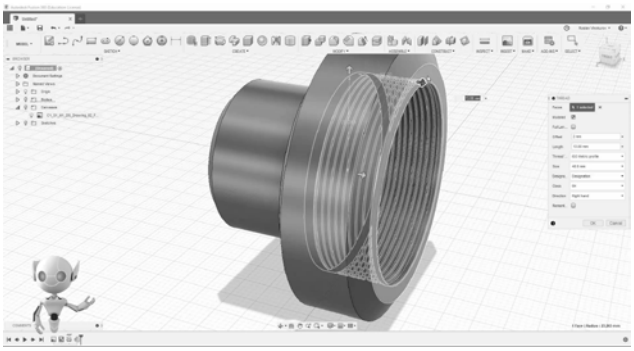

Fig. 7. Screenshot of one of the videos, which was provided at Odessa National Polytechnic University.

The proposed informational-training system is a new generation of distance learning system. ITS MindGate can be applied in any field, which involves the study of technological processes, design, construction and so on.

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