Specifics of VR implementation in structuring of learning processes

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Abstract. Today there are many devices that allow people to perform everyday tasks faster, more reliably and more efficiently, such as informal communication, business correspondence, planning the daily routine, calculations, keeping records, including training. New ways of acquiring knowledge appeared, such as webinars, forums, knowledge bases, e-courses and distance learning. Nevertheless, the devices themselves are just a tool that can be used to increase the functionality of certain software tools. Annually the functionality of the programs is increasing, together with the improvement of the amount of code, resources and data in applications. In order to optimize their products, to reduce the size of applications and the resources they use, to support multiplatform, as well as to accelerate the development and implementation of new functionality and less labor-intensive support developers began to use various approaches.

1. Introduction

Virtual reality is a virtual world created with the help of technical means, which is transmitted to a person through his natural senses. The virtual world can represent both a model of the current real world and its future embodiment, as well as objects that do not exist in reality. The world allows modeling not only various objects, but also various processes. In addition, the created virtual world can react in real time and change its state due to human influence. Usually, worlds are built on the principle of the most approximate reaction of the real world to human influences, for example, a change in the projection of an image transmitted to a user when a head is turned or displaced, or the position of the limbs of the virtual body of a user depending on the position of his limbs in the real world.

Today, virtual worlds are mainly used for entertainment technologies, but the potential of the technology is huge. Many startups and large companies are beginning to create programs for process simulation, so that a user can practice skills on a virtual model for more effective learning due to the strong immersion effect in learning that other technologies can not yet provide [1]. Considering the increasing transition to digital formats of information presentation in the industry, such technologies are becoming more relevant day by day [2].
It is necessary to note that in everyday life there are two concepts “Virtual reality” and “Augmented reality”, they differ radically: the first one completely creates a new virtual world around a user and the second one brings virtual additions to the existing real world. Both of these technologies can be used in conjunction with IIoT devices for training or improving industrial safety [3].

The devices are available on the market. Currently, a fairly large number of virtual reality devices are already presented on the market, such as: Oculus Rift, Samsung GearVR, Vive, Google Daydream, Google Cardboard, Microsoft HoloLens. Let us take a closer look at the most affordable option on the market.

Oculus Rift is the first successful virtual reality glasses were created by Oculus VR even before the release of the custom version in 2016. It was very successful in commercial terms. Moreover, it was used not only by developers [4-5].

Samsung GearVR was the first custom VR headset that was released in September 2014. It is distinguished by the absence of wires and mobility, instead of a personal computer, it uses a smartphone for calculations, it also lacks a display and a smartphone screen is used instead.

Google Cardboard is a cardboard VR headset similar in design to GearVR, presented as an experiment at Google I/O in 2014. Surprisingly despite its simplicity and triviality it has become very popular, due to the support of almost all modern smartphones based on Android, a very low price, as well as the ability to create your own branded helmet and distribute it.

2. Structure of software solution
Modern educational applications should include courses and lessons from specialists, practical exercises, chats between students via the Internet, virtual rooms to study various cases in small groups.

In addition, for the purpose of access to courses and various kinds of certification, the system of authorization must be implemented in the corresponding applications.

Since training systems are always large enough, they are usually developed by a large team. Accordingly, such projects should have a modular application architecture, which implies that the entire software part consists of abstractly separated modules (user interface module, transport module, avatar module, transport module, content delivery module).

In addition, such a solution allows effective use of Git version control system, using the submodules of this system. This solution allows each developer to work in their own separate submodule, developing and debugging it in a separate project, without transferring the submodule testing code to the main project. This will allow all developers to simultaneously start working with individual functionality of an application and test it, before the development of the software core of an application.

It also makes sense to store and work with content in a “modular” way. Accordingly, the content of all network rooms, scenes, lessons, etc. is not located in the project or project assembly, but is assembled and developed separately and uploaded to the repository on a server. During running a program, this content will be downloaded from the server as needed and loaded into the application for further use. This allows reducing the volume of the application, both an installer and already installed one, due to the fact that only the content that is available to a user and the one without which the program can not be run gets to the device of a user. This significantly speeds up the time of importing and assembling a project, since assembling a project with content can take more than a few hours, versus a couple of minutes if the content is in a separate project.

3. Applied technologies
During the development of an application ready-made modern development tools, libraries and services are used as often as possible in order to reduce development time. One of the most popular development tools for VR systems and applications is Unity3D.

Unity3D is a cross-platform, partially free tool that is widely used to create applications and games with 2D and 3D graphics. It implements a convenient user interface to develop graphical applications;
it has a large number of useful libraries and functions and built-in support for almost all popular virtual reality helmets.

Dependency injection is used in order to achieve the flexibility of the code during development and the possibility to develop and modernize an application. In particular, the Zenject library is implementing this pattern in Unity3D. Its approximate work is that there are two types of containers, global and for scenes and accordingly special installers are created for them that implement dependencies. When an application is launched, the global installer is launched and creates dependencies, which are stored respectively in the global container based on the data passed to it. Accordingly, using Zenject, it is possible to change the implementation of certain functions after compilation during program running, by changing the parameters passed to the installer, or replacing the implementation of individual functions during compilation [3].

WebRTC library is used to transfer data about user actions in network modes, as well as for peer-to-peer voice transmission between user devices. WebRTC library is an open source project, used to transfer streaming data between two devices over the Internet using peer-to-peer technology. It allows transferring not only voice, but also other abstract data.

4. Layout and use of content in applications

The storage of content can be organized through appropriate services such as, for example, Amazon S3 (Amazon Simple Storage Service) in order to reduce the cost of storing content on the server side, as well as to have sufficient bandwidth. Due to this solution, there is no need to store all data on your server, which makes it easy to scale the training application both in volume and in performance.

For the reduction of the time of importing resources and assembling a project, content is placed in a separate repository during application development. At the same time, the content assembly takes place separately from the application assembly. It is reasonable because the content of a training application is collected not by programmers, but by authors, producers and other specialists. The content is collected in special containers - bundles, which are uploaded to the server and, when running the project code, are loaded from there dynamically as needed. Then, they are saved in the memory of a device and can be reused after the application is restarted.

In this case, when a small change in the project code is made or an error is fixed, the entire content is not rebuilt. This is also applied in the opposite case, if a designer needs to correct the color of the object or a modeler needs to make a change to a model, then it is only necessary to rebuild a specific bundle and not rebuild the project, upload it again to the server and force a user to download the updated version of an application with a large size due to minor content edits.

It also reduces the size of installation file, which can be limited by the service that distributes this application and a user does not have to download the entire application if he just wants to try it or he is only interested in a particular function.

In terms of structuring, it is found that the specific content of an application can not be changed. It can only be created or deleted. In this case, in order to change the content used in an application, it is necessary to create a new one with a new unique identifier and add it to the list of application content and delete the old one from there. This helps to avoid the problems with content versioning.

5. Architecture of content delivery module

The content delivery module is designed to download the requested content from the server, store it on the device, remove irrelevant content and provide paths to the content file to an object that requests it. The module is multiplatform, i.e. it should work on all platforms on which an application is launched. Moreover, it should perform this using native platform tools if possible [6, 7].

Structurally, the module consists of a kernel, an installer that sets the dependency of the implementation of functionality for specific platforms, a loader that provides loading from an HTTP server, Input/output methods and a garbage collector that removes irrelevant content from the memory of a device (Figure 1).
When it is requested, the module can give the content file itself, its data or a link to the content. This is done using Generic methods, where the type in which it is necessary to return the content is passed. The module can also return its state (content readiness, path to it, link per content loader instance). The module can be instructed to start downloading content, stop the download or interrupt the download of content. In these cases, during the interaction with the module, a unique content identifier ID is transmitted to it. It is possible to pass a complete list of relevant content for a given user to a module on a given platform, so that it initiates the wipe of irrelevant content.

The module must have a garbage collector that is initialized by the module kernel when a list of actual content arrives from the outside. The garbage collector finds all downloaded content on the device, checks it according to the list of current content and deletes all the files that do not match.

6. Conclusion
As it is mentioned above, modern virtual reality technologies, which are currently used mainly for games, can also be used for visual learning tasks. To implement them in this context, it is necessary to select the final technologies and methods, adjusted for the specificity of such systems. It is necessary to note that training systems, in contrast to games, are distinguished by the need for authentication systems, user authorization and dynamic nature. Often, academic modules (in terms of content) can be rebuilt several times a year, constantly being optimized and improved.

References
[1] Kondratiev S I, Pechnikov A N, Khekert E V 2018 Ergonomic approach to estimation activities of marine specialists: the essence of the problem and the approach to its solution. Marine intellectual technologies 4(4) 166-174
[2] Makhovikov A B, Katuntsov E V, Kosarev O V, Tsvetkov P S 2019 Digital transformation in oil and gas extraction. Innovation-Based Development of the Mineral Resources Sector: Challenges and Prospects (ed. Litvinenko) - 11th conference of the Russian-German Raw Materials (ISBN: 978-0-367-07726-6), pp. 531-538
[3] Kosarev O V, Tsvetkov P S, Makhovikov A B, Vodkaylo E G, Zulin V A, Bykasov D A 2019 Modeling of industrial iot complex for underground space scanning on the base
of arduino platform. Topical Issues of Rational Use of Natural Resources - Proceedings Of The International Forum-Contest of Young Researchers, pp. 407-412

[4] Koroleva E A, David G M, Vladimir A Z, Makashina I I, Filatova E V 2018 Advantages of networking and distance learning use in maritime education and training. Proceedings of the 2018 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering, ElConRus 2018, 2018-January, pp. 61-65.

[5] Makashina I, Fayvisovich A, Truschenko I 2017 Distant learning assessment system opportunities for improvement quality of maritime education. 18th Annual General Assembly of the International Association of Maritime Universities - Global Perspectives in MET: Towards Sustainable, Green and Integrated Maritime Transport, IAMU 2017, 1, pp. 36-44

[6] Kondratiev S I, Boran-Keshishyan A L, Tomilin A N 2019 Conceptual bases for development of the bank of test tasks for the state final certification of graduates of maritime educational institutions Marine intellectual technologies 1(2) 142-148

[7] Ivanchenko A A, Turkin V A, Karakayev A B, Konev G A 2019 State and perspective directions of development of cad in shipbuilding Marine intellectual technologies 1(2) 41-45

[8] Karlina A I, Kondrat'ev V V, Kolosov A D, Balanovskiy A E, Ivanov N A 2019 Production of new nanostructures for modification of steels and cast irons. IOP Conference Series: Materials Science and Engineering 560(1) 012183

[9] Stotzer M, Gronstedt P, Styczynski Z, Glaunsinger W, Buchholz B M, Suslov K V 2012 Demand side integration-A potential analysis for the German power system, IEEE Power and Energy Society General Meeting 2012, 6345090

[10] Voropai N I, Suslov K V, Sokolnikova T V, Styczynski Z A, Lombardi P 2012 Development of power supply to isolated territories in Russia on the bases of microgrid concept. IEEE Power and Energy Society General Meeting 6344612