Такая структура полностью соответствует общей методике решения оптимизационных задач, которая предусматривает определение исходного варианта, направленный перебор вариантов и признак оптимальности.

Предложенная методика и программная система опробовалась на студентах младших курсов. Особых нареканий не получено. Результаты обучаемых и опрашиваемых довольно положительные. Можно использовать как компьютерное средство при проведении практических занятий и модульной оценке, по дисциплинам, связанным с принятием оптимальных решений.

## ИСТОЧНИКИ

1. Юхименко Б. И., Гаценко В. А. Некоторые математические модели транспротной логистики. Научное издание ХГМА Вестник.

2. Юхименко Б. И. Методы оптимизации. Формализация задач размещения производительных сил. Информатика и математические методы в моделировании. - 2012, №4. - с. 337 — 343.

3. Д. Сошников. Функциональное программирование на F#. 2017.

# AUTOMATIZATION OF AUGMENTED REALITY MARKERS  CREATION USING UNITY AND VUFORIA

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*This paper is devoted to automatization of the user's own augmented reality objects creation process. The paper describes a prototype of the application, which allows you to significantly simplify and speed up the process of augmented reality creation*

*Keywords: augmented reality, AR, unity, vuforia*

**Introduction.** Over the past 2 years, the demand for AR-applications has increased almost 4 times (Augmented Reality - AR) [1 , 2], but at the moment it is difficult to find an application on the AR-products market that would allow users to add their own markers. Vuforia is a platform for development of AR applications for mobile devices, which allows you to upload 2D images and simple 3D objects of the real world, which later become "markers" - the source of AR. Vuforia simplifies AR integration into applications, thereby bringing augmented reality to the broad masses of users. However, the purpose of this work is to further simplify the process of creating AR objects and providing the average user, without the developer skills, the possibility to create his own markers of augmented reality for their application without reference to the subject area, which determines the relevance of this work.

Main part. In July 2018 at the Odessa National Polytechnic University in the process of participation in the summer school "Augmented Reality. IT is a culture" was developed a mobile application that allows user to create his own sources of augmented reality using a mobile phone camera. The prototype of the application was created in the Unity3D development environment using the Vuforia framework. Google Disk was used as a temporary database. Table 1 shows the steps and phase time calculations of the standard process of AR - applications development using Vuforia by a regular user.

*Table 1 - Steps in the standard AR creation process using Vuforia*

| № | Stage | Time |
|---|-------|------|
| 1 | creating a vuforia account and obtaining a license key | 5 to 7 minutes |
| 2 | learning how to work with unity 3d | > 30 minutes |
| 3 | learning how to work with the Vuforia plugin in Unity3D | > 30 minutes |
| 4 | download and import Vuforia in Unity3D | > 5 minutes |
| 5 | creating a project inside the development environment for future work | 5 to 15 minutes |
| 6 | creating marker images | 5 to 15 minutes |
| 7 | upload marker images to the Vuforia website | 5 to 15 minutes |
| 8 | import and attachment of marker libraries to Unity | 5 to 15 minutes |
| 9 | building and running an application on a mobile device | 5 to 15 minutes |
| 10 | spare time for possible errors during development | 0 to 60 minutes |
| Final result: | | > 2 hours |

Table 2 summarizes the steps involved in creation of AR using our application.

*Table 2 - The process of creating an AR using our application.*

| № | Stage | Time |
|---|-------|------|
| 1 | installation and start of the application | 1 to 2 minutes |
| 2 | pointing the camera and creating a photo that will automatically become a Vuforia marker and will be loaded into the database | < 1 minutes |
| 3 | customization of your marker - selection and placement of content using a convenient interface | < 2 minutes |
| 4 | pressing the save button - sending the finished work to the server, whereupon other users will be able to see it | instantly |
| Final result: | | 4-5 minutes |

Picture 1 - An example of using the application

As a result of the comparison, we can conclude that a person with no development experience will need more then 2 hours to create an AR. For a person with experience in Unity3D and Vuforia, the process from scratch will take about 30 minutes. However, using our app the whole process takes no more than 4-5 minutes, and less then 1-2 minutes with the already installed application.

**Findings.** Owing to simplification and acceleration of augmented reality creation our project can be applied in all spheres of human activity - both for fun and in professional activities (in the sphere of culture, marketing, charity, in the offices of companies, etc.), which will promote the technology of computer vision through it's use by people without any development experience.

As future plans of this application were highlighted:

- expanding the choice of content that can be used for AR, as well as allowing the user to add his own materials ;
- adding the ability to create mini-databases for users;
- ensuring censorship of user - generated content;
- connection of the relational database to the application;
- add the ability to work with the application in augmented reality glasses.

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REFERENCES

1. Bischof D., Droste M., Letellier J., Schöbinger S., Sieck Jü., Thielen E. Development of Mixed Reality Applications for Culture and Tourism // VI Ukrainian-German conference "Informatics. Culture. Technology" Odessa, 12.09 – 22.09.18. – Pp. 13-20

2. Jonathan Linovez. Virtual reality in Oneness. / Translation Ragimov R.N. –M.: DMK Press, 2016. – 316 c.

3. Vuforia [Electronic resource]: – Access mode:  https://ru.wikipedia.org/wiki/Vuforia