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ScienceDirect

Procedia Computer Science 190 (2021) 745–749

Procedia Computer Science

www.elsevier.com/locate/procedia

2020 Annual International Conference on Brain-Inspired Cognitive Architectures for Artificial Intelligence: Eleventh Annual Meeting of the BICA Society

Application of VR instruments in preprofessional education in the area of mechatronics and robotics in a nuclear research university

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Abstract

In the area of computer sciences there is a rapidly developing subject of mechatronics and robotics since its relevance to the fourth industrial revolution, especially in preprofessional education – schools etc. On the other side, technologies of virtual reality (VR technologies) have been spreading in education so far, including computer sciences and mechatronics and robotics education in Russian leading research universities. In National Research Nuclear University MEPhI we have a broad experience of application of hi-tech in education. In this paper we present the results of our practical research of application of VR instruments in preprofessional education in the area of mechatronics and robotics. One of the features of our research is that we have developed the educational program for obtaining practical skills in the area of VR digital technologies in compliance with the CDIO standards.

Keywords: Computer sciences education; mechatronics and robotics; VR; preprofessional education

1. Introduction

The developing fourth industrial revolution [1-5] bases on the development and implementation of cyber-physical systems in mass industry. These cyber-physical systems include robotic and mechatronic systems. In National Research Nuclear University MEPhI such cyber-physical systems are in focus of research, development and education,

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1877-0509
10.1016/j.procs.2021.06.087

with educational programs designed specially for training of high-quality specialists in this area. These educational programs are developed in compliance with the CDIO international standards [6-9].

The purpose of the CDIO Initiative is to bring the content and effectiveness of engineering educational programs into the compliance with the development level of modern technologies and employee's expectations. The CDIO Standards (12 CDIO Standards) determine special requirements to the CDIO programs, which can be the guidance to reform and evaluate the educational programs in the sphere of processes and technologies, as well as to create the conditions of their continuous improvement.

12 CDIO Standards determine the requirements to the following:

- The concept of engineering educational programs (Standard 1)
- The formation of curriculum (Standards 2, 3)
- The practice-oriented educational environment (Standards 4, 5, 6)
- The educational methods and qualification of teachers (Standards 7, 8, 9,10)
- The methods to evaluate the students' training results and the program in whole (Standards 11 and 12)

CDIO Syllabus (Planned educational results) are the competencies of the present bachelors' in the sphere of processes and technologies; they are classified as per four main sections:

- Disciplinary knowledge and Engineering bases
- Professional competencies and personal qualities
- Interpersonal competencies: team work and communication
- Planning, design, production and use of products (systems) in the context of enterprise, society and environment

On the other hand, VR technologies is a rapidly growing technological area applied in education [10-14]. Virtual reality attracts people's attention. This technology is used in many fields, such as medicine, industry, education, video games, or tourism. Perhaps the biggest area of interest is leisure and entertainment. Regardless of the field, the introduction of VR or AR had several advantages: it was expensive, had poor ergonomics, or required too much work to create content. Recent technological innovations, including the rapid adoption of smartphones in society, have made it easier for anyone to access VR and AR. In addition, several major companies such as Apple, Facebook, Samsung, and Magic Leap, among others, have increased their investments to make these technologies more accessible over the next few years. Educational institutions will benefit from greater availability of virtual technologies; this will allow teaching in virtual environments that cannot be visualized in physical classrooms, such as access to virtual laboratories, visualization of machines, industrial plants, or even medical scenarios. The vast possibilities of available virtual technologies will allow you to go beyond formal education.

VR and AR technologies are used in a wide variety of environments, from gaming to construction and engineering. The use of these technologies allows both to prevent possible errors in the design, and hence subsequent losses due to the visual presentation of the work results, and positively affects the involvement in the model development process.

In addition, the use of virtual reality opens up many new opportunities in teaching and education process that are too complex, time consuming or expensive with traditional approaches.

2. The developed program on application of VR instruments in preprofessional education in mechatronics and robotics

In compliance with the CDIO standards described above we have developed the educational program on application of VR instruments in preprofessional education in mechatronics and robotics. The purpose of the program is to interest students in studying the engineering direction, introduce them to VR technology and teach them the basics of developing new technical systems.

2.1. Program objectives

Teaching:

- To give a complex of knowledge of the basics of designing complicated technical systems
- To give knowledge of the basics of working in various CAD systems
- To give knowledge of the basics of working in the Unreal Engine environment

- To teach how to correctly use the existing base of 3d models, translate them into different formats and change them
- To teach how to correctly work with controllers and VR glasses
- To teach how to competently prepare a virtual room and workplace for various tasks

Developing:

- To develop logical thinking
- To form the skills of constructive thinking
- To develop cognitive and creative activity
- To promote the initial career guidance of students

Educational:

- To form self-discipline and responsibility for your own work
- To improve communication skills that ensure successful teamwork

The program provides a group form of classes, since students may have different projects within the same area of activity.

2.2. Planned results

Knowledge:

- Features of the use of VR technologies
- Features of work in various CAD systems
- Features of work in the Unreal Engine environment

Skills:

- To use various bases of 3d models
- To properly prepare models for further work
- To competently operate various equipment

The results of application of the developed program are shown at Fig. 1.

Fig. 1. Teaching students of application of VR instruments in mechatronics and robotics according with the developed preprofessional program

2.3. Forms of control and summing up the results of the implementation of the additional general education program

For each year of study, the main parameters are identified, according to which the students' knowledge and skills are evaluated.

Table 1. Parameters for assessing knowledge, skills and abilities.

Parameters	The minimum level of knowledge and skills, 1 point	The acceptable level of knowledge and skills, 2 points	The optimal level of knowledge and skills, 3 points
Safety knowledge	Uncertain formulation of safety rules while setting up a VR kit	Knowledge of safety rules while setting up VR kits, the ability to apply them in practice	Excellent knowledge of safety rules while setting up VR kits, the ability to apply them in practice and help comrades
Knowledge of the features of work in various software environments	Inaccurate knowledge of work in the used programs	Accurate knowledge of work in the used programs	Accurate knowledge of work in the used programs, the ability to help comrades
Ability to prepare a model for visualization and import it into Unreal Engine	Lack of knowledge of working with the model and importing it	Ability to work with a model and import it under the guidance of a teacher or senior comrades	Independent skill to prepare and import a model

The certification of students is carried out in accordance with the Regulations on the certification of students in study groups and collectives following the results of the implementation of educational programs with the issuance of certificates.

3. Conclusion

We have presented the results of application of VR instruments in preprofessional education in mechatronics and robotics on the basis of a specially developed educational program. The program has been developed in compliance with the CDIO international standards.

References

[1] Devon McGinnis (2020) “What Is the Fourth Industrial Revolution?” Retrieved from https://www.salesforce.com/blog/category/fourth-industrial-revolution/

[2] Min Xu, Jeanne M. David and Suk Hi Kim (2018) “The Fourth Industrial Revolution: Opportunities and Challenges.” *International Journal of Financial Research* **9** (**2**): 90–95.

[3] Al Rodhan, Nayef (2015) “The Moral Code: How to Teach Robots Right and Wrong.” Retrieved from https://www.foreignaffairs.com/articles/2015-08-12/moral-code

[4] Maslov, Vladimir et al. (2017) “The Fourth Industrial Revolution: origins and consequences.” *Bulletin of the Moscow University. Series 27. Globalistics and Geopolitics* **2**: 38–47.

[5] Balatsky, Evgeniy (2019) “Global challenges of the Fourth Industrial Revolution.” *Terra Economicus* **17** (**2**): 6–22.

[6] Varyatchenko, Elena et al. (2015) “The Development of Approaches to Engineer Training Improvement in the Research University in Compliance with the International Standard.” *Biosciences Biotechnology Research Asia* **12** (**1**): 939–946.

[7] Fedorov, Igor et al. (2011) “Engineering education: problems and tasks.” *High Education in Russia* **12**: 54–60.

[8] CDIO., Knowledge Library. CDIO Standards (2020) Retrieved from http://www.cdio.org

[9] Crawley, Edward (2001) “The CDIO syllabus: a statement of goals for undergraduate engineering education.*” The Department of Aeronautics and Astronautics, Massachusetts Institute of Technology*.

[10] Martín-Gutiérrez, Jorge et al. (2017) “Virtual Technologies Trends in Education.” *EURASIA J Math Sci Tech Ed* **13** (**2**): 469–486.

[11] Yuen, Steve Chi-Yin et al. (2011) “Augmented reality: An overview and five directions for AR in education.” *Journal of Educational Technology Development and Exchange* **4** (**1**): 119–140.

[12] Ildikó, Horváth (2018) "Evolution of teaching roles and tasks in VR / AR-based education." *International Conference on Cognitive Infocommunications.*

[13] Stelian, Nicol et al. (2018) "VR for Education in Information and Tehnology: application for Bubble Sort." *International Symposium on Electronics and Telecommunications.*

[14] Hadi, Ardiny et al. (2018) "The Role of AR and VR Technologies in Education Developments: Opportunities and Challenges." *International Conference on Robotics and Mechatronics*.