Development of Music Education in Virtual and Extended Reality

Oleksii PAVLENKO[1],
Ihor SHCHERBAK[2],
Viktoriia HURA[3],
Valentyn LIHUS[4],
Iryna MAIDANIUK[5],
Tamara SKORYK[6]

[1] Nizhyn Mykola Gogol State University, Ukraine, pavlenkoaleksei1@gmail.com, https://orcid.org/0000-0001-5164-6504

[2] V.O. Sukhomlynskyi National University of Mykolaiv, Ukraine, shcher.i.v@gmail.com, https://orcid.org/0000-0002-4649-6510

[3] Sumy State Pedagogical University named after A.S. Makarenko, Ukraine, gyravita@gmail.com, https://orcid.org/0000-0002-7618-811

[4] Kyiv National University of Culture and Arts, Kyiv, Ukraine, ligus-valentin@ukr.net, https://orcid.org/0000-0003-2430-0166

[5] National University of Life and Environmental Sciences of Ukraine, mira-i@ukr.net, https://orcid.org/0000-0001-8096-0244

[6] T.H. Shevchenko National University «Chernihiv Colehium», Ukraine, tamskorik@ukr.net, https://orcid.org/0000-02-1442-6024

Abstract: *The relevance of the chosen topic of the paper is determined by the need to study the development of music education in our time in virtual and augmented reality, focused on the study of new vectors of music education in Ukraine and its entry into the world educational and cultural space based on innovative technologies. The study aims to define and justify the development of music education in virtual and augmented reality, research of innovative technologies to expand the possibilities of the creative process in the art of music, and definition of methods of musical expansion reality. The paper analyzes the directions of development of music education in the works of researchers and scientists, as in the last few decades, scientists have become more interested in the virtualization of society and music education, in particular. Virtual reality is becoming the object of study in philosophy and the humanities and the natural sciences, art history. The article also collects theoretical developments on the topic, specifies the tasks in the music education system in our time in virtual and augmented reality, explores the role and place of innovative technologies to expand the creative process in music, methods of expanding musical reality determined.*

Keywords: *High-tech revolution; mixed reality; multimedia technical means; entertainment; musical art.*

Introduction

In the XXI century, virtual and augmented reality technologies are among the most promising areas for implementation and practical use in various fields of culture and art.

The constant search for new means of artistic expression and the desire to increase the spectacle of the imagination in the last few decades have led to a steady trend of diverse applications of multimedia technologies in music. This, in turn, led to the transformation of choreographic art and scenography, as well as the emergence of new forms of dance performances and the merging of different arts.

The development of multimedia hardware has led to the formation of sophisticated multimedia devices for creating and viewing virtual reality. **Virtual reality technology** is multimedia that includes a whole set of multimedia tools and technologies (audio, video, graphics).

Multimedia tools and technologies are used at all stages of creating a space of virtual reality and the implementation of musical production.

Special multimedia hardware (helmets or virtual reality goggles, Motion Parallax, 3D displays, audio or multichannel speakers, feedback devices, controllers) are also required to view the created content.

Virtual reality technologies have gained practical significance by actively introducing virtuality and its elements in modern artistic and aesthetic culture. The very concept of "virtual reality" in recent years has been actively used in academic literature, and in the long run, can take an essential place in the conceptual and categorical apparatus, becoming on a par with traditional concepts of culture, aesthetics and art.

The author of the article notes that the scientific works of domestic and foreign researchers deserve attention in the study of the development of music education in virtual and augmented reality in the art of music: Ivanova (2018), who intensely studied the technologies of virtual and augmented reality; Kirnarskaya (2007), who pointed out the peculiarities of the psychology of exceptional abilities in the development of music education; Nazaikinsky (1972) on the psychology of musical perception in virtual and augmented reality, Kholopova (2014) - the study of virtual and augmented reality in modern musical works.

The author of the article is also impressed by the opinion of Nosov (2015), who linked the musical term "virtual" with mental processes related

to consciousness and memory and uses this category to denote the contrast between reality and relevance.

During the XXI century, we are experiencing a high-tech revolution, when electronic, especially computer systems are increasingly entering our lives and each new development of information and computer systems stimulates the emergence of creative experiments and, consequently, the emergence of new synthetic and musical forms, genres, instruments, sound technologies.

"Augmented reality", "virtual reality", "mixed reality" as some of the applications of this revolution, of course, is at the forefront of scientific research and technological progress. According to the slogan on the front page of one of the largest international conferences on virtual reality (ISMAR), "augmented reality has a significant impact on business and all humanity today. This area is largely interdisciplinary; combining digital signal processing, computer vision, computer graphics, user interfaces, psychology, wearable electronics, mobile devices, computer networks, displays, sensors - and that is just it. A small part of those areas where the strong influence of this "reality" is felt", Ivanova (2018, p. 34).

The call echoes them: "Join us to find out why any organization, any innovative project and every investor should plunge into augmented reality – otherwise, you will remain an outsider", Krasnoskulov (2015, p. 56).

The main objectives of the paper are to study modern technologies, namely: virtual and augmented reality, which contribute to the expansion of the creative process in the art of music; research of methods and ways that contribute to the expansion of musical reality.

Innovative technologies to expand the possibilities of the creative process in the art of music

The art of music, like any other, always seeks to use existing technology to enhance the creative process, so this perspective of general interest attracts the attention of hundreds of musicians and researchers around the world to explore the sound possibilities of augmented and virtual reality.

In the last few decades, scientists have become more interested in the virtualization of society and music education, in particular. Virtual reality is becoming the object of study in philosophy and the humanities and the natural sciences, art history.

Definitions of "virtual reality" in various studies contradict what makes this phenomenon difficult to understand scientifically.

Worth noting in the study of the development of music education in virtual and augmented reality in the art of music are the scientific works of domestic and foreign researchers: Ivanova (2018), who intensely studied the technologies of virtual and augmented reality; Kirnarskaya (2007), who pointed out the peculiarities of the psychology of exceptional abilities in the development of music education; Nazaikinsky (1972) on the psychology of musical perception in virtual and augmented reality, Kholopova (2014) – the study of virtual and augmented reality in modern musical works.

Thus, the paper's author supports the opinion of Nosov (2015), who linked the musical term "virtual" with mental processes related to consciousness and memory and uses this category to denote the contrast between reality and relevance.

Essential for understanding are the views of scientists Iqbal et al. (2017), who study virtual technologies used in the art of music (choreography), that virtual technologies offer new opportunities.

Based on the analysis of the work of more researchers and the legal framework, the author of this article proposes the following definition of the term "virtual reality technology in music": it is a complex technology that constructs a new artificial world with software and hardware by influencing the human senses.

The set of tools for creating virtual reality can simultaneously use various multimedia tools and technologies: three-dimensional graphics, surround stereo, video and audio objects and more, Teplov (2003).

Augmented reality is a kind of virtual environment or, commonly called, virtual reality. Virtual technologies completely immerse the user in a synthetic environment, and during the "immersion", the user cannot see the natural world around him. On the contrary, augmented reality allows us to see objective reality with virtual objects superimposed or composed of existing objects. Therefore, augmented reality expands completely replaces the "constant" reality. Although virtual reality immerses itself in the artificial world quite deeply, augmented reality, to some extent, allows achieving this effect even more because there is a connection with the natural world - the one in which we spend most of our lives, Ivanova (2018).

Traditionally, augmented reality technologies are implemented through tracking – using a camera and smartphone software – any "marker".

Such "markers" can be specially prepared images (e.g., QR codes), as well as any images, objects, sounds, location data, or even the person himself.

The data of the "markers" are processed and compared with a database where potentially matched digital objects (which can be 2D images, 3D objects, sound and animation). If there is a match, the relevant digital content from the database is superimposed "on top" of visual or audio reality, Medvid (2016).

All senses, not just sight, can perceive augmented reality. To date, however, in most cases, researchers have focused on mixing real and virtual images and graphics. However, augmented reality can be augmented, including in the sound field.

Sound is used in virtual reality to enhance the sense of the effect of "presence", increase the illusion of the reality of the digital world "sound in virtual reality – not a luxury but a necessity", Loviscach (2018).

Similarly, the application in augmented reality of a wide range of sound solutions – from acoustic effects to musical interactivity – has an even greater force of "persuasion".

Sound can be used in augmented reality together with visual and tactile components, but it can also be used by itself: in this case, we get a different from the traditional but no less effective area of "sound augmented reality", Matuga (2004).

In addition, such technology can be used as another channel of information; it also creates new forms of interactive interaction and creative involvement.

As an example of such interactivity, let us call the Moff Band project, a device in which gestures control the sound in the context of sports and free-creative play (the project is aimed primarily at children).

The bracelet uses a built-in accelerometer and gyroscope to determine the child's hand movements. Selected sound effects are reproduced in real-time to match these movements and include the sounds of drums, guitars, swords, and sports, Kholopova (2014).

Another approach to interactivity in augmented reality is the Konstruct project, which according to Kholopova (2014), is an example of augmented reality implementation, where you can create virtual sculptures with the sound of your voice. It is a unique view of augmented audio because instead of the traditional way – to create sound as a consequence of the visual process – it is proposed to prioritize the sound process by creating

abstract images (essentially a set of three-dimensional models), analyzing smartphone voice parameters (volume, pitch).

For several decades, a large number of different scientific conferences have been held in the field of sound and music research with the use of computer technology – including the use of the possibilities and features of augmented reality. Some of them are focused exclusively on music issues; at some conferences, the music direction is presented "on an equal footing" with developments in the visual and technical fields.

The complete picture of augmented and virtual reality research activity in the music and sound spheres is formed by analyzing the materials of the two largest specialized conferences – the International Conference on Computer Music and the International Conference on New Interfaces of Musical Expression (Iqbal et al., 2017).

Methods of expanding musical and virtual reality

The expansion of musical and virtual reality is carried out by researchers mainly in two ways – through the interaction of space with physical objects in real space or through the transformation of real acoustic space with virtual sound elements.

The first method allows looking at the ordinary world differently; expanding simultaneously auditory perceptions because using ordinary objects in an unusual context can awaken the creative imagination.

The second method is most often carried out outdoors, for example, when moving through the city streets (Agarwal & Thakur, 2014).

The computer (using laptops, smartphones containing electronics) analyzes the sounds of the surrounding space, as well as the biological parameters of the study participant (for example, sensors record heart rate data) and, depending on the results, "mixes" certain synthetic sounds and music into the general acoustic picture, speeds up or slows down their sound.

To achieve the effect of an augmented audio environment, researchers use various technological techniques, including specially designed headphones with external microphones, Azuma (1997).

Headphones reproduce sound, which is a combination of the natural sound of the surrounding space, received by microphones and any other, to some extent, synthesized signal. In addition, the presence of microphones also allows to "mask" or hide the sounds of the environment. Although the latter is not easy, the existing developments in sound analysis, neural

networks and artificial intelligence allow us to do it today (with varying degrees of reliability).

The technology of capturing movements (tracking) shows that along with the expansion of physical reality, this area dominates in the research conducted in the analyzed area. The desire to understand more deeply the translation of gestures from the "analogue" to the "digital" plane is reasonably expected because, firstly, the gesture is an essential component of musical and stage expression, and secondly, achieving an accuracy of motion recognition remains the biggest problem facing when using augmented reality systems. According to researchers, "methods of interaction, calibration, display and software implementation have been studied in detail for a long time, as the technological capabilities of augmented reality, systems continue to be a deterrent", Tarayeva (2011, p. 56).

If at first in augmented reality studies to capture the movements of hands and fingers used special glove-trackers, and later – mounted on the head or collar of the camera, in the last decade in scientific works most often used devices (Kinect, Leap Motion) to analyze the entire space scenes. A general approach in research is also to recognize the movements of a musician's fingers on the fingerboard of a musical instrument or keyboard.

To create a deeper immersion in the virtual reality environment. It is essential to interact with digital objects and have feedback from them. "Tactile interaction provides great opportunities – say Ferris and Bannon (2012) – because the physical objects used are well known, and this allows them to be easily used. We can apply a similar concept to augmented reality, where we can combine the intuitive clarity of real physical objects as input devices with enhanced display capabilities by superimposing virtual images" (Ferris & Bannon, 2012).

The art of music should use a group of technologies that are currently used in several areas:

- creation of fundamentally new forms of musical productions;

- creation and introduction of additional multimedia elements in a musical production;

- a new way of presenting the product to the audience and interacting with it, Popovich (2012).

Here are the stages of creating projects of musical productions using virtual reality technology:

- rehearsal process, which takes into account the peculiarities of staging, posture, manners, facial expressions and facial expressions of dancers;

- creating a computer model of performers in a virtual format;

- creation of stage costumes in 3D format;

- creation of virtual scenery and other scenography elements;

- "capture the movement" of dancers using the system "computer vision";

- data Processing;

- data integration into the development network;

- creating graphics, setting up a visual scene, Petrushin (2008).

The features of musical productions that use virtual reality technology include:

- ability to supplement the production with three-dimensional virtual characters, scenery and props;

- productions with the possibility of interactive interaction with the spectator, objects of the environment and dancers;

- instant change of locations of musical representation in the space of virtual reality;

- the ability to supplement the production with visual effects, including real-time mode;

- the ability of the viewer to independently determine the direction, angle, angle and detail of the picture, as well as to interact with the objects of the environment;

- the director has the opportunity to use more means of artistic expression, Medvid (2016).

Unfortunately, the possibilities of the augmented reality interface are limited to actual physical objects - a table, a wall, a touch screen – which are interacted with either through the projection of a digital image on them or through the use of so-called "multitouch" displays.

Conclusions

The paper also collects theoretical developments on the topic, specifies the tasks in the music education system in our time in virtual and augmented reality, explores the role and place of innovative technologies to expand the creative process in music, and methods of expanding musical reality determined.

"Image recognition" and "augmented reality" are based on the traditionally straightforward "visual" approach to technology: the image of physical reality is perceived by the camera device (often a smartphone, rarely – specialized devices such as HoloLens), analyzed by software and then displayed on top of the actual scene graphic elements, three-dimensional objects and scenes with virtual musicians.

Of course, all virtual objects that appear in different ways – spatially, dynamically – are correlated with musical fragments and individual sounds, resulting in a musical score.

In this direction, there are also studies and projects - usually educational - in which the sound of musical instruments is reproduced when hovering over the appropriate image of an instrument.

Augmented and virtual reality has come a long way, but it will have a long way to go. Reaching a broad audience is possible only in the case of breakthroughs in research, which leads to the development of augmented reality devices, their technical improvement, and reduction in cost when it becomes possible to use augmented and virtual reality systems in everyday life freely.

At the same time, "augmented reality is no longer just a technology; it is about how we want to live in the real world with its help and how we will develop the accumulated experience that will ultimately help all of humanity.

Augmented virtual reality will radically change how we live, work and have fun. Sound augmented reality is a relatively new field, where most research has been conducted only in recent years.

Due to numerous problems and unknown paths in this field, it will remain an active area of research, at least for the next few years.

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