Synthesis of virtual reality technologies and design

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Abstract. The article examines the phenomenon of synthesis of virtual reality and the design of a digital environment and possible areas of its application. The main terms and definitions are given. The historical background of the development and formation of virtual reality technology is given. The main technologies providing design means and virtual reality technologies’ interaction are described. The theoretical basis for the interaction of virtual reality technologies and design tools, such as visualization and image creation techniques, is considered. A design solution for using virtual reality technologies in design as a method for solving design and artistic problems is presented.

Introduction
Virtual reality technology has started its active development in recent years, becoming an integral part in many areas of human life. So, thanks to the high-tech developments of Sony, HTC, Microsoft, created for games and entertainment, this technology has been actively used in medicine to create simulators for the rehabilitation of people who have suffered a stroke, in driver training, in online stores, in construction and game design.

In the study of the virtual reality technologies’ possibilities and their application in the field of design, first of all, it is necessary to emphasize that this area is promising and multifaceted. In parallel with VR technology, which creates the effect of complete immersion, affecting the human brain with the further perception of virtual space as natural, augmented reality (AR) technology, in turn, expands the range of applications and virtuality by superimposing visual images on the real world that a person sees in front of himself. Augmented reality (AR) technology is actively used in quest games.

The study of the latest technologies, novelties and technical capabilities of virtual reality made it possible to conclude that it is necessary and relevant to integrate VR technology, augmented reality (AR) technology and design, which will solve the problem with the static space and move to a new digital level in design - engineering.

The practical orientation of the research demonstrates the mechanisms of such interaction on the example of creating a digital environment of various virtual spaces designed by a designer with a person immersed in augmented reality glasses into the virtual world of travel.

The phenomenon of virtual reality synthesis and digital environment design and possible areas of its application
The objectives of the study were to study the virtual reality technologies’ development, their application in the field of design with solving the problems of substantiating the relationship between design and
virtual reality technologies and a practical design solution for creating an interactive, self-changing space (non-residential premises) using augmented reality glasses.

Considering the possibilities of virtual reality technologies in terms of adaptation in modern design needs to highlight the specifics of the application, tools and their scope.

The subject of the research is digital technologies for solving the interior design problems based on virtual reality technologies.

The object of research is the phenomenon of virtual reality and possible areas of its application, features of the digital environment design.

Study boundaries. The temporal boundaries of the study cover the turn of the XX - XXI centuries. Territorial boundaries cover the development of virtual reality technology that began in foreign countries. Foreign experience and technologies are involved in the analysis of modern and experimental trends.

The main research methods are determined by the goals and objectives. During its implementation, a systematic approach was applied, which made it possible to consider the main characteristics of the object and the subject of research in their relationship; a comprehensive analysis of the features of technology and design of the digital environment, historical, cultural and methodological positions; analytical modeling method; experimental design method.

The scientific novelty of the research consists in proposing a new method of using virtual reality technologies in design, for solving a number of problems and searching for the technological solutions for the non-standard creative ideas’ implementation.

The theoretical foundations of the virtual reality and design technologies integration are considered as a complex of knowledge in the field of technology, psychology of perception, philosophy, innovative design in design activity. The key works that influenced the formation of an innovative design holistic view are the works of S. I. Orekhov, N. L. Sokolova, in which the concept of virtual reality, its role in modern culture, its philosophical and psychological component, types and modern trends are considered as an innovative trend. The opinion of such experts as K. Rashid, V. Ryzhonkov, as well as the founders of such major companies as Sony, HTC, Microsoft, was of great importance for the research part. The main provisions on innovative trends and the problems associated with the entertainment centers’ organization were studied in connection with the works of I. S. Ivyanskaya, M. V. Monastyrskaya, K. V. Auer. In addition, it was possible to learn about the digital environment design and game design from the English-language works of such authors as R. Koster, J. Shell, T. Sylvester. The position of foreign scientists and the priority of considering the phenomenon of virtual reality as a unique technology deserves close attention.

In the process of research, the virtual reality technologies’ development chronology has been established, from the creation of a stereoscope in 1837 by Chalz Whiston, in 1950 the Sensorma attraction and in 1957 a telescopic mask, as the first prototype of VR glasses, by Marton Hayling, the creation of the Atari virtual reality laboratory in 1982 and the appearance the term "virtual reality" itself, the development of VPL Research cyber gloves in 1983 by Tom Zimmerman, Scott Fischer and in 1991 VR machines by the Virtality group until the technology turning point in 2014. With the invention of the virtual reality helmet HZT-1 in 2011 by Sony and the Oculus Rift DK glasses in 2012, a technological breakthrough occurred in the possibilities of using virtual reality in various spheres of human life.

Virtual reality as a part of technical informational progress is described by the representatives of reality comprehensive philosophy [1-3]. According to Segal A.P. the term "virtuality" also carries a mathematical understanding [4].

In the course of the study, an optimal solution - chroma key technology was found. The problem of using AR technologies in space was that the final image is not of high enough quality, interference is created in illuminated places, and a sharp color change. Based on the virtual reality glasses analysis and the search for the model and technology most adaptive to design, it was concluded that the implementation is compatible with augmented reality glasses and chroma key technology. The key components of the chromakey application have been identified. Light is primarily needed for the screen
to be distributed as evenly as possible. Cool green is preferred, but when shooting green subjects, they will dissolve in space. The study of the chroma key technology possibilities made it possible to solve the technical drawbacks for this idea implementation. In the course of studying innovations in the field of virtual reality, a model of glasses, functionality and technical capabilities that will solve design problems were identified. This is the Microsoft Hololens model. Using virtual reality and chroma key technologies together makes it possible to maximize the image quality of the digital space created specifically for augmented reality glasses. The combination of chromakey technology with the necessary interior lighting will allow the visitor to fully experience the digital interior. It should be noted that the analysis of consumers allowed us to conclude that 40% of people aged 17 to 20 and 35% of people aged 31 to 45 are interested in this modern technology.

Creation of virtual reality scenes is based on a design tool - empathy. Empathy works for the image. G.V. Ioivleva writes about psycho-emotional impressions of image perception [5].

Being in the virtual space, the visitor, as a user of a unique technology, is a part of another world and is able to interact with his environment in meaningful relationships. This is the so-called telepresence effect: a combination of immersion and interactivity.

It is necessary to note the words of V.V. Kulenenok about the possibilities of three-dimensional graphics [6].

From the point of view of the symbiotic, the immersion method is described by the researchers Yu.M. Shaev and Morozov M.G. [7-8]

Effective immersion requires the user to be able to explore the life-size visuals in a virtual environment and to take in the entire space. The user should be able to view the space.

The process is similar to the process described by D.V. Agadzhanyan, M.I. Chukarin [9].

It was possible to implement the idea of integrating the design ideas and the technological capabilities of virtual reality using the example of designing public interiors. Within the framework of the project, the object of the GorkiPark shopping and entertainment center in Kazan was selected. In the initial situation, the total area of the premises is 323 m². Load-bearing walls divide the room into two parts: the main room and the corridor. After the redevelopment, it was decided to divide the premises into three spacious zones, two utility rooms, a bathroom and a corridor. One of the zones is intended for a virtual reality cafe (Figure 1).

Figure 1. Floor plan. Initial situation and redevelopment

It was revealed that thanks to the integration of AR (MR) technology and chroma key technology, the cafe visitor will be able to completely immerse himself in the virtual world, while still remaining in reality, that is, being able to see his interlocutor. It should be noted that the lighting in the room should be uniform and well illuminate the entire surface of the chroma key. And also, all surfaces should be perfectly flat, not distorted in places of poor illumination and surface deformation. All coverings of walls, ceilings, floors, furniture in the cafe hall are painted in matte blue. This color is the chroma key coating for the glasses to work correctly. All corners are smoothed and rounded with blue fabric to avoid dark areas. The styling of the interior is due to the chroma key technology requirements (Figure 2).
A key part of the research-based project is to design a digital environment for augmented reality glasses. The number of digital scenes can be unlimited. The search for the actual approach to solving problems is presented in three scenes. The filling of each scene is a strict adherence to the requirements of technology and at the same time the expression of the design idea in the subject shaping of images and a color scheme that amazes the visitors’ imagination.

By choosing Microsoft Hololens glasses with a specific theme of the scene, visitors get the impression of aesthetic unity and the interpenetration reception of artistic and technical means. The virtual reality interaction is mentioned in their works by Averbukh, N.V. A. A. Shcherbinin [10].

The scene "Breakfast at the tavern" developed by 3D-design imitates the pristine medieval nature, overlooking the mountains, in the courtyard of a rare tavern. The scene will allow the visitor to be transported from the noisy city, causing the visitor to be pacified and calm. The boundaries of the room are highlighted to indicate the area covered by the space in the initial situation before immersion in an unreal virtual world (Figure 3).

The "Lunch Inside a Picture" scene is designed for the fans of fantasy and thrills. In this digital scene, the visitor moves to lunch inside a real painting, where the entire space is composed of artists’ brushstrokes. This scene should induce a contemplative emotional state in the viewer (Figure 4).
Figure 4. Scene "Lunch inside a painting"

The Dinner at the Space Station scene is designed for dreamers. Restrained monochrome colors reflect the vast space. Looking at the glass floor, the visitor observes the illusion of a green forest. The artistic image of the scene, thanks to its color combinations, creates a dreamy state in the viewer (Figure 5).

Figure 5. "Dinner at the Space Station" scene. Overall plan.

The rendered virtual reality scenes become a kind of theatrical stage. These are the new 3D visualization tools. The synthesis of virtual reality and design technologies opens up vast possibilities for creativity.

Summary

Key findings and results of the study.

- The design problem was identified due to the lack of innovative methods of using virtual reality technologies in the field of design, due to the small amount of scientific research and technology novelty.
- The technological capabilities of new products in the field of virtual reality were considered.
- The drawbacks of modern virtual reality glasses are revealed, the main of which are the visual image insufficient elaboration and the imperfection of the methods of transmitting the necessary information. The solution to the problem is chroma key technology and the correct light setting.
- The synthesis of virtual reality and design technologies will solve the problem of a static and closed space illusion, provide a breakthrough in design - engineering, that is, the transition from a "real" interior to a "digital".
- The ways to solve the highlighted problem, based on the example of developing a virtual reality cafe space using design tools and chroma key technology with 3D visualization of virtual travel scenes were proposed and visualized.

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