ANALYSIS OF THE IMPACT OF THE DIGITAL REVOLUTION ON CREATIVITY IN CONTEMPORARY ART: TECHNOLOGICAL CHANGES, INTERACTIVITY AND VIRTUAL AESTHETICS

ANÁLISE DO IMPACTO DA REVOLUÇÃO DIGITAL NA CRIATIVIDADE DA ARTE CONTEMPORÂNEA: MUDANÇAS TECNOLÓGICAS, INTERACTIVIDADE E ESTÉTICA VIRTUAL

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Abstract: The purpose of the study is to provide a comprehensive analysis of digitalisation changes in contemporary art through the prism of interactive technologies and virtual aesthetics. The research methods include content analysis of scientific works. The main criteria for selecting the literature were the relevance of the methodology and its inclusion in modern ranking scient metric databases. The scientific novelty lies in the study of the digital revolution in art as a complex cultural and technological phenomenon, taking into account not only current digitalisation changes but also their impact on the interaction between the creator and the viewer. The study found that the digital space in art represents a wide range of technologies and tools used by artists to create and visualise their unique creative solutions. One of the important components of the digital system is computer programs focused on creating graphics, digital resources, and platforms for video and audio processing, virtual and augmented reality technologies, artificial intelligence, etc. These software tools expand the possibilities of artists, opening up new horizons for them, allowing them to create and perform works that are unattainable without the use of digital technologies. The conclusions emphasise that interactivity and virtual aesthetics not only transform the process of art creation but also deeply rethink the communication between the viewer and the creator. The viewer becomes not just an observer, but an active participant in the creative process, which opens up new paradigms for the study of creative expression, enriching the process of creating and understanding art.

Keywords: Digitalisation. Aesthetics. Interactivity. Art. Transformation. Contemporary art. Virtual aesthetics.

Resumo: O objetivo do estudo é fornecer uma análise abrangente das mudanças da digitalização na arte contemporânea através do prisma das tecnologias interativas e da estética virtual. Os métodos de investigação incluem a análise de conteúdo de trabalhos científicos. Os principais critérios de seleção da literatura foram a relevância da metodologia e a sua inclusão em bases de dados cientométricas de classificação moderna. A novidade científica reside no estudo da revolução digital na arte como um fenômeno cultural e tecnológico complexo, tendo em conta não só as atuais mudanças na digitalização, mas também o seu impacto na interação entre o criador e o espetador. O estudo concluiu que o espaço digital na arte representa uma vasta gama de tecnologias e ferramentas utilizadas pelos artistas para criar e visualizar as suas soluções criativas únicas. Um dos componentes importantes do sistema digital são os programas informáticos centrados na criação de gráficos, recursos digitais e plataformas para processamento de vídeo e áudio, tecnologias de realidade virtual e aumentada, inteligência artificial, etc. Estas ferramentas de software alargam as possibilidades dos artistas, abrindo-lhes novos horizontes, permitindo-lhes criar e executar obras que são inatingíveis sem a utilização de tecnologias digitais. As conclusões sublinham que a interatividade e a estética virtual não só transformam o processo de criação artística, como também repensam profundamente a comunicação entre o espetador e o criador. O espetador torna-se não apenas um observador, mas um participante ativo no processo criativo, o que abre novos paradigmas para o estudo da expressão criativa, enriquecendo o processo de criação e compreensão da arte.

Palavras-chave: Digitalização. Estética. Interatividade. Arte. Transformação. Arte contemporânea. Estética virtual.

1.   Introduction

One of the current defining events is the digital revolution, which has affected not only the economy and science, but also contemporary art. Technological changes, interactivity, and virtual aesthetics are uniting in an invisible chain that intertwines with artistic expressions, creating new opportunities and challenges for creators.

In addition, the digital revolution has irreversibly changed the way we perceive and interact with art. From the traditional canvas to virtual spaces where objects come alive, and creativity crosses the boundaries of reality and fantasy. Technological innovations contribute to the development of innovative expressive means, and artists use these opportunities to create exciting and innovative works. At the same time, interactivity in the contemporary art system becomes a kind of bridge between the creator and the viewer. The sense of own participation, the possibility to interact with the work, turns the observer into a co-author, expanding the boundaries of perception and understanding. This interaction evokes emotions that become not only a passive experience but also an active participation in the creative process.

Virtual aesthetics, with its limitless freedom of shapes and colours, opens up endless possibilities for artists to express themselves. It transforms traditional art media into digital platforms where the virtual and the real intertwine, and viewers become participants in the art world.

In this context, the analysis of the impact of the digital revolution on creativity in contemporary art is defined not only as a look at technological achievements but also as a recognition of a new stage in the evolution of art, where every click or touch can become an impetus for incredible creative discoveries.

Accordingly, the purpose of this paper is to study the impact of digitalisation on creativity through the prism of analysing current technological changes and their significance for the development of interactivity and virtual aesthetics. The main objectives of this study are as follows:

1. Identify the impact of digitalisation on contemporary art.

2. Characteristics of the main interactive technologies used in contemporary art (virtual, augmented reality, artificial intelligence, graphic tools and instruments, 3D technologies, etc.)

3. The study of virtual aesthetics through the prism of the artist-viewer (user) relationship.

2. Theoretical framework and literature review

Researchers have repeatedly addressed the issue of the impact of digital technologies on contemporary art. Some of the essays have a rather broad context, given the integration of modern technologies into social life and activities. For example, SANAKUIEV (2022) examined the value of knowledge in the context of the challenges of globalisation from a philosophical and intellectual perspective, which is reflected in current trends in the global world and possible philosophical approaches to solving these problems. LAZZERETTI (2020) explores the role of culture in the challenges of the digital revolution. The author focuses on the importance of cultural aspects in the context of modern changes caused by digital transformation. His reflections on research behaviour are also important. The study aims to formulate questions that can form the basis for further research. POPYUK (2020) traced the integration of art education in Ukraine and Europe at the turn of the XX-XXI centuries, using metalworking as an example. He also explores trends in the development of

art and education in this context. Each of these articles helps to highlight different aspects of the interaction between art and other fields such as philosophy, innovation, digital art, and education.

The study by SCHIUMA (2017) discusses the role of art as a catalyst for creative organisations in the context of the Fourth Industrial Revolution, focusing on the interaction of art and innovation in modern business. ELVER BOZ; DEMIRKAN; URGEN (2022) focused on determining the visual perception of objects in the built environment in virtual reality. The authors systematically defined the aesthetic experience of a person in spaces with curved boundaries. GIANNINI; BOWEN (2022) traced the role of museums in digital culture, especially in the context of the COVID-19 pandemic. They explore the transition from reality to digital space in museum activities. WAHL (2018) studied the impact of the digital revolution on higher education in art and design. The author described the main changes in pedagogy, teaching methods, and student development in the context of digital transformation.

For this study, the work of YANG (2022) is important, which investigates the professional development of contemporary art teachers in China in the 20th and 21st centuries in a multicultural context. The author analysed the impact of cultural and technological changes on teaching and professional development of teachers. These papers have explored important aspects of the interaction between digital transformation and traditional art forms, higher education in art and design, and the professional development of art teachers. Their findings contribute to understanding and adaptation in contemporary art and education.

Elkheshen (2020) describes the impact of the digital revolution on the ideologies of thinking and creativity in graphic arts. The researcher described how digital technologies change approaches to graphic art and influence creative processes. At the same time, LUGHI (2014) studied the interaction between digital media and contemporary art. He explored how digital technologies affect creativity and expression in art. Important aspects include the role of technology in shaping and understanding contemporary art. GRONLUND (2016) examined the interaction between contemporary art and digital culture. The author focuses on various aspects of the use of digital technologies in contemporary art, analyses the impact of digital culture on the creative process and the interaction between art and viewers. SHANKEN (2016) explored the relationship between contemporary art and new media. This author raises the issue of the interaction between digital art and modern technologies

and provides insights into contemporary aspects of digital art. These materials interact with various aspects of the impact of digital transformation on art, culture, and the perception of the environment in virtual reality. They provide an in-depth overview and understanding of the important aspects of studying digital influence in the contemporary world.

CHIBALASHVIL; TYMOFIIENKO (2022) explored the concepts of virtual art, focused on current concepts in digital art, and considered important aspects and trends in virtual art. CONGREVE (2020) analysed public art in British new cities. The author described the past, present, and future development of public art in the context of British new cities. He explores the role of art in the formation and development of communities.

At the same time, TVRDIŠIĆ (2022) examined the impact of digitalisation on traditional art forms. The author examines how digital technologies affect the creation and perception of traditional art, focusing on changes in the production and consumption of art in the era of digital transformation. These works represent a wide range of topics and disciplines, such as art education, virtual art, and the role of public art in urban planning. They contribute to the understanding of different aspects of contemporary art and its interaction with different spheres of life. LEITÃO (2021) devoted his review to the concept of "initial reality" in the architectural virtual. The author described the aesthetics of the virtual in the context of architecture. The main idea is that virtuality can be not only a copy of reality but also an independent study of architectural forms and ideas. CEAUȘU (2023) focused on the relationship between art education and creative art therapy. This author explored how art education can influence creative development and be used for medical purposes. The role of art education in the development and maintenance of psychological well-being is important. These three papers complement each other, providing a wide range of perspectives on the interaction of culture, architecture, and art with digital technologies. Their conclusions can be used for further research and development of modern theories and practices.

3.   **Research design and methods**

The topic of digital transformations and their impact on the formation of contemporary art is relevant for study and further consideration through the prism of highlighting various elements. A number of scientific methods were used to analyse the impact of the digital revolution on creativity in contemporary art. First of all, the content

analysis method was used to collect and process professional literature on the proposed topic. This means a selection of relevant (not older than the early 2000s) papers that have high citation indices and are published in journals included in recognised scientometric databases (i.e., a high selection barrier for publication in such journals). Attention was also drawn to the relevance of the research, i.e., the extent to which the scientific concepts proposed in the publications correspond to the current state of the art. Through the use of synthesis, the individual elements of the research were combined into a common narrative that made it possible to describe existing ideas about the role of digitalisation in the development of contemporary aesthetics and art. The use of synthesis also made it possible to combine the disparate opinions of researchers into a certain commonality, to fully consider the issues of the digital revolution and its impact (positive and negative) on contemporary art.

The formation of a scientific narrative on artistic topics is impossible without the use of analysis as a basic method of obtaining information. This means separating individual elements from the main subject of the study and considering them in comparison and contrast with the contemporary views of scholars. The views of scholars were also analysed, and the use of the comparison method made it possible to trace the structure of their views, to highlight the similarities and differences in approaches to understanding the trends in the development of contemporary art in the age of digitalisation.

4. Results

The advent of the digital age has significantly changed the way we perceive art, making it more accessible. Today, we have the opportunity to view art from around the world, in places we may never travel to. This accessibility makes art education easier, particularly for academic audiences interested in studying less accessible works of art.

As early as the early twentieth century, Walter Benjamin recognised that "the cathedral is leaving its place... a choral work that was once performed in a hall or in the open air can now be heard in any room" (TVRDIŠIĆ, 2022, p. 89-90). This prediction has become even more relevant due to the introduction of recording and replication methods, which have become even more important in the modern world. The digital transformation of analogue art is only the first step in this direction.

Contemporary art emerges directly from digital applications (SONG, 2021; MUTIBWA, 2021). In particular, digital photography and films using visual effects (VFX) or

computer graphics (CGI) are obvious examples. Also worth noting are modern virtual tours of galleries or museums that use augmented reality. Of course, there are virtual tours of galleries or museums that are created virtually to emulate real space. Computer-generated imagery (CGI) games are often not considered art, but the work of a character modeller or environment designer can also be included as a digital art product (TVRDIŠIĆ, 2022). Interestingly, SHANKEN (2016) argues that websites or other online media are not only a repository of various forms of multimedia content, but also works of art in their own right, specially designed with dynamic and changing presentations.

All of the aforementioned works created in the original digital media exist only as binary code. This means that, for example, photographs that were once taken on a 35mm colour negative are now just binary text that can be easily replicated in as many copies as needed, each one identical to the first.

Thus, contemporary art, perhaps in comparison to other art forms, is completely immersed in digital technologies (CROWTHER, 2018; MARAIEVA, 2020). Contemporary researchers argue that it permeates the production of making and circulation. Cultural artefacts of the past are blurred and re-formed, organically fitting into a new orientation. Digital technologies act as a catalyst for creating not only new forms and concepts of art but also for preserving the possibility of using traditional techniques.

In the world of contemporary art, the term "modern" is associated with the use of various technologies. Therefore, the artistic space is wide and diverse, encompassing conceptual art, performance, abstraction, action art, installations, photography, and many other areas (RUSAKOV; BIEDIN (2023). This indicates that contemporary art is not only the use of specific technologies but also a synthesis of different trends.

In the context of the digital era, the role of the digital ecosystem is manifested in establishing communication between contemporary art actors. This includes promoting, popularising, and creating the preconditions for the wide recognition of the author's work (SOFILKANYCH, 2022). Digital platforms, such as virtual galleries or social media, help to create a place where artists can communicate with the audience and support the interaction between the creator and the viewer.

Thus, in the world of contemporary art, digital space is becoming not only a tool for creating and displaying works, but also an integral part of the process of interaction itself, contributing to the discovery of new facets and opportunities in artistic creation.

Digital space in the art system is a huge range of technologies and tools used by artists to create and visualise their unique creations (RUSAKOV; BIEDIN, 2023). One of the key components of the digital system is computer programs aimed at creating graphics, digital resources and platforms, video, and audio. These programs open up new horizons for artists, allowing them to create and perform works that would be simply impossible without digital technologies.

Digital technologies in the arts are not limited to computer programs; they encompass a wide range of other innovations such as 3D printing, virtual reality, augmented reality, artificial intelligence, etc. Table 1 presents the main digital technologies that open up a wide range of possibilities for creativity and expression of artistic vision.

Table 1. The main technologies that influence the development of contemporary digital art

| Technologies	Explanation.
Graphic applications and computer graphics	Digital graphics programs such as Adobe Photoshop, Illustrator, or CorelDRAW allow artists to create digital images, illustrations, and graphic compositions. They provide a wide range of tools for drawing, retouching, and image processing.
Video and audio processing	Video (e.g. Adobe Premiere, Final Cut Pro) and audio (e.g. Audacity, Adobe Audition) editing software allows artists to create and edit video and audio compositions, combining sound, movement, and images into a single work of art.
Virtual reality (VR) and augmented reality (AR)	VR and AR open up new horizons for art, allowing for interactive and immersive experiences for viewers. Artists can create virtual worlds where viewers can interact with the work, being immersed in an alternative reality.
3D modelling	3D modelling technologies such as Blender or Autodesk Maya allow artists to create three-dimensional objects and scenes. With the help of 3D printing, these objects can be transformed into real physical specimens.
Programming and the art of code generation	Some artists use programming to create interactive works of art or algorithmic compositions. The art of code generation uses algorithms and programming to create unique artistic expressions.
Social networks and virtual galleries	The Internet and social media provide artists with the opportunity to showcase their work, find an

audience, and connect with other creators. Virtual galleries and online art platforms are also becoming popular venues for exhibitions and sales.

Source: compiled based on works by (RUSAKOV; BIEDIN, 2023; OLIVEIRA; FILHO, 2022).

It is worth noting that augmented and virtual reality open up new horizons for contemporary art, providing artists and viewers with unique experiences and opportunities for interaction. These technologies not only expand the boundaries of traditional art but also rethink the very process of creation and perception. Augmented reality introduces elements of the virtual world into a real context, creating a unique interactive experience (SPARTIN; DESNOYERS-STEWART, 2022). For example, artists are creating AR filters for social media platforms like Instagram, where viewers can interact with art by applying it to their own photos (SOREANU, 2021). Large galleries use AR to create interactive installations, expanding the possibilities of perceiving art and involving the viewer in the creative process.

At the same time, artificial intelligence is becoming an increasingly prominent factor in influencing the work of contemporary artists, changing the way we understand and perceive art. The impact of AI on creativity has several key aspects, which are presented in Figure 1.

Figure 1. Features of artificial intelligence in contemporary art
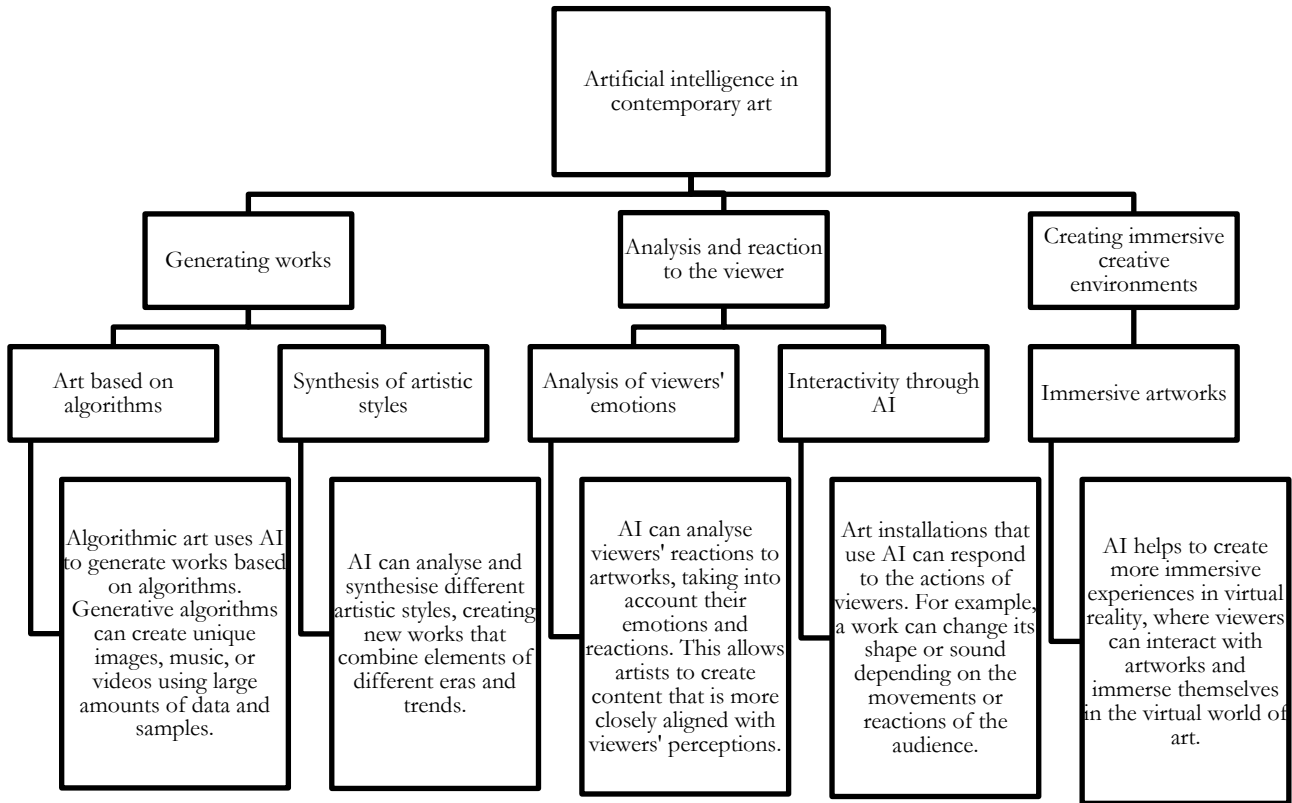

Source: based on RAKHIMOV (2022).

Virtual reality (VR), on the other hand, immerses the viewer in a completely new virtual world. Art exhibitions in VR expand geographical boundaries, enabling people from different parts of the world to attend exhibitions and communicate with each other. VR art creates interactive and immersive works where viewers can interact with the world around them and transform it according to their ideas (DIODATO, 2022). These technologies are opening up new avenues for creativity, allowing artists to experiment with new forms of expression and engage more deeply with viewers. AR and VR are transforming the way we experience art, making it more accessible, immersive, and personal for everyone. As such, these digital technologies empower artists by providing them with the tools to express and communicate in the digital space.

Thus, artificial intelligence and virtual and augmented reality technologies open up new opportunities for creativity, allowing artists to experiment and interact with technology that expands the horizons of traditional art and provides a new level of innovation.

The main function of the artist in digital art is not only to create the work itself but also to define the framework for the interaction space. This approach expands the role of

the user to include them in the active process of creating, interacting with, and influencing the work. The use of real-time interaction and evolutionary image processes integrates viewers directly into an interactive world where each user becomes an important part of the work. In this context, the viewer is not only an observer but also a participant whose behaviour and emotions become an important part of the artistic process (see Figure 2).

Figure 2. The relationship between artist and viewer in the digital art space
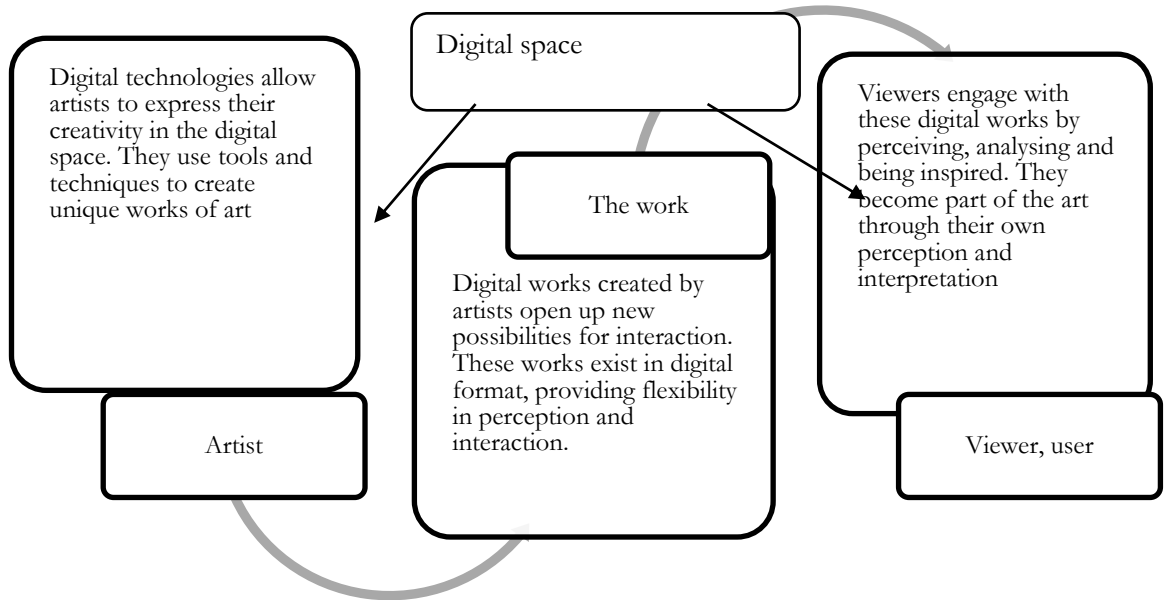
Source: compiled by the authors

It is also noteworthy that digital space in art facilitates not only the creative process itself but also expands the possibilities of interaction between artists and viewers. In particular, it allows for innovative forms of interaction, such as virtual art tours, where viewers can immerse themselves in the art world and join the creative process (RUSAKOV; VOROZHEIKIN, 2022). At the same time, interactivity in digital art is determined not only by the viewer's ability to perceive but also to actively interact with the work. The combination of sensor technologies, virtual reality, and data processing expands the scope of interaction. For example, interactive virtual installations allow viewers not only to observe but also to influence the further development of the scenario, creating an individual experience.

On the other hand, interactive technologies allow artists to interact with the viewer in real-time, creating artworks that can change according to the audience's reaction (JAILLANT, 2019). For example, by responding to the viewer's movements or emotions, interactive works turn the artistic process into an open communication. This contributes to

the emergence of virtual aesthetics, which in digital art opens up unlimited possibilities for artists to express, experiment, and create unique experiences. This concept combines visual, sound, and other sensory aspects, transforming them into a virtual system where the artist can interact with the audience through a new range of experiences.

In addition, in the digital virtual space, artists can experiment with light and colour without restriction, allowing them to create incredible experiences. Textures, brightness, smooth transitions, and geometric shapes can be created using algorithms and special effects. Digital technologies allow artists to create physically impossible images. Distracted perspectives, anti-gravity scenes, and other elements can change the viewer's perception and evoke emotions that are impossible to achieve in the real world.

In the field of sculpture and installation, digital space opens up new horizons for creativity. Artists can now create complex shapes and structures that would not have been possible with traditional materials. The use of digital technologies in these artistic genres allows for bold experiments and the realisation of ideas that previously seemed unattainable (DAI, 2021).

The digital revolution is also having a major impact on video and film art. Artists are now able to create innovative films and video art using a variety of digital technologies such as virtual and augmented reality, animation, and others. These technologies open up new possibilities for creating unforgettable works that differ from traditional film and video, providing viewers with a unique immersive experience

In the music and sound arts, the digital ecosystem is expanding the creative potential of artists. Thanks to digital technologies, they can create complex compositions and effects that would not be possible without the use of digital instruments. This allows artists to immerse listeners in a new sound world where they can explore non-standard sound textures and emotional shades (SKAKUN, 2022). Thus, the digital space opens up endless possibilities for creative expression in various artistic fields, enriching artistic discourse and creating new, exciting works.

It should be noted that virtual aesthetics often includes interactive elements and experiments with the perception of time and space. Shifts in time frames, transformation of spatial realities, abstraction, or hyper-realism - all of this becomes possible thanks to virtual aesthetics. We believe that virtual aesthetics is becoming a catalyst for creative innovation and expanding the boundaries of art in general.

5.   Discussion

This study confirms the idea of the impact of digitalisation on creativity and the perception of artworks in the modern information age. The findings that contemporary art, in comparison to other art forms, is fully immersed in digital technologies are confirmed in the work of TVRDIŠIĆ (2022), which describes in detail the impact of digitalisation on traditional art forms. For this reason, we agree with those authors who believe that modern technological changes cause a rethinking of traditional methods and materials, opening up new opportunities for artists (LUGHI, 2014; CROWTHER, 2018). This leads to the creation of complex and innovative works, expanding the arsenal of artists' expressive means (RUSAKOV; VOROZHEIKIN, 2022). This allows us to understand that technological transformations cause a rethinking of traditional methods and materials, opening up new creative possibilities for artists.

The results also confirmed the idea that artificial intelligence technologies are important in contemporary digital art (RAKHIMOV, 2022). These theses are found in the works of many scholars, including SHANKEN (2016), who notes that intelligent algorithms can be used to experiment with new art forms and techniques. AI can offer alternative ways of expression, helping artists to expand their creative horizons. In addition, AI has been shown to play a role in automating routine tasks, allowing artists to spend more time on creativity. Automating the process of creating the basic elements of a work can free the artist from technical details and simplify the creative process.

Additionally, the paper shows that AI can be used to generate works of art. This has been confirmed in other works. The use of deep learning and content generation algorithms allows the creating unique, autonomous works that impress with their creativity and originality. At the same time, art created with the help of artificial intelligence can function as an independent work or serve as a source of inspiration for human creators. This shows that digital art is developing and solving new problems in the future.

However, it is worth noting that the use of AI in art raises ethical and philosophical questions, in particular, regarding the autonomy of the creative process and interaction with the audience (RAKHIMOV, 2022). These considerations are also popular among contemporary scholars (TVRDIŠIĆ, 2022). However, despite these reflections, the role of artificial intelligence in contemporary digital art is recognised as important, bringing a new level of innovation and experimentation to creativity.

In some contexts, these results contradict the arguments of some researchers. One cannot agree with SOREANU's (2021) claim that all art exhibitions are equally effective in an online format (p. 214-215). This can be refuted, as some art forms may lose their authenticity when they are transferred to a virtual space. It is also possible to disagree with the idea that all artistic projects are ideally suited to the online format (SOREANU, 2021). Some types of art, such as installations or interactions, may lose their essence when attempted to be recreated in an online environment (ZHOU, 2020).

Thus, the scientific novelty of this study lies in the consideration of the digital revolution in art as a complex cultural and technical phenomenon, taking into account not only technological changes but also their impact on the interaction between the creator and the viewer, and in a detailed analysis of certain technologies, including the use of virtual reality, augmented reality, artificial intelligence and other digital tools in the creation and perception of art.

In general, the practical significance of the work is to provide scholars and artists with certain guidelines for the use of digital technologies in the creative process, helping to explore, expand, and enrich creative possibilities. The results of the study can also serve as a basis for further discussions and research in the field of cultural studies, contributing to the development of contemporary culture and art.

6. Conclusion

Thus, the digital revolution plays a crucial role in the transformation of creative space in contemporary art. Technological changes, interactivity, and virtual aesthetics are combining to provide artists and viewers with new opportunities and experiences. Changes in technology have allowed artists to experiment with new materials and forms. This paper identifies that graphics software, 3D tools, artificial intelligence, and virtual and augmented reality technologies provide artists with the opportunity to create works that not only reflect their artistic vision but also actively interact with the viewer and the environment. Thus, the digital revolution is affecting the process of creation and pushing the boundaries of creativity.

Interactivity, in turn, transforms the perception of art, making the viewer an active participant in the creative process. Artists can experiment with new forms of communication and interaction, creating works that respond to the viewer's actions. This creates a new level of connection between the creator and the audience, expanding the possibilities for

expressing and understanding art. Virtual aesthetics introduces new dimensions to the artistic experience, allowing artists to create works that cross the boundaries of the real and virtual worlds. The use of various digital technologies, such as virtual and augmented reality, allows for unique immersive experiences for viewers.

As a result, the digital revolution is transforming the creative landscape in contemporary art, enriching it with new opportunities and perspectives. Technological changes, interactivity, and virtual aesthetics jointly define a new stage in the development of art, where each work becomes a unique experience, and viewers become active co-creators of the creative act.

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