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DIGITAL TECHNOLOGIES IN MODERN VISUAL ART

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The purpose of the article is to analyse the modern visual digitally created artworks, to find out the particularity of their application and to identify the relations between traditional and innovative methods in modern painting; to consider the method of applying paint and the functional component of 3D printing in the process of paintings "production". The research methodology is a complex of several methods: analytical – to examine the historical literature and literature on the art studies, theoretical and conceptual method – to characterise the terminological system of the research, and also comparative and typological – to compare traditional technologies of painting with innovative and digital ones. The scientific novelty of the research is to identify the features of the introduction of digital technologies in visual art. Conclusions. It was revealed that with the help of technology of "artificial intelligence", it becomes possible to recreate the lost fragments of images. It was demonstrated that due to the technology of three-dimensional printing, it is possible not only to make copies, but also to create unique artistic compositions. It was shown that thanks to the algorithmic analysis and mathematical modelling, it is possible to establish a certain ratio of sign systems of musical and pictorial works and, based on the identified results of algorithmic calculation, to establish a certain ratio of expressive means of art in digital (mathematical) equivalent. Thus, due to "artificial intelligence", it is possible to synthesize different types of art in one work and use the methods of various branches of knowledge. Having analysed the facts of introduction of digital technologies, algorithmic analysis of paintings and 3D printing technology, we can state the fact that algorithmic art is only at the first stage of its development and has great prospects for the future.

Keywords: digital technologies; painting; technique; algorithmic art; generative neural network

Introduction

Technological features of artwork creation have always been a relevant topic for the scientific research, taking into account the introduction of technical innovations in all spheres of human life, which is confirmed by a significant number of related publications.

Foreign scientific research by A. Ruesseler (2006), P. Daum (Daum et al., 2006), R. Askott (2004), F. Stedman, as well as domestic research by V. Zatserkovnyi and N. Karevina (2014), Ya. Prudenko (2014), Yu. Miliutina (2011) study the issue of innovation in art. As L. Molchanova (2010) rightly points out: "the emergence of innovations in the visual art is connected with the cultural changes in society, with the development of industrial civilization, which, unlike traditional civilizations, focuses on continuous scientific and technical progress, accelerates and directly affects the artist" (p. 37). The author of this article agrees with this view and at the same time emphasizes that these interactions can be applied to all types of art.

Methods of painting techniques, the use of various colours, mixtures and laws of colour are studied in the works of the artist Zh. Viber (1961), graphic artist L. Feinberg and art critic Yu. Grenberg (1989). The historical aspect of painting is considered in the scientific research of E. Berger (1961).

In recent years, significant historical, cultural and theoretical works have been published, where much attention is paid to the introduction of digital technologies in various fields of art, including painting. In particular, D. Shavlygin and A. Obmorokova (2015) and V. Shcheglov (2017) explore the relationship between digital technologies and art. V. Shcheglov points out to a number of repeated sequences in the context of artistic content, which the author calls algorithms, and thus the painting – an algorithmic system. The significance of the introduction of digital technologies in the socio-cultural sphere is contemplated in the works of M. Lovejoy (2004), F. Popper (2007) and D. Galkin (2013). However, among the significant number of scientific studies that address the issues of painting, there is a lack of work devoted to the study of the introduction of modern digital technologies in the art of painting.

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The scientific novelty of the research is that this article analyses the principles of creating of a modern visual artwork with the help of digital technologies and also explores the uniqueness of such works for the first time.

Purpose of the article

The purpose of the article is to analyse modern visual digitally created artworks, to find out the particularity of their application and to identify the relations between traditional and innovative methods in modern painting; to consider the method of applying paint and the functional component of 3D printing in the process of paintings "production".

Main research material

Painting technologies have been changed with time, trends, and the development of the technical component of fine art. It is known that the first cave paintings were carved with stones and show images of the animal world typical for that time (buffaloes, mammoths, rhinos, lions, etc.). The oldest image is about 40,000 years old. At that time, the tools for creating the first drawings were stones and natural, organic pigments. An example is the cave paintings in the Rock Shelters of Bhimbetka, India (about 9,000 years old), created with red ochre, red and black pigments (Pic. 1).

Picture 1. Cave art. The Bhimbetka rock shelters, India, the Stone Age

As you know, the technology is a method of using tools (stones, pigment, brush, paint). In the historical cross-section of art, there is a certain ratio of its technical and technological component: the more complex is the technique (tools), the easier is the technology of its application for a person. And vice versa: using of a simple tool requires more complex work. Example: it took primitive man a long time to carve an image on a cave wall. However, now a person with a set of modern tools spends less time to create the same drawing.

As the historical development of paintings shows, with the advent of new materials and tools (brushes, paints, gouaches or tempera) the image application technology has been changing. Therefore, now there are many painting techniques -tempera, gouache, pastel, ink, fresco, grattage, grisaille, glue paints, watercolours, acrylics, wax painting, which names are often identical to expendable materials. Today, in the process of painting, apart from tools and raw materials, computer equipment is used, which radically changes the technology of making works of visual art.

Artificial intelligence is a technology that can be used to perform a number of manipulations in a certain sequence programmed by a person. It is well known that copies of works by famous artists are created using

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artificial intelligence. The famous event was the New York auction, 2018, where a copy of Rembrandt's "Edmond de Belamy, from La Famille de Belamy" was sold for $ 432,500 (Cohn, 2018).

"New Rembrandt" (original name "The Next Rembrandt") - a portrait-painting that reproduces the creative style of Rembrandt with exceptional accuracy, but is not a copy of the image of the famous paintings of the master (Pic. 2). The work became possible due to the use of "artificial intelligence" technologies. Experts from Microsoft, Delft University of Technology, the Mauritshuis Royal Picture Gallery and the Rembrandt House Museum in Amsterdam, using Microsoft Azure computing resources and a number of specialized algorithms, conducted a three-dimensional scan of 346 paintings of the artist and found out not only genre and stylistic specifics, but also the artist's typical techniques and techniques for working with oil paints. A painting, which was created as a result of an 18-month-long study of the artist's works with the help of 3D printing, showed that artificial intelligence technologies could produce a unique art product that imitated the work of a famous artist, but have its own content.

Picture 2. "The Next Rembrandt", 2016.
Creators: ING Bank, J. Walter Thompson Amsterdam, Microsoft, TU Delft, Mauritshuis, Museum Het Rembrandthis

The example of the "New Rembrandt" shows that the mathematical analysis of the artists' creation makes it possible to detect certain algorithms of the artist's (author's) work, analyse the main components of an artistic work, and transform the sign system of art into a system of different organization – a numerical one. So, the colour, shape, and location of the objects depicted on the canvas (a composition) are all converted into numerical formulas and combinations. The graphic image is transformed into a digital, algorithmic one. A certain system of numbers is built, which makes it possible to use the obtained numerical combinations to group works (of the same artist, epoch, art direction) into single systems-collections, analyse and identify similar algorithmic chains and create new art products based on these algorithms.

The definition of "products of art" (not works of art) is used intentionally due to the fact that a work as a result of the creativity can only be created by a person. And "artificial intelligence" technologies can produce objects that can only claim a right to be considered artistic.

Now, with the help of "artificial intelligence" technology, you can recreate lost images and even damaged fragments of famous paintings.

The painting of the famous Spanish artist Pablo Picasso "The Old Guitarist" was created on the canvas of another, previously painted picture "Sitting Woman" (Pic. 3). This fact became known thanks to the radiography during the restoration of the painting. However, it was not possible to see the distinct image, it was too difficult to reproduce it for everyone to see. Using a neural network of artificial intelligence, which due to the algorithmic analysis can distinguish the style of one artist from another (as with the work of P. Picasso - to differentiate one period from another), researchers from the University College of London have created an exact copy of the hidden picture of Picasso. The neural network is based on the technique of "neural style transfer" by Leon Gatys (from the University of Tübingen, Germany, 2015), according to which the machine scanning

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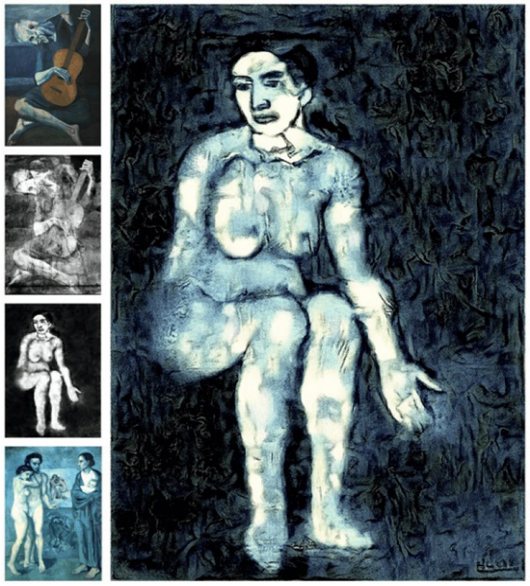
technique can determine the style of a picture and use it in the creation of a completely different image. During the study, researchers Anthony Bourached and George Cann analysed the style of another masterpiece of Picasso's Blue Period "La Vie" (1903) and using a 3D printer reproduced an image of a woman taking into account the stylistic features of the artist.

If modern art products are created using algorithmic analysis, then the production process can also be considered as an algorithmic art.



Picture 3. "Sitting Woman" by Pablo Picasso

Algorithmic analysis is possible in various fields of art – graphics, painting, architecture, music, and so on.

Researchers have been studying the synthesis of different types of art for a long time – painting and drawing, music and choreography, sculpture and architecture, theatre and cinema. Artists inspired by music draw the pictures, and vice versa, under the influence of visual art, musical, architectural and screen works are created. These forms of interaction between different types of art have been known for a long time. However, today, it is possible to perform a comparative analysis of several artistic works based on algorithmic calculation and establish a certain ratio of the expressive means of art in the digital (mathematical) equivalent.

Significant within the framework of the research is the work "Kandinsky" of Microsoft company created due to the algorithmic analysis of Kandinsky's paintings, the musical work of Richard Wagner (the opera "Lohengrin", 1916), the atonal compositions by Arnold Schoenberg, as well as works of modern music.

Due to the generative neural network, the algorithmic construction of the works of the artist, music compositions by R. Wagner, A. Schoenberg have been analysed, the ratio of the image and sound has been revealed. For example, each colour shade corresponds to a certain sound, and the combination of dots and strokes corresponds to a certain leitmotif.

Changing the melodic pattern, the image is changing accordingly. Random combinations added to the sound sequence start making changes to the visual content. There is an internal creative improvisation in the creation of an image. Works of modern musical directions are also subjected to comparative algorithmic analysis and accompanied by pictorial visualization in accordance with the algorithms for creating a painting by the artist V. Kandinsky. Thus, artificial intelligence shows us how an artist would paint a picture today if he listened to modern music, instead of being inspired by the work of famous expressionists.

"Generative adversarial networks are constructed in the following way – two networks contest with each other – one, based on its stock of samples, creates new images, and the second evaluates them. This method is used to solve a variety of issues, but it is the example of art that appeared to be the most obvious. The picture allows us not only to understand better how modern methods of artificial intelligence work, but also to get closer to understanding of the creative process itself," said Vladislav Shershulsky Director for Prospective Technologies, Microsoft Russia.

The example of this project shows how due to algorithmic analysis and modelling, a certain ratio of sign systems of musical and pictorial works is determined. A person cannot predict how the images will change and, in the end, what the final result of the work will be.

So, we can state the fact that artificial intelligence technology creates art products that are unique in their kind. The production of digitally created art products is an algorithmic art. Painting created by "artificial intelligence" becomes algorithmic painting.

At the same time, we do not deny the uniqueness of human activity and artistic creativity. Moreover, we insist on the need to develop a symbiosis between man and digital technologies in art: to combine the capabilities of "artificial intelligence", aesthetic sensitivity and creative activity of a man.

Conclusions

It was revealed that with the help of digital technology, which is now called "artificial intelligence", it becomes possible to recreate the lost fragments of images of paintings. On the example of the painting by

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P. Picasso “Sitting Woman” it is shown that now only with the help of “artificial intelligence” it is possible to reproduce hidden fragments of the image.

It was demonstrated that due to the technology of three-dimensional printing, it is possible not only to make copies, but also to create unique artistic compositions.

It was shown that thanks to algorithmic analysis and mathematical modelling, it is possible to establish a certain ratio of sign systems of musical and pictorial works and, based on the identified results of algorithmic calculation, to establish a certain ratio of expressive means of art in digital (mathematical) equivalent. Thus, due to “artificial intelligence”, it is possible to synthesize different types of art in one work and use the methods of various branches of knowledge.

Having analysed the facts of introduction of digital technologies, algorithmic analysis of paintings and 3D printing technology, we can state the fact that algorithmic art is only at the first stage of its development and has great prospects for the future.

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ЦИФРОВІ ТЕХНОЛОГІЇ В СУЧАСНОМУ ВІЗУАЛЬНОМУ МИСТЕЦТВІ

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Мета дослідження – на основі аналізу творів сучасного візуального мистецтва, створених з використанням цифрових технологій, з'ясувати специфіку їх застосування та виявити співвідношення традиційного й інноваційного методів в сучасному живописі; вияснити спосіб нанесення фарби та функціональний складник 3D-друку у процесі «виробництва» живописних полотен. Методологічна база дослідження становить комплекс кількох методів: аналітичного – для розгляду історичної та мистецтвознавчої літератури, теоретично-концептуального методу – для характеристики понятійно-термінологічної системи дослідження, а також порівняльно-типологічного – для порівняння традиційних технологій живопису з інноваційними цифровими. Наукова новизна дослідження полягає у висвітленні специфіки запровадження цифрових технологій у візуальне мистецтво. Висновки. Виявлено, що за допомогою технології «штучного інтелекту» можна відтворити втрачені фрагменти зображень. Встановлено, що завдяки технології тривимірного друку можливе не лише виготовлення копій, а й створення авторських художніх композиції. Виявлено, що на основі алгоритмічного аналізу та математичного моделювання можна встановити співвідношення знакових систем музичних і живописних творів та на основі виявлених результатів алгоритмічного обчислення встановити певне співвідношення виразних засобів мистецтв в цифровому (математичному) еквіваленті. Отже, завдяки «штучному інтелекту» можливе синтезування різних видів мистецтва в одному творі та використання методів різних галузей знань. Проаналізувавши факти впровадження цифрових технологій, алгоритмічного аналізу живописних полотен і технології 3D-друку, можна констатувати той факт, що алгоритмічне мистецтво знаходиться лише на першій стадії свого розвитку та має значні перспективи в майбутньому.

Ключові слова: цифрова технологія; живопис; техніка; алгоритмічне мистецтво; генеративна нейромережа

ЦИФРОВЫЕ ТЕХНОЛОГИИ В СОВРЕМЕННОМ ВИЗУАЛЬНОМ ИСКУССТВЕ

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Цель исследования – на основе анализа произведений современного визуального искусства с использованием цифровых технологий выяснить специфику их использования и выявить соотношение традиционного и инновационного методов в современной живописи; рассмотреть способ нанесения краски и функциональную составляющую 3D-печати в процессе «производства» живописных полотен. Методологическая база исследования представляет собой комплекс нескольких методов: аналитического – для рассмотрения исторической и искусствоведческой литературы, теоретико-концептуального метода – для характеристики понятийно-терминологической системы исследования, а также сравнительно-типологического – для сравнения традиционных технологий живописи с инновацийними цифровыми. Научная новизна исследования заключается в освещенни специфики внедрения цифровых технологий в визуальное исскуство. Выводы. Выявлено, что с помощью технологии «искусственного интеллекта» можно восстановить утерянные фрагменты изображения. Выяснено, что за счет технологии трехмерной печати возможно не только изготавливать копии, а и создавать авторские художественные композиции. Выявлено, что за счет алгоритмического анализа и математического моделирования можно установить соотношение знаковых систем музыкальных и живописных произведений и на основе полученных результатов алгоритмического вычисления выяснено определенное соотношение средств выразительности искусств в цифровом (математическом) эквиваленте. Таким образом, за счет «искусственного интеллекта» возможно синтезирование разных видов искусства в одном произведении и использование методов разных областей знаний. Проанализировав факты внедрения цифровых

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технологий, алгоритмического анализа живописных полотен и технологии 3D-печати, можно констатировать тот факт, что алгоритмическое искусство находится лишь на первой стадии своего развития и имеет значительные перспективы в будущем.

Ключевые слова: цифровая технология; живопись; техника; алгоритмическое искусство; генеративная нейросеть