

ANTONENKO ARTEM

National University of Life and Environmental Sciences of Ukraine

<https://orcid.org/0000-0001-9397-1209>e-mail: artem.v.antonenko@gmail.com**MISHKUR YURIY**

State University of Information and Communication Technologies

<https://orcid.org/0009-0004-6807-6914>e-mail: yuriy.mishkur@gmail.com**TVERDOKHLIB ARSENIY**

State University of Information and Communication Technologies

<https://orcid.org/0000-0002-6591-2866>e-mail: poltavapride@gmail.com**VOSTRIKOV SERGIY**

State University of Information and Communication Technologies

<https://orcid.org/0009-0008-8425-8872>e-mail: sergey.a.vostrikov@gmail.com**BALVAK ANDRIY**

State University of Information and Communication Technologies

<https://orcid.org/0000-0002-6441-8225>e-mail: balvakandrii@gmail.com

NEURAL NETWORKS IN ART AS A GRAPHIC DESIGN TOOL

The article examines the possibilities of various neural networks as tools for the implementation of projects in graphic design, evaluates their ability to ensure quality and efficiency in the creation of visual content for various types of products. The advantages and disadvantages of each neural network are also analyzed. The work presents the opinions of scientists and practitioners about the variety of neural networks that can be used to perform graphic design tasks. In addition, the results of own practical experience of working with neural networks are given. The study confirmed the effectiveness of neural networks in creating concepts of characters and locations for computer games, illustrations for printed and electronic publications, as well as in the development of trademarks and logos, corporate style and graphic design of packaging. However, their functionality does not yet provide the necessary quality level for such products as posters created on the basis of figurative language tropes; fonts; engineering graphics in axonometric projections showing the internal structure of devices or equipment; layout for print publications, websites and mobile applications, as well as infographics based on stylized images and design solutions for packaging. Maze Guru, Midjourney, and Leonardo AI are best for graphic design content. The ChatGPT neural network is an effective tool for matching peers and gathering feedback from scientists. The advantage of using neural networks is a significant acceleration of the process of creating visual content, as well as the possibility of combining different programs to supplement and improve the results obtained. Disadvantages include mainly English-language communication between the user and the network, as well as discrepancies between the images that exist in the user's mind and those generated by the network. Creations created by neural networks are easily recognizable, and for similar text queries, they can give very similar results.

Keywords: neural network, illustrative content, design products, electronic software tool, software

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Національний університет біоресурсів і природокористування України

МІШКУР ЮРІЙ, ТВЕРДОХЛІБ АРСЕНІЙ, ВОСТРІКОВ СЕРГІЙ, БАЛВАК АНДРІЙ

Державний університет інформаційно-комунікаційних технологій

НЕЙРОМЕРЕЖІ В МИСТЕЦТВІ ЯК ІСТРУМЕНТ ГРАФІЧНОГО ДИЗАЙНУ

У статті досліджено можливості різноманітних нейронних мереж як інструментів для реалізації проектів у графічному дизайні, оцінено їх здатність забезпечувати якість та ефективність у створенні візуального контенту для різних видів продукції. Також проаналізовано переваги та недоліки кожної нейронної мережі. У роботі представлені думки вчених і практиків про різноманітність нейронних мереж, які можна використовувати для виконання завдань графічного дизайну. Крім того, наведено результати власного практичного досвіду роботи з нейронними мережами. Дослідження підтвердило ефективність нейронних мереж у створенні концепцій персонажів і локацій для комп'ютерних ігор, ілюстрацій до друкованих та електронних видань, а також у розробці торгових марок і логотипів, фірмового стилю та графічного дизайну упаковки. Проте їхня функціональність ще не забезпечує необхідного рівня якості для таких продуктів, як плакати, створені на основі образних мовних тропів; шрифти; інженерна графіка в аксонометричних проєкціях, що показує внутрішню будову приладів або обладнання; верстка для друкованих видань, сайтів і мобільних додатків, а також інфографіка на основі стилізованих зображень і дизайнерських рішень для упаковки. Maze Guru, Midjourney і Leonardo AI найкраще підходять для вмісту графічного дизайну. Нейронна мережа ChatGPT є ефективним інструментом для пошуку аналогів і збору відгуків від науковців. Перевагою використання нейронних мереж є значне прискорення процесу створення візуального контенту, а також можливість комбінування різних програм для доповнення та покращення отриманих результатів. До недоліків можна віднести переважно англomовне спілкування між користувачем і мережею, а також розбіжності між образами, які існують у свідомості користувача, і тими, які генерує мережа. Творіння, створені нейронними мережами, легко розпізнати, і для схожих текстових запитів вони можуть давати дуже схожі результати.

Ключові слова: нейронна мережа, ілюстративний контент, дизайнерські продукти, електронний програмний засіб, програмне забезпечення

Formulation of the problem

Today, the influence and expressiveness of visual content, even created with a pragmatically oriented goal in the field of graphic design, largely depends on its uniqueness and originality. The rapidity of aesthetic tastes and preferences, in particular regarding works of art, encourage artists and designers to increasingly involve in their own work the technical capabilities of computer programs, the variation and combinatory combination of which provides structurally complex and to some extent unique visual compositions. To fulfill these tasks, electronic software tools are being developed, of which we consider neural computer networks to be the most innovative and effective.

Programs focused on a narrowly defined sector of tasks are already beginning to stand out from existing neural networks. Some of them provide high-quality generation of illustrative content based on raster graphics, others demonstrate a high degree of perfection in the generation of identification signs and logos. From here, the task arises — to structure the entire range of graphic design products and to find out the components that can be qualitatively embodied with the help of neural networks, and which neural networks from the existing arsenal of software tools are able to ensure the quality and effectiveness of visual content generation in each type of product.

Taking into account the existing variety of programs operating on the principle of artificial intelligence in various fields of economic activity, we consider it necessary to determine the set of them that is most suitable for creating visual informational content of graphic design, and to establish the conditions under which visual content generated by networks can be considered qualitative.

Analysis of recent sources

A problematic issue in the study of neural networks is the superiority of mathematical models and descriptions of physical properties and algorithms of the work of neural networks over art studies. Therefore, in this publication, we rely mainly on the results of the author's own experiment and feedback from other designers, practitioners or contactors who had the opportunity to practically familiarize themselves with the work of neural networks. In order to establish the quality level of works of art and design generated with the help of neural networks, methods of theoretic analysis of publications and comparison of skill levels of designers and neural networks were applied to the research.

To analyze the possibilities of neural networks, the generalized statements of Ya. Goodfellow (Goodfellow I.), studies of the principles of neural networks, carried out by T. Kinariwala (Kinariwala, 2019), scientific intelligence J. WITH. Tesoro et al. (Tesoro et al., 2020). The technological aspects of optimizing the work of neural networks are highlighted in the publications of the following researchers: N. Yurkovich, O. Gerasimov, V. Yurkovich and M. Maryan (2014); technical aspects of the use of neural networks in the creation of website design are thoroughly covered by N. Lazarchuk, O. By foot, V. Rybii and M. Tsyutsurayu (2020); Tze Tao (Tao, 2022) focuses attention on mathematical models for the construction of package scans and their addition with communicative elements.

The historical context of the development of neural networks, their evolution and problems of authorship are described in the publications of R. Vieira and F. Luisa Schiavoni (Vieira & Schiavoni, 2022). Issues of the effectiveness of the implementation of neural networks in graphic design products are fragmentarily revealed in the publications of Sh. Wu (Wu, 2020), researchers from Latvia A. Irbite and A. Strode (Irbite & Strode, 2021). Most of the feedback on the results of the interaction of contactors with neural networks for the creation of graphic design products can be found mainly from practitioners, among whom we should single out the publications of S. Kazaryana (2023), O. Musienko (2022), E. Karaata (Karaata, 2018), B. Mustafa (Mustafa, 2023). In this publication, we intend to reveal the level of skill of neural networks in relation to the entire exhaustive list of graphic design products. For this purpose, we are interested in a fairly wide range of neural networks, which includes such programs as: Midjourney, DALL-E, Logaster, Designmantic, Turbologo, Logomaker, Logojoy, Font Finder, Deepfloyd, AI WebScore, The Grid, Artbreeder, Stable diffusion, Leonardo ai, Maze Guru, Gigapixel AI-Topaz Labs, NeRF, Font Finder, AI WebScore, The Grid, ChatGPT.

The purpose of the article is to analyze neural networks as a tool for creating applied digital graphics. Highlight the relevance of such electronic software tools as neural networks to the needs of creating each of the components of graphic design products. As a result of the research, a set of neural networks that best meet the requirements of working with content in the field of graphic design should be determined, as well as the advantages and disadvantages of each of the available networks and their ability to perform authorship functions in creating 2D and 3D graphics.

Presenting main material

The requirements to minimize the time for creating graphic design products encourage designers to more actively turn to modern and innovative technologies that expand the boundaries of project activity, and to use advanced forms of project tools, which currently include neural networks — programs capable of analytically examining analog projects, determining their specific features and generate innovative visual content based on them. Such networks consist of a large number of interconnected neurons that work in a similar way to human brain activity.

In the publication of specialists from the Uzhhorod National University N. Yurkovich and others. (2014) neural networks are positioned as a new generation of tools, representing an electronic analogue of the structure of the human brain, capable of learning from experience and improving in the process of work.

The principle of operation of neural networks was depicted by Ya. Goodfellow in 2014. A generalized statement of this principle can be found in the work of T. Kinariwala (2019), where the concept of generative adversarial networks (GANs) consisting of a discriminator and a generator is presented. The generator looks at large amounts of training data and tries to create an image that looks so similar to the weekend that the discriminator cannot

tell that it was created by the network itself. The goal is to achieve such a level of system optimization that the generated result cannot be distinguished from real counterparts.

J. WITH. Tesoro et al. (Tesoro et al., 2020) proposed a saliency-based semantic image classification algorithm that uses a low-rank decomposition matrix algorithm to intelligently divide the main image semantic regions. We note that the given principle of operation is not characteristic of one neural network, but of a set of them, the priority of which for working with various graphic design products has yet to be established.

However, all the mentioned scientists primarily consider applied technologies and mathematical descriptions of the processes of analysis and generation of images and their visual quality. Instead, the issues of innovativeness of such images and their ability to figuratively encode contents remain outside the attention of scientists and are covered mainly by practitioners — contactors. To establish the ability of neural networks to ensure the quality of visual communications, we consider it necessary to first of all determine the entire list of products developed by graphic design specialists. According to the scheme, one of the important parts of graphic design is identification signs and visual navigation systems. That is why researchers of neural networks pay the most attention to this product of graphic design. In order to reproduce and build innovative signs, the contact person with the network should first of all set the task of analyzing analog objects that serve as material for imitation by neural networks.

According to the results of contact experience expressed by E. Karaata (Karaata, 2018) and B. Mustafa (2023), the most advanced program for creating identification marks and logos is Logojoy. However, the authors of this publication also include Logaster, Designmantic, Turbologo, and Logomaker among the specialized program generators of logos based on neural networks. Universal tools for creating signs and logos in particular are Deepfloyd and Midjourney. Each of these programs is able not only to generate identification marks, but also to instantly visualize examples of the variability of branding of advertising and graphic products based on the generated marks.

The effectiveness of the work of neural networks with navigation signs and icons was proven by researchers from Latvia A. Irbite and A. Strode (Irbite & Strode, 2021). However, the authors consider the high degree of similarity of identification marks with existing prototypes to be a disadvantage of this type of product. The results of the author's experiment proved that the most valuable results of the work of neural networks should be considered the components of the image style, created on the basis of groups of geometric primitives and devoid of such graphic constants as the manufacturer's sign and logo. The authors of this study consider the ability of networks to form complex and at the same time recognizable patterns and stylistically similar compositional structures for the presentation of image style to be the most useful function of neural networks. The above statement is supported by the conclusions of R. Vieira and F. Luis Schiavoni (Vieira & Schiavoni, 2022) that neural networks were created primarily to produce results that are difficult to reproduce with "classical" art techniques and even with existing applied digital technologies, because such results may not exist in the minds of designers.

However, the pictorial sign forms generated by the network are mostly signs of the conventional rather than iconic type. This means that their implementation in the information environment will require significant financial support and numerous implementations on media to be established in the minds of consumers. It's also worth noting that all web-generated sign images are bitmap, even if they mimic flat design (vector graphics). This means that in the future, the generated image will need to be reproduced in vector graphics editors to ensure print quality when scaling on media. The next design object in graphic design is fonts, typefaces and calligraphic compositions. In the study of the possibility of generating such objects by networks, the task was to process the letters of both the Latin and Cyrillic alphabets. From the publication of B. Mustafa (Mustafa, 2023, p. 246) we get information about the Font Finder program, which is able to generate accidental fonts in Latin based on images of the surrounding world.

As a result of own experiments obtained during contact with various networks, it was concluded that of the currently available neural networks, except for Font Finder, only Deepfloyd is able to generate images with readable letters. However, the fonts in such compositions are not author's, but borrowed from those available on the Internet. Instead, the Midjourney network, which is most adapted to the needs of graphic design, still generates not fully readable text, although its letters differ from the forms common on the Internet. Midjourney may break off letters or distort them, making them difficult to read. So, until now, only Font Finder provides a synthesis of structural unity and imagery when working with letters (but only the Latin alphabet). However, we assume that this shortcoming is only a matter of time, since neural networks are developing very rapidly, and their developers, based on critical feedback from consumers, are constantly improving the software and enabling the growth of the level of tasks, which includes the development of fonts.

More positive, as compared to the creation of fonts, are the results of creating calligraphic compositions with the Font Finder program. Based on the testimony of B. Mustafa (2023, p. 246), neural networks fairly correctly imitate the plastic properties of letters specified by the contactor and selected in analog projects. The presence of an insignificant level of graphic imperfection is associatively compared with "manual" technologies for performing calligraphic compositions. When considering typography and pictorial compositions based on letter-text elements made by neural networks, we should take into account the opinion of B. Mustafa (Mustafa, 2023), as well as the results of his own experience working with the Midjourney and Deepfloyd programs, which make it possible to create portraits or images of objects in the surrounding world from letters, or their individual microelements. These networks demonstrate an appropriate level of graphic culture in creating typographic compositions based on letters of 1-3 fonts, in which words and lines are of different scales. A significant number of options generated by the programs allows you to quickly get and choose the desired option.

The next type of graphic content is engineering and technical graphics. Certain limitations and differentiation

of tasks are observed in its creation. If the Midjourney program is tasked with creating an illusory three-dimensional linear image of a complete object (household appliance or technical equipment) based on its photograph, the program will successfully complete it. If it is necessary to generate an axonometric image with the removal of part of the outer shell and the image of the internal components and mechanisms inside the device, then this task may contain a significant amount of errors or distorted data. An alternative option is the step-by-step creation of engineering graphics with gradual uploading to the neural network of photos of devices or equipment that illustrate all their structural components and details. Among the numerous programs involved in this task, the neural networks Midjourney, Stable diffusion, Leonardo ai, and Maze Guru have shown good results.

The results of the generation of posters by neural networks are also quite controversial from the point of view of visual influence, which is due to the creative nature of this type of graphic design products. Considering that the basis of poster language is visual tropes (metaphors, allegories, metonymy, etc.), the ability of neural networks to represent information figuratively is seen as naive and inappropriate. Exceptions can be only those situations in which a visual image was formed in the imagination of a contact with the network and translated into clear guidelines for its visualization. In favor of the given statement, the conclusions of A. Irbite and A. Strode (Irbite & Strode, 2021), as well as the results of practical experiments of the authors of this publication with various networks.

However, if it comes to creating collages and advertising banners based on realistic graphics or images corresponding to one of the existing artistic styles or stylistic currents, then neural networks fully ensure the quality of their generation. According to the testimony of S. Kazaryan (2023), their work is able to replace the professional activity of models and photographers, to offer a surprisingly wide list of realistic and animated images that until now were the result of the creative imagination of designers, animators or artists. Concepts of murals, graphics in interiors and illustrations for multi-page calendars also acquire a high level of quality. These conclusions were made on the basis of the publication of Sh. Wu (Wu, 2020), as well as according to the results of his own experiments. The variable spectrum of images generated by the Midjourney, Stable diffusion, Leonardo ai, and Maze Guru neural networks with the retention of common stylistic features meets the needs of conceptual information presentation and can be successfully implemented in the above graphic design products.

However, testifying to the effectiveness of generating visual content, we must state the inability of networks to simultaneously ensure the systematicity and variability of the synthesis of the original layout (for example, twelve-page calendars or printed editions) and their illustrative content. At the same time, in the illustration of printed editions with the help of innovative technologies, you can see the worlds of Stanislaw Lem, Jules Verne, Ray Bradbury and other luminaries of literature simply by entering texts from their works, or add illustrations previously made by famous artists.

A problematic issue of the implementation of network-generated images for illustrating printed publications is their partial inconsistency with the proportions and the place allocated in the publication for the location of the illustration. The subsequent cropping of the image can remove significant communicative elements or cause a feeling of incompleteness of the work.

It is noteworthy that the high level of image quality for banners, posters, murals, and calendar concepts is provided by a fairly wide range of programs, but Midjourney, DALL-E, and Stable diffusion prevail among them.

To evaluate the results of the work of neural networks for the creation of the design of sites and mobile applications, we will refer to the publication of N. Lazarchuk et al. (2020), in which the outlined question is considered meticulously and comprehensively. The authors of the publication convincingly prove that in the near future, modern neural networks will improve so much in creating websites that they will be able to create an interface and vary the structural elements of websites with minimal effort. The authors of the study refer to the WebScore AI tool, developed by the uKit Group team, which is able to analyze and evaluate the attractiveness of websites, and generate innovative offers based on the received data. In B. Mustafa, we find a reference to another specialized program for creating sites, namely The Grid (Mustafa, 2023, p. 246). However, N. Lazarchuk and others. (2020), and B. Mustafa (Mustafa, 2023) come to the unanimous conclusion that so far the design of sites constructed by the network needs to be refined by programmers. However, the authors express their belief that the software toolkit of neural networks, applied comprehensively, will make it possible to obtain and critically evaluate a wide range of variable implementations of site design as soon as possible, which will lead to changes in the interaction between the customer and the web developer. However, taking into account the parallel development of programming technologies, the authors mentioned above do not see the possibility of completely replacing programming specialists with neural networks. Instead, the networks themselves are seen as a powerful and most advanced toolkit in the programming and design of sites and mobile applications.

Another product of graphic design, which until now required a significant amount of time and effort of designers, is packaging design, which encompasses a constructive and communicative solution. Currently, research by scientists on the possibilities of using neural networks for this type of product is few. However, among them, we consider it necessary to highlight the scientific research of Tze Tao (Tao, 2022), which highlights the processes of optimizing the design of the location of graphic communicative elements on packaging products. Despite the fact that the author's main attention is focused on the technical means and mathematical models of building standard packaging layouts in order to fill them with communicative elements, it provides an opportunity to make sure that neural networks already provide quality and make it possible to obtain a large number of options of different proportional and compositional arrangement with incredible speed graphics on existing packaging designs (Tao, 2022).

These conclusions are confirmed both in the publication of O. Musienko (2022) and by the results of the

authors' own experiment. We should also note that with the help of the ChatGPT neural network, it is possible to collect the necessary information about the preferences of different groups of consumers and organize it many times faster. On the basis of the received data, with the help of Midjourney, Stable diffusion, Leonardo ai or Maze Guru, it is possible to obtain options for communication solutions with incredible speed and to update the means of presentation of brands that are already on the market and have the favor of consumers. However, when trying to diversify not only communicative elements, but also the constructive solution of packaging products, the capabilities of neural networks turn out to be significantly limited. Images of innovative design solutions obtained from textual descriptions do not meet the requirements of manufacturability and economy of production, at least for packaging made of cardboard and elastic polymer materials. And currently, we have not found targeted research aimed at eliminating this problem.

Focusing attention on such visual design products as concept art (design of characters and locations for computer games), we should note so far a small number of publications outlining the powerful and growing possibilities of creating such a product with the help of neural networks. Among the researchers, we should mention S. Kazarian (2023) and O. Musienko (2022). The most productive networks tested for creating characters and locations include Artbreeder and NVIDIA Style GAN. Less productive, but also functionally suitable, are programs Midjourney, Stable diffusion, Leonardo ai.

It is noteworthy that the characters produced by the Artbreeder and NVIDIA Style GAN networks are able to change not only the details of the figure, clothes and accessories and the environment, but also the style of the graphic embodiment — from photorealistic visions to the stylistic features of Japanese cartoons. At the same time, the quality of the images and processing of structural elements is extremely high, and the resulting characters can be presented in any perspective: as full-face, profile, and three-quarter images.

The next form, highlighted in the composition of graphic design products, is infographics, which in turn operates with such components as the visualization of data arrays based on diagrams, graphs and cartography, which are supplemented and acquire individual features thanks to visual content. It is worth noting that this content is embodied with the help of a wide range of visual means: from photorealistic images to highly stylized ones (both illusory two-dimensional and three-dimensional). Visualization of data based on operation of exclusively digital components and presentation of graphs and diagrams are tasks that are already successfully implemented by neural networks and can be presented in both static and dynamic dimensions. ChatGPT may collect information and analytics to create infographics. Already mentioned above Midjourney, Stable diffusion, Leonardo ai, Maze Guru can generate visual content with defined stylistic features. The formation of information content based on the addition of photorealistic images with digital and textual data is also a quite possible task, the quality of which is ensured by the network with minimal efforts of the contact person. The AI-Topaz Labs Gigapixel network can be useful in the design of infographics, which increases the quality of finished images in JPG, TIF format. This neural network does not just increase the resolution of the image, but "finishes" it. That is, if we put a blurred spot image into the program, we can get a detailed and clear display of it as a result.

However, in the design of infographics, there is still no program that can provide all stages of the creative process: from the selection of information to its structured presentation through the interaction of visual, textual and numerical content, as well as implemented in the dimensions of graphs or diagrams. It has been established that the generation of a variable spectrum of stylized graphic images, necessary for pictorial coding of meaningful content, is the most problematic so far. The problems are: insufficient number of analog projects; the difference in proportional scale ratios of parts of realistic and stylized images and the arrangement of an accurate description of those differences that each of the images should possess in the overall composition of the infographic.

At the end of this study, we will turn to the most innovative product of graphic design, namely motion design - animated videos that have a significant number of characters and the variability of the locations in which these characters act. It is worth noting that during the creation of such videos, as well as in infographics, the stylistic properties of the original images acquire significant importance. Note that the technical capabilities of neural networks are improving so quickly that they change almost every week. So, in the process of writing the material of this publication, an updated version of the NeRF program, capable of creating photorealistic videos from just a few photo images, saw the light of day. The program analyzes the structure of the space organization in the provided photos and generates images of this space from different views, the logical sequence of which forms a continuous video and replaces a personal viewing of the premises. In our opinion, with the help of such technology, commercial tours of museums and architectural monuments of the world can be created. In addition, with the help of the Stable diffusion program, which operates by scaling photorealistic components, you can also create a continuous video, based on the illusion of penetration from macro to micro worlds.

However, animations created by neural networks have significant drawbacks, namely: animation frames have discrepancies in information content, as a result of which the logic and sequence of content perception is lost, which is enhanced by color coding, which mainly contains "acid colors". That is, there is no stabilization in the frame, the impression is that each frame is drawn from scratch. Sometimes colors create harmony, but mostly on the contrary - disharmony. This applies specifically to animations created in the Stable Diffusion program. Despite the revealed "ease" of operating with photo images and obtaining videos based on them, neural networks for creating animated videos with stylized characters and locations have not yet acquired the necessary degree of perfection, especially those in which both components (characters and locations) are variable and require or gradual phased transformations, or successive personnel changes. For this type of production, specialized programs are still relevant and still

indispensable, which include: Cinema4D, Blender, Autodesk Maya, Adobe After Effects, and the skill of designers who encode necessary and predictable content into stylistically minimalist graphics.

From the presented material, we get a structured presentation of the components of graphic design products and their comparison with neural networks that are able to ensure the quality and effectiveness of visual content generation in each type of product. Neural networks are able to provide a high level of generation of such graphic design products as navigation and identification signs, including trademarks and logos, character and location concepts for computer games, illustrations for print and electronic publications, corporate identity carriers and graphic solutions for packaging. The capabilities of neural networks can be extremely useful when exploring and reproducing the stylistic properties of illustrations, posters and collages, color correction or updating old photos, particularly with "blurry" images. Neural networks have an extremely powerful arsenal of generating patterns of interaction of communicative elements in complex metrorhythmic groupings, which can be useful in the design of image style.

At the same time, their functionality is still limited and does not prove the presence of an appropriate level in such products as: posters based on figurative language tropes; accidental fonts; engineering graphics in axonometric projections with visualization of the internal structure of devices or equipment; original layout of printed publications, websites and mobile applications, infographics based on stylized images, constructive solutions for packaging products, animation based on stylized images with changing plot events and locations.

Conclusions

Neural networks are a rapidly improving graphic design tool. However, a significant number of graphic design products require specialized software tools. Among the large number of modern neural networks for working with graphic design content, the most suitable and to some extent universal programs are Midjourney, Stable diffusion, Leonardo ai. The advantage of using neural networks is a significant acceleration of the process of generating visual content and the ability to combine different programs and supplement and improve the results of each of them. The advantages of neural networks also include the possibility of creating visual content based on a text request, that is, the contact person does not need to learn to draw, master human anatomy and create 3D models or study 3D sculpting, which requires the greatest expenditure of energy, time and resources. Neural networks make it possible to jump the steps of professional growth. On the one hand, this is an advantage, and on the other hand, it can be a significant disadvantage. As a result of saving time and energy, professional development becomes secondary for the artist — this factor leads to a decrease in competitiveness and limits the scope of creativity in neural networks.

The disadvantage is mainly monolingual communication of the contactor with the network. In most neural networks, the request for creating pictures can be written only in English. Another disadvantage of the results of the creativity of neural networks is that there is no actual creative process, guided by the imagination of the artist and the images that may exist in the mind of the contactor with the network. That is, after entering the request, the artist (contactor) receives the final result, which is not subject to further adjustment. This narrows the vision of the artist (contactor) and deprives him of the primary artifacts of the creative process. For example, when creating illustrations or concept art, the designer can save the intermediate results of the work and adjust its finished version. When working with three-dimensional graphic editors, when creating a 3D scene, it is always possible to save a large number of primary file options — artifacts in the form of 3D models and textures for them. If necessary, you can return, change the properties of objects (sizes, textures, lighting, etc.) and achieve the optimal result. In the creativity of neural networks, these artifacts are absent. This factor devalues the work, because it is impossible to prove the authorship of the work without the presence of original artifacts, draft versions and staged adjustments. Although neural networks create spectacular and beautiful works, they have their own visual signature and are easily identifiable. Robots created by neural networks based on approximate text queries provide even too similar results. If it would be possible to teach the neural network not only different directions of art, but also to create art on request in different languages, this would add to the eclecticism and originality of creativity. In this case, for example, the works of Japanese artists will be significantly different from the works of Ukrainian artists.

So, analyzing the further development of neural networks, we can note that: the development of artificial intelligence (AI) technologies will extend to the creation of not only raster, but also vector images, in particular three-dimensional graphics, which will make it possible to create 3D scenes and animations, save intermediate work results and adjust them. This can cause a lot of artists to lose their work because the neural network is very fast and efficient. There may also be competition among digital artists and neural networks. To win in this struggle of art, artists need to endow their works with special meanings and coded content, saturate them with associative images, so that the overall picture is similar to examples of fine art. Prospects of scientific research. To further determine the effectiveness of the work of neural networks, it is necessary to establish the level of their creativity and suitability to independently establish and implement project concepts corresponding to the needs of graphic design.

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