

Interactive installations and innovative design solutions using artificial intelligence

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Abstract

Artificial intelligence (AI) technologies have increasingly penetrated the field of modern design, particularly in the creation of interactive installations. This study aimed to analyze the impact of AI-generated interactive installations on user experience and aesthetic perception. The research employed a comparative approach, content analysis, and case study methodology. A total of 50 scholarly sources were collected and analyzed using the PRISMA protocol to ensure systematic selection and review. The findings demonstrated that key AI tools used in interactive installations include generative adversarial networks (GANs), variational autoencoders (VAEs), computer vision systems, natural language processing (NLP), behavioral analytics, and adaptive machine learning algorithms. These tools, while powerful, require high levels of digital competence, precise configuration, and substantial financial investment. Case analyses of installations such as Living Light, The AI Van Gogh Museum, AI-Driven Storefront, and AI Classcape revealed the following benefits: enhanced interactivity, user personalization, innovative use of AI capabilities in aesthetic experiences, and the emergence of AI as a co-author in artistic creation. AI-driven interactive installations offer significant potential in design and digital art. However, their effectiveness is currently limited by the lack of intuitive human-like creativity, reliance on pre-programmed datasets, and the cost of implementation. The results highlight both the transformative potential and the current limitations of AI as a creative agent in modern design environments.

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1. Introduction

The current development of artificial intelligence (AI) systems is significantly transforming approaches to digital art and interactive design, increasing the possibilities for personal artistic expression or creating

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communication with the user audience. The use of interactive installations generated using AI has become a very tangible means of aesthetic influence. In addition, they have become important mechanisms for forming new communicative formats that will continue to set the tone for the interaction between humans and interactive environments [1]. Due to the active use of machine learning algorithms, computer vision technologies, or automatic generative design, installations can adapt to viewers' real-time behavior, creating both personal and dynamic visual or sound effects. Currently, interactive installations using AI are quite effectively applied in museum exhibitions, urban space objects (architecture and street art), advertising campaigns, and digital art [2]. For example, digital algorithms of various neural networks allow for generative video installations shaped by the viewers' movements and their angle of view (Refik Anadol used such technologies). Various light or audiovisual projections were formed in the structures of public space. They are also programmed to respond to people's behavior and emotions so that digital projections change color, shape, or dynamics because of the presence of viewers and their interaction with them. These and similar technologies significantly improve the aesthetic experience of art objects while opening new opportunities for further research into the user experience of interacting with digital objects and environments. Despite the growing popularity of various interactive installations based on the use of AI, several important issues remain unresolved in scientific literature. There are currently no unified approaches to analyzing the impact of such digital interactive installations on user experience or aesthetic perception. Similarly, the technical and conceptual challenges faced by professional designers and artists when working on interactive solutions involving artificial intelligence have been analyzed in a fragmented manner. The proposed research should fill in such specific scientific gaps and offer a comprehensive analysis of the possibility of using key technologies and certain principles for user interaction and digital installations. Particular attention will also be paid to the analysis of the challenges that the creative industry faces because of the interaction between technology and people.

The purpose of the proposed article is to study the impact of interactive installations created with the help of artificial intelligence on user experience and aesthetic perception in contemporary design. This goal involves the implementation of specific research questions:

1. What artificial intelligence technologies are often used to create interactive installations?
2. How do interactive AI installations change how users interact with digital art?
3. What are the challenges and limitations of developing interactive installations using AI?

The answers will allow us to better understand the role of AI in developing interactive design and digital art and to trace potential opportunities for further use in the creative industry.

2. Literature review

The use of interactive installations created through interaction with AI systems has been the subject of active scientific discussion in recent years. The COVID-19 pandemic and related quarantine restrictions have made it possible to reassess the potential of digital technologies, including in art and design. The emergence of extensive AI systems in the public domain has paved the way for understanding the use of neural networks for artistic events. Particular attention is paid to the study of their impact on user experience, the process of artistic creation, and aesthetic perception. The scientific literature presents different points of view on the possibilities of AI in such contexts. Researchers have paid particular attention to the problems of adapting machine learning technologies [3], [4], the history of computer design and summarizing the existing scientific literature [5], [6], and an overview of virtual reality and its applications, including in museums [7], [8]. The definitions and theoretical considerations established by researchers are strong enough to develop the following generalizations on the proposed issue. Scientists paid attention to some key aspects of interactive installations. They actively studied the issue of neural networks for generative video installations [9], [10]. Rane [11] demonstrated how AI algorithms (ChatGPT) can be applied in architectural engineering. Spennemann [12] noted that AI systems are essential tools for the future preservation of cultural heritage, making them necessary for further development and improvement.

Ismail and Huang [13] demonstrated that AI systems could interactively respond to viewer movements, creating unique visuals that redefine visualization needs. Separately, researchers have focused on various elements of using light and audiovisual projections or design elements in public spaces [14], [15]. Accordingly, the number of studies that have been growing significantly in recent years indicates the popularity of the topic of AI's interaction with human emotions or behavior.

Equally relevant are studies in which researchers argue about using various technical aspects of interactive installations. Some researchers point out that an extremely sensitive issue is ensuring stability and reliability in the evolution of AI systems [16], [17]. There is also a particular debate about how to define the problems of AI interaction with many users in real time [18]. Some researchers addressed the technical aspect of this problem, offering solutions based on much more complex pattern recognition algorithms and technologies to optimize resource-intensive processes [19]. Other scholars have emphasized that with the current development of AI systems, they are best at individualizing each user's approach [20]. Moreover, the current discussion points to further research into the best ways to use AI for art installations and design solutions. It is also worth emphasizing that there are still several gaps in scientific literature in the study of the impact of interactive installations on aesthetic perception. Scholars have ignored the issue of unified methodological approaches to analyzing aesthetic aspects and have only partially pointed out the existing difficulties of users' emotional reactions to AI installations. Most studies focus on technical aspects and consider the issues of cultural and social contexts to a much lesser extent.

In addition to the technical, pedagogical, and artistic aspects of organizing installations and design creativity using AI, researchers have drawn attention to the ethical component of using digital systems. Belk [21] pointed to existing scientific discussions in the field of the ethical development of robotics and AI, which can be used not only for creative purposes but also for criminal or military purposes. Prokopenko and Sapinski [22] identified some difficulties in using AI in pedagogy, including in art education: difficulties in determining how algorithms work, vast opportunities for compilation or plagiarism, and the need for a high level of digital competence.

Scholars have also been actively researching the problem of AI's further impact on society from the perspective of the humanities [23], [24]. As a result, current research aims to identify the ethical implications of using interactive installations using AI. It is recognized that, in general, these systems are expanding our knowledge of their potential in art and design [25], [26]. At the same time, there is a further need for research. It is essential to comprehensively determine the effects of installations on user experience and aesthetic perception, including through the lens of the ethical use of AI as a tool for creating original work, but not as a mechanism for borrowing or compiling from existing designs without citing the sources.

3. Research method

3.1. Research design

This study employs a qualitative analysis of cases involving interactive installations and innovative design solutions that incorporate artificial intelligence. The qualitative approach is selected as it provides the most effective means of evaluating distinct examples of interactive installations utilizing AI technologies. Furthermore, the analysis of specific cases facilitates a deeper investigation into the influence of AI-driven interactive installations on user experience and aesthetic perception within the context of contemporary design environments.

3.2. Materials

The primary research materials are a variety of scientific literature, which concerns the analysis of project documentation, the study of the features of the use of AI in design, and the research of user experience in design technologies. For this purpose, various scientific materials of both viewing (theoretical) and empirical content are involved. This made it possible to comprehensively approach the chosen problems of the study. Four cases

were selected for the study, which highlight the variety of approaches to the integration of AI into the artistic-educational and commercial space:

1. Living Light (Seoul) is an example of an environmental initiative in an urban environment.
2. The AI Van Gogh (Amsterdam) is an art project that combines emotional modelling and the development of creativity.
3. AI-Driven Storefront (Nike + Google) is a commercial interactive installation demonstrating business innovations.
4. AI ClassCape (Helsinki) is an educational initiative that defines the influence of AI on the development of creativity skills.

These cases are chosen because they allow you to analyze the use of AI in the design of the environment. In addition, cases were selected for analysis because of their variety of AI in the key areas:

1. Living Light has influenced the integration of AI into the urban space to enhance ecological consciousness.
2. AI Van Gogh made it possible to trace the use of AI in art for emotional modelling.
3. AI-Driven Storefront made it possible to cover the features of using AI in commerce to personalize brand interaction.
4. AI ClassCape influenced the analysis of the introduction of AI in education for the development of basic skills.

3.3. Instruments and procedures

Prisma's methodological approach was used to collect, analyse, and interpret scientific materials. This method is recognized as effective for collecting various types of scientific sources. It has been proven that this approach makes it possible to quickly determine and identify important scientific materials for the chosen issue. In addition, this method allows you to effectively reject inappropriate scientific sources and duplicates; therefore, it is actively used by modern scientists [27]. The following scientific databases were first selected: Google Scholar, Scopus, Web of Science, and OpenAlex.

The following keywords were introduced into the searches:

1. Interactive installations
2. AI OR Artificial Intelligence
3. Van Gogh OR AI ClassCape
4. AI-Driven Storefront
5. Living Light
6. Innovative Technologies OR Innovation
7. Design
8. Designer Solutions
9. Generative networks
10. Creative technologies
11. Digital installations

A total of 1589 positions were received (Figure 1). All duplicate works were rejected without a properly substantiated scientific novelty (-391). After that, 1198 results were obtained. The following were excluded from those publications that did not meet the criteria. This is based on analyzing keywords, annotations, and titles (-401).

Further, 89 more results were rejected, which did not contain topical abuse. After that, the exception criteria were used in the positions:

1. The study does not describe the main interstratification installations using AI
2. If the work doesn't outline mechanisms of working with AI technologies

3. Writing language: English; sources written in other languages are subject to exclusion
4. Creation time: from 2019 to 2025; sources were written earlier
5. Materials whose primary purpose is commercial advertising of a particular product, not scientific analysis

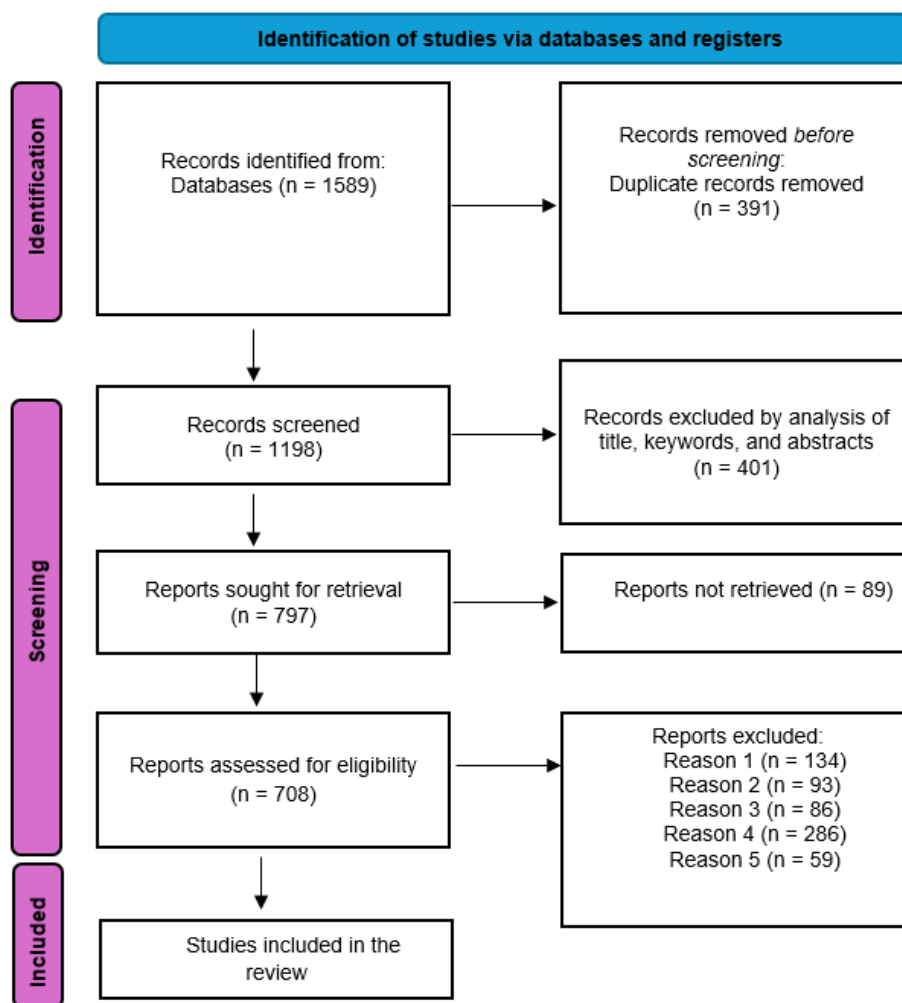


Figure 1. Identification of the studies; Source: author's development

3.4. Data analysis

The content analysis of scientific sources was used for the data analysis. This project was gradual and systemic, envisaged coding of information, categorizing results, and comparing data. In particular, the coding process is carried out based on familiarization with the texts of scientific sources and the isolation of fragments containing relevant references to:

1. Application of AI in the design of interactive installations
2. Innovative approaches
3. Methods and basic mechanisms for the interaction of AI with users
4. The effects of exposure

Each highlighted fragment received a code, that is, a short mark that indicated its content (“environmental interaction”, “emotional modeling”, “personalization of experience”, “development of skills”, “development of creativity”). After coding, all codes were combined into categories in meaningful closeness. This process was called categorization; in particular, the following categories were formed:

1. Ecological consciousness and emotional interaction through art (Living Light - The AI Van Gogh)
2. Personalization and development of skills (AI-Driven Storefront-AI ClassCape)

After that, a comparative analysis of the data obtained was carried out, and common approaches and differences in the design of the AI in design were identified.

4. Results and discussion

Specific AI capabilities are used to create installations in interactive art and design. First, new technological solutions are used to change the process of creativity (creation of art objects), but also for high-quality interaction with viewers. AI systems provide automation or analysis but can co-create, adapt, and personalize experiences. The capabilities of AI can be summarized in Table 1.

Table 1. Using AI technologies to create interactive installations

№	Technology	Description
1	Generative networks (Gan, VAE)	Learning interaction allows these systems to generate individual images, sounds, text, and multimedia objects. GANs create visual materials for art installations in real time, depending on users' actions or feedback.
2	Computer Vision	Many modern installations use systems to recognize faces, emotions, body movements, or objects in space. This allows you to see the viewer and consider their physical presence, transforming visual effects, animations, or sound effects accordingly. Often, this technology is linked to depth cameras or other sensitive sensors.
3	NLP	NLP allows you to respond to voice commands (or text queries from users for simpler versions). Accordingly, viewers can communicate with installations, receive the necessary answers, or even provoke the installation to perform certain actions, depending on the requests and capabilities of the system. Such technologies are also present in voice chatbots, smart guides, etc.
4	Behavioral analysis	AI systems can recognize users' emotional states by analyzing facial expressions, intonation, or gestures. Therefore, there are opportunities to adjust the installation according to the audience's mood. The system allows you to transform sound effects, music inserts, colors, etc. These technologies are popular in experimental art.
5	Adaptive models of machine learning	Some AI systems can learn on their own because of interaction. They can adjust themselves to interact with the audience in real-time. Therefore, the dynamics of installations depend on previous actions, as AI “remembers” behavioral patterns and can use them for the next visitors.

Source: compiled by the authors based on [28], [29], [30]

Thus, creating modern interactive installations is a qualitative combination of art, technology, and data analysis. AI allows designers to further intuitive dialogue with viewers, consider their emotional environment, etc. Thanks to these effects, installations far exceed their previous static capabilities and turn into modern cultural media objects. Analyzing individual cases allowed us to identify practical directions and the implementation of modern design installations and interactions with AI (see Table 2).

Table 2. Case studies of installations and innovative design solutions

Project name	Context and purpose	A brief description of the installation	The role of AI	Results and influence	Short conclusions
Living Light	An urban program that provided for the renewal of public space in Seoul (South Korea). The purpose of the project is to investigate how much SI-technologies can integrate into the design of installations to increase the ecological consciousness of citizens.	A translucent dome with LED panels that the city authorities and indifferent citizens have installed in the city park. The installation changed the color and light intensity, depending on the level of air pollution in the city.	Digital systems have processed large amounts of information in real-time mode by applying the elements of machine learning. This made it possible to predict and automatically customize visual effects, UX-staging	Increasing the number of residents involved in the environment: more than 30 thousand individual interactions in the first month of work. Increasing environmental competence: Growth in Google Search Query on Air quality by over 45%.	The Living Light project indicated that AI systems can turn space into an ecosystem of communication with city dwellers.
The AI Van Gogh	The Van Gogh Museum in Amsterdam, together with NVIDIA specialists, created the installation of The AI Van Gogh. Its purpose is to combine the capabilities of AI, emotional modeling, and artistic decisions.	The project consisted of a large interactive hall with 360 ° screens. They reacted to the movements, voices, and moods of visitors. AI chose paintings, color, palette, and musical accompaniment in the appropriate style.	The systems have complexly analyzed emotions and use generative models (GAN) and adaptive design methods.	The survey noted exceptional interactivity: more than 80% of respondents noted that their experience was emotionally significant. Innovations: The project received the award at the ARS Electronica festival. Availability: The project is also available online.	The AI Van Gogh has shown how AI can create new forms and interact emotionally.
AI-Driven Storefront	Nike, along with Google specialists, used the AI-Driven Storefront. The purpose of the project is to measure the increase in the level of interaction with the brand because of interactive interaction and personal communication with the AI.	The project consisted of creating a large digital LED window with motion sensors and tracking cameras that analyzed the age, gender, and style of passers-by. The AI-generated video advertising with appropriate shoes or clothing samples.	AI systems have computer vision, machine learning, digital analytics, and dynamic content.	Involvement of new clients: Time to interact with LED-shock increased by 65%. Sales: The purchase of new products has increased by 32%. Treatment: The concept was also followed by other firms.	AI-Driven Storefront has made it possible to determine how much modern design, digital technology, and AI analysis can form new formats for communications.

Project name	Context and purpose	A brief description of the installation	The role of AI	Results and influence	Short conclusions
AI ClassCape	Initiative of the University of Applied Sciences in Helsinki. The purpose of the project is to form a flexible environment that stimulates education, creative skills, and cooperation skills.	The project was to create a simple audience, which was equipped with pro -e -walls, digital panels, lighting, noise, and temperature sensors. Digital systems regulate the visual and sound formats of interaction.	AI systems had to process emotional data. The capabilities of the neurotransmitters were aimed at the adaptive environment.	Increasing concentration in the educational process: 74% of students noted that their focus on learning has improved significantly. Increasing creativity: the projects received a higher average rate by 22%. Involvement: Teachers noted that the level of activity increased by 30%.	AI ClassCape has determined how innovative educational design, together with the AI systems, can transform the training space, making it more effective.

Source: author's development

The comparative analysis of the cases allowed us to identify the main conclusions pointing to the importance of working with AI systems when organizing installations, graphic design, educational, or marketing projects related to visualization or artistic ideas. All cases have demonstrated their positive impact on the perception of a product (advertisement, message, etc.), which indicates the importance of using AI, at least for user engagement and interest. Some of the findings can be summarized in Table 3.

Table 3. General conclusions about project implementation; Source: author's development

Conclusion	Description
Emphasis on interactivity, combined with the capabilities of the AI	Using new formats and designs has created new opportunities for communication between spaces/brands/environments, ordinary digital technology users, and even ordinary passers-by.
Personalization	The focus on achieving a specific goal through interaction with a specific consumer has become a key trend, which is noticeable in examples of the effectiveness of using attention (Nike advertising), understanding specific experiences (Artmorph), improving the educational process through art (AI ClassCape), and accentuation of the importance of eco-consciousness.
Using AI Opportunities in Design	The successful implementation of analyzed cases indicates that AI systems function in different contexts, which makes them independent of the field of use. The ability of AI is equally relevant for art, education, marketing, and urban areas.
Custom experience	The application of AI aims to realize the central goal - the gradual formation of custom experiences. This process is relevant for creativity, emotionality, cognitive, or social aspects.
The leading role of AI	AI systems have become real co-authors who have demonstrated themselves while working in art and educational environments. AI, from a simple tool, has become a separate creative participant in the artistic, creative, or creative process.

Therefore, using AI systems has many advantages when preparing and organizing design installations and working with the public, educational environments, and potential consumers of products. At the same time, the proposed systems have a particular set of disadvantages that should be considered when using AI in the future when organizing installations, working with graphic design, etc.

Table 4. Challenges in using AI when working with installations, art projects, or design

№	Challenge	Description
1	Lack of intuition	Despite the perfect style of execution, the work of AI can be devoid of depth and aesthetic nuances. The use of templates can narrow the impression of organized installation.
2	Data dependence and algorithms	AI systems generate content based on data that has been either provided by developers or generated by machine learning. Accordingly, there are risks of unethical use of other people's work, visualization of prejudice, etc.
3	Crisis of creativity	The capture of the use of creative opportunities of AI can lead to a crisis of creativity in the environment of artists, designers, architects, and more. Since AI models will develop in the future, there is also a need to consider this development and its impact on training and training of specialists.

Source: compiled by the authors of the article based on [31], [32], [33], [34]

Therefore, while AI systems are powerful tools for designing and art, it is essential to consider the negative aspects of their use. It is important not to delegate creative initiative to AI but to use it as a tool or partner in realizing ideas. AI mechanisms are integral to modern life, affecting all its sectors and manifestations. This is a consequence of digitalization, which has developed significantly and offers some opportunities to facilitate routine tasks. The article aims to analyze the impact of interactive installations created with the help of AI on user experience and aesthetic perception in modern design. The realization of this main task required consideration of the following issues: what artificial intelligence technologies are most often used in the creation of interactive installations; which interactive installations with AI change the interaction of users with digital art; and what difficulties arise because of the development of interactive installations using AI?

The proposed results show that specific AI capabilities are used to create interactive art and design installations. First, generative networks (GAN, VAE), computer vision, speech recognition systems (NLP), behavioral analysis, and adaptive machine learning models are used in this area. All these tools require an appropriate level of digital competencies, careful setup, and expensive equipment. At the same time, the findings confirm the conclusions of other researchers who have compiled similar lists of AI capabilities for preparing installations or working with design solutions [35], [36]. The researchers arrange them in different sequences, which are objectively determined by both their subjective vision and the circumstances of the research. Some scholars, however, emphasize the importance of semantic analysis, which can be applied in marketing or educational environments [37].

Such digital tools are used to interpret texts or user queries. For example, a user may be interested in a particular aspect of installation, and AI will offer such personalized content. Such a tool looks quite promising but has not yet received broad support from scholars [38]. However, no serious reservations have been expressed either. The results of the research include specific cases of AI application in installations: Living Light in Seoul (South Korea), The AI Van Gogh Museum in Amsterdam, AI-Driven Storefront (a joint project of Nike and Google), and AI ClassCape (an initiative of the University of Applied Sciences in Helsinki, Finland). The comparative analysis revealed standard positive features realized with digital systems. First, the following features were

identified: emphasis on interactivity combined with AI capabilities, opportunities for personalization, use of AI capabilities in design, emphasis on user experience, and the leading role of AI as an actual co-author of installations. These results confirm the findings of other researchers who agree that AI offers a wide range of possibilities already being applied in practice [39], [40].

Experts also point to the multifunctionality of AI systems that have proven equally effective in art, education, marketing, or urbanism [41], [42], [43]. In such circumstances, AI is a promising tool for creating dynamic, flexible environments that can change according to the situation in the future. At the same time, problematic aspects of using AI in preparing an installation or implementing design solutions have also been identified. First, there are such difficulties as the lack of natural intuition in AI, dependence on programmed data, and the fact that preferring AI systems to ordinary creativity can make artists, installers, and creators dependent on developing digital technologies. With various amendments, such results are confirmed in the works of other researchers who recognize the difficulties in using AI [44], [45].

At the same time, certain problems are also discussed in scientific circles, which are related to the fact that even the most advanced modern digital models can generate unpredictable results, especially when interacting with many users [46], [47]. There is also a likely factor of errors, technical failures (also potential hacker attacks). Although due to the relative novelty of AI in installations and the design process, such negative manifestations are more likely to be exceptions [48] than general rules, such possibilities should be considered. Another problematic aspect is the financial component of using AI systems in installations [49], [50]. This will require a team of technical specialists and access to the necessary powerful equipment, servers, and cloud computing. This will create obstacles to the use of AI technologies, especially for independent artists who do not have adequate financial support.

The methodology used in the study has certain limitations that should be considered in the following interpretations of the scientific results. First, the application of the PRISMA scientific method has some limitations. On the one hand, referring to the most up-to-date scientific literature is justified since AI technologies have been integrated into artistic life relatively recently. However, some relevant opinions (in particular, on digitalization, design, and art projects) appeared earlier and were not included in the proposed review. This aspect will need to be considered in the future, particularly by writing separate studies on such topics.

5. Conclusions

AI mechanisms are integral to modern life, affecting all its sectors and manifestations. Specific AI capabilities are used to create installations in interactive art and design. First, generative networks (GAN, VAE), computer vision, speech recognition systems (NLP), behavioral analysis, and adaptive machine learning models are used in this area. All these tools require a proper level of digital competencies, careful setup, and expensive equipment.

Based on specific cases (Living Light in Seoul (South Korea), The AI Van Gogh Van Gogh Museum in Amsterdam, AI-Driven Storefront (a joint project of Nike and Google), AI ClassCape (an initiative of the University of Applied Sciences in Helsinki, Finland), the advantages of using AI in installations are identified: an emphasis on interactivity combined with AI capabilities, opportunities for personalization, the use of AI capabilities in design, emphasizing user experience, and the leading role of AI as an actual co-author of installations.

At the same time, problematic aspects of using AI in the preparation of an installation or the implementation of design solutions were also identified. First, there are difficulties, such as the lack of natural intuition in AI, dependence on programmed data, and the fact that the preference for AI systems over conventional creativity can make artists, installers, and creators dependent on developing digital technologies. Another problematic aspect is the financial component of using AI systems in installations. This will require a team of technical

specialists and access to the necessary powerful equipment, servers, and cloud computing. This will create obstacles to the use of AI technologies, especially for independent artists who do not have adequate financial support.

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The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

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