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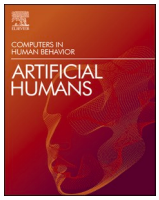

Artificial intelligence in fine arts: A systematic review of empirical research

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ABSTRACT

Artificial intelligence (AI) tools are quickly transforming the traditional fields of fine arts and raise questions of AI challenging human creativity. AI tools can be used in creative processes and analysis of fine art, such as painting, music, and literature. They also have potential in enhancing artistic events, installations, and performances. In this systematic review, we investigated empirical studies on the use of AI in fine arts We gathered the data from three major bibliographic databases. After an initial search, we screened 723 articles based on pre-established inclusion criteria, resulting in 44 studies. Over half concerned visual arts, such as paintings and drawings, and one quarter concerned music. Experimental studies focused on human responses to AI art showed that people generally do not recognize the difference between human-made and AI-made art, but human-made art was valued more than AI-made art in some studies. The power of AI lies in the analysis of large-scale datasets. Case studies have reported development of an AI painter, DJ, performance artist, and music accompaniment for improvisations. AI tools have been applied to enhance consumer experience in online art shops and to provide virtual reality (VR) access to historical cathedrals. Fast development of AI will likely pose a challenge for the current concept and understanding of fine arts. AI challenging human creativity is one of the most powerful signs of the cultural and societal transformation stemming from AI.

1. Introduction

Artificial intelligence (AI) technologies are increasingly sophisticated, and we are currently in the middle of transformative societal and cultural change (Dwivedi et al., 2021; Rust & Huang, 2021). Recent developments in AI involve creativity and fine arts, encompassing the visual arts, architecture, music, theater, film, dance, and literature. Deep-learning-based tools, such as Dall-E 2 and Midjourney, are very easy to use, and they have sparked discussion about copyrights, authorship, and transparency (Ghosh & Fossas, 2022; Peres et al., 2023; Roose, 2022; Wasielewski, 2023). In September 2022, The New York Times reported that Jason M. Allen, a board game developer, won a digital-art prize with the help of Midjourney. Artists accused Allen of cheating although he had not broken any rules and had even informed others of his use of Midjourney (Roose, 2022). A similar case from spring 2023 involved photographer Boris Eldagsen, who won the Sony World Photography award with an AI-created image. His intentions were purely provocative: to test whether people would even notice that the work was done by AI and to see if the competition's organizers were prepared for AI images entering the contest. Eldagsen refused to take the award after revealing his experiment (Glynn, 2023).

There is currently an increasing need to understand AI's role in the field of fine arts. The fast development of deep-learning tools, such as Midjourney and Dall-E, raises questions about creativity and AI's role in fine arts. AI has considerable potential in general as a tool. It could be used in multiple ways to enhance the production of artistic events, for example, which could be highly beneficial for art exhibitions and museums. Roles given to AI would not necessarily challenge human creativity.

This systematic review is an investigation of the usage of AI in fine arts, especially in the fields of social sciences, arts, and humanities. We use fine arts to refer to forms of art that are most typically noted in aesthetics and art history (Graham, 2005; Honour & Fleming, 2005; Wolff, 1983). These include visual arts, architecture, music, theater,

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film, dance, and literature. Our study was motivated by the rapid development of AI tools and the need for a systematic review of evidence of how people perceive the use of AI; how these tools are employed; and how they could enhance the analysis, production, distribution, and consumption of art. AI also has the potential to challenge our conceptions of art, especially the notion of authorship appreciated in Western aesthetics. AI's role in the current field of fine arts should therefore be understood from the wider cultural perspective, which involves our very idea of creativity in general.

1.1. AI transforms society and culture

The current development of AI is transformative, and it is considered one of the main pillars of the Fourth Industrial Revolution (Hecklau et al., 2016). AI technologies can learn by analyzing vast amounts of data and is already making its mark in various aspects of life, particularly in developed countries. Its widespread usage and ongoing advancements have become nearly unavoidable, with AI being integrated into most everyday devices, systems, and technologies we rely on (Dwivedi et al., 2021; Kennedy et al., 2023).

AI's potential has been discussed widely since the 1950s with the development of modern computers. Creative aspects of computers and AI have been dealt with in the field of computation creativity – a subfield of AI research – over the past few decades. An important milestone in the field's development was Margaret Boden's (1977) *Artificial Intelligence and Natural Man*, which included a chapter on creativity. Much the development of the field has occurred in the 2000s (Boden, 2010; Colton & Wiggins, 2012; Jordanous, 2012, 2016; Toivonen & Gross, 2015). Computational creativity is considered the frontier for AI research, and some authors have also opposed idea of AI being creative: "Perhaps creativity is, for some proponents of AI, the place that one cannot go, as intelligence is for AI's opponents. After all, creativity is one of the things that make us human; we value it greatly, and we guard it jealously" (Colton & Wiggins, 2012, p. 21).

Although AI creativity has long been considered in theory and research, major leaps in generative AI tools have been made only recently. In 2022–2023, the introduction of generative AI tools, such as ChatGPT and Stable Diffusion, changed the idea of what AI could do and can do in the near future (Peres et al., 2023). In particular, ChatGPT is an emerging AI chatbot, which is built based on OpenAI's large language models. Stable diffusion is a deep-learning-based model that can generate detailed images based on text descriptions. Recent developments are based on advancements in deep-learning algorithms, neural techniques, and computer hardware (Sarker, 2021). For example, a neural-network architecture called Transformer, which applies the self-attention mechanism, plays a large role in handling sequence-to-sequence tasks (Vaswani et al., 2017). Therefore, it has been widely used in various natural-language processing applications, such as AI chatbots. Meanwhile, as recent AI-related tasks have become increasingly computationally expensive, various kinds of hardware accelerators have been implemented based on FPGAs, GPUs, and ASICs to support computation-intensive tasks (Talib et al., 2021).

Huang et al. (2019) argued that there is an ongoing swift transition from the current thinking economy to a feeling economy. AI is increasingly used to do cognitive tasks humans previously completed, and the most mechanical and routine tasks are the ones in which humans are first replaced. With the development of AI technology, AI systems could take over higher-level cognitive tasks with superior efficiency and precision. In the long run, AI is also likely to take over communication, interaction, and empathy tasks humans previously completed (Huang et al., 2019; Huang & Rust, 2018; Rust & Huang, 2021).

Because the current development of AI is groundbreaking, AI arouses mixed feelings among people and attitudes toward AI vary among countries (Bergdahl et al., 2023; Neudert et al., 2020). People have concerns regarding the security of programs and applications that rely on AI, which have led to some apprehension about this technology. Additionally, fears about the potential displacement of human workers by AI have been expressed (Frank et al., 2019; Suseno et al., 2022). Despite these worries, AI's capabilities continue to captivate and intrigue people, sparking curiosity about its possibilities (Park & Woo, 2022; Rhee & Rhee, 2019; Wollny et al., 2021).

All that happens in the development and implementation of AI also has consequences for the cultural sector and fine arts, which traditionally in Western aesthetics include art forms such as visual arts, architecture, music, theater, film, dance, and literature. The fine arts are a culturally, societally, and economically important sector. AI's potential is significant, for example, in helping people organize art events, finding events, and buying and selling art. However, the use of AI also raises concerns about the production and authorship of art and the replacement of people working in various fine arts fields.

1.2. AI in fine arts – a long history and new challenges

Despite the recently exploding discussion about art and AI, the idea of non-human-made art dates back centuries. Historians have traced the idea of artificial life, such as robots, back to Greek mythology (Mayor, 2018). Art-producing machines existed centuries ago. For example, the Greek mathematician Appolonius of Perga (ca. BCE 240–190) invented an automatic musical instrument, a wind instrument, and Leo the Philosopher (ca. 790–869) made self-operational machines (i.e., automata), including singing birds (Roads, 1980). However, from the contemporary perspective, automata were rather simple and mostly functioned following a pre-designed structure. The modern interest in AI and art arose with the invention of digital computers in the 1930s, especially with the introduction of commercially produced microprocessors in the 1970s.

Perhaps the most important modern example is AARON, a computer program by Harold Cohen (1927–2016), who made computer-generated outputs the primary focus of his artistic practice. Cohen created AARON in 1968 and developed it into a series of programs designed for line drawing and later also coloring (Boden, 1998). Also, in music, the use of algorithms dates to the 1950s and 1960s (Fernández & Vico, 2013). In an article titled "The Creative Process Where the Artist Is Amplified or Superseded by the Computer", Cornock and Edmonds (1973) questioned the traditional role of artist and claimed that it may not be important anymore to consider the artist a specialist of art but rather "a catalyst of creative activity" (p. 11). Attempts at computer-made visual artwork were documented in the 1970s (Kugel, 1981), and the potential of computers and AI in art was discussed before the technology was developed (Kugel, 1981; Wilson, 1983).

The most obvious and discussed topic over the past few decades has been whether AI-made art is really art. This topic involves the question of whether AI can be creative. This question has been especially important in the field of computational creativity (Boden, 2010; Zylinska, 2020). According to Roland Rust and Ming-Hui Huang and Rust (2021), the question of AI's creativity is tied to the distinction of analytical and intuitive intelligence. The latter involves thinking and feeling and is often very important also for art. Certainly, the current technology enables analytic intelligence, but intuitive intelligence is a far more complex issue. Rust and Huang (2021) concluded that AI is still limited in its creative potential.

Boden (1998) made a distinction between combinational creativity, exploratory creativity, and transformational creativity. According to Rust and Huang (2021), AI can combine things (combinational creativity) and explore new possibilities (exploratory creativity), but it has not reached transformational creativity, in which new ideas are generated at a new conceptual level. Transformational creativity involves not only tweaking what already exists but also combining things in previously impossible ways (Boden, 1998). In music, this means, for example, not only composing music for a particular genre but creating a totally new genre or a sub-genre. Of course, much of art is not necessarily transformative in this sense. Repetition has been a part of artistic

practices for centuries. The question, then, is are we expecting from AI something that we do not expect of most human artists? Zylinska (2020) suggested that we stop asking whether AI can be creative but rather see humans as part of the machine. In our technological world, a more suitable question would be "*In what way* can the human be creative?" (p. 55).

Sociology and the social history of art underline the fact that what we consider fine art is based on convention (Hauser, 1977, 1982; Wolff, 1983, 1993). The very idea of creativity is rather recent from the historical perspective, as are the qualities related to the production of art. For example, during the early Renaissance (the 15th century CE), a painter's work was entirely collective and based on craftmanship (Hauser, 1977). The Renaissance marked the birth of the individualistic notion of the artist as a genius and the work of art as "the creation of an autocratic personality, that this personality transcends tradition, theory and rules, even the work itself, is richer and deeper than the work and impossible to express adequately within any objective form" (Hauser, 1977, p. 61). This role and authority of the artist has remained undisputed in many contexts despite attempts to challenge it (Barthes, 1977; Foucault, 1994). Myths about the artist as an individual hero or genius also mask the circumstances or the artistic production, such as the use of tools such as camera obscura and of assistants. More recent research has however underlined that the production of many art forms is a collaborative effort (Wolf, 1993).

The 20th century challenged the notion that artists create objects. Marcel Duchamp's ready-mades (e.g., *Fountain*, 1917) and Andy Warhol's mass-produced images at Factory are good examples of this. Neither art as a field nor the artist as an individual were challenged, however. French sociologist Pierre Bourdieu (1979, 1980) underlines in his field theory how the field of art functions. Players in the field do not question the value of art, and gatekeepers maintain that not just anyone can enter the field. In Bourdieu's theory, cultural and social capital are needed to enter the field of art (Bourdieu & Wacquant, 1992). The artists' outrage in an exhibition reported in the New York Times (Roose, 2022) is an example of reactions to the use of AI. What if anyone could produce art? What if AI becomes so creative that it starts not only to combine and explore but also to transform? The challenge AI poses concerns the whole field of art and our concept of what fine art is.

1.3. This study

This study was motivated by the recent developments in AI technologies. Our aim was to portray the current usage of AI in fine arts based on empirical research articles. One important background question is the general question of what art and authorship are in the era of AI. Another major question generally concerns AI's role in the cultural field and what kind of possibilities it could open in the production of cultural events, for example. AI can be used as a tool in the creative process, as an assistant in art event organization; and in the analysis of artistic works, such as paintings and compositions. Yet there are no systematic reviews analyzing what the state of the art is. Our systematic review focused on empirical research articles, especially in the fields of social sciences, arts, and humanities, on AI's role in fine arts. Our research questions were.

RQ1: What kind of empirical studies have been conducted on the usage of AI in fine arts over the past 20 years?
RQ2: How do participants perceive AI-produced art?
RQ3: What kind of AI tools have been developed to help in a) the analysis of fine arts and b) the production of fine arts?

2. Method

2.1. Data collection

We used systematic literature review as a research method. We relied on PRISMA 2020 guidelines in reporting systematic reviews and did the literature search in three well-known databases: Scopus (Elsevier), Web of Science (Clarivate), and the Arts and Humanities Database (ProQuest). To encompass all relevant studies, we created and used a set of specific keywords with the Boolean operators "AND," "OR," and "AND NOT." Table 1 lists the Boolean phrases applied in the databases. Our initial search without exclusions produced 1,426 articles from Scopus, 173 articles from Web of Science, and 1,138 articles from the Arts and Humanities Database for articles published by 2022. Fig. 1 illustrates our process of filtering and selecting the articles.

The selection criteria used in the search engines were 1) published between 2002 and 2022, 2) peer-reviewed article, and 3) published in English. We limited the search to 2002–2022 in all databases. We conducted the search in April 2022. We marked scholarly journals as a source type in Scopus and Arts & Humanities Database. In Web of Science, this was not necessary because it mostly consists of peer-reviewed research literature. We excluded articles that were did not meet the selection criteria (publication date, publication type, and language).

All three databases provide various search options. We utilized all their functionalities to gather an optimal selection of articles for manual screening. In Scopus, we limited the search to social sciences, psychology, and arts and humanities. We selected 545 articles for manual screening after excluding articles that did not match the criteria. From Web of Science, we selected 122 articles for manual screening. In the Arts & Humanities Database, we limited the search using keywords the database suggested, "art" and "artificial intelligence," and then using the keywords "aesthetics," "agents (artificial intelligence)," "algorithms," "architecture," "art galleries & museums," "art history," "artists," "creativity," "literature," "machine learning," "museums," "music," "musical instruments," "musical performances," "neural networks," "painting," "poetry," and "visual artists." We ultimately selected 56 articles for manual screening from the Arts & Humanities Database.

We extracted basic information (i.e., title, author details, publication year, and database details) from the selected 723 articles to an Excel spreadsheet, and two independent coders performed a manual article cross-check. The criteria for our manual check were 1) articles focused on the use of AI in the field of fine arts (e.g., AI used in production, performance, or analysis of fine arts) and 2) articles representing an original empirical study. In our review, we considered an article empirical if it utilized some type of data and presented empirical results. Reliability among raters was good, with 95.68% agreement and a Cohen's kappa of 0.61. During our manual screening, we subjected 66 articles to discussion due to a disagreement between the coders. The final list consists of 44 articles. Fig. 1 presents the data collection and data selection processes.

2.2. Method of analysis

Our aim was to summarize the evidence from empirical studies focused on the use of AI in fine arts, especially from the perspective of the social sciences, arts, and humanities. We based our definition of fine arts on aesthetics and art history (Graham, 2005; Honour & Fleming, 2005; Wolff, 1983). Therefore, we included and analyzed articles only if they focused on visual arts, architecture, music, theater, film, dance, or

Table 1
Boolean search phrases used in databases.

Database	Boolean phrase
Scopus and Arts and Humanities Database	*("artificial intelligence" OR "computational intelligence" OR "creative machine" OR "computational creativity") AND ("art" OR "artist" OR "artificial artist" "art market" OR "artwork") AND ("empirical" OR "views" OR "perception") AND NOT ("state of the art")*
Web of Science	*(artificial intelligence OR AI) AND (art OR artist OR artificial artist OR art market OR artwork) AND (empirical OR perceptions OR attitudes) NOT (state of the art)*

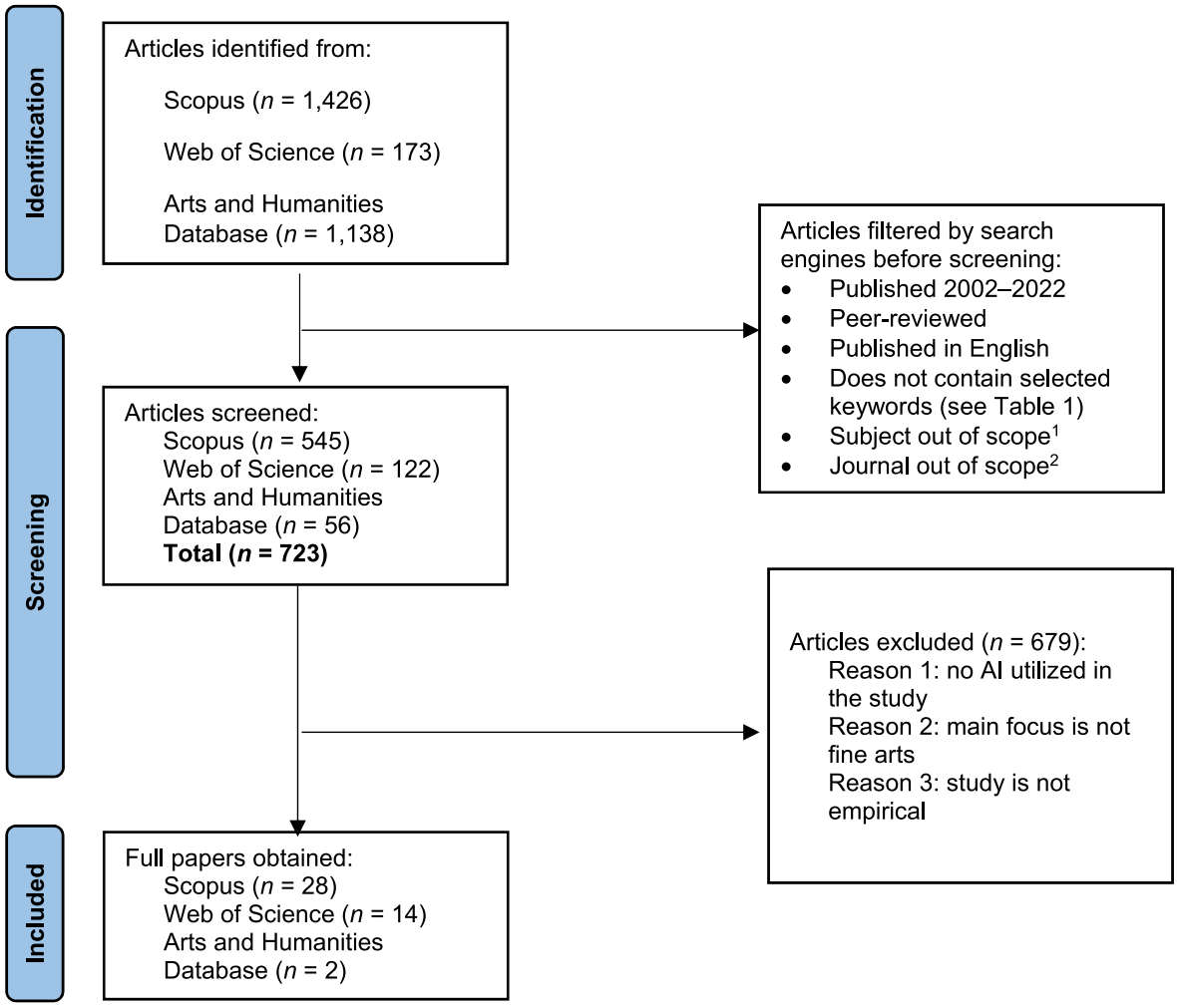

Fig. 1. Data collection and data selection process.
Note. The PRISMA flow diagram is based on Page et al. (2021). [1]In Scopus, the search was limited to social sciences, psychology, arts, and humanities. In the Arts and Humanities Database, the search was limited using keywords. [2]Not a scholarly journal in the Arts and Humanities Database.

literature. We categorized the articles by publication year, country where the study was conducted, the field of art as the focus, the field of the study, and general methodological approach.

Due to the diversity in study design, participants, measures, and methods, we did not conduct a meta-analysis of the results. We used content analysis following a well-used protocol to answer our research questions (Krippendorf, 2018). Research questions guided the analysis, and we analyzed and reported each included article from this perspective. The results section follows the order of the research questions. We begin by showing what kind of empirical studies have been published on the usage of AI in fine arts (RQ1). Then we review empirical research findings on how human participants perceive AI-produced art (RQ2). We devoted the final parts of the results section to developed AI tools helping in the analysis (RQ3a) and production (RQ3b) of fine arts.

3. Results

3.1. Descriptive details of the published articles

The final dataset comprised 44 research articles published between 2003 and the end of May 2022 (see Table 2). The number of studies published has increased in the last few years, as Fig. 2 shows. Of all the included studies ($n = 44$), the majority ($n = 37$, 84%) were conducted in a single country. The largest number of studies were conducted in the United States ($n = 14$, 32%), followed by China ($n = 7$, 16%), the United Kingdom ($n = 7$, 16%), and Italy ($n = 6$, 14%). Over half of the studies ($n = 24$, 55%) focused on visual images, particularly paintings, drawings, and art images, followed by music ($n = 10$, 23%), literature ($n = 5$, 11%), and architecture ($n = 5$, 11%). The authors also investigated pottery making ($n = 2$) and art installation ($n = 1$) as well as performing arts, such as dance ($n = 1$) and improvised poetry ($n = 1$).

3.2. Studies on perceptions of AI

Studies focusing on human perceptions of AI in art varied in their methodology, including an experiment (Lyon et al., 2021), survey experiments (Epstein et al., 2020; Gangadharbatla, 2021; Hong & Curran, 2019; Hong et al., 2021, 2022; Lima et al., 2021; Tubadji et al., 2021; Wu et al., 2020), and mixed-method studies (Jansen & Sklar, 2021; Schubert et al., 2017).

Lyu et al. (2021) found that participants with an art or design background could recognize various artistic styles of visual arts (Fauvism, Expressionism, Cubism, and Renaissance) even after AI-created changes. Gangadharbatla (2021) and Schubert et al. (2017) concluded that participants were unable to distinguish AI-produced from human-produced art. For example, AI-generated artwork was more likely to be associated with human-made abstract art and representational art (Gangadharbatla, 2021). Participants also struggled to distinguish human-played musical performances of classical music from algorithmic performances. Even experts failed to hear the difference in

Table 2
Descriptive information of the reviewed articles.

Reference	Art form	Method	Research topic
Akimoto and Ogata (2014)	Literature	Design-focused study	Development of an AI system for narrative generation based on narrative analysis
Allal-Chérif (2022)	Architecture	Multiple-case study	Virtual cathedral experience facilitated by virtual and augmented reality and AI
Augello et al. (2015)	Image	Design-focused study	Internal and external evaluation as part of the creative process of an artificial agent
Augello, Infantino, Manfré, et al. (2016)	Image	Design-focused study	A novel cognitive architecture for computational creativity based on the Psi model and dual process theories
Augello, Infantino, Lieto, et al. (2016)	Image	Design-focused study	Analysis and development of creative characteristics of a robotic artist
Casacuberta (2004)	Music	Design-focused study	Developing an artificial DJ producing music that is artificial but meaningful to humans and testing it at a live event
Cavazza et al. (2005)	Installation	Design-focused study	Development of a VR platform supporting development of VR art installations.
Cetinic et al. (2019)	Image	Content analysis	Predicting image aesthetics, visual sentiment, and memorability of over 105K images with convolutional neural networks
Costa et al. (2021)	Image	Content analysis	Using convolutional neural networks for a high-level analysis of the features of over 130k paintings
Criminisi et al. (2004)	Image	Content analysis	Analyzing the accuracy of convex mirrors depicted in 15th-century paintings by applying mathematical techniques drawn from computer vision
Demir et al. (2021)	Image, architecture	Content analysis	A neural-network model that recognizes and classifies the design principles in artwork produced since the late 20th century, professional photos, and facade pictures of contemporary buildings.
Dominguez et al. (2020)	Image	Mixed methods	Two user studies (n = 121, n = 177) on AI-based art recommendation systems in an online art store
Duan et al. (2021)	Image	Design-focused study	Investigating personalized art derivatives by setting up a design perspective
Epstein et al. (2020)	Image	Survey	Two survey experiments (n = 127, n = 320) were used to analyze participants' observations of credit and responsibility of AI art and its heterogeneity based on the level of anthropomorphosis
Gangadharbatla (2021)	Image	Survey	Two survey experiments investigating whether participants (n = 211, n = 530) are able to differentiate human and AI-generated artwork accurately and the role of attribution knowledge
Gualandi et al. (2021)	Pottery	Content analysis	Automatic recognition and classification of pottery through neural-network algorithms
Harrison and Pearce (2020)	Music	Content analysis	Developing a computational cognitive model for the analysis and generation of voice leadings
Hong and Curran (2019)	Image	Survey	Survey experiment to analyze how participants' (n = 288) presumed knowledge of an artist's identity (human vs. AI) affects individuals' evaluation of art
Hong et al. (2021)	Music	Survey	Survey experiment to test the influence of expectancy violation on participants' (n = 299) assessments of AI-composed music
Hong et al. (2022)	Music	Survey	Survey experiment investigating the participants' (n = 222) evaluation of musical performances of AI and the acceptance of AI music generators as musicians
Hou et al. (2022)	Literature	Design-focused study	The synergic modification of Anglo-American traumatic narrative literature by AI and interactive design psychology
Jansen and Sklar (2021)	Image	Mixed methods	Survey, interview, and video-analysis investigation of visual artists (n = 21) for the development of a physical human-AI co-creative drawing prototype
Kontogeorgakopoulos and Kotsifa (2013)	Music, architecture	Content analysis	Presenting three interactive sound design projects involving music, installation, and analysis of audience.

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Table 2 (*continued*)

Reference	Art form	Method	Research topic
Lima et al. (2021)	Image	Survey	Pre-study ($n = 45$) and two online experiments ($n = 140$, $n = 263$) about how interacting with AI-generated art affects the perceived moral standing of the AI-generative system
Liu (2021)	Music, image	Content analysis	Developing a method for music classification that also visualizes the analyzed content in real time
Lyu et al. (2021)	Image	Experiment	Studying factors affecting an audience's ($n = 31$) cognitive difference and preference of artistic style transfer to investigate the application of an AI generator model in art creation
Manfré et al. (2016)	Dance	Design-focused study	Endowing a cognitive architecture with artificial-creativity capabilities to make a robot dance to various musical genres.
Manitsaris et al. (2014)	Pottery	Content analysis	Presenting a method to analyze and model gestures and skills used in traditional wheel-throwing pottery making
Mazzone and Elgammal (2019)	Image	Design-focused study	Discussing an AI process developed for making art (AICAN) and the issues AI creativity raises for understanding art and artists in the 21st century
Meany and Clark (2012)	Performing arts, literature	Design-focused study	Explores design dramaturgy through a case study that employs chatbots to play the roles of "comedian" and "straight man"
Nawar (2019)	Image	Design-focused study	Investigation of "bread" as one's peculiar voice and political statement through an interactive art project employing AI
Rodriguez et al. (2018)	Performing arts, literature	Design-focused study	Characterizing the cognitive skills involved in the development of socially interacting robots using performing arts, such as oral improvised poetry, as a useful testbed
Savery et al. (2021)	Music	Design-focused study	A new generative system for emotional musical prosody and exploration of how a robot's response outside of its key creative task alters perception of the robot

Table 2 (*continued*)

Reference	Art form	Method	Research topic
Schubert et al. (2017)	Music	Survey	Experiment testing whether participants ($n = 172$) can distinguish algorithm-generated performances of piano music from human performance
Shamir and Tarakhovsky (2012)	Image	Content analysis	Demonstrating that computers can automatically analyze paintings of various artists and schools of art in an unsupervised fashion
Shamir (2015)	Image	Content analysis	Comparing Pollock's unique artistic style to that of those who mimic him by using computational methods to characterize the low-level numerical differences
Song (2021)	Image	Content analysis	Development of AI-based improved support vector machine algorithm for the analysis of paintings
Starkey et al. (2020)	Music, image	Design-focused study	Development of AI techniques that monitor a painting evolving in real time and produce musical notes that relate to the individual elements of art
Tang et al. (2021)	Image	Content analysis	Painting and calligraphy identification by simulating the expert identification process for AI analysis and modeling
Thom (2003)	Music	Design-focused study	Presents an AI-based intelligent companion that plays music and improvises with users
Tubadji et al. (2021)	Music	Survey	Quasi-experimental design study on valuation of music created by AI and humans before and after the participants ($n = 960$) become aware of the nature of the composer
Wu et al. (2020)	Literature, image	Survey	Survey experiment on participants' (U.S. $n = 251$ and China $n = 293$) explicit and implicit perceptions of AI-generated artistic work
Zhang et al. (2021)	Architecture	Content analysis	Presenting a visual-recognition method to classify decorative openwork windows' patterns in Suzhou traditional gardens
Zohar and Shimshoni (2021)	Architecture, *image*	Content analysis	Geographic information science integrated with computer vision for the analysis of old

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Table 2 (*continued*)

Reference	Art form	Method	Research topic
			engravings and drawings depicting Jerusalem and Tiberias

music (Schubert et al., 2017).

Along with identifying AI-made art, researchers have focused on participants' evaluations of AI-made art (Gangadharbatla, 2021; Hong & Curran, 2019; Hong et al., 2021, 2022; Jansen & Sklar, 2021; Lima et al., 2021; Tubadji et al., 2021; Wu et al., 2020). The studies dealt with artistic value, monetary value, quality, and appreciation of AI-created artworks. Hong and Curran (2019) found notable differences in artistic value seen in images created by humans and AI: human-made art earned higher ratings in composition, expression, and aesthetic value. This finding led Hong and Curran to conclude that AI artists were not able to pass the Turing test. Their results also showed that the knowledge that AI created the artwork did not affect the participants' evaluation of it. However, if participants had a prior stereotypic perception that AI cannot produce art, they were more negative in their evaluations. Similarly, beliefs that AI can be creative were positively related to the evaluation of the music it produces (Hong et al., 2021). Also, in the follow-up study, AI-created songs were evaluated regardless of their characteristics, but people who accepted the AI as a musician still evaluated its songs more positively than those who did not (Hong et al., 2022).

Other factors also influenced assessments of AI-produced art. They included AI's perceived moral status (Lima et al., 2021), cultural differences (Wu et al., 2020), and the context in which AI was used (Jansen & Sklar, 2021). Lima et al. (2021) showed in two experiments that participants' evaluation of AI's agency (AI's ability to create and experience art) was not changed by the process in which they were exposed to AI-generated art. However, if AI-generated art was overvalued during the experiment, participants tended to attribute less agency to the AI. The authors stated that participants start to devalue art when they know AI made it. Participants also considered more often abstract images AI-made and realistic images human-made.

In the study by Wu et al. (2020), participants from the United States were more critical of AI-generated poetry and painting than participants from China. Jansen and Sklar (2021) conducted a multimethod user study with drawing practitioners. Based on their interview data, they concluded that artists' views on AI varied: co-creative AI was preferred over didactic AI, and artists were the most critical of automation of creative work with AI. Tubadji et al. (2021) found that participants' evaluations of AI-generated music were negatively influenced when they knew the music's composer was an AI. This knowledge influenced the participants' assessments of quality, causing them to shift away from AI-generated compositions and toward those humans created. Knowledge of the artwork's creator was also connected to the participants' assessment of the artwork and reported purchase intentions (Gangadharbatla, 2021).

AI's human-like traits have been shown to affect perceptions of AI art (Epstein et al., 2020; Hong et al., 2022). The perception of AI's human-likeness can be manipulated by changing the language describing AI (Epstein et al., 2020). Human-like traits given for an AI music generator made it more acceptable as a musician (Hong et al., 2022). In an experimental study by Epstein et al. (2020), framing AI as an agent rather than a tool changed how participants credited the artwork, diminishing the artist's role and placing more importance on the programmer and AI role. Despite the manipulation, participants still believed artists played the biggest role in realizing the artwork.

3.3. Analysis and classification of artistic work

Analysis tools utilizing AI have been developed for many areas of fine arts. Various AI tools are being developed for image analysis. For example, Demir et al. (2021) developed a neural-network model, which is a system that identifies and categorizes design principles utilized in contemporary buildings, using professional photographs and facade images dating back to the late 20th century. Cetinic et al. (2019) utilized AI when analyzing high-level features of 105,121 art images. They focused on aesthetic, sentiment and memorability features of art images and were able to produce new findings about factors influencing these features. For example abstract art was considered more memobable, but having lower score in aesthetics and positive sentiment.

Along with pictures, paintings have been analyzed with the help of AI. Costa et al. (2021) developed a logical-style painting classifier that not only identified a painting's style but also provided explanations for its classification. As another example, Song (2021) used an AI-based improved support-vector machine algorithm for the analysis of paintings. Criminisi et al. (2004) studied algorithms that allow the user to rectify mirror images shown in the paintings. This information provides additional information about place and has been used to provide more information about the ways paintings were created. Gualandi et al. (2021) developed two machine-learning tools for the automatic

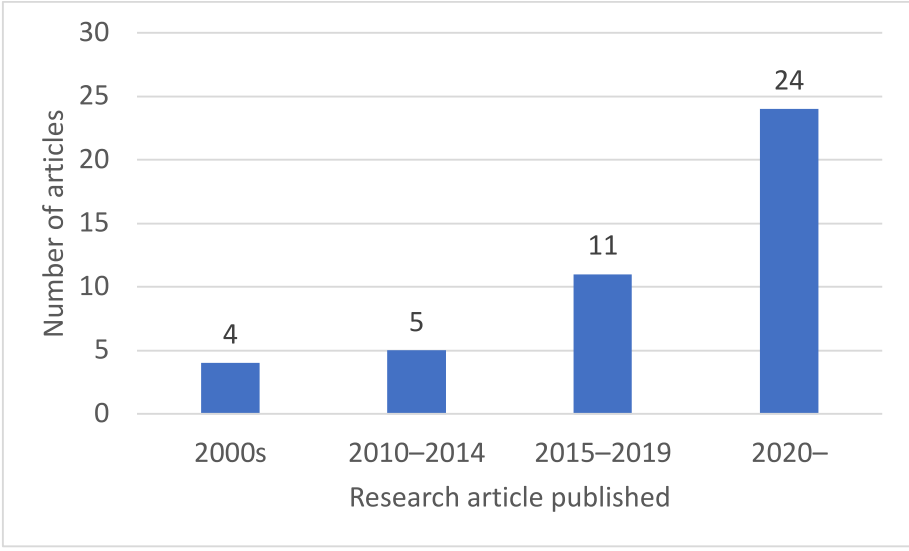

Fig. 2. Number of research articles published, by year.

recognition and classification of pottery, utilizing shape and decorative features. Manitsaris et al. (2014) developed a methodology for capturing and modeling the gestural knowledge and skills used in wheel-throwing pottery. They created a technological prototype called ArtOrasis to validate the methodology, which provided continuous feedback in real time by measuring the differences between an expert's and a learner's gestures. Such AI systems can be used to learn the gestures.

Researchers have also used AI tools in music. Harrison and Pearce (2020) developed a computational cognitive model of voice leading and analyzed a corpus of 370 chorale harmonizations by J. S. Bach. The authors applied the model to the voicing of harmonic progressions in various musical genres. Liu (2021) developed a method for classifying various styles of music that included real-time visualization of the analyzed content. This visualization method has the potential to offer users personalized services on a large scale tailored to their individual preferences. It can enhance the user's audio-visual experience and represent the connection between AI and human emotions. Music was also part of Kontogeorgakopoulos and Kotsifa's (2013) three case studies involving interactive performance, architectural design, and sound installation.

AI tools have also been developed to recognize patterns and address the issues of forgery and plagiarism. Shamir and Tarakhovsky (2012) used AI tools in art analysis to find similarities and links. Their results showed that AI tools could mimic humans in such tasks. Shamir (2015) used computational methods to compare Jackson Pollock's distinct artistic style with those of imitators. Tang et al. (2021) developed a method for AI identification of paintings and calligraphy that mimics expert identification processes. Their results indicated that a convolutional neural network using atlas features achieved the highest accuracy, with classification and identification rates over 96%. Furthermore, incorporating multivariate spectral features greatly improved accuracy in pseudo-color-image data.

In another study that dealt with AI-based analysis tools, Zhang et al. (2021) developed a visual recognition method for identifying patterns in decorative openwork windows in Suzhou traditional gardens. Their results indicated that their model proved suitable for recognizing these patterns and holds promise for sustainable use in traditional gardens. Zohar and Shimshoni (2021) used geographic information science methods and computer vision to analyze old engravings and drawings depicting Jerusalem and Tiberias and developed a new approach for extracting spatial information from these artworks. Their system allowed for the identification of embedded features not originally drawn and potentially extraction of spatial information reflected in the artwork.

3.4. AI in production of fine art

The final part of the Results section concerns how AI is used in the production of art. These studies are generally speaking-case studies, user studies, and design-focused studies. They focus on visual arts, music, and literature. Much of the work in our data involves visual arts and painting. Duan et al. (2021) reported findings based on AI emotion analysis that was used to create personalized art derivatives based on Van Gogh's paintings (Duan et al., 2021). Nawar (2019) reported on an interactive art project exploring bread as a representation of one's peculiar voice and political statement, in which a machine created drawings of bread in front of the audience. Augello et al. (2015, 2016a, 2016b) focused on cognitive architectures for artificial agents creating paintings. They proposed integrating internal and external evaluation as a part of the creative process (Augello et al., 2015) and described a robot with creativity traits that created collages through visual and verbal interaction with a human user (Augello, Infantino, Manfré, et al., 2016) as well as a robot executing creative paintings through four activities triggered by urges and motivations (Augello, Infantino, Lieto, et al., 2016). Mazzone and Elgammal (2019) described an AI process developed for making images and proposed a partnership between human and machine creativity to overcome the challenges of AI creativity in art and ensure it complements rather than conflicts with human artists' emotional and social intentions.

Music is another major field in the articles. Starkey et al. (2020) developed an AI technique combining drawing and music. An AI tool generated musical notes in real time based on drawings conducted in a live stage performance. Casacuberta (2004) reported that AI was used to create a DJ playing music live at an art festival in Berlin. Thom (2003) introduced an AI-based companion that plays and improvises music with users. Manfré et al. (2016) taught a humanoid robot to dance to any music genre by using an interactive genetic algorithm. A human instructed a robot in experiments, and the robot was able to learn any music genre. Savery et al. (2021) developed a generative system for emotional musical prosody and found that communicating with the robot in a way that relates to its core functionality can increase its likeability and perceived intelligence.

Several studies have involved the use of AI in literature and the performing arts. Hou et al. (2022) proposed a model using AI and interactive design psychology to modify Anglo-American traumatic narrative literature. Akimoto and Ogata (2014) introduced an integrated narrative-generation system with functional modules for knowledge bases and narrative techniques to enhance literary theory. Meany and Clark (2012) studied design dramaturgy by using chatbots to play two roles and highlighted that dramaturgy can help designers gain new perspectives on their creative processes. Rodriguez et al. (2018) presented a speech-based humanoid poet-performer capable of generating poems on demand and proposed an embodied cognitive architecture for achieving fluent coordination and joint-action timing in live events. However, Hou et al. (2022) highlighted that essential literary creation relies on human intelligence.

AI was used to create VR art installations and to make historical cathedrals accessible through immersive technologies. Cavazza et al. (2005) used AI to support new user experiences in and Allal-Chérif (2022) explored how immersive technologies, including AI, can preserve and make cultural sites accessible from home, resulting in a powerful spiritual experience. AI has also been used to increase user experience with a recommender system of artistic images in an online art store (Dominguez et al., 2020).

4. Discussion

4.1. General overview of the results

This systematic literature review was an analysis of empirical studies on the use of AI in fine arts. Analysis of the final selection of 44 articles published between 2002 and 2022 showed that studies on AI in fine arts have increased significantly, especially after 2020. AI is applied to various forms of fine arts, including visual arts, literature, music, performing arts, and architecture. This is perhaps not a surprise because the development of computers aroused much interest in computer-based art (Cornock & Edmonds, 1973; Kugel, 1981) and the use of AI in music (Roads, 1980) decades ago. Much of the theoretical work on AI and creativity has shown AI's potential in various art forms. Our systematic review shows that empirical research during the 2000s has been conducted in multiple fronts in fine arts.

Studies on perceptions of AI-generated art have varied in methodology and included experiments and mixed-method studies. These studies have generally focused on participants' ability to recognize and evaluate AI-created art. Participants' evaluations of AI-made art were influenced by factors such as artistic value, knowledge of AI involvement, cultural differences, and the context of AI usage. Based on this review, AI systems are rather developed, and participants in various experimental studies have struggled to differentiate AI-made from human-made art (Gangadharbatla, 2021; Lyu et al., 2021; Schubert et al., 2017). Only Hong and Curran (2019) underlined that the artistic value of human-made art was perceived as greater than that of AI-made

art.

AI's power lies in the analysis of large-scale datasets in visual arts, music, and literature. The range and scope of AI in the classification of art is rather extensive. AI has also been employed, for example, to classify paintings based on style (Costa et al., 2021), extract spatial information (Zohar & Shimshoni, 2021), and identify and authenticate artwork (Tang et al., 2021). Many studies have reported that AI has been used in the production of visual and performative arts, such as music. Case studies reported, for example, the development of an AI painter (Augello, Infantino, Lieto, et al., 2016), DJ (Casacuberta, 2004), performer (Manfré et al., 2016; Rodriguez et al., 2018), and music accompaniment (Thom, 2003) for improvisations. AI tools have been applied to enhance consumer experience in online art shops and to provide VR access to historic cathedrals.

4.2. Theoretical and practical implications

Our systematic review has theoretical and practical implications. AI's role will need to be explored in aesthetics. Experimental research has shown that participants were unable to separate AI-made from human-made visual arts (Gangadharbatla, 2021), and even experts had difficulties in in distinguishing an AI's and a human's musical performance (Schubert et al., 2017). Hong and Curran (2019), however, showed that AI-made art was judged as having less artistic value. They also concluded that AI artists cannot yet pass the Turing test. Rust and Huang (2021) recently argued that AI has not reached transformational creativity. Creativity is, however, a rather complex concept and involves many contexts. Therefore, some authors have criticized the use of the Turing test in the context of creativity (Jordanous, 2012).

Our review showed that AI could already have practical implications for the field of art. AI tools can already do many creative tasks that only humans previously completed. The level at which they operate poses questions for gatekeepers in the field of art. Do we accept the use of AI as a tool as a common practice? The field of fine arts is based on conventions; therefore, AI provides a significant challenge for artists and institutions. It also concerns the broader questions of what it means to be human, what human creativity is, and what the limits of being human are.

AI has massive potential as a tool to analyze large quantities of data for art museums and art historians. AI tools could be used in art sales to detect frauds. They could enhance the ways art is perceived and consumed. AI could significantly benefit the whole art field and eventually change it. AI is not likely to be welcomed by all because it is also transforming the fields of art as we know them. Our review showed several innovative examples how AI has been used.

Articles in our data included little discussion on the copyright issues that have often arisen. This issue affects massive-scale industries, such as music. AI is currently able to imitate living and dead artists and make music using their style. In April 2023, an AI-created song using cloned voices of Drake and The Weeknd went viral, but it was later pulled from Spotify, Apple Music, and other music streaming services due to demands from record companies (Rutherford, 2023). This case presents an issue regarding individual rights and copyrights (Rozbicka et al., 2023). Generative AI will certainly raise extensive discussion about copyright legislation as well as authorship and renumeration (Senftleben, 2023).

4.3. Limitations

Although our study covered a rather large range of types of articles, we recognize that our methodological choices might have limited the selection of articles and our review might not include all the articles in the field. We limited our study to empirical articles, and our study does not include studies focused solely on technical development of certain tools without applying these tools to actual data. Our broad scope for fine arts might have limited our ability to provide insights for a specific field of art, such as music, and excluded articles focusing on entertainment industries of certain art fields. We limited our search to three databases (Scopus, Web of Science, and the Arts and Humanities Database by ProQuest), so we might have missed some relevant articles despite the comprehensiveness of these databases. Future studies could focus more on specific art forms, such as visual arts, music, and literature, or cover entertainment fields outside fine arts.

4.4. Conclusions

We are in the middle of a transition in which AI is used increasingly as a tool to create art. In the future, we might need to evaluate whether AI solutions are making better products than humans are. At this point, these tools have presented multiple possibilities for not only professional artists but anyone interested in learning, exploring, and inventing what a machine can do with simple instructions. AI systems are close to becoming transformative in their creativity, but they are currently at least very effective tools for artists and people working in the arts. Bigger questions in the field of art include, however, questions on authorship and copyrights. Our reviewed articles did not consider these questions, but it is obvious that the development of AI will make these questions more relevant than ever. As we stand now, AI is a fast and reliable tool in the analysis of large-scale data, and it can provide solutions that would take a very long time for humans to reach. The possibilities of practical applications of AI in the field of art are huge and involve the production, distribution, and consumption of art. We are in the middle of societal and cultural transformation, and changes in art and creativity are some of the most powerful signs of this transformation.

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Ethics approval

The ethics committee of the Tampere region in Finland gave approval for the procedures of the project. Systematic literature review does not consist any ethical issues.

Data availability statement

Data is publicly available.

Declaration of competing interest

Authors report no conflict of interest.

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