

A BIBLIOMETRIC ANALYSIS OF NON-INDUSTRIAL ROBOTICS AND AUTOMATION RESEARCH FROM A CREATIVE APPLICATIONS PERSPECTIVE

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ABSTRACT

Robotics research has expanded rapidly over the past two decades, encompassing industrial automation, human–robot interaction, artificial intelligence, and creative applications. This study presents a bibliometric analysis of research trends, publication growth, and citation patterns in robotics and automation, with a focused examination of creative and artistic applications within the field. Bibliographic data were retrieved from the Scopus database, yielding 31,261 initial records, which were refined to 426 relevant publications published between 2000 and 2025 within the Arts and Humanities subject area. Quantitative analyses were conducted using Microsoft Excel for temporal trend analysis, VOSviewer for collaboration and keyword network visualization, and Publish or Perish for citation performance assessment. The results reveal a substantial increase in robotics-related publications after 2017, with the United States, China, and the United Kingdom emerging as leading contributors. Influential journals, institutions, authors, and citation networks highlight the interdisciplinary nature of robotics research and demonstrate how creative and non-industrial studies contribute foundational methods in perception, motion control, human–robot interaction, and digital technologies that are later adopted in industrial automation. Overall, this study provides a structured overview of how robotics and automation research has evolved in terms of productivity, intellectual influence, and thematic development, while illustrating the role of creative-domain research as an innovation precursor supporting the advancement of industrial robotic applications.



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I. INTRODUCTION

Before robots were deployed on factory floors, they were first conceived in human imagination - shaped by myths, literature, and performing arts [1]. The term “robot” itself originated from Karel Čapek’s 1921 theatrical play R.U.R. (Rossum’s Universal Robots), where robots were envisioned not as mechanical devices but as artificial workers designed to serve human needs, ultimately raising questions about control, intelligence, and rebellion. Although contemporary robotics research is predominantly associated with industrial automation, its advancement continues to rely on insights drawn from non-industrial explorations. Bibliometric analysis provides a systematic framework to examine how such interdisciplinary research contributes to the intellectual evolution of robotics. By focusing on creative and artistic applications of robotics, this study highlights how non-industrial research domains inform, inspire, and accelerate innovations that ultimately shape industrial robotics systems.

II. LITERATURE REVIEW

During the 16th century, automata, mechanical figures powered by gears and pulleys, were used in courts and religious rituals. The Writer was designed by [2], [3]. This creation merged artistry, craftsmanship, and early automation with technology and culture.

The year 1956 marked the start of robotic art when Nicholas Schoffer created "CYSP 1", which responded to sound and light stimuli [4]. It integrates feedback systems, sensors, motors, and autonomous movements into art. In the 70's, artists began integrating motors, sensors, and microcontrollers. Nam June Paik used robotics and video in interactive installations [5]. In 1980, Survival Research Labs demonstrated industrial robotic machines in choreographed performances, highlighting early non-industrial applications in structured human-machine interaction [6], [7]. Digital and AI integration began in the 90's using Arduino with accessible robotics, allowing more artists to experiment. Ken Rinaldo and Stelarc created bio-robotic and cyborg performance art. The contemporary era began in 2010, when robotic arms were used for painting and sculpting, such as e-David at the University of [8]. Similar to cobots in Amazon warehouses, human-robot collaborative performance has been shown in Japanese theatre. AI and robotics collaborations, like Shimon (robotics marimba player), were created by Professor Gil Weinberg and the Robotic Musicianship Group at Georgia Tech's Center for Music Technology, designed to perform improvisational music with humans [9], [10]. Boston Dynamics has developed dancing robots, RoboRebel [11]. Robots are part of immersive experiences with interactive exhibitions, influencing humans (e.g., Theo Jansen's Strandbeests and Ken Rinaldo's Autopoiesis). Motors and servos create moving sculptures (e.g., Arthur Ganson's mechanical art) [12]. Holography with robotics combines projection mapping with robot motion (e.g., robotic puppets with animated faces) [13].

II.1 CREATIVE ROBOTICS AS AN INNOVATION PRECURSOR FOR INDUSTRIAL SYSTEMS

Robotics has transformed applied art by automating design, manufacturing, and customization processes. It aids in AI generative design (electroloom), manufacturing (sewbots), fashion shows (robot models), responsive clothing (anoukwiprecht), and virtual fitting (pepper robots) [14], [15]. Robots draw using machine learning algorithms to generate AI patterns and strokes [16]. FRIDA, which produces human-like paintings through a Real-to-Simulation-to-Real framework, demonstrates adaptive control, perception-driven decision-making, and transfer learning capabilities directly transferable to industrial inspection, surface finishing, and quality assessment tasks [17]. Similarly, robotic systems such as Paul, which replicates human sketching, and Hektor, which generates large-scale graffiti using suspended cables, contribute to the development of precision motion control, cable-driven robotics, and scalable workspace coverage, all of which are highly relevant to industrial automation, warehousing, and construction robotics [18]. AI and robotics innovate dance moves [19]. Creative applications in cinematography and drone-based performances have significantly advanced aerial robotics, swarm coordination, and autonomous navigation [20], [21]. Virtual and augmented reality platforms used in museums, digital art creation, and immersive performances also inform industrial digital-twin development, remote operations, and training systems [22], [23]. RangoliBot draws symmetrical designs. Robotic arms create Tibetan mandalas, while CNC tools etch mythological figures. The Telegarden allows users to remotely manage a garden through robots [24]. Non-industrial robotics—encompassing domains such as art, design, human-robot interaction (HRI), social robotics, education, and interactive installations—often serves as a testbed for early-stage experimentation [25], [26]. Concepts initially explored in creative contexts later mature into robust industrial solutions. Key industrial technologies that originated or evolved through creative research include [27], [28]:

- Intuitive human-machine interfaces
- Multimodal sensor fusion and perception systems
- Expressive motion planning and adaptive control
- Natural interaction through vision, gesture, and emotion modeling

These innovations directly inform collaborative robots (cobots), service robots, and smart manufacturing systems, demonstrating that creative robotics research contributes foundational knowledge to industrial automation.

II.2 EXISTING LITERATURE REVIEW

Table 1 presents a systematic literature review of art and robotics conducted by various researchers in the field. Some studies have explored themes such as robotic creativity, human-machine collaboration, and aesthetic evaluation, while others have categorized robotic artworks based on emotional responses, interactivity, and cultural significance. Most of these reviews have been published within the last eight years, indicating a rising academic interest in this niche area.

Table 1: Existing reviews on robotic and art.

Title	Year	Focus Area / Subject
Augmented Reality and Robotics: A Survey and Taxonomy for AREnhanced HRI [29]	2022	AR + Robotics in human robot interaction; design, modalities, application domains
Understanding and Creating Art with AI: Review and Outlook [30]	2022	AI & Art (creative generation, computational aesthetics) - overlaps robotics as artistic tool
Augmented Reality Meets Artificial Intelligence in Robotics: A Systematic Review [31]	2021	AR + AI integration in robotics - relevant to interactive robotic art installations
Action Representations in Robotics: Taxonomy & Systematic Classification [32]	2019	Action representations, robotics taxonomy - can be applied to robotic performance art
Soft Robotics: Academic Insights and Perspectives Through Bibliometric Analysis [33]	2018	Soft robotics bibliometrics (actuators, sensors, biomedical) - informs artistic softrobot design
Bibliometric Analysis of Social Robotics Research [34]	2017	Social / HRI robotics - applicable to robotic art with social themes or performance

Source: Authors, (2026).

III. METHODOLOGY

III.1 RESEARCH QUESTIONS

To systematically map and evaluate the scholarly output on non-industrial robotics and automation from a creative applications perspective, this bibliometric study addresses the following research questions:

RQ1: What are the annual publication output and growth trends of research related to non-industrial robotics and automation in creative applications during the period 2000–2025?

RQ2: Which countries, institutions, and authors exhibit the highest research productivity and influence in this domain based on bibliometric indicators?

RQ3: What are the prominent author keywords and thematic structures, and how have these research themes evolved over time within the studied literature?

III.2 DATA SOURCE

Bibliometric analysis applies quantitative methods to statistically examine patterns and trends and their impacts within the published literature. Electronics bibliography databases from Scopus were used to gather the relevant articles.

III.3 BIBLIOMETRIC ANALYSIS

Based on these data, we performed a bibliometric analysis to address our research questions. We followed the steps prescribed for this bibliometric study [35], as shown in Figure 1. The most suitable keywords for exploring the considered theme were identified after reviewing multiple combinations of keywords in Stage 1. This keyword search work was done in July 2025 and considered the publications up to 2025. Initially, the number of publications found was very large, considering the keyword search criterion only. It shows publications from all diversified fields that may not be as relevant to the study. We narrowed our search by considering the inclusion criteria (IC), such as English language and subject area, and exclusion criteria (EC), such as unidentified authors.

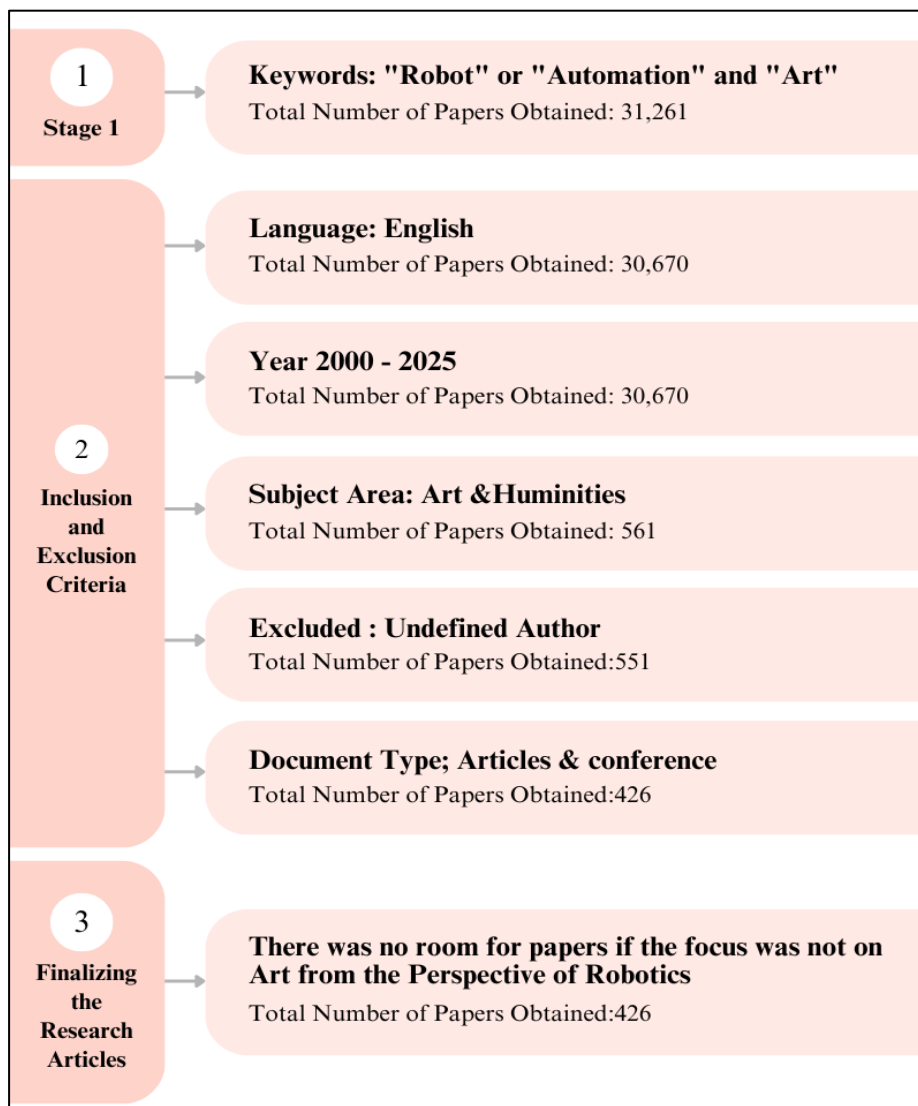


Figure 1: PRISMA flow diagram.

Source: [35].

IV. RESULTS & DISCUSSION

IV.1 PUBLICATION GROWTH OVER TIME

The annual publication distribution, presented in Figure 2 (bar chart) and summarized in Table 2, provides a quantitative overview of the temporal evolution of research activity.

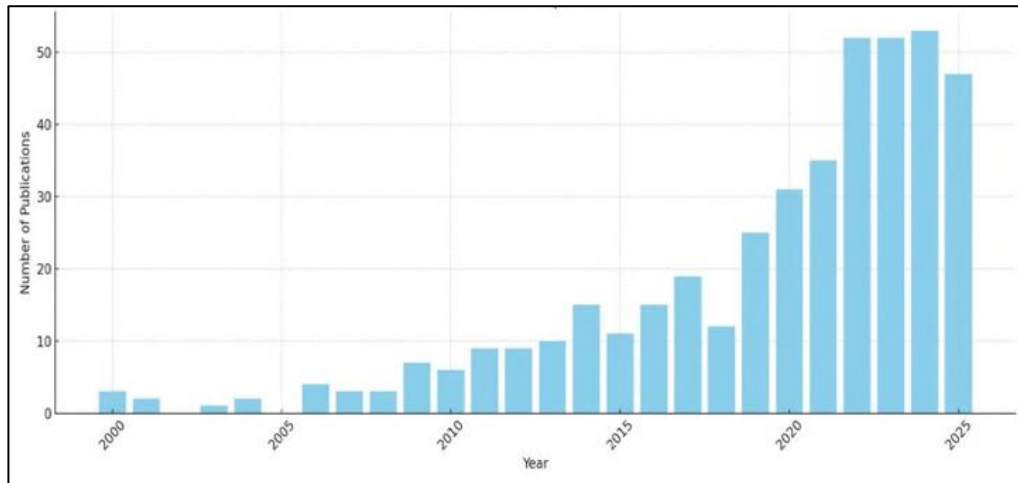


Figure 2: Bar chart – Publication Trend.

Source: Authors, (2026).

Together, these two elements reveal a clear long-term growth trend, despite minor year-to-year fluctuations that are typical in bibliometric data.

Table 2: Publication Trend.

Year	Publications	Year	Publications
2025	47	2013	10
2024	53	2012	9
2023	52	2011	9
2022	52	2010	6
2021	35	2009	7
2020	31	2008	3
2019	25	2007	3
2018	12	2006	4
2017	19	2004	2
2016	15	2003	1
2015	11	2001	2
2014	15	2000	3

Source: Authors, (2026).

Based on publication intensity and growth patterns, the research field's development spans three periods. The first period (2000–2010) showed limited output, with fewer than five publications annually and no publications in 2002 and 2005. The second period (2011–2016) demonstrated gradual increase, with peaks between 2014 and 2016. The third period (2017–2025) showed accelerated growth, with publication counts exceeding 50 in recent years. To interpret the growth behavior, classical mathematical growth models were applied to the annual publication data. The justification for modeling lies in the longitudinal dataset, monotonic increase after 2011, and accelerated rise after 2017. In early stages, publication output often follows an exponential growth pattern, expressed as:

$$P(t) = P_0 e^{rt} \quad (1)$$

Where $P(t)$ represents publications in year t , P_0 is initial publication count, and r denotes annual growth rate. Post-2011 data in logarithmic form shows approximately linear trend, indicating exponential growth behavior. As research expands, growth may slow due to saturation, described by the logistic model:

$$P(t) = K / (1 + e^{-r(t-t_0)}) \quad (2)$$

Where K represents the theoretical publication limit, r is growth rate, and t_0 denotes maximum growth acceleration point. Current data shows no clear saturation, suggesting the field remains below saturation level. The analysis of values, visualization, and growth modeling shows the research field's evolution. The sustained increase after 2017 indicates rapid growth phase without saturation evidence. While models are derived from publication counts for trend analysis, they provide a quantitative framework for interpreting publication dynamics.

IV.2 LEADING JOURNALS AND CONFERENCES

The distribution of papers by journal is shown in Table 3.

Table 3: Journal list with the number of Publications.

Journals/Conferences	Publications
International Journal of Social Robotics	30
13th International Conference on Learning Representations (ICLR 2025)	29
Artificial Intelligence	18
Artificial Intelligence Review	17
12th International Conference on Learning Representations (ICLR 2024)	16
Proceedings of the Annual Conference of the International Speech Communication Association Inter speech	16
AI and Society	15
Proceedings of the Annual Meeting of the Association for Computational Linguistics	10
2021 Joint: 6th International Conference on Digital Arts Media and Technology with 4th ECTI Northern Section Conference on Electrical Electronics Computer and Telecommunication Engineering (ECTI DAMT & NCON 2021)	6
Proceedings of the Technical Association of the Graphic Arts (TAGA)	6
11th International Conference on Learning Representations (ICLR 2023)	5
2020 Joint International Conference on Digital Arts Media and Technology with ECTI Northern Section Conference on Electrical Electronics Computer and Telecommunications Engineering (ECTI DAMT & NCON 2020)	5
10th International Conference on Learning Representations (ICLR 2022)	5
Proceedings of the International Conference on New Interfaces for Musical Expression	5

Source: Authors, (2026).

The International Journal of Social Robotics, ICLR 2025, Artificial Intelligence, and Artificial Intelligence Review contributed 94 papers (22% of our sample). The next 14 journals produced 112 articles (27% of the sample size). Most of the papers, that is, 220 articles (51% of the sample), were published with only four or fewer articles each on art and robotics.

IV.3 INFLUENTIAL AUTHORS AND INSTITUTIONS

The visualization highlights the author collaboration network generated using VOSviewer for the art and robotics research domains, as shown in Figure 3. It shows the key authors, their co-authorship patterns, and the strength of their connections. Larger nodes represent more prolific authors, and thicker lines indicate stronger collaboration.

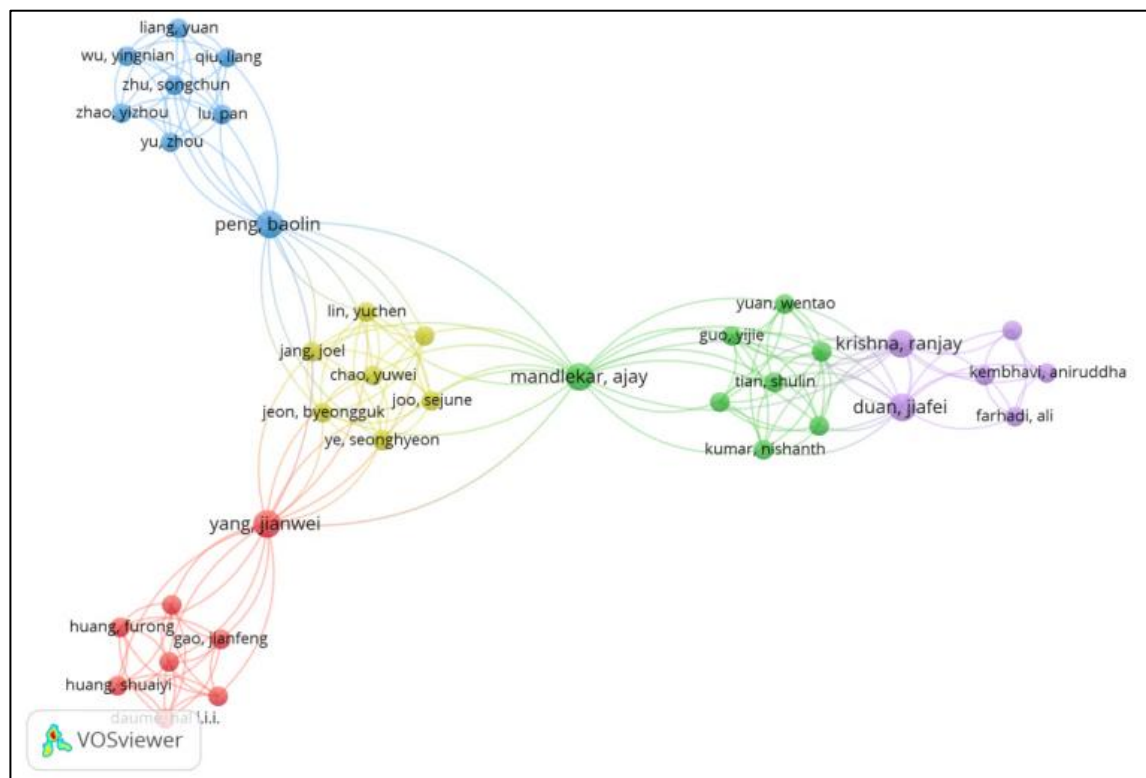


Figure 3: Author Collaboration Network.

Source: Authors, (2026).

Table 4 shows the contributions of authors, with Kapur, A. leading with five articles, followed by Proter, F. and Vacher, M. with four articles.

Table 4: Top Authors by Publication Count.

Author name	Publications
Kapur, A.	5
Portet, F.	4
Vacher, M.	4
Diakopoulos, D.	3
Finn, C.	3
Levine, S.	3
Neumann, G.	3
Yoma, N.B.	3
Yoon, S.Y.	3

Source: Authors, (2026).

The contributions of each academic institution are shown in Table 5, with Chiang Mai University, Chinese University of Hong Kong, Delft University of Technology, CNRS Centre National de la Recherche Scientifique, Stanford University, and University of Cambridge having seven publications each on art and robotics.

Table 5: Top Universities by Publication Influence.

Affiliation	Publications
Chiang Mai University	7
Chinese University of Hong Kong	7
Delft University of Technology	7
CNRS (Centre National de la Recherche Scientifique)	7
Stanford University	7
University of Cambridge	7
Carnegie Mellon University	6
Educational Testing Service	5
The University of Texas at Austin	5
Microsoft Research	5
Massachusetts Institute of Technology	5
Shanghai Jiao Tong University	5
Tsinghua University	5
Concordia University	5
Shanghai Artificial Intelligence Laboratory	5
Nanyang Technological University	4
Google LLC	4
University of Pennsylvania	4
King's College London	4
University of Toronto	4
Simon Fraser University	4
Georgia Institute of Technology	4
Swiss Federal Institute of Technology of Lausanne	4
Columbia University	4
Karlsruhe Institute of Technology	4
Grenoble Computer Science Laboratory	4
California Institute of the Arts	4

Source: Authors, (2026).

IV.4 COUNTRY COLLABORATION

The USA dominated with 112 studies (26.29%), followed by China, the United Kingdom, Germany, Italy, France, Canada, Australia, and India. This reflects the presence of numerous active research groups in the field of robotics in these countries.

Table 6: Top Country by Publication Count.

Country/territory	Publications
United States	112
China	43
United Kingdom	43
Germany	30
Italy	25
France	22
Canada	21
Australia	17
India	15
Netherlands	14
Thailand	13
Hong Kong	12
Japan	9
South Korea	9

Source: Authors, (2026).

To normalize national contributions, a relative contribution index was considered.

$$RCI_i = P_i / \sum (P_j)_{1 \text{ to } n} \quad (3)$$

Where P_i is the publication count of country i . The United States exhibits the highest relative contribution, accounting for approximately 26.29% of the total publications, while all other countries individually contribute less than 11%. Based on publication intensity, contributing countries can be stratified into high-, medium-, and low-output tiers, indicating a hierarchical distribution of global research activity. This pattern suggests that robotics research output remains concentrated within a limited number of technologically advanced regions, with broader participation emerging across multiple countries.

IV.5 SUBJECT AREA ANALYSIS

Out of all subject area searches, we confined our study to the subject area of Arts and Humanities, as the inclusion of other subjects may broaden the aspect of study.

Table 7: Publication Count by Subject Area.

Subject area	Publications
Arts and Humanities	426
Computer Science	287
Social Sciences	225
Engineering	102
Psychology	48
Mathematics	24
Medicine	14

Source: Authors, (2026).

Figure 4 illustrates the keyword co-occurrence network created using VOSviewer with a minimum occurrence threshold of four. The network reveals key research themes represented by clusters of frequently co-occurring keywords in the dataset.

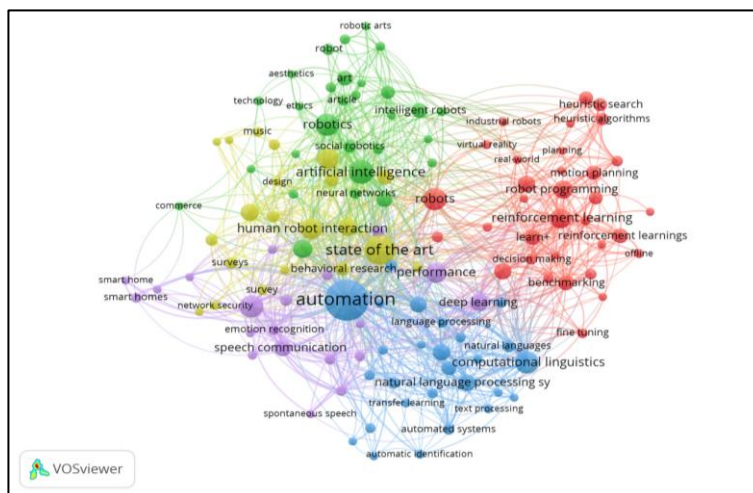


Figure 4: Co-occurrence Network of Keywords.
Source: Authors, (2026).

IV.6 CITATION & CO-CITATION ANALYSIS

Publish or Perish is a citation analysis tool that retrieves and analyzes Scopus data. It provides key metrics, such as total citations, h-index, and g-index, to assess the impact of authors and journals. It helps bibliometric studies to evaluate research performance and influence.

Table 8: Citation analysis from Public or Perish.

Query	export_19773b86-a015-4f25-b5b8-ea42a939f931_2025-07-27T12_21_47.869329218.ris [2025-07-27 17:52:02]
Source	RIS/Ref Manager
Papers	426
Citations	7479
Years	25
Cites, Year	299.16
Cites, Paper	17.56
Cites, Author	2705.43
Papers, Author	195.77
Authors, Paper	3.46
h_index	40
g_index	76
hc_index	40
hI_index	9.94
hI_norm	24
AWCR	1557.99
AW_index	39.47
AWCRpA	515.65
e_index	56.94
hm_index	24.42
Query Date	7/27/2025 18:26
Cites Author Year	108.21
hI_annual	0.96
h_coverage	64.7
g_coverage	78.9
Star count	43
Year first	2000
Year last	2025
ECC	7479
acc1	222
acc2	167
acc5	87
acc20	15
hA	17

Source: Authors, (2025).

Figure 9 presents a co-citation network of authors generated using VOSviewer with a minimum of four publications per author. It shows how frequently pairs of authors are cited together in the literature, indicating their intellectual influence and thematic similarities. The size of each node reflects the author's impact on citations.

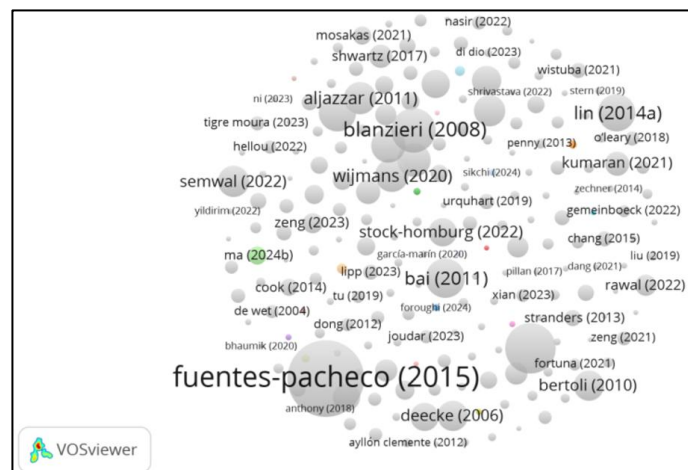


Figure 5: Author Co-citation Networks.

Source: Authors, (2026).

V. CHALLENGES, IMPLICATIONS, AND FUTURE DIRECTIONS

This study identifies the major challenges in applying robotics to the creative arts and examines their broader implications for authorship, cultural value, and artistic practice. Table 9 outlines the key challenges and their implications for future research. Despite these insights, this study has certain limitations. In the qualitative review, experiential or practice-based dimensions may have been overlooked as the field continues evolving. Similarly, bibliometric analyses have focused primarily on English-language publications within the Arts and Humanities, potentially omitting philosophical or cross-disciplinary contributions. Bridging the gap between theory and practice is essential for advancing this field. Enhancing accessibility to creative robotic tools and fostering interdisciplinary collaboration can further expand the scope and inclusivity of this field. Future work will aim to incorporate real-time bibliometric updates and cross-domain semantic mapping to capture emerging trends in robotics and automation in this evolving, creative landscape.

Table 9: Challenges and Implications of Robotics in Art.

Sr. No.	Challenge	Implications
1	Artistic Authorship & Creativity	Difficult to find authenticity of art [36]
2	Human touch	Difficulty in conveying genuine emotion
3	Technical Complexity	Need advance hardware, software and coding artist [31]
4	Interdisciplinary Collaboration	HRI (Human-Robot Interaction) leads to interdisciplinary innovation
5	Accessibility	High costs reduce accessibility, but barriers lowered for limited fine motor skill artist
6	Ethical and Legal Concerns	Dilemmas around machine authorship
7	Preservation and Longevity	Precise art long term conservation but comes with cost
8	Cultural Resistance	Division between traditional and tech-driven art communities
9	Perception of Value	Undervaluation or skepticism toward tech-assisted works

Source: Authors, (2026).

VI. CONCLUSION

This study presents a comprehensive bibliometric analysis of research trends, publication growth, and citation patterns in robotics, based on publications indexed in the Scopus database between 2000 and 2025. By examining productivity trends, leading journals, influential authors and institutions, collaboration networks, and citation structures, the analysis reveals the evolving intellectual landscape of robotics and automation research. A focused examination of creative and artistic applications demonstrates how interdisciplinary domains contribute to the diversification and expansion of robotics and automation research. The analysis conducted using Microsoft Excel revealed continuous growth in publication trends from 2000 to 2025, demonstrating increasing scholarly attention towards the integration of robotics, automation, and art. The bibliometric mapping identified clusters of leading journals, including IJSC and ICLR (2025), with prominent authors such as Kapur, A. and Portet, F. The leading institutions contributing to this domain are Chiang Mai University and the Chinese University of Hong Kong. The United States, the United Kingdom, and Germany emerged as the most productive countries. The primary subject areas represented were Arts and Humanities (426 publications) and Computer Science (287 publications), supported by several conference proceedings that bridge artistic inquiry and technological innovation. VOSviewer analysis revealed patterns of author collaboration, keyword co-occurrence, and co-citation networks, whereas Publish or Perish provided comprehensive citation metrics, underscoring the multidisciplinary nature of robotic research.

VII. AUTHOR'S CONTRIBUTION

Conceptualization: Ashish Batuklal Jagani and Nikunj Rachchh.

Methodology: Nikunj Rachchh.

Investigation: Ashish Batuklal Jagani and Nikunj Rachchh.

Discussion of results: Ashish Batuklal Jagani and Nikunj Rachchh.

Writing – Original Draft: Ashish Batuklal Jagani.

Writing – Review and Editing: Ashish Batuklal Jagani and Nikunj Rachchh.

Resources: Ashish Batuklal Jagani and Nikunj Rachchh.

Supervision: Ashish Batuklal Jagani.

Approval of the final text: Ashish Batuklal Jagani and Nikunj Rachchh.

VIII. DATA AVAILABILITY

The data used in this study were retrieved from the Scopus database. Due to database licensing restrictions, the raw data are not publicly available but can be accessed by authorized users directly from Scopus.

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