ENGINEER

international scientific journal

ISSUE
4, 2024 Vol. 2
ISSN
3030-3893

A bridge between science and innovation

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

ENGINEER

A bridge between science and innovation

ISSN 3030-3893

VOLUME 2, ISSUE 4

DECEMBER, 2024

engineer.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

ENGINEER

INTERNATIONAL SCIENTIFIC JOURNAL
VOLUME 2, ISSUE 4 DECEMBER, 2024

Founder of the international scientific journal “Engineer” – Tashkent State Transport University, 100167, Republic of Uzbekistan, Tashkent, Temiryo‘lchilar str., 1, office: 465, e-mail: publication@tstu.uz.

The “Engineer” publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

The journal is published 4 times a year and contains publications in the following main areas:

- Engineering;
- General Engineering;
- Aerospace Engineering;
- Automotive Engineering;
- Civil and Structural Engineering;
- Computational Mechanics;
- Control and Systems Engineering;
- Electrical and Electronic Engineering;
- Industrial and Manufacturing Engineering;
- Mechanical Engineering;
- Mechanics of Materials;
- Safety, Risk, Reliability and Quality;
- Media Technology;
- Building and Construction;
- Architecture.

Tashkent State Transport University had the opportunity to publish the international scientific journal “Engineer” based on the **Certificate No. 1183** of the Information and Mass Communications Agency under the Administration of the President of the Republic of Uzbekistan. **ISSN 3030-3893.** Articles in the journal are published in English language.

Bibliometric analysis of improving the performance system of human robot collaborative (HRC) assemblies based on standardization

I. Normatov[1][a]

[1]Andijan machine-building institute, Turin Polyechnic university in Tashkent, Uzbekistan

Abstract: In recent years, the use of Human-Robot Collaboration (HRC) in manufacturing systems has grown significantly, within the framework of Industry 4.0 and emerging Industry 5.0. The purpose of this study is to review and analyze the scientific papers written on improving performance systems of HRC based on standardization. 224 documents were obtained in the general search, after eliminating duplicates and applying certain inclusion and exclusion criteria, 65 papers were used for this review.

Keywords: human robot collaboration (HRC), standardization, quality control, assembly, industry 4.0 Efficiency, Scopus

1. Introduction

Collaborative robots, also known as cobots, are emerging as a promising technology in the field of robotics. These robots are designed to work alongside humans and are capable of performing a wide range of tasks, from simple pick-and-place operations to complex assembly tasks [1]. Due to their ability to work safely and efficiently alongside human workers, cobots have become increasingly popular in the manufacturing industry. In particular, they are widely used in product assembly where their use leads to increased productivity, improved quality and reduced costs [2].

Human-robot collaboration (HRC), or the collaboration between cobots and human operators, is one of the cornerstones of both Industry 4.0 and Industry 5.0, which focus on integrating digital technologies into the manufacturing process [3]. In these new industrial paradigms, there is a rising need for flexible and agile production systems that can quickly adapt to changes in demand and product design. In fact, in today's market, there is a growing demand for short runs of a wide variety of products. This is due to increasing customer demand for customisation, which is leading to an increase in the number of variants of the same product [4, 5]. This approach, called mass customisation, involves the use of flexible manufacturing processes that can quickly and cost-effectively adapt to the specific needs, preferences and requirements of customers [6].

Collaborative robots are well suited to these needs, as they can be easily programmed and reconfigured to perform a wide range of tasks and can work alongside human workers to improve overall efficiency and productivity. In addition, cobots can provide real-time data and feedback that can be used to optimise production processes and improve product quality. The ability to collect data in real time also allows cobots to be integrated into the digital twin of the entire production system [7] that is essential for the continuous monitoring of production processes and machine diagnostics.

Another key aspect in a competitive market is product quality. To achieve business success, it is essential to implement and improve quality control procedures [8]. The need for quality control in all production systems is to prevent non-conforming products from reaching the end customer or end-user [9]. Collaborative robots are increasingly used in quality control, as their ability to accurately perform repetitive and monotonous tasks can ensure the consistent production of high-quality products.

Furthermore, the use of cobots can also reduce the risk of injury or strain to human workers, resulting in increased productivity and a safer working environment. As a result, the adoption of cobots for quality control is a promising solution for improving product quality and competitiveness.

This study provides three main conclusions:

During the period 2002-2024, academic interest in this topic has increased and the keywords are HRC, standardization, quality control, assembly, industry 4.0;

A list of authors who have conducted scientific work on the basis of HRC is compiled;

The top 12 countries that conducted scientific work based on HRC are presented based on geographical analysis.

VOS viewer software was used to investigate the bibliometric research method and bibliographic display maps. There are three phases to the bibliometric research process, they are search criteria and source identification, software and data extraction, and then data analysis and interpretation. To our knowledge, several bibliometric comparative reviews on HRC have been published. This study serves as a continuation of the above related studies.

2. Research methodology

The Scopus search engine was used to find a comprehensive literature on the HRC of the theory. Scopus is one of the most comprehensive databases of citations and abstracts for peer-reviewed literature. Based on Figure 1, there are three steps in the bibliometric research process, which are search criteria and source identification, software and data acquisition, and then data analysis and interpretation.

Step 1, source identification with search criteria and bibliometric analysis, consists of scientific database retrieval and publication information collection from the Scopus database. In the search process, we initially identified documents with the terms "HRC". As a result of the bibliometric search, 224 documents were found, and when we synthesized them for the years 2002-2024, 194

[a] https://orcid.org/0000-0003-3732-4060

documents were identified. Bibliometric analysis was performed on the basis of 65 documents.

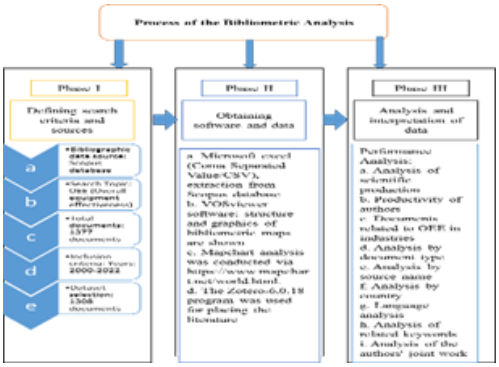


Figure 1. Process of the Bibliometric Analysis

In Phase 2, the results were downloaded from the Scopus database in three different formats. The following data was received in CSV format for data viewing through Microsoft Excel: Authors, affiliations, titles, publication years, cited publications, abstracts, author keywords and other important bibliographic information are included in the downloaded metadata, which must be examined and improved. The use of bibliometric approaches to describe the knowledge structure of HRC project is illustrated. The outcome of VOS viewer software analysis, such as Bibliometric coupling; includes co-citation analysis and keyword co-occurrence.

The site www.mapchart.net was effectively used in the formation of analyzes by countries. Zotero software was used to compile the list of references. The results obtained in the Phase 3rd stage were analyzed.

3. Results and Discussion

We can see the development dynamics of scientific research on determining Human Robot Collaboration (HRC) between 2002 and 2024 through Fig.2. Between these years, 65 scientific researches were conducted, and these indicators are fluctuated during the given years. In particular, the maximum increase points of the indicators are more than 10 in 2021 and 2023.

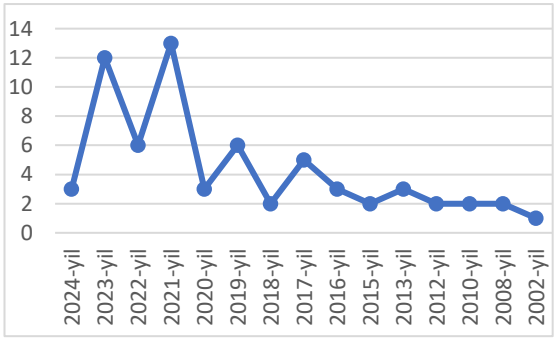


Figure 2. Growth of scientific production relating to HRC (www.scopus.com)

In the Scopus database, 159 authors conducted scientific research on the Human Robot Collaboration (HRC), and the top 24 authors who has done at least two scientific research were determined by Figure 3.

Fig. 3 is built on the basis of the Poretto diagram, and we can see the obtained results.

Fig.3 shows us that "Saenz, J." is considered the most effective among the authors who conducted research on HRC, and he is on the first place with 5 indicators. In addition, 8 of them has 3 and 15 of them has 2 indicators respectively.

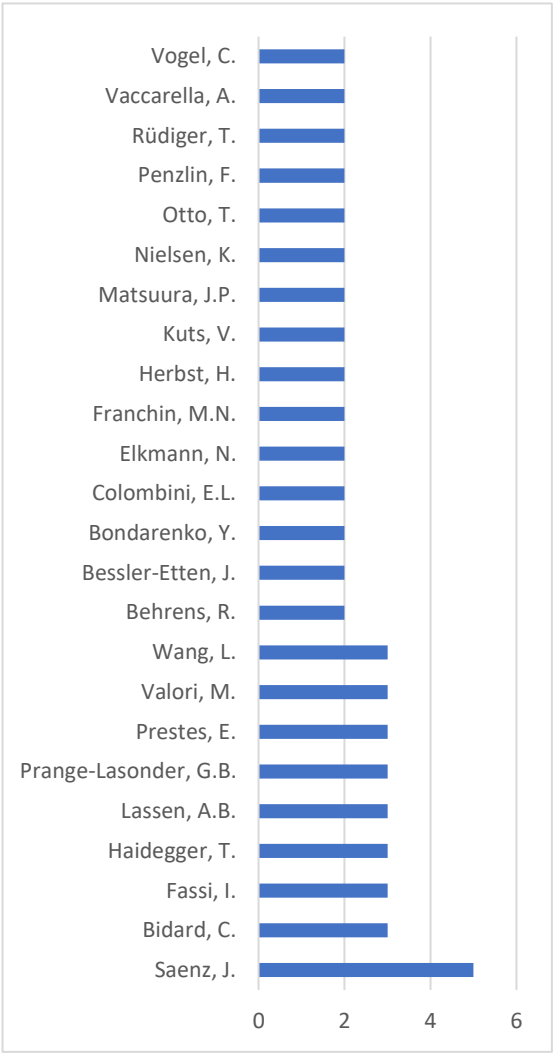
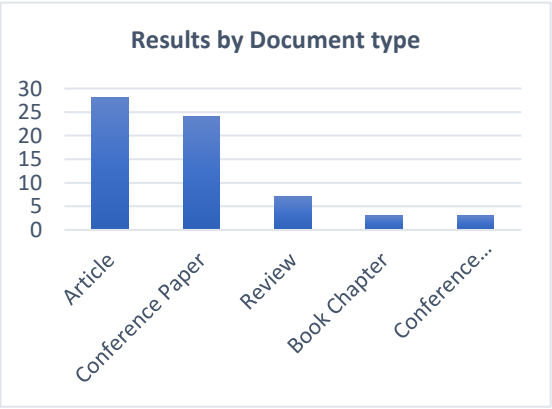


Figure 3. Top-24 authors who has done at least two scientific research

In the Scopus database, scientific works were carried out in 18 directions on the Human Robot Collaboration (HRC).

Almost 30% of the total scientific research was carried out in the direction of Computer Science and Engineering, 6% in the direction of Medicine.

Through Fig.4, we can see how the work done on HRC in the Scopus database is distributed by source. The main place in this is occupied by articles (43%), conference papers (36%), reviews (11%), book chapters and conference review



(5% each) respectively.

Figure 4. Results by document type

Fig. 5 shows which country is active in HRC research. Roughly 113 countries have conducted research on HCR. When we determined the top 12 in this regard, it is clear that most of the research was done by European countries almost 70%. If we go in detail Germany took first place with 17%, Italy with 13%, Brazil and the United States with 10% each respectively.

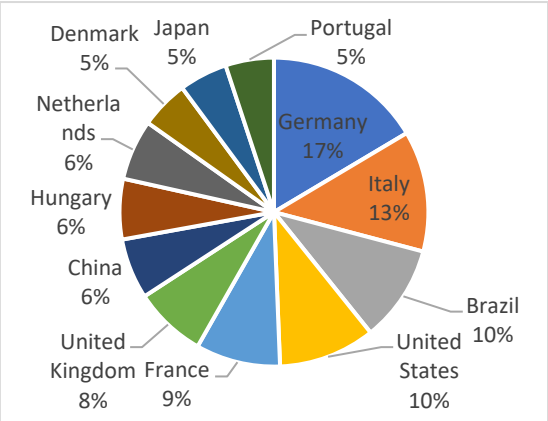


Figure 5. Results of Geographical analysis of research on HRC in 2002-2024

Fig. 6 was formed based on the information obtained from the Scopus database. The site www.mapchart.net was used to create a world map and place data.

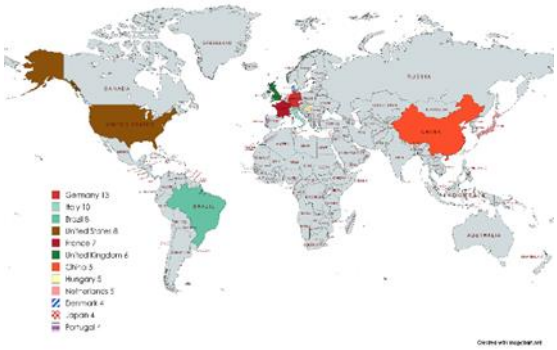


Figure 6. Geographical analysis of research on HRC in 2002-2024

4. Conclusion

Using bibliometric and network analysis, this paper provided an overview of the distribution of publications on Human Robot Collaboration (HRC). By querying the Scopus database with predefined keywords, a collection of 65 published papers was retrieved. There are three phases, first search criteria and source identification, second software and data acquisition, and third data analysis and interpretation. In summary, research findings on HRC using VOS Viewer have been identified. Collaborative robots have become popular in assembly processes because they can work alongside human workers to perform repetitive tasks without interruption or fatigue, increasing the efficiency of the production process. They also create a safer working environment by performing hazardous tasks that could put human workers at risk.

References

[1] Peshkin M, Colgate JE. Cobots. Ind Robot An Int J 1999;26:335–41.

[2] Weiss A, Wortmeier A-K, Kubicek B. Cobots in Industry 4.0: A Roadmap for Future Practice Studies on Human–Robot Collaboration. IEEE Trans Human-Machine Syst 2021;51:335–45.

[3] Krüger J, Lien TK, Verl A. Cooperation of human and machines in assembly lines. CIRP Ann 2009;58:628–46.

[4] ElMaraghy H, Schuh G, ElMaraghy W, Piller F, Schönsleben P, Tseng M, et al. Product variety management. Cirp Ann 2013;62:629–52.

[5] Faccio M, Minto R, Rosati G, Bottin M. The influence of the product characteristics on human-robot collaboration: a model for the performance of collaborative robotic assembly. Int J Adv Manuf Technol 2020;106:2317–31.

[6] Verna E, Genta G, Galetto M, Franceschini F. Planning offline inspection strategies in low-volume manufacturing processes. Qual Eng 2020.

[7] De Ketelaere B, Smeets B, Verboven P, Nicolaï B, Saeys W. Digital twins in quality engineering. Qual Eng 2022;34:404–8.

[8] Montgomery DC. Statistical quality control. 7th Ed. New York: John Wiley & Sons; 2012.

[9] Genta G, Galetto M, Franceschini F. Inspection procedures in manufacturing processes: recent studies and research perspectives. Int J Prod Res 2020;58:4767–88.

Information about the author

Normatov Islom
Andijan machine-building institute PhD student, Turin Polyechnic university in Tashkent assistant teacher
E-mail: islombeknormatov@gmail.com
Tel.: +998903808812
https://orcid.org/0000-0003-3732-4060

CONTEXT / MUNDARIJA