

# Global Robotics Market Dynamics: Trends, Growth, and Future Projections Based on Machine Learning

Nirav Mehta<sup>1,\*</sup>, Khunti Suresh<sup>2</sup>, Odedara Rajesh<sup>2</sup>, Karavadra Sanjay<sup>2</sup>, Kadachha Dhaval<sup>2</sup>

## Abstract

Robotics is advancing rapidly, fueled by technological innovations and a wide range of applications. In 2020, the global robotics market reached a valuation of \$40 billion, with industrial robotics comprising \$25 billion. Robots are increasingly being utilized in manufacturing, driving automation and enhancing efficiency. Countries like South Korea, Singapore, and Germany are leading in robot density, highlighting their role in enhancing productivity and competitiveness. The analysis presented in this paper is based on a comprehensive review of existing literature, industry reports, market analyses, and academic research publications related to the robotics industry. Primary and secondary sources of data were utilized to gather relevant information regarding the trends, growth drivers, challenges, and future projections of the global robotics market. The robotics industry, valued at \$40 billion in 2020, is rapidly advancing with industrial robotics reaching \$25 billion. High robot density in leading countries like South Korea and Singapore is boosting productivity. Service robotics, worth \$12 billion, are widely adopted, especially in healthcare. Significant R&D investments, such as the U.S. government's \$2 billion allocation in 2020, highlight a commitment to innovation. Projections suggest the industry could surpass \$150 billion by 2027, promising transformative impacts. Emphasizes the paper's value as a resource for industry stakeholders, policymakers, investors, and researchers in understanding current trends and leveraging future opportunities in the robotics industry.

**Keywords:** Robotics, global robotics market, industrial robotics, manufacturing sectors robots, service robotics, surgical robots, robot density

## INTRODUCTION

The field of robotics is experiencing rapid expansion and transformation, driven by technological breakthroughs and diverse applications. In 2020, the global robotics market surged to a valuation of \$40 billion, indicating a significant upward trajectory. Industrial robotics, accounting for \$25 billion of this market, are witnessing notable growth, particularly in automation and efficiency enhancements across manufacturing sectors. Noteworthy is the leadership of countries such as South Korea, Singapore, and Germany in robot density, underscoring the pivotal role of robotics in bolstering productivity and competitiveness. Moreover, the service robotics sector, valued at \$12 billion, is experiencing widespread adoption across various domains including healthcare, agriculture, and logistics. For instance, surgical robots are revolutionizing healthcare by enabling minimally invasive procedures with unprecedented precision [1].

### \*Author for Correspondence

Nirav Mehta, PhD  
E-mail: [mr.niravmehta1@gmail.com](mailto:mr.niravmehta1@gmail.com)

<sup>1</sup>Assistant Professor, Department of Computer Science, Shri V. J. Modha College of Information Technology College in Porbandar, Gujarat, India

<sup>2</sup>Student, Department of Computer Science, Shri V. J. Modha College of Information Technology College in Porbandar, Gujarat, India

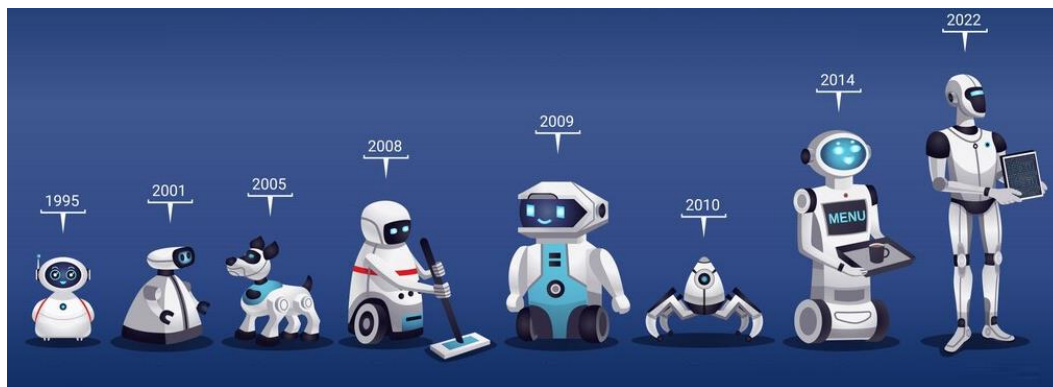
Received Date: November 20, 2024

Accepted Date: December 23, 2024

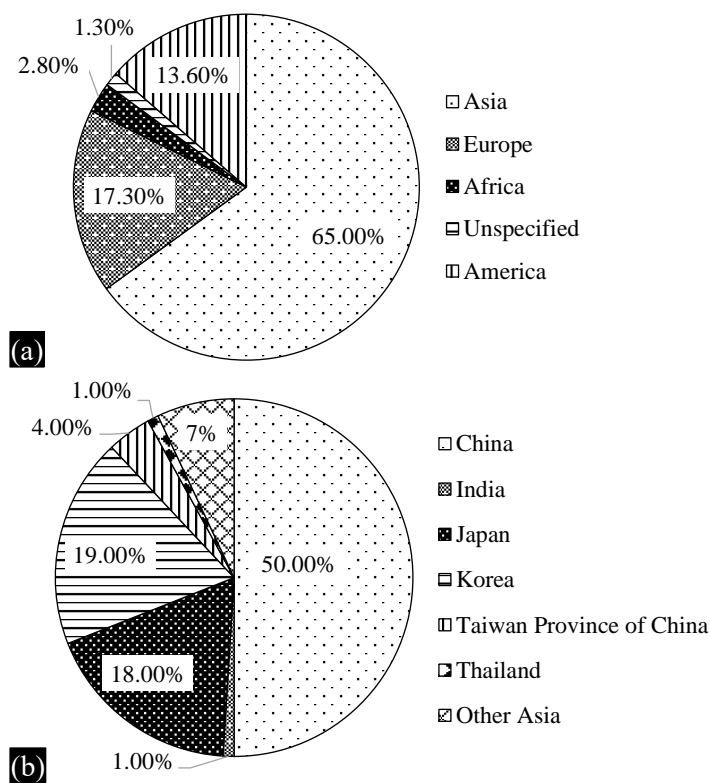
Published Date: December 31, 2024

**Citation:** Nirav Mehta, Khunti Suresh, Odedara Rajesh, Karavadra Sanjay, Kadachha Dhaval. Global Robotics Market Dynamics: Trends, Growth, and Future Projections Based on Machine Learning. Journal of Advancements in Robotics. 2025; 12(1): 1–8p.

Amidst this growth, substantial investments in research and development (R&D) underscore the paramount importance of innovation within the robotics domain. In 2020, the U.S. government allocated over \$2 billion towards robotics R&D,



**Figure 1.** Evolution of robotics.



**Figure 2.** Industrial robot usage.

demonstrating a dedicated commitment to technological advancement in this field. Looking ahead, robotics holds vast potential for disruptive innovation and societal transformation. With projections foreseeing a market value surpassing \$150 billion by 2027, it is evident that robotics will continue to exert a profound influence on industries and everyday life [2].

In the global robotics market, machine learning revolutionizes various aspects. It optimizes robot design by analyzing data and simulations, leading to more efficient models [3]. Machine learning enhances manufacturing processes by improving automation accuracy and adaptability, reducing errors and increasing productivity. It also aids in predictive maintenance, minimizing downtime by detecting equipment failures and optimizing maintenance schedules. Furthermore, in consumer robotics, machine learning enables robots to understand and respond to human behavior, enhancing usability in areas like home automation and healthcare. Overall, machine learning drives innovation, efficiency, and user experience across the global robotics market. Evolution of robots and chart is as shown in Figure 1 and usage of robots across regions shown in Figure 2.

## LITERATURE REVIEW

This literature review highlights various research studies focused on the advancements, methodologies, and limitations in the field of robotics, covering applications ranging from surgery to manufacturing and web detection as shown in Table 1.

**Table 1.** Literature review.

S.N.	Paper title	Authors	Year	Method	Limitation
1.	Robotics for surgery	D. Howe and Yoky Matsuoka [4]	1999	The method employed in the text is primarily descriptive, detailing how robotic technology enhances surgery through precision, stability, and dexterity, while also addressing challenges like clinician acceptance and cost concerns [5].	Limitations include the absence of concrete evidence, oversimplified cost considerations, and a narrow focus on technical aspects, neglecting broader ethical and social implications [6].
2.	Dominants and features of growth of the world market of robotics	V Makedon et al. [7]	2021	The method integrates logical deduction, statistical analysis, graphical representation, systemic examination, and comparative assessment to analyze the life cycle of technologies and goods, with a focus on interdisciplinary research through graphical presentation.	Limitations include the risk of technological unemployment alongside emerging job opportunities, necessitating effective measures for professional retraining and social support [8].
3.	The robotics market: development prerequisites, features and prospects	O Digilina et al. [9]	2021	The method involves analyzing the robotics market's development, emphasizing benefits and strategies to enhance Russia's competitiveness [10].	One limitation is Russia's relative lag in robotics adoption and development compared to leading countries, despite the potential for competitiveness in the global market through stimulating domestic demand and attracting investments.
4.	Industrial robotics and the global organisation of production	De Backer et al. [11]	2021	The method involves providing a historical overview of industrial robotics, proposing a four-generation classification, and detailing key characteristics and milestones from the 1950s to the end of the 20th century [12].	One limitation is the focus on historical evolution without addressing contemporary challenges or future implications, potentially overlooking current advancements in industrial robotics.
5.	A brief history of industrial robotics in the 20th century	A. Gasparetto and L. Scalera [13]	2019	The method examines the impact of rising robot use on production organization within global value chains, alongside government policies, assessing trends in offshoring and reshoring [14].	A limitation is the reliance on historical data and preliminary evidence, which may not fully capture the broader impact of robotics on production location and global value chains, especially considering ongoing digital advancements and data limitations.
6.	A survey of knowledge representation in service robotics	D Pauliu [15]	2019	The method entails examining knowledge representations in service robotics, discussing their gathering, representation, and utilization for problem-solving, along with exploring associated learning models and addressing challenges in robot learning.	A limitation is the lack of discussion on the efficiency of representation and retrieval algorithms, focusing instead on principles behind effective knowledge representation for robots to utilize their full potential.

S.N.	Paper title	Authors	Year	Method	Limitation
7.	Robotics software engineering: a perspective from the service	S. Garcia et al. [16]	2020	The method comprises semi-structured interviews with industrial practitioners and a survey with robotics domain respondents to evaluate robotics software engineering practices, emphasizing processes, tools, challenges, and solutions [17].	The study's reliance solely on practitioner interviews and surveys may limit the breadth of insights, potentially overlooking perspectives from academia and other industry sectors in robotics software engineering.
8.	A survey on the application trends of home service robotics	Zachiotis GA, et al. [18]	2018	The authors conducted a survey to identify and overview dominant application areas of home service robots, analyzing functional capabilities to highlight key enabling features.	Development of home service robots is primarily confined to research-oriented projects due to challenges in user interaction, cybersecurity, ethics, and provider reliability [19].
9.	A survey on actuators-driven surgical robots	Le HM, et al. [20]	2016	The study reviews four transmission systems in actuators-driven surgical robots, assessing their designs, modeling, and control, and offers recommendations for future advancements in the field.	A limitation is the potential bias towards actuator-driven surgical robots, potentially overlooking alternative robotic systems and their applications in surgery.
10.	A review on recent advances in soft surgical robots for endoscopic applications	H. Naghibi et al. [21]	2019	Reviewing key Minimally Invasive Surgery (MIS) and Natural Orifice Translumenal Endoscopic Surgery (NOTES) studies to identify limitations in current endoscopic devices, focusing on implementing soft robotics [22].	One limitation is the exclusive focus on soft surgical endoscopes, potentially neglecting advancements in traditional rigid endoscopes and their applicability in minimally invasive surgery.
11.	A research review on clinical needs, technical requirements, and normativity in the design of surgical robots	Roemi Fernández et al. [23]	2017	This study examined clinical and technical aspects of robotic surgery, defining safety metrics and reviewing standards for industry growth and system integration [22].	Despite ongoing efforts to define metrics and regulatory standards, the field of surgical robotics is still in its early stages, with challenges remaining in achieving widespread adoption and integration into existing surgical practices.
12.	Literature review of mobile robots for manufacturing	Michael Schneier et al. [24]	2015	The authors conducted a review of mobile robots for manufacturing, covering types, selection criteria, localization, control, safety in human collaboration, standards, and advanced applications [25].	Challenges remain in ensuring product specifications, comparing products, and developing flexible task programming for mobile robots in manufacturing, potentially impeding their widespread adoption despite advancements.
13.	Robots, skill demand and manufacturing in US regional labour market	Benjamin Kraft et al. [26]	2020	Reviewing contributions to the jobs/artificial intelligence (AI) debate, proposing a modified approach, and analyzing two models using robot stock data and online job postings to assess robotics' impact on US manufacturing employment at the metropolitan level [27].	Limitations include a narrow focus on manufacturing, potentially overlooking broader impacts, and a reliance on econometric approaches, neglecting insights from qualitative methods into the complex relationship between robot adoption and labor dynamics.

S.N.	Paper title	Authors	Year	Method	Limitation
14.	Density-based control of multiple robots	Manish Kumar et al. [28]	2011	Introduces density-based control using a modified SPH method for multiple robots, featuring decentralized controllers with collision avoidance, enhancing swarm control capabilities [29].	The paper lacks extensive real-world validation and theoretical underpinnings, potentially limiting its applicability and generalizability to diverse robotic systems [30].
15.	A density based clustering approach for web robot detection	Mahdieh Zabihi et al. [31]	2014	This study proposes DBC_WRD, a density-based clustering method for web robot detection, using behavioral patterns and invariant features, achieving high performance in supervised evaluations compared to existing algorithms.	The method, DBC_WRD, may struggle to accurately differentiate between malicious and non-malicious web robots, warranting future research in this area [32].

## FINDINGS

Robotics can be effectively integrated into the computer field to streamline processes, enhance efficiency, and perform tasks that require precision and automation. Here are several applications of robotics in the computer field:

1. *Manufacturing of computer components:* Robotics can be employed in the manufacturing process of computer components such as circuit boards, microchips, and hard drives. Automated robotic arms can perform tasks like soldering, assembly, and quality inspection with high precision and efficiency [33].
2. *Data center management:* Robotics can assist in managing data centers by automating tasks such as server provisioning, maintenance, and monitoring. Automated robotic systems can ensure optimal performance, scalability, and reliability of computer networks and infrastructure.
3. *Network security:* Robotics can play a role in enhancing network security by automating tasks such as intrusion detection, threat analysis, and incident response. Autonomous security robots can patrol networks, identify vulnerabilities, and respond to security threats in real-time.
4. *Robotic process automation (RPA):* In the computer field, RPA involves the use of software robots to automate repetitive tasks such as data entry, file manipulation, and system maintenance. RPA can streamline workflows, reduce errors, and improve overall operational efficiency.
5. *Education and research:* Robotics can be used in educational institutions and research laboratories to teach computer programming, artificial intelligence, and robotics concepts. Students and researchers can learn about computer algorithms, sensors, and control systems through hands-on experimentation with robotic platforms [34].

## RESULTS

1. *Market valuation:* The robotics industry was valued at \$40 billion in 2020, with industrial robotics comprising \$25 billion, indicating substantial market size and growth [35].
2. *Sector breakdown:* Industrial robotics are witnessing notable growth, particularly in sectors like manufacturing, while service robotics, valued at \$12 billion, are experiencing widespread adoption across domains such as healthcare [36].
3. *Regional leadership:* Leading countries such as South Korea, Singapore, and Germany demonstrate high robot density, highlighting their role in driving productivity and competitiveness through robotics adoption [37].
4. *Investment in R&D:* Significant investments in research and development, such as the U.S. government's allocation of over \$2 billion in 2020, underscore the commitment to innovation within the robotics industry [38].
5. *Future outlook:* Projections suggest a promising future for the robotics industry, with the market expected to surpass \$150 billion by 2027, promising transformative impacts on industries and everyday life [39].

---

## CONCLUSION

In conclusion, the rapid evolution of robotics, underscored by technological advancements and diverse applications, has propelled the global robotics market to a valuation of \$40 billion in 2020. With industrial robotics comprising a significant portion at \$25 billion, countries like South Korea, Singapore, and Germany are leading in robot density, enhancing productivity and competitiveness in manufacturing sectors. Moreover, the widespread adoption of service robotics, valued at \$12 billion, particularly in healthcare, highlights the transformative impact of robotics across various domains. Substantial investments in research and development, exemplified by the U.S. government's allocation of over \$2 billion in 2020, signify a commitment to innovation within the robotics industry. Looking ahead, projections suggest a promising trajectory, with the industry expected to surpass \$150 billion by 2027, promising further disruptive innovation and societal transformation.

This conclusion emphasizes the significance of the paper as a valuable resource for stakeholders, policymakers, investors, and researchers in navigating current trends and leveraging future opportunities in the dynamic field of robotics.

## REFERENCES

1. Thakrar Z, Gonsai A. Predicting fishing effort: data collection for machine learning model using scientific and indigenous method. In: Choudrie J, Mahalle PN, Perumal T, Joshi A, editors. International Conference on Information and Communication Technology for Intelligent Systems. Singapore: Springer Nature; 2023. pp. 207–215.
2. Thakrar Z, Gonsai A. HEFZ–RNNLSTM: an ingenious deep learning hybrid model for ensemble-based prediction of potential fishing zone areas in the Indian Ocean. *J Harbin Eng Univ.* 2023; 44 (7): 714–721.
3. Mehta N, Rathod P, Raychura B, Bokhiriya S. A comprehensive review of digital transformation in healthcare: addressing privacy, security, and usability challenges in electronic health records. *Res Rev J Med Sci Technol.* 2024; 13 (3): 9–14.
4. Howe RD, Matsuoka Y. Robotics for surgery. *Annu Rev Biomed Eng.* 1999; 1 (1): 211–240.
5. Krishnaprabu S. E-governance in education sector. *Int J Recent Technol Eng.* 2019; 8 (1C2): 958–961.
6. Mehta N, Thaker H. Data collection for a machine learning model to suggest Gujarati recipes to cardiac patients using Gujarati food and fruit with nutritive values. In: Choudrie J, Mahalle PN, Perumal T, Joshi A, editors. International Conference on Information and Communication Technology for Intelligent Systems. Singapore: Springer Nature; 2023. pp. 271–281.
7. Makedon V, Mykhailenko O, Vazov R. Dominants and features of growth of the world market of robotics. *Eur J Manage Issues.* 2021; 29 (3): 133–141.
8. Salet JK, Gokani PK. Design and develop e-governance system for facilitation between government and citizens. *J Emerg Technol Innov Res.* 2019; 6 (6): 508–516.
9. Digilina O, Teslenko I. The robotics market: development prerequisites, features and prospects. *SHS Web Conf.* 2021; 101: 02029.
10. Salet J, Rakholia K, Rahul O, Jignesh K, Jay K. Navigating the evolution: current trends and future directions in programming languages. *Int J Innov Res Computer Sci Technol.* 2024; 12 (4): 43–46.
11. De Backer K, DeStefano T. Robotics and the global organisation of production. In: von Braun J, Archer SM, Reichberg GM, Sánchez Sorondo M, editors. *Robotics, AI, and Humanity: Science, Ethics, and Policy.* Cham, Switzerland: Springer; 2021. pp. 71–84.
12. Salet JK, Parekh B. Implementation of e-governance framework for rural areas of India. In: Goar V, Kuri M, Kumar R, Senjyu T, editors. *Advances in Information Communication Technology and Computing: Proceedings of AICTC 2022.* Singapore: Springer Nature; 2023. pp. 341–352.
13. Gasparetto A, Scalera L. A brief history of industrial robotics in the 20th century. *Adv Historical Stud.* 2019; 8: 24–35.
14. Kanjibhai SJ, Gokani PK. Effective role of e-governance in higher education. *NOLEGEIN – J Corporate Business Laws.* 2020; 3 (1): 1–6.

15. Paulius D, Sun Y. A survey of knowledge representation in service robotics. *Robotics Autonom Syst.* 2019; 118: 13–30.
16. Garcia S, Strüber D, Brugali D, Berger T, Pelliccione P. Robotics software engineering: a perspective from the service robotics domain. In: *Proceedings of the 28th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering, Virtual Event, November 8–13, 2020.* pp. 593–604.
17. Mehta N. Fuzzy logic driven nutrition-based recommendation system for Gujarati cardiac patients: integrating cultural preferences and patient feedback. *J Computer Technol Appl.* 2024; 15 (1): 59–83.
18. Zachiotis GA, Andrikopoulos G, Gornez R, Nakamura K, Nikolakopoulos G. A survey on the application trends of home service robotics. In: *2018 IEEE international conference on Robotics and Biomimetics (ROBIO), Kuala Lumpur, Malaysia, December 12–15, 2018.* pp. 1999–2006.
19. Mehta N, Thaker H. Study of nutrition-based recommender system for diabetes and cardiovascular patients based on various machine learning techniques: a systematic review. In: Goar V, Kuri M, Kumar R, Senjyu T, editors. *Advances in Information Communication Technology and Computing: Proceedings of AICTC 2022.* Singapore: Springer Nature; 2023. pp. 317–327.
20. Le HM, Do TN, Phee SJ. A survey on actuators-driven surgical robots. *Sensors Actuators A Phys.* 2016; 247: 323–354.
21. Gifari MW, Naghibi H, Stramigioli S, Abayazid M. A review on recent advances in soft surgical robots for endoscopic applications. *Int J Med Robotics Computer Assist Surg.* 2019; 15 (5): e2010.
22. Kishorchandra PV, Rajnikant AP. A critical analysis using data mining techniques to predict students' educational performance: analyzing the impact of non-intellectual parameters. In: Goar V, Sharma A, Shin J, Mridha MF, editors. *Deep Learning and Visual Artificial Intelligence: Proceedings of ICDLAI 2024.* Singapore: Springer; 2024. pp. 205–213.
23. Díaz CE, Fernández R, Armada M, García F. A research review on clinical needs, technical requirements, and normativity in the design of surgical robots. *Int J Med Robotics Computer Assist Surg.* 2017; 13 (4): e1801.
24. Schneier M, Bostelman R. Literature Review of Mobile Robots for Manufacturing. [Online]. NISTIR 8022. Available at [https://tsapps.nist.gov/publication/get\\_pdf.cfm?pub\\_id=915942](https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=915942)
25. Pandya V. Role of e-learning based higher education in sustainable development. *E-Commerce Future Trends.* 2023; 7 (2): 20–23.
26. Leigh NG, Kraft B, Lee H. Robots, skill demand and manufacturing in US regional labour markets. *Cambridge J Regions Econ Soc.* 2020; 13 (1): 77–97.
27. Pandya V, Monani D, Aahuja D, Chotai U. Traditional vs. modern education: a comparative analysis. *Int J Res Anal Rev.* 2024; 11 (2): 172–183.
28. Zhao S, Ramakrishnan S, Kumar M. Density-based control of multiple robots. In: *Proceedings of the 2011 American Control Conference, San Francisco, CA, USA, June 29–July 1, 2011.* pp. 481–486.
29. Thakrar Z, Buddhadev KJ, Bhatt HD, Bhadrecha NH, Bhogayata MD. Swimmer safety alert system for encounters with unidentified marine aquatic animals. *Int J Innov Res Computer Sci Technol.* 2024; 12 (4): 47–51.
30. Kishorchandra PV, Vadher B, Meghnathi R, Raychura M, Keshwala K. A comprehensive review – building a secure social media environment for kids – automated content filtering with biometric feedback. *Int J Innov Res Computer Sci Technol.* 2024; 12 (4): 25–30.
31. Zabihi M, Jahan MV, Hamidzadeh J. A density based clustering approach for web robot detection. In: *2014 4th International Conference on Computer and Knowledge Engineering (ICCKE), Mashhad, Iran, October 29–30, 2014.* pp. 23–28.
32. Thakrar Z, Gonsai A. Combined study of oceanography and indigenous method for effective fishing. In: Yadav S, Haleem A, Arora PK, Kumar H, editors. *Proceedings of Second International Conference in Mechanical and Energy Technology: ICMET 2021.* Singapore: Springer Nature; 2022. pp. 147–155.
33. Thakrar Z, Gonsai A. Comparing fish finding techniques using satellite and indigenous data based on different machine learning algorithms. In: Goar V, Kuri M, Kumar R, Senjyu T, editors. *Advances in Information Communication Technology and Computing: Proceedings of AICTC 2022.* Singapore: Springer Nature; 2023. pp. 329–340.

- 
34. Kumar KS, Kumar TC, Rajan MS, Thakrar ZT, Cheepurupalli NR, Mungekar PR. Based on 5G internet of things technology (IoT), the integrity of agricultural products and the sustainability of the origin's ecological environment. *J Informatics Educ Res.* 2024; 4 (2): 2141–2147.
  35. Bouwman CH, Fuller K, Nain AS. Market valuation and acquisition quality: empirical evidence. *Rev Financial Stud.* 2009; 22 (2): 633–679.
  36. Nadikattu AK. Influence of artificial intelligence on robotics industry. *Int J Creative Res Thoughts.* 2021; 9 (1): 4708–4714.
  37. Normann R. Regional leadership: a systemic view. *Systemic Pract Action Res.* 2013; 26: 23–38.
  38. Benmelech E, Zator M. Robots and Firm Investment. [Online]. Cambridge, MA, USA: National Bureau of Economic Research; 2022. Available at [https://www.nber.org/system/files/working\\_papers/w29676/w29676.pdf](https://www.nber.org/system/files/working_papers/w29676/w29676.pdf)
  39. Delmerico J, Mintchev S, Giusti A, Gromov B, Melo K, Horvat T, Cadena C, Hutter M, Ijspeert A, Floreano D, Gambardella LM. The current state and future outlook of rescue robotics. *J Field Robotics.* 2019; 36 (7): 1171–1191.