



THE MODERN APPROACH TO PROBLEM-SOLVING IN MECHANICAL ENGINEERING - APPLICATION OF ARTIFICIAL INTELLIGENCE

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ABSTRACT: This study explores the integration of artificial intelligence (AI) as a contemporary problem-solving approach in mechanical engineering. Beginning with an overview of artificial intelligence, the paper delves into its applications within various industries, focusing on its impact. By drawing insights from recent literature, the study examines how AI technologies have reshaped problem-solving methodologies. Through a detailed exploration of current studies and advancements, the research highlights AI's role in enhancing efficiency, precision, and innovation in processes. Ultimately, the paper aims to provide a comprehensive understanding of artificial intelligence's significance in modern problem-solving strategies employed within the mechanical engineering domain.

KEY WORDS: *Artificial intelligence, efficiency, mechanical engineering, research*

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SAVREMENI PRISTUP REŠAVANJU PROBLEMA U MAŠINSTVU - PRIMENA VEŠTAČKE INTELIGENCIJE

REZIME: Ova studija istražuje integraciju veštačke inteligencije (AI) kao savremenog pristupa rešavanju problema u mašinstvu. Počevši od pregleda veštačke inteligencije, rad se bavi njenim primenama u različitim industrijama, fokusirajući se na njen uticaj. Izvlačenjem uvida iz novije literature, studija ispituje kako su AI tehnologije preoblikovale metodologije rešavanja problema. Kroz detaljno istraživanje trenutnih studija i napretka, istraživanje naglašava ulogu veštačke inteligencije u poboljšanju efikasnosti, preciznosti i inovacija u procesima. Na kraju, ovaj rad ima za cilj da pruži sveobuhvatno razumevanje značaja veštačke inteligencije u savremenim strategijama rešavanja problema koje se koriste u domenu mašinstva.

KLJUČNE REČI: *Veštačka inteligencija, efikasnost, mašinstvo, istraživanje*

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INTRODUCTION

Artificial Intelligence represents a growing scientific discipline that explores and develops the theory, technology, and application systems for simulating and extending human intelligence, including disciplines such as psychology, cognitive sciences, science of thinking, computer science, system science, and biosciences [1]. Artificial Intelligence essentially simulates the process of human thought data interaction with the hope of understanding the essence of human intelligence and then producing a smart machine. This intelligent machine can react and solve problems in a similar way to a human being [2], [3].

With the continuous advancement of science and technology, mechanical engineering is also constantly evolving and changing, moving from traditional mechanical engineering to electromechanical engineering. Its level of automation and intellectualization is continuously improving, entering a new stage of development [4].

The application of AI technology is based on the assumption of computer technology development, which has improved computer technology through its analysis to achieve the realization of intelligent technology. When intelligent technology is applied in mechanical engineering, it mainly achieves the automation of mechanical engineering control [5], [6]. The applications of artificial intelligence in mechanical engineering are not just the use of computer technology, but also the combination with information technology, psychology, linguistics, and other areas of knowledge.

The aim of this paper is to report on the composition and development of AI, as well as the relationship between artificial intelligence and mechanical engineering. Most importantly, the goal is to explore how artificial intelligence is applied in the field of mechanical engineering.

1 ARTIFICIAL INTELLIGENCE IN MECHANICAL ENGINEERING AND AUTOMOTIVE INDUSTRY

In the modern era, the application of artificial intelligence and machine learning (ML) in mechanical engineering and the automotive industry is becoming increasingly significant due to the potential this technology offers in optimizing problem-solving, improving design processes, and enhancing production efficiency. Subsequently, there will be a review of contemporary literature in this field to further explore current studies, advancements, and applications of artificial intelligence in these areas.

Research [7] delves into the realm of smart computer programs that possess the ability to learn independently, showcasing their potential in enhancing machine design. It expounds on the fundamental aspects of these intelligent programs, juxtaposing various types and shedding light on the tools and data utilized by engineers in this domain. Global research examples demonstrate the current efficacy of these programs in the realm of machine part design. Despite the potential for high costs and time-intensive processes in optimizing these intelligent programs, the paper underscores the evolving landscape towards increased efficiency and affordability. To propel further advancements, the paper concludes by

proposing areas for researchers to explore, aiming to continually refine the application of smart programs in the realm of machine design.

Authors [8] explore into the impact of new computer technologies on China's machine-making industry, emphasizing its growth and enhanced efficiency. It elucidates the role of these technologies under the umbrella term of AI, likening it to empowering computers to think autonomously and learn tasks independently. Furthermore, the study underscores the advantageous effects of implementing artificial intelligence in optimizing the performance of machines, thereby boosting productivity and positively impacting the economy. As countries worldwide focus on harnessing these technologies to maintain competitiveness in production, it becomes evident that the integration of traditional machine-making practices with contemporary computer technologies holds significant promise. In its closing remarks, the paper advocates for further exploration and research on how artificial intelligence can continuously elevate the machinery industry, showcasing a path towards ongoing enhancement and innovation.

Artificial intelligence, a sophisticated form of computer technology, is increasingly integrated into the manufacturing process, aiding in the identification of flaws, quality checks, and enhancing workplace safety standards [9]. This innovative technology has seamlessly integrated itself into daily life, evident in the prevalence of smart appliances like dishwashers and sweepers, showcasing its fusion with machine production. Its crucial role lies in ensuring precise manufacturing standards, consequently improving work efficiency and ensuring the safety of individuals. The advent of artificial intelligence is ushering in a transformative wave in the machine-making industry, facilitating automation and smarter functioning in factory settings. By leveraging artificial intelligence, individuals can streamline the process of sourcing required machine parts through image recognition or computer models, alleviating the need for memorizing intricate technical details.

The special issue of the journal [10] presents 10 new studies focusing on the practical applications of AI in various aspects of manufacturing processes. These studies showcase how AI plays a crucial role in optimizing manufacturing operations, from machine maintenance and production planning to intricate tasks such as laser metal shaping, plastic component integration, and complex assembly procedures. The research emphasizes how AI technology enhances efficiency, problem-solving capabilities, and overall productivity in manufacturing settings.

Group of authors [11] reviewed how AI, especially artificial neural networks (ANNs), is used for checking machine health, analyzing machine parts, and improving designs. It's still early days for using ANNs in this way, but they're already showing they can make systems more efficient. The paper also talks about a special kind of AI network that helps identify problems in machines that move back and forth really fast. This AI network uses sound, oil, and other signals to figure out what's wrong with the machines. The research is important because it can help factories and businesses save money by catching problems early.

Investigation [12] demonstrates how AI has been used in engineering over the last five years, focusing on things like learning from data, making smart choices, and improving designs. Researchers are paying more attention to AI that can explain how it makes decisions, and they're finding that AI can do things faster and more accurately than humans in some cases. It's important to pick the right kind of AI for each engineering problem to get the best results.

Author [13] reports how AI can plan the best path for a robotic arm to move, using a method called the ant colony algorithm. The ant colony algorithm is inspired by how real ants find

the shortest path to food, but the paper talks about making this method even better. By improving the ant colony algorithm, the robotic arm can work faster and more efficiently, which is great for businesses that use these machines. The paper tested the new method and found that it was indeed better than the original, making it a promising tool for future mechanical engineering projects.

Mechanical engineers design machines, and now they're using AI, which is like a smart computer helper, to make better designs [14]. AI has been around since 1956 and is really good at tasks like planning how parts move and figuring out forces in machines. Sometimes machines are too complicated, and that's when AI becomes super useful for mechanical engineers. The paper shows how AI and mechanical engineering are starting to work together, which is a new kind of teamwork between computer and mechanical engineers. There are examples in the paper of how AI has helped in designing machines, which might inspire more cool projects.

The next research [15] explores how smart computer programs are used to make the process of designing gear-reducing machines more efficient. It discusses the challenge of using the internet to quickly access and share design tools, data, and knowledge for creating these machines. A new AI algorithm, which is a set of rules for the computer to follow, is introduced to improve the design process. The paper also talks about using a neural network model, which is a computer system designed to think like a human brain, to make the design system stronger. Finally, the research includes tests to show how these AI methods can make the manufacturing of gear-reducing machines better.

The study [16] discusses how to use computer programs to make designing parts for machines easier and better by using AI, which is like a smart helper that can think and learn. It talks about the problem of getting and sharing design tools and information over the internet quickly and easily. The paper introduces a new smart AI method to improve how machines are designed. To make the design system more reliable, it uses a special kind of AI that works like the human brain. The research also includes tests to show that these AI methods can improve the making of machines.

The paper [17] discusses the importance of AI, focusing on three main AI technologies: physical robot technology, machine learning, and RPA (Robotic Process Automation). Physical robots, which are a crucial part of AI development, are changing various industries by performing tasks that humans used to do. Machine learning, a type of AI that allows machines to learn from experience, is used to make better decisions in mechanical and electronic engineering. RPA is a technology that automates repetitive tasks, which helps in making the manufacturing process more efficient and of higher quality.

In the last 20 years, this technology has helped many parts of life and work, like business and space, and has made things better and more efficient. The paper [18] talks about how artificial intelligence is now playing a big role in mechanical engineering, helping to solve problems and improve experiments and the way machines are made (Figure 1). By using advanced technology and smart computer programs, artificial intelligence can find and fix issues in mechanical automation, which is when machines work on their own without people having to control them all the time. The article aims to look closely at how artificial intelligence can be used in the area of making machines work automatically and the benefits it brings.

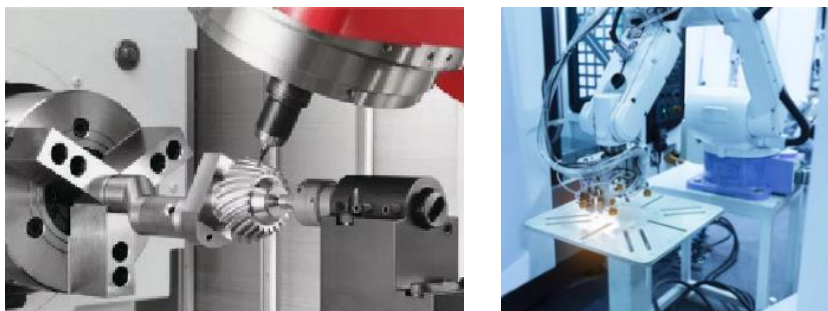


Figure 1 Application of artificial intelligence in mechanical processing [18]

The rapid advancement of AI in the automotive industry is astonishing. Looking ahead, the future of AI in this sector is increasingly intriguing. Projections suggest that by 2033, the market will expand to an impressive \$35.71 billion. This surge reflects AI's transformative influence on the automotive sector, highlighting its essential role within the industry [19].



Figure 2 Automotive artificial intelligence market size 2023 (USB Billion) [19]

AI is not only transforming automotive technology on the road, but also reshaping customer experiences. The integration of AI enhances digital car shopping and ownership by making them more user-friendly and engaging. This progression is expected to boost the online car-buying market to \$754.2 billion by 2024, highlighting the growing demand for personalized, AI-driven services.

The industry stands on the edge of a major shift as AI integrates data and innovations throughout the automotive spectrum. By 2031, the automotive data analytics market is projected to reach \$15,387 million. AI's ability to analyze data transforms decision-making, improves real-time vehicle diagnostics, and changes maintenance and safety practices. AI in the automotive sector is driving a revolution focused on efficiency and safety, enhancing the human experience. Each innovation, from AI-driven design to smart cars, contributes to a vision of the future where technology and transportation seamlessly merge.

According to study [20], AI is poised to transform automobile manufacturing. As AI applications grow, from driver assistance to AI-powered fleet management, companies are revising operations to enhance performance and productivity through AI diagnostics. The current integration of AI in vehicles signals a shift toward self-driving cars becoming standard, with autonomous vehicles projected to comprise 10-15% of new car sales by 2030. AI is not just improving the driving experience; it is redefining the automotive industry, promoting a future of interconnected efficiency, safety, and innovation.

In the provided literature, there is a clear focus on the integration and impact of AI across various fields, including the automotive industry. These discussions highlight the significant potential of AI in enhancing problem-solving capabilities, automation, and efficiency within the engineering domain. Specifically, in the automotive sector, AI is pivotal in developing advanced driver assistance systems and optimizing manufacturing processes to create more efficient vehicles. The papers collectively underscore the transformative role of AI in revolutionizing design processes, improving machine performance, and streamlining manufacturing operations. Additionally, the texts stress the importance of AI in ensuring precise standards, enhancing workplace safety, and accelerating advancements in technological innovations. The studies also showcase how AI is increasingly being adopted in diverse applications, ranging from machine maintenance and part optimization to complex problem-solving tasks. Overall, the papers present a compelling argument for the continued integration and exploration of AI technologies in engineering practices to drive efficiency, productivity, and innovation in the industry.

2 CONCLUSION

The integration of artificial intelligence and machine learning into mechanical engineering offers numerous advantages that significantly enhance various aspects of the field. One of the primary benefits is improved design. AI and ML allow engineers to create more efficient mechanical components and parts by analyzing data from previous projects. This analysis leads to more accurate designs that better meet the specific needs of each project.

Another advantage is automation. AI and ML can automate certain tasks, reducing the time and effort required to complete them and minimizing the possibility of errors. This not only streamlines the workflow but also enhances reliability and precision in executing repetitive tasks.

The implementation of AI and ML also leads to substantial cost savings. By optimizing the design and manufacturing processes, engineers can lower production costs, making projects more cost-effective and reducing overall expenses. This economic efficiency is particularly advantageous in large-scale production environments.

Furthermore, AI and ML significantly increase productivity. Automating routine tasks permits engineers to dedicate more time and effort to complex problems that require innovative and creative thinking. This shift in focus boosts the overall productivity of engineering teams, enabling them to achieve more in less time.

Lastly, the quality of mechanical products is greatly improved through the use of AI and ML. By analyzing data from past projects, engineers can pinpoint areas for improvement and implement changes that enhance the final product's quality. This results in superior mechanical components that meet higher standards of performance and durability.

In summary, the integration of AI and ML in mechanical engineering and automotive industry leads to improved design accuracy, task automation, cost reduction, increased productivity, and higher product quality, collectively advancing the field in notable ways.

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REFERENCES

- [1] Liu, J. N.: "Discussion on Relation between Mechanical Electronic Engineering and Artificial Intelligence," *Journal of Tianjin Vocational Institutes*, Vol. 20, 2018, pp. 76-79.
- [2] Russell, S., Norvig P.: "Artificial Intelligence: A Modern Approach," 4th ed. Prentice Hall, 2020.
- [3] Wen, W. H.: "Application of artificial intelligence technology in mechanical and electronic engineering," *Automation and instrumentation*, Vol. 2, 2016, pp. 96-97.
- [4] Lei, Y., Yang, B., Jiang, X., Jia, F., Li, N., Nandi A. K.: "Applications of machine learning to machine fault diagnosis: A review and roadmap," *Mech. Syst. Signal Process.* Vol. 138, 2020.
- [5] Zheng, H., Moosavi, V., Akbarzadeh, M.: "Machine learning assisted evaluations in structural design and construction," *Autom. Constr.*, Vol. 119, 2020, pp. 103–346.
- [6] Chang, C. W., Lee, H. W., Liu, C. H.: "A Review of Artificial Intelligence Algorithms Used for Smart Machine Tools," *Inventions*, Vol. 3, No. 41, 2018.
- [7] Jenis, J., Ondriga, J., Hrček, S., Brumerčik, F., Čuchor, M., Sadovsky, E.: "Engineering Applications of Artificial Intelligence in Mechanical Design and Optimization," *Machines*, doi: 10.3390/machines11060577, 2023.
- [8] Jiaheng, H.: "The application of artificial intelligence technology in the field of mechanical and electronic engineering reflects," *International Conference on Mathematics, Modeling and Computer Science*, doi: 10.1117/12.2671679, 2023.
- [9] Ferit, A.: "Applications of Artificial Intelligence in Mechanical Engineering," *European journal of science and technology*, doi: 10.31590/ejosat.1224045, 2022.
- [10] Keiichi, N., Keigo, T.: "Editorial: Application of Artificial Intelligence Techniques in Production Engineering," *International journal of automation technology*, doi: 10.20965/ijat.2023.p0091, 2023.
- [11] Alhakeem, M. R. H., Ilham, D. N.: "Application of Artificial Intelligence in Mechanical Engineering," *Brilliance: Research of Artificial Intelligence*, Vol. 2, No. 3, 2022, pp. 177-181.
- [12] Khaleel, M., Ahmed, A. A., Alsharif, A.: "Artificial Intelligence in Engineering," *Brilliance: Research of Artificial Intelligence*, Vol. 3, No. 1, 2023, pp. 32-42.
- [13] Chen, Y.: "Relevance Research of Artificial Intelligence Technology in the Field of Mechanical Engineering," 2022 World Automation Congress (WAC), San Antonio, TX, USA, 2022, pp. 453-457.
- [14] Arturo, J.: "The Design of Mechanisms via Artificial Intelligence," doi: 10.58830/ozgur.pub95.c437, 2023.

- [15] Ye, X.: "Application of Computer CAD Software Optimization in the Manufacture of Mechanical Reducer Considering Artificial Intelligence," 2022 International Conference on Edge Computing and Applications (ICECAA), Tamilnadu, India, 2022, pp. 1057-1060.
- [16] Xianzhen, Y.: "Application of Computer CAD Software Optimization in the Manufacture of Mechanical Reducer Considering Artificial Intelligence," 2022 International Conference on Edge Computing and Applications, doi: 10.1109/ICECAA55415.2022.9936183, 2022.
- [17] Yunze, Y.: "The value and application of artificial intelligence technology in mechanical and electronic engineering," Academic Journal of Engineering and Technology Science, doi: 10.25236/ajets.2022.050702, 2022.
- [18] Wanling, L., Fanzhao, M.: "Research on the Application of Artificial Intelligence in the Field of Mechanical Automation," J. Phys.: Conf. Ser. 1885, doi: 10.1088/1742-6596/1885/4/042015, 2021.
- [19] <https://www.precedenceresearch.com/automotive-artificial-intelligence-market>
- [20] Breunig, M., Kässer, M., Klein, H., Stein, J.P.: "Building smarter cars with smarter factories: How AI will change the auto business, McKinsey and Company, 2024.