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ARTIFICIAL INTELLIGENCE IN MECHANICAL ENGINEERING

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ABSTRACT
The article theoretically discusses the significance of artificial intelligence (AI) in mechanical engineering, which is increasingly being integrated to automate routine tasks, optimize processes, and improve quality control in terms of other important criteria such as machine-tool user-friendliness and economic aspects. AI has numerous applications in mechanical engineering, including computer-aided design (CAD), data analysis, and 3D scanners, all of which are widely used in Uzbekistan's manufacturing plants.
Engineers declare that AI is critical to making this trend work and understanding how AI will affect the next generation of mechanical engineering. The analysis' findings are likely to provide students studying mechanical engineering with potential insight into basic AI operations.
Keywords: *computer-aided design, productivity, 3D scanner, AI application, smart devices, advanced technology, remote control*

INTRODUCTION

In mechanical engineering, AI can be linked in a variety of ways, altering established methods of mechanical system design, analysis, and optimization. Here are some specific examples of how AI can be used into mechanical engineering:
AI algorithms can be used to examine enormous datasets of design parameters and performance criteria in order to identify optimal designs. AI can help provide creative designs for mechanical components and systems by utilizing machine learning approaches, resulting in increased efficiency, reduced weight, and higher performance.
Predictive Maintenance: By evaluating real-time sensor data, AI can be used to predict the maintenance needs of mechanical systems. AI can assist in scheduling maintenance tasks by spotting patterns suggestive of prospective failures, saving downtime and preventing costly equipment failures.
Production Process Optimization: AI-powered solutions can automate and optimize mechanical engineering production processes. Robotics and artificial intelligence (AI) can be

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used together to improve quality control, increase production efficiency, and enable adaptive manufacturing processes that adjust to real-time changes in demand and supply.

Simulation and Analysis: Artificial intelligence (AI) can improve the accuracy and efficiency of simulation and analysis in mechanical engineering. AI-powered simulation tools can simulate complicated mechanical systems, allowing engineers to virtually test and optimize designs before building actual prototypes. This can result in substantial cost and time savings during the product development cycle.

Intelligent Control Systems: AI can be applied into mechanical device and process control systems. Control systems can adapt to changing operating circumstances, enhance performance, and improve energy efficiency in mechanical systems such as engines, turbines, and HVAC systems by utilizing AI algorithms.

Autonomous cars and Robotics: Artificial intelligence (AI) is vital in the development of autonomous cars and robotic systems, which have extensive applications in mechanical engineering. AI allows these systems to observe their surroundings, make judgments, and adapt to changing conditions, resulting in breakthroughs in transportation, manufacturing, and logistics.

Materials Science and Nanotechnology: Artificial intelligence (AI) can be utilized to speed up material research and development in mechanical engineering. AI can help in the creation of new materials with specialized properties by evaluating large datasets and predicting material properties, leading to advancements in areas such as lightweight composites, high-strength alloys, and smart materials.

Human-Machine cooperation: Artificial intelligence (AI) can facilitate human-machine cooperation in mechanical engineering, allowing engineers to use AI-powered tools for complicated problem-solving, decision-making, and creativity. This collaboration has the potential to result in more innovative and efficient mechanical systems.

RESEARCH METHOD

Connecting AI to CNC machines in mechanical engineering can lead to substantial breakthroughs in manufacturing, design, and quality control. Here's how artificial intelligence can be used in this area:

The formula for computing the ideal feed rate in CNC machining is a key formula in integrating AI to CNC machines and mechanical engineering. The feed rate is an important characteristic that governs how quickly the cutting tool advances into the work piece. The formula for calculating the best feed rate is as follows:

Feed Rate = (Cutting Speed × Number of Teeth × Chip Load)

Where:

Cutting Speed: The rate at which the cutting tool passes through the material being machined, expressed in surface feet per minute (SFM) or meters per minute (m/min).

Number of Teeth: The tool's number of cutting edges.

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Chip Load: The amount of material removed by each cutting edge during one revolution of the cutting tool, usually measured in inches per tooth (IPT) or millimeters per tooth (mm/tooth). Considering the following example to demonstrate how to calculate the ideal feed rate using this formula:

Assume we have a CNC milling operation with the parameters listed below.
Cutting Speed (S): 500 SFM
Number of Teeth (N): 4
Chip Load (CL): 0.005 inches/tooth
Using the formula: Feed Rate = (500 SFM × 4 teeth × 0.005 inches/tooth) Feed Rate = 10 inches per minute

The ideal feed rate for the given machining operation is computed to be 10 inches per minute in this case. This formula can be optimized using AI algorithms to dynamically adjust the feed rate based on real-time data such as cutting forces, tool wear, and material properties by integrating AI into CNC machines, resulting in improved machining efficiency and productivity in mechanical engineering applications.

Using CNC milling machines with AI can improve the production process in a variety of ways. Based on the material being machined, AI can optimize tool routes, detect probable tool wear, and alter cutting parameters in real time. This can contribute to increased efficiency, shorter production times, and higher precision. Furthermore, AI can offer predictive maintenance by detecting possible problems before they create machine downtime. AI can also be used for quality control, examining sensor data to guarantee that each product fulfills the appropriate criteria.

Figure.1 Today's CNC milling machine to have been using AI

When it comes to incorporating AI in CNC machines, efficiency and productivity are the most crucial factors. CNC machines can employ artificial intelligence to examine all of the data they generate during production and offer real-time findings to their operators. This is critical for increasing production. When the data is examined, the machines can provide recommendations

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to their operators. This allows the operators to make changes that alter how the machine runs. This increases the efficiency of the machinery.

Initially, industries relied on human operators to drive machining modifications. However, AI is altering this. They may now use analytics, real-time data, and machine learning to control how CNC machines learn, respond to demands, and maximize performance. AI has enabled operators to gain insights into how CNC machines run, function, and perform. Furthermore, this has provided a comprehensive understanding of how all CNC machines operate and interact with one another. This allows operators to see the performance of each machine and eliminate anything that slows it down. The machines are also learning how to improve their performance and making recommendations to their operators. This improves the performance of the machine.

If you ask any manufacturing plant management today, they will tell you that their ability to service their machines on time has an impact on their production costs. They must understand when the machines must be tuned, calibrated, and parts adjusted. This always takes time. However, artificial intelligence is making their lives easier. It enables enterprises to forecast the time required for servicing or performing maintenance activities on CNC machines. AI drives machines with data and provides operators with real-time data on how the machines operate. This enables the operators to forecast when the machines will require repair or when a certain element would need to be replaced. They can save money by ensuring that the machines are always working and servicing them at the appropriate times. AI is revolutionizing all industries that rely on CNC machines for their manufacturing processes.

The main differences between typical CNC milling machines and CNC milling machines with AI lie in their capabilities and adaptability.

Typical CNC milling machines operate based on pre-programmed instructions and are limited to executing the specific commands they have been given. They lack the ability to adapt to changing conditions in real time and are not equipped to make autonomous decisions.

On the other hand, CNC milling machines with AI are integrated with artificial intelligence, allowing them to analyze data from sensors, optimize tool paths, adjust cutting parameters, and even predict maintenance needs. This enables them to adapt to changing conditions during the machining process, leading to improved efficiency, reduced waste, and enhanced precision. Additionally, AI-equipped CNC milling machines can learn from past production data and continuously improve their performance over time.

In summary, the key differences lie in the adaptability and autonomous decision-making capabilities that AI brings to CNC milling machines, enabling them to operate more efficiently and effectively in dynamic manufacturing environments.

The incorporation of artificial intelligence into these devices has resulted in not just enhanced output but also significant technical transformation. CNC machine operators, for example, can utilize IoT devices to manage the machines, rate their performance, and make any necessary improvements regardless of where they work. Artificial intelligence has made this possible.

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Various sectors have used automation to streamline their processes in recent years. This has been greatly aided by technological improvements. Similarly, several CNC machine production processes have been automated, owing to the introduction of AI. These machines are learning what to do and responding to directions from their operators. Furthermore, companies are utilizing collaborative robots to change automation. These robots can operate CNC machines using AI, increasing productivity, lowering the possibility of human error, and ensuring that most operations are automated. As a result, they are functioning independently and streamlining their operations. AI makes this feasible.

CONCLUSIONS

To summarize, the comprehensive integration of AI into mechanical engineering involves a wide range of applications, such as design optimization and predictive maintenance, as well as manufacturing process automation and materials research. By leveraging AI technology, mechanical engineers may be able to push the boundaries of innovation, leading in the development of smarter, more efficient, and more sustainable mechanical systems.

Improved machining efficiency, predictive maintenance capabilities, adaptive control systems, process optimization, and increased quality control are some of the benefits of integrating AI with CNC machines. These findings represent a paradigm shift in the design, manufacturing, and operation of mechanical components and systems.

As AI advances, its impact on CNC machines and mechanical engineering is predicted to increase tremendously, pushing innovation and opening up new avenues for the development of smarter, more efficient, and more sustainable mechanical systems. The collaboration of AI and CNC machines has the potential to open up new horizons in manufacturing, ultimately determining the future of mechanical engineering.

Artificial intelligence (AI) is a powerful and promising technology that has the potential to improve and change the field of mechanical engineering. However, AI introduces substantial challenges and risks that must be addressed and minimized. As a result, mechanical engineers should exercise caution and care while learning and implementing AI, as well as collaborate with other professionals and stakeholders to ensure safe and responsible AI development and deployment.

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