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Information technologies and artificial intelligence in metrology – new opportunities and application prospects

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Abstract: The article discusses the use of advanced information technologies and artificial intelligence to automate measurement processes in metrology.

Keywords: metrology, artificial intelligence, automation, machine learning, neural networks and deep learning algorithms

Информационные технологии и искусственный интеллект в метрологии – новые возможности и перспективы применения

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Аннотация: В статье рассматривается применение передовых информационных технологий и искусственного интеллекта для автоматизации измерительных процессов в метрологии.

Ключевые слова: метрология, искусственный интеллект, автоматизация, машинное обучение, нейронные сети и алгоритмы глубокого обучения

Metrologiyada axborot texnologiyalari va sun'iy intellekt - yangi imkoniyatlar va qo'llash istiqbollari

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Annotatsiya: Maqolada metrologiyada o'lchash jarayonlarini avtomatlashtirish uchun ilg'or axborot texnologiyalari va sun'iy intellektdan foydalanish muhokama qilinadi.

Kalit so'zlar: metrologiya, sun'iy intellekt, avtomatlashtirish, mashinani o'rganish, neyron tarmoqlar va chuqur o'rganish algoritmlari

Introduction

In the modern world, where the boundaries between sciences are increasingly blurred, there is an increasing need for continuous development and improvement of technologies. This necessity unites various branches of knowledge and opens up new horizons for the application of new scientific discoveries. Metrology, the science that measures and evaluates physical quantities and processes, takes an active part in this progressive process [1].

One of the most important and relevant areas in the field of metrology is the use of artificial intelligence. These two concepts complement each other and create opportunities for achieving more accurate results and more effective data evaluation. Artificial intelligence in metrology provides us with new opportunities and reverses our understanding of what methods of measurement and evaluation of quantities should be.

The use of artificial intelligence in metrology makes it possible to improve the accuracy of measurements and reduce the time spent on experiments. It helps to minimize the human factor by eliminating the possibility of errors related to insufficient qualifications of the examiner or subjective perception of the data. The use of artificial intelligence in metrology also makes it possible to automatically process and analyze the data obtained, which reduces training costs and increases the efficiency of the measurement process as a whole.

Measurement automation is an integral part of modern metrology. With the help of specialized equipment and software, it becomes possible to carry out measurements with a high degree of automation and accuracy. Automatic measurement technology

significantly reduces the time spent on the process and eliminates human intervention with its subjective factor [2].

One of the key areas of measurement automation is the use of software based on data processing algorithms. This makes it possible to significantly improve the accuracy of measurements by taking into account and eliminating possible systematic errors and interference.

Methodical section

Another important aspect of automation is the use of modern technical means, such as robotic systems, high-resolution sensors, equipment for remote monitoring of processes, and many others. This allows for more accurate and reliable measurement data.

The improvement of the measurement process is also achieved through the use of machine learning methods. Machine learning algorithms allow you to automatically optimize the measurement process, taking into account various parameters and factors that may affect the accuracy of the results.

Thus, measurement automation and increased accuracy play a key role in the development of metrology and provide accurate results in a wide variety of applications, from scientific research to industrial production (Fig. 1).

Various technologies such as machine learning, neural networks, and deep learning algorithms can be used to automate the measurement process using artificial intelligence. These systems provide rules and algorithms that allow you to solve complex recognition and classification problems. Thus, devices with artificial intelligence can independently determine the type of measured quantity, detect anomalies and calibrate in real time [3].

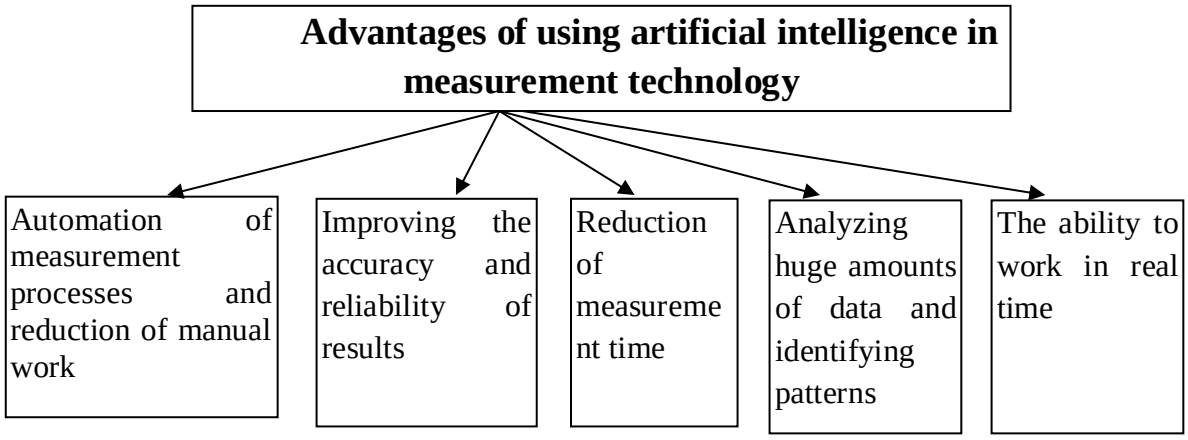

Fig. 1. Application of artificial intelligence to automate the measurement process

When working in the field of metrology, it is necessary to provide the most accurate and reliable data for measurements and analysis. The use of artificial intelligence provides an opportunity to significantly improve the quality of the data obtained, reduce possible errors and increase the degree of confidence in the measurement results.

Accuracy is one of the key parameters in measurements. The use of AI allows for automatic data processing using complex algorithms that can take into account various factors affecting measurement accuracy. As a result, higher accuracy is achieved and the level of reliability of the results is increased.

The reliability of the data obtained is also an important aspect in metrology. The use of AI makes it possible to eliminate or reduce the impact of random and systematic errors that may occur during the measurement process. By analyzing a lot of data and recognizing patterns using AI, it is possible to identify and correct errors, increasing the reliability and stability of the results obtained.

In general, AI is a powerful tool for improving the accuracy and reliability of data in metrology. It allows you to automate the processes of data processing and analysis, eliminate or reduce the human factor in measurements. This opens up new opportunities for the development of research and applications in various fields where accurate and reliable data is needed to make important decisions.

The search for optimal solutions for quality control can be carried out using various technologies and methods, while avoiding approaches based only on common sense and random samples. Strict adherence to formal procedures and the use of mathematical models make it possible to eliminate the human factor and improve the accuracy and objectivity of control.

One of the ways to optimize quality control is to automate the process. The introduction of specialized software systems and equipment allows for monitoring with high accuracy and speed, as well as eliminating the likelihood of human error. The use of data processing and statistical analysis algorithms makes it possible to identify patterns and trends, which ensures more effective decision-making [4].

In addition to automation, optimization of quality control can be achieved by applying new methods of data research and analysis. The development and use of innovative technologies such as machine learning and artificial neural network make it possible to improve the control process and predict possible defects even at the production stage. This makes it possible to quickly respond to problems and reduces the likelihood of defective products entering the market.

Optimization of quality control is an important aspect of the successful implementation of artificial intelligence in metrology. Through the use of the latest technologies and approaches, enterprises can achieve more reliable and effective

control, which contributes to improving product quality, customer satisfaction and the competitiveness of the enterprise as a whole.

One of the roles of artificial intelligence in optimizing quality control is to automate the process of analyzing and evaluating products and materials. Through the use of machine learning and deep learning algorithms, artificial intelligence is able to process large amounts of data and find hidden patterns that are not always accessible to human perception.

Another important role of artificial intelligence is to predict possible defects and deviations in the manufacturing process. Based on the analysis of historical data and trained models, artificial intelligence is able to predict the likelihood of defects and offer recommendations on how to eliminate problem areas.

Another important role of artificial intelligence is to optimize the quality control process. Artificial intelligence makes it possible to automate the selection of optimal parameters and control criteria, leading to a reduction in time and costs for data processing and analysis. Due to this, enterprises can plan and manage the production process more effectively, achieving high quality indicators and increasing their competitiveness.

The use of Artificial Intelligence in the quality control process has the potential to significantly improve business processes and increase customer confidence and satisfaction. It allows you to automate and optimize processes, which leads to more efficient use of resources, lower costs and improve the quality of products or services. The advantages offered by Artificial Intelligence in the quality control process make it an indispensable tool in modern metrology, providing reliable and reliable results.

The use of modern statistical analysis and machine learning methods makes it possible to create models that are able to identify patterns and correlations between various factors affecting system performance. This allows you to predict the probability of failures and prevent their occurrence by taking appropriate measures in advance.

An important aspect of predicting and preventing failures is the development of effective algorithms and systems for monitoring the condition of equipment. Such systems can continuously monitor and analyze various indicators that determine the system's performance. In case of detection of precursors of failure, the system takes the necessary actions to prevent the occurrence of the problem.

The implementation of forecasting and failure prevention in various fields of activity can significantly reduce the risks and costs associated with unforeseen failures and breakdowns. Artificial intelligence methods used in this field continue to evolve and improve, which opens up new opportunities for improving the efficiency and reliability of engineering systems and devices.

In light of the rapid development of technology and the penetration of computer systems into all areas of our lives, security and reliability issues are becoming increasingly relevant. Failures and damages in various technical systems can lead to serious consequences, including accidents and unplanned production downtime [5].

Conclusion

In the process of metrological control, which aims to ensure the accuracy and reliability of measurements, artificial intelligence can play an important role in predicting possible failures and damages. It is able to analyze large amounts of data, identify hidden patterns and build forecasts of future events based on this information.

The use of artificial intelligence makes it possible to improve the quality of forecasting and increase the efficiency of metrological control systems. With the help of developed machine learning algorithms that take into account the frequency and statistics of failures and damages, you can quickly warn about potential problems.

To achieve the most accurate results, artificial intelligence can use various sources of information, including sensor data, data on past failures and damages, as well as expert knowledge from specialists. This approach allows you to take into account many factors and increase the reliability of forecasts.

However, it is obvious that artificial intelligence cannot completely replace humans in this field. Rather, it is a tool that helps professionals in their work by providing additional information and decision-making tools. However, the introduction of artificial intelligence into metrology already makes it possible to significantly improve the processes of monitoring and detecting potential risks.

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