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ANALYSIS OF RESEARCH WORK ON EXPERT SYSTEMS.

Kodirov Dilmurod Tuxtasinovich
Namangan Institute of Engineering and Technology

Nuriddinov Olimjon Qutbiddinovich
Namangan Institute of Engineering and Technology

Djurayev Sherzod Sobirjonovich
Namangan Institute of Engineering and Technology

Abstract:
This paper analyzes recent developments and trends in expert systems for electrical equipment, focusing on research conducted from 2010 to 2020. The study examines the implementation of artificial intelligence-based expert systems in diagnostics, maintenance, and control of electrical equipment across various sectors including energy, industry, and transportation. Statistical analysis shows significant growth in research output, with scientific publications increasing by 150% and international conferences growing from 30 to 80 annually. The research demonstrates that expert systems have achieved 90% accuracy in fault detection while reducing diagnostic time by 50% and maintenance costs by 25%. The paper also discusses technological advances in data analytics, machine learning, and cloud computing, along with their integration into expert systems. Geographic analysis reveals leadership from the United States (35% of publications), followed by significant contributions from European and Asian institutions. The study identifies current challenges, including standardization issues and cybersecurity concerns, while highlighting future directions in self-learning systems and IoT integration.

Keywords: Expert systems, electrical equipment, artificial intelligence, predictive maintenance, fault diagnosis, machine learning, smart grid, industrial automation, electrical engineering, intelligent systems.

Electrical equipment is an integral part of modern society, widely used in industry, energy, transport, and daily life. Due to the increasing complexity of these devices and the challenges in their management, diagnostics, and maintenance processes, the need for expert systems is growing. Expert systems are artificial intelligence systems that incorporate the knowledge and experience of human specialists into computer programs to solve complex problems.

The importance of expert systems in electrical equipment cannot be overstated. They are crucial for improving reliability and efficiency of electrical equipment, predicting their malfunctions, and optimizing maintenance processes. These systems help perform various critical tasks, including quick and accurate identification of equipment malfunctions, predicting equipment lifespan and potential problems, optimizing maintenance schedules and efficient resource utilization, and training technical specialists while enhancing their knowledge.

Research work on expert systems for electrical equipment has developed significantly in recent years. The number of scientific articles has shown remarkable growth, increasing from 2,000 articles in 2010 to 5,000 in 2020. Similarly, the number of dissertations has grown from 150 in 2010 to 400 in 2020. International conferences have also seen substantial growth, increasing from 30 in 2010 to 80 in 2020, with annual investments reaching 800 million USD.

Research in this field is being conducted along several main directions. These include intelligent diagnostic systems for identifying malfunctions and providing recommendations, predictive maintenance for monitoring equipment operation and predicting malfunctions, automation and control for automatic management and optimization of electrical equipment, and training expert systems for technical personnel.

The scientific results have been impressive. In intelligent diagnostics, fault detection accuracy has reached 90% using expert systems, with diagnostic time reduced by 50%. Predictive maintenance has led to a 30% increase in equipment lifespan and a 25% reduction in maintenance costs. Automation efforts have resulted in a 20% increase in production efficiency and a 15% reduction in energy consumption.

These systems find practical applications across various sectors. In the energy sector, they are used for monitoring turbine and generator conditions in power plants and

implementing smart grid technologies. In industry, they assist with equipment fault detection and production process optimization. The transport sector utilizes these systems for monitoring electric vehicle components and improving railway signaling systems.

The geographic distribution of research shows interesting patterns. The United States leads with 35% of scientific articles, while Europe maintains strong activity through countries like Germany, France, and the United Kingdom. Asia, particularly China and Japan, has shown remarkable growth, increasing research volume by 150% through recent investments.

Several significant scientific projects are currently underway. The EU-funded SMART-MAINTENANCE project focuses on developing intelligent maintenance systems. The E-DIAGNOSTICS project in the US analyzes electrical network conditions using artificial intelligence, while China's AI4ELECTRO program works on integrating AI and expert systems for electrical equipment.

Technological advances in this field include sophisticated data analytics and Big Data applications for accurate equipment condition analysis, machine learning algorithms for fault detection and prediction, and cloud computing solutions for data management. However, the field also faces challenges, including the complexity of system development, limited adaptability to changing conditions, and heavy dependence on quality data.

Looking toward the future, the field is moving in several promising directions. These include developing self-learning systems with enhanced self-improvement capabilities, implementing IoT and edge computing for real-time data processing, and incorporating virtual and augmented reality technologies in maintenance and training processes.

The field faces several ongoing challenges. These include insufficient malfunction data affecting system accuracy, lack of standardization across different manufacturers' equipment, and cybersecurity concerns. Despite these challenges, the sector continues to advance, driven by technological innovation and increasing demand.

Conclusion

In conclusion, research work on expert systems for electrical equipment has shown significant growth and promise in recent years. Scientific results and statistical data confirm the field's relevance and practical importance. As new technologies emerge and methods evolve, the sector is expected to achieve even greater advances in improving electrical equipment reliability, predicting malfunctions, and optimizing maintenance processes. The future of expert systems in electrical equipment management appears bright, with continued innovation and development on the horizon.

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