

Research on the Integration of Electronic Communication Technology in Intelligent Electromechanical Manufacturing

Li JingSi

Heilongjiang Technician College, Heilongjiang Jixi 158100;

Abstract: Against the backdrop of rapid development in the manufacturing industry, intelligent manufacturing has emerged as a pivotal force driving industrial upgrading. As a crucial component of intelligent manufacturing, electromechanical intelligent manufacturing aims to achieve automated and intelligent production of electromechanical systems. Meanwhile, electronic communication technology provides robust support for efficient data transmission and collaborative operations among equipment. Integrating electronic communication technology into electromechanical intelligent manufacturing can significantly enhance production efficiency, optimize workflows, and reduce costs. Through electronic communication technology, real-time information exchange and sharing between electromechanical devices can be realized, enabling better responses to complex and dynamic production demands. Therefore, research on the integration of electronic communication technology in electromechanical intelligent manufacturing holds substantial practical significance.

Keywords: electronic communication technology; electromechanical intelligent manufacturing; integration research; information exchange

1 Overview of Electronic Communication Technology and Electromechanical Intelligent Manufacturing

Common electronic communication technologies mainly include wireless communication and wired communication. Wireless communication utilizes electromagnetic wave signals propagating through free space to exchange information. Taking Wi-Fi as an example, it operates in the 2.4GHz or 5GHz frequency bands, converting wired network signals into wireless signals via access points, which are then received by smart devices through built-in wireless network cards to establish network connections. Its key feature is high flexibility, allowing devices to move freely within signal coverage without being constrained by cables, making it suitable for various scenarios such as homes, offices, and public spaces. Wired communication, on the other hand, relies on physical transmission media like twisted-pair cables and optical fibers for information transfer. Fiber-optic communication leverages the principle of total internal reflection of light within fibers, offering advantages such as high transmission speeds, strong anti-interference capabilities, and long-distance transmission.

Mechatronics intelligent manufacturing is the deep integration of mechanical, electronic, automation, and information technologies to achieve intelligent, automated, and flexible production processes. Its objectives include improving production efficiency, reducing costs, enhancing product quality, and strengthening a company's market competitiveness. Key characteristics include automated control of production processes, where sensors, controllers, and other devices enable real-time monitoring and precise control of production equipment; data-driven decision-making, utilizing big data analytics, artificial intelligence, and other technologies to mine and analyze production data for informed decision-making; and highly flexible production, capable of rapidly adjusting processes and product specifications in response to market demands.

The integration of electronic communication technologies with mechatronics intelligent manufacturing holds significant importance for enhancing production efficiency. Through wireless communication, real-time data exchange and collaborative work among production equipment can be achieved, reducing waiting times and human intervention during production, thereby improving the continuity and automation of workflows. In terms of product quality, this integration enables real-time monitoring and precise control of various production parameters, allowing timely detection and correction of deviations, thus enhancing product consistency and stability.

2 The Role of Electronic Communication Technology in the Integration of Intelligent Electromechanical Manufacturing

Electronic communication technology enables real-time data transmission and sharing between electromechanical equipment. In intelligent electromechanical manufacturing, various devices generate substantial operational data, such as temperature, pressure, and rotational speed. Wireless communication technology liberates devices from cable constraints, allowing flexible and rapid transmission of this data to the central control system. Wired communication, with its stability and high speed, ensures accurate and error-free data transmission. After collecting data from all devices, the central control system integrates and analyzes it to inform production decisions. For example, based on equipment operational status data, maintenance schedules can be arranged in advance to prevent production interruptions caused by equipment failures. Production progress data can be used to rationally adjust production plans, thereby improving efficiency.

Electronic communication technology facilitates collaborative work among multiple electromechanical devices. Through communication networks, these devices can exchange information and coordinate actions according to predefined programs and rules. On automated production lines, equipment at different stages achieves synchronized operation via communication technology. Once a device completes processing, it immediately signals the next device to initiate the corresponding operation, reducing idle time between processes and enhancing the overall performance of the production system while ensuring product quality consistency.

Electronic communication technology also enables remote monitoring and management of intelligent electromechanical manufacturing processes. Management personnel can access real-time information on equipment status and production progress from any location via the network. If abnormalities in equipment or production issues are detected, adjustments can be promptly directed. For instance, when equipment triggers a fault warning, remote diagnosis can identify the cause and guide on-site personnel in performing repairs, minimizing downtime and maintenance costs while ensuring smooth production operations.

3 The Challenges of Integrating Electronic Communication Technology with Electromechanical Intelligent Manufacturing

In complex industrial environments, electronic communication faces numerous issues that affect reliability. Industrial sites contain a large number of electrical devices that generate electromagnetic interference. For instance, during the startup and shutdown of large motors, instantaneous strong electromagnetic pulses are produced, which can disrupt electronic communication signals, causing signal distortion (*Phoxinus phoxinus* subsp. *phoxinus*) and leading to data transmission errors. Additionally, metal structures (*Broussonetia papyrifera*), buildings, and other obstacles in factories can block and reflect communication signals, resulting in signal attenuation. In wireless communication, signal strength weakens over long distances, and when it falls below the sensitivity threshold of receiving devices, communication interruptions occur.

Data transmission security and privacy protection are critical in electronic communication processes. In electromechanical intelligent manufacturing, the data exchanged between devices includes production processes, product designs, and other sensitive information. Unauthorized disclosure of such data could cause significant losses to enterprises. Cyber attackers may exploit communication networks to steal this sensitive information. Malicious software can also infect communication devices, tampering with transmitted data and causing errors in production processes. Enterprises must implement a series of security measures to safeguard data. However, as cyberattack methods continue to evolve, the difficulty of maintaining robust security defenses also increases.

Compatibility issues exist among different electronic communication technologies and electromechanical equipment standards. The market features various communication protocols and standards, such as Modbus and Profibus, and different electromechanical devices may adopt distinct communication standards. When integrating such devices, communication barriers arise. Electromechanical equipment produced by different manufacturers may also differ in interface standards, data formats (*Parazacco spilurus* subsp. *spilurus*), making seamless connectivity and data sharing between devices challenging. Compatibility problems reduce the stability of integrated systems, increase the difficulty of debugging and maintenance, impair integration effectiveness, and hinder the deep convergence of electronic communication technology with electromechanical intelligent manufacturing.

4 Strategies for the Integration of Electronic Communication Technology and Electromechanical Intelligent Manufacturing

Selecting and optimizing communication protocols suitable for electromechanical intelligent manufacturing can enhance communication efficiency and reliability. Industrial environments are complex, requiring communication protocols with strong anti-interference capabilities and excellent real-time performance. Protocols like Industrial Ethernet, with their fast transmission rates and support for real-time communication, can meet the demands of rapid data transfer between electromechanical devices. Further improvements in communication stability can be achieved through protocol optimization, such as adopting adaptive transmission rate adjustments and enhancing error detection and correction mechanisms.

Implementing encryption technologies and identity authentication measures ensures security and privacy during electronic communication. During data transmission, symmetric or asymmetric encryption algorithms can be applied to encrypt data, ensuring that even if intercepted, attackers cannot access sensitive information. Identity authentication guarantees that only authorized devices and personnel can access the communication network. Multi-level access permissions can be established, granting different operational rights to personnel and devices at varying levels. Regular security vulnerability assessments and fixes for the communication system, along with the installation of firewalls and other protective software, help prevent external cyberattacks and maintain secure and stable operation of the communication system.

Promoting the standardization of electronic communication technologies and electromechanical equipment enables better integration outcomes. Industry associations and relevant government departments should play a guiding role in establishing unified communication protocols and device interface standards. Encouraging enterprises and research institutions to participate in the standard-setting process ensures the scientific and practical nature of these standards. Companies should actively adopt unified standards, strengthen cooperation and exchange with other enterprises, and collectively advance the implementation of industry standards. For existing equipment and systems, compatibility with unified standards can be achieved by developing conversion interfaces and adaptation software. Standardization reduces the difficulty and cost of device integration, enhances the openness and interoperability of production systems, and fosters deeper integration of electronic communication technologies with electromechanical intelligent manufacturing.

5 Conclusion

The integration of electronic communication technology with electromechanical intelligent manufacturing represents an inevitable trend in the development of the manufacturing industry. By gaining an in-depth understanding of the fundamental principles and significance of this integration, clarifying the role of electronic communication technology within it, recognizing the challenges faced during the integration process, and proposing corresponding solutions, we can promote the deep convergence of electronic communication technology and electromechanical intelligent manufacturing. Although certain difficulties currently persist in the integration process, continuous technological advancements and the gradual refinement of relevant standards will enable electronic communication technology to usher in more efficient and intelligent development prospects for electromechanical intelligent manufacturing. This will robustly propel the manufacturing industry toward higher-end and smarter directions.

References

- [1] Cong Miaomiao, Ma Haohao, Feng Yanwei. Research on Homo sapiens Integration and Automation Technology in Intelligent Manufacturing Systems[J]. Equipment Manufacturing Technology, 2024, (05): 157-160.
- [2] Prunus salicina Steel, Sun Xiaoxiao. Project-Based Engineering Practice Training for Mechanical Professional Degree Masters Based on Intelligent Manufacturing System Integration Platform[J]. China Metallurgical Education, 2024, (05): 59-63.
- [3] Song Ling. Design and Innovative Application of Integrated Auxiliary Systems for Welding Operation and Maintenance in Mechanical Manufacturing Under the Background of Intelligent Manufacturing[J]. Papermaking Equipment & Materials, 2025, 54(01): 69-71.