Chapter 6
Revolutionizing Smart Manufacturing for Industry 5.0:
IoT-Driven Mechanical Fault – Predictive Prognosis as a Pillar of Industrial Prosperity

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ABSTRACT

Industry 5.0 has brought in a more stable and networked industrial environment with the use of the Internet of Things (IoT). Industry 5.0 creates a work environment where human-machine interaction is optimized for better performance by combining human cooperation with robots and intelligent equipment. Industrial Internet of things (IIoT) includes a range of services in large settings, such as digital domains that are available for company management, real-time production monitoring, and machinery condition tracking. Industry 5.0 aims to achieve the best possible balance between productivity and the efficiency in a variety of industries, including heavy manufacturing, oil and gas, and warehouse management all of which heavily rely on heavy gear. This chapter comprehensively explores the various dimensions of the IoT in industry 5.0 using in smart manufacturing for fault screening and mechanical

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Diagnosis and Prognosis.

1. INTRODUCTION

Smart manufacturing is thus developing as a game-changer in the context of industrial evolution, converging human intellect and the advanced cognition of smart machines in the world of Industry 5.0. In such exhilarating change, one of the fundamental enablers of this revolution is the predictive prognosis of mechanical faults, capable by means of the Internet of Things (IoT). Traditional reactive and scheduled maintenance paradigms have evolved into IoT-driven mechanical fault prediction, allowing for real-time diagnostics, prognostics, and adaptive interventions (Vatin et al., 2024). Manufacturers can embed IoT sensors into machinery and industrial components to harvest vast volumes of data on parameters such as vibration, temperature, noise, pressure, and torque, which are processed with artificial intelligence (AI) and machine learning (ML) algorithms to predict malfunctions before they impede operation. This method not only provides continuous operation of the critical assets, but also helps to maximize operational performance, safety, and cost efficiency (Wang et al., 2024). With the key factors of competition in Industry 5.0 being human-centric innovation, collaboration induces complex decisions, optimizations, and sustainable production between human workers and intelligent systems. In this respect, IoT-based predictive maintenance is one of the trends that leads value generation, significantly reducing unforeseen downtimes, increasing equipment lifetime and optimizing maintenance resource allocation. Digital twins virtual replicas of physical machines undergo continuous synchronization with real-time data, allowing wear-and-tear scenarios to be simulated and predictive analytics to inform and guide asset management decisions. It enables remote monitoring, instant problem-solving, and proactive decision-making through these virtual counterparts which enhances resilience and agility in manufacturing ecosystems.

With edge architecture, sensor data can be processed locally and quickly, resulting in ultra-fast diagnostics and anomaly detection without competing with centralized cloud infrastructure. This not only decreases latency, but improves data security and system responsiveness. This shift toward IoT-enabled predictive models for smart manufacturing systems is especially important in exceptionally complex industries such as aerospace, automotive, pharmaceutical, and energy, where equipment breakdown can cause major disasters and loss of millions of dollars. Integrating the domains of cyber-physical systems (CPS), industrial IoT (IIoT), and predictive analytics through the Industry 5.0 framework enables a transition towards autonomous decision-making and self-healing systems.

Cross-Cultural Study of the Potential Applications of Artificial Intelligence in Higher Education (Russia, Vietnam, and China)

Svetlana Valentinovna Murafa, Hoang Trung Hocand Xiao Jingyu (2025). *Integration Strategies of Generative AI in Higher Education (pp. 229-246).*
www.irma-international.org/chapter/cross-cultural-study-of-the-potential-applications-of-artificial-intelligence-in-higher-education-russia-vietnam-and-china/357819