RADemics

Integrating Internet of Things IoT for Real Time Data Driven Operational Decision Making

M. Boobalan M.E., B. Bommirani
Vivekanandha College of Engineering for Women,
Sengunthar Engineering College (Autonomous)

Integrating Internet of Things IoT for Real Time Data Driven Operational Decision Making

[1]M. Boobalan M.E., Assistant Professor, Department of CSE, Vivekanandha College of Engineering for Women, Namakkal, Tamil Nadu, India. boobalan.mtech@gmail.com

[2]B. Bommirani, Assistant Professor, Department of EEE, Sengunthar Engineering College (Autonomous), Tiruchengode, Namakkal (D.T), Tamil Nadu, India. bommirani.eee@scteng.co.in

Abstract

The integration of Artificial Intelligence (AI) with the Internet of Things (IoT) has revolutionized real-time data-driven operational decision-making across various sectors, enhancing efficiency, accuracy, and predictive capabilities. This book chapter explores the intersection of IoT and AI, focusing on the application of machine learning, deep learning, and edge computing for real-time anomaly detection, fault diagnosis, and predictive analytics. With the exponential growth of data generated by IoT devices, the need for advanced analytical techniques to process and interpret this data in real-time has become paramount. AI-driven approaches enable the continuous monitoring of IoT systems, identifying anomalies, classifying faults, and predicting potential failures before they disrupt operations. The chapter delves into the challenges and solutions in deploying AI models for IoT systems, emphasizing the role of edge AI, federated learning, and transfer learning in enhancing privacy, scalability, and computational efficiency. By integrating these advanced AI techniques with IoT frameworks, industries can achieve predictive maintenance, optimize resource allocation, and improve operational resilience. This comprehensive analysis provides valuable insights into the future of smart systems, where real-time decision-making is empowered by AI and IoT convergence.

Keywords: Artificial Intelligence, Internet of Things, Real-time Analytics, Anomaly Detection, Predictive Maintenance, Edge Computing.

Introduction

The convergence of Artificial Intelligence (AI) and the Internet of Things (IoT) has opened new frontiers for real-time data-driven operational decision-making across various industries [1]. IoT devices, through the continuous collection of sensor data, enable the monitoring and optimization of physical systems, while AI algorithms bring the ability to analyze, interpret, and make intelligent decisions based on this data [2]. This integration has significantly transformed how industries manage resources, monitor equipment health, and ensure operational efficiency [3]. As the volume of data generated by IoT devices grows exponentially, traditional methods of data processing and analysis are no longer sufficient [4]. AI-powered techniques such as machine learning, deep learning, and edge computing have emerged as key enablers for transforming raw data into actionable insights in real time [5].

Real-time anomaly detection and fault diagnosis, powered by AI, have become essential for enhancing the reliability and safety of IoT systems [6]. By continuously analyzing sensor data and

identifying deviations from normal operating conditions, AI can predict failures, detect faults, and trigger timely interventions to prevent costly downtime or system malfunctions [7]. These capabilities are particularly critical in sectors like manufacturing, healthcare, transportation, and smart cities, where operational continuity is crucial [8]. The chapter explores the role of AI in addressing the challenges associated with real-time data analysis, including noise filtering, data processing at the edge, and the need for scalable solutions that can handle vast amounts of data across distributed IoT networks [9].

The integration of AI with IoT also brings about significant advancements in predictive maintenance, energy optimization, and operational automation [10,11]. By analyzing historical data and detecting patterns, AI models can predict the remaining useful life of equipment, optimize resource allocation, and improve operational decision-making [12,13]. Deploying these advanced AI models in IoT systems comes with its own set of challenges [14,15]. Issues related to privacy, computational limitations of edge devices, and the dynamic nature of IoT networks need to be addressed for the successful implementation of real-time AI solutions [16,17]. This chapter examines these challenges and highlights emerging solutions, such as federated learning, transfer learning, and edge AI, which enable scalable, privacy-preserving, and efficient AI-driven decision-making in IoT environments [18,19].

In the integration of AI and IoT is reshaping the way industries approach real-time monitoring, fault detection, and operational decision-making [20,21]. As IoT systems continue to proliferate, the demand for AI-driven solutions that can handle complex, real-time data analytics will only grow [22.23]. This chapter provides an in-depth exploration of how AI and IoT together offer transformative capabilities for optimizing operational efficiency, enhancing system reliability, and enabling smarter, more autonomous decision-making in various applications [24,25].