


Chapter 4


AI-Based Fault Detection and Diagnosis Techniques in Control System Engineering: Focus on Food Processing Industry

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ABSTRACT

This chapter presents the major applications of Artificial Intelligence techniques (AI) in fault diagnosis of various control engineering fields. AI has made substantial improvements in various fields of Engineering, including control engineering. There are few noteworthy applications of AI in fault diagnosis related to control systems includes the control of industrial automation, power systems, robotic automation, medical applications, transportation systems, renewable energy, building automation, telecommunications etc. The early and effective diagnosis of fault can prevent downtime and repairs. In industrial automation, AI can efficiently detect anomalies in sensor readings and abnormalities in machine operation. Neural networks learn from the patterns of past historical data and identify the faults or anomalies. This chapter mainly focuses on the benefits and challenges in applying AI for fault diagnosis in the field of control engineering in food processing, monitoring control and future research perspectives

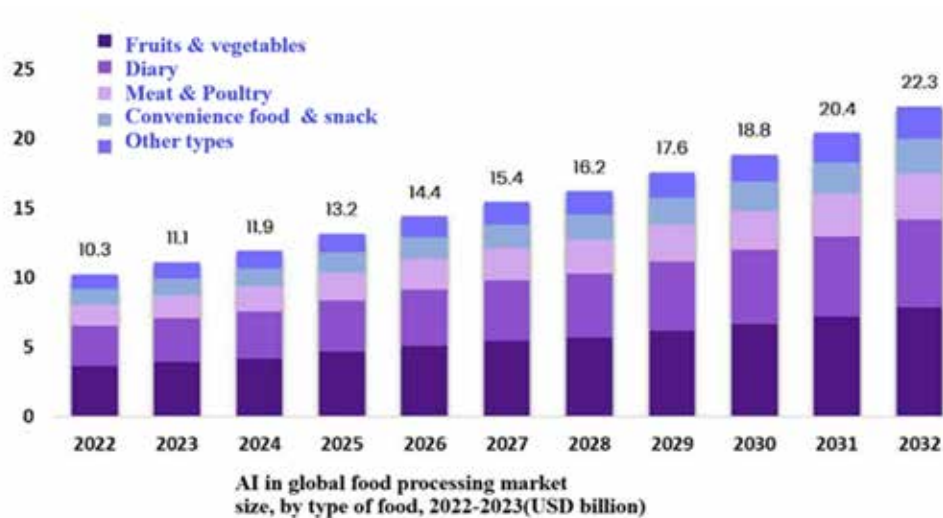
INTRODUCTION

In recent years, there is a growing interest in the application of AI techniques in various fields. The monitoring, control, predictive maintenance, fault diagnosis is performed in all the industries right from power sector (Patel, & Shah, 2018), (Fausing Olesen, & Shaker, 2020), transportation (Ersöz et al., 2022), (Alqasi et al., 2024) to food manufacturing operations (Addankiet al., 2022), (Misra et al., 2020). The

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main purpose of this AI applications to the field of food processing and manufacturing is to ensure the high degree of product quality during the mass production (UmaMaheswaran et al., 2022). Cutting-edge process control techniques are adopted to realize further improvements in process design and operation efficiency (Mavani et al., 2022). Moreover, food safety and quality evaluation are gaining more attention globally. AI usage in global food processing market is depicted in Figure 1. AI techniques for fruits and vegetables quality prediction, quality assessment, sorting and packaging hold the first position globally followed by the dairy field (*AI in Global Food Processing Market*)

Figure 1. AI in global food processing market



Food safety is very important to human life, ensuring people’s health and providing a elementary assurance for the steady growth of society. Conventional methods of food quality and safety evaluation methods are often unrealistic due to time constraints. The food industry usually satisfies the consumers by providing speedy delivery and quality of food. Various automatic process techniques are used in the controlled variables from standards which can be adjusted, and minimized to improve the process operations. Proportional integral-derivative (PID) control is widely used. Model-based control is recently adopted in the food industry to improve the performance (Huang, 2013). AI based process control techniques are gaining more attention and it provides good yield, reducing production cost, and cultivating food quality. Recently control strategies such as AI, machine learning, deep learning techniques and model-based controls are made several new prognoses to the food industry. Food processes are generally nonlinear in nature and exhibit different process dynamics with various raw materials and different processing conditions. Hence, advanced process control techniques are vital compared to conventional control approaches.

This chapter deals with advanced control strategies, particularly AI based techniques such as machine learning, deep learning and machine vision systems used for food processing and to assess the food quality and food security. Various applications of AI techniques are there to integrate the food industries

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