Chapter 12
Machine Learning and Image Processing Based Computer Vision in Industry 4.0

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ABSTRACT

Industry 4.0 reshapes the industrial landscape through new technologies such as robotics, data networking, machine learning (ML), and computer vision (CV). ML is a critical innovation in technology that enables enterprises and factory floors to embrace Industry 4.0. Systems and algorithms can learn from their failures using machine learning, a form of artificial intelligence (AI). A vision system becomes an essential component of sophisticated industrial systems for the quality control throughout the manufacturing process, and it allows robotic assembly to be provided with the necessary knowledge to create products from simple components. Predictive maintenance (PdM) is a form of digital transformation that services repairs as immediately as an issue emerges. The criterion above leads to a manufacturing environment that is intelligent and autonomous on recent breakthrough information and communication technologies. This chapter explores the challenges in Industry 4.0 with technologies such as cyber-physical systems (CPS), image processing, internet of things (IoT), computer vision, etc.

INTRODUCTION

Revolutions have always prompted economic and social reforms. In developed countries, urbanisation is accelerating. Industry 4.0 introduces the industries of the twenty-first century to constantly changing technologies. The German government established the word to define a sequence of technological advances in product development as well as the priorities of a framework for sustaining global standards across German industry (Villalba-Diez et al., 2019). The next industrial type, Industry 4.0, has been identified. It encompasses the digital modification of products, as well as the industries and value-creating activities that surround them.

The goal of Industry 4.0 is to create a 'smart factory,' a production facility that uses data from all types of sensors and all available sources to enhance processes. Computer Vision is a complicated method to smart manufacturing that enables computers and machines to "see" the real environment by extracting, processing, and analysing data from visual inputs. The computer vision market is on the edge of exploding; advantages of computer vision include time efficiency (it works around the clock), high precision, repeatability, and cost savings (cheaper than labour cost). Computer vision can be used in a variety of industries. Measurement inspections of machine parts, anomaly detection for any physical parts/components, defect identification, package inspection, product composition verification, and many more are just a few examples.

For the foreseeable future, image processing will play a critical role in both manufacturing and commercial activities. Image processing system applications are expected to result in self-organized production based on extensive data gathering, better and more efficient business models, and automated, visually identified information, as well as more efficient production through extensive networking of computer vision in operational processes. AI is the key to unlock understanding of industrial data captured from smart machines, IoT equipment, as well as customers and workforces. Machine learning and advanced analytics can automatically discover and contextualise trends in machine data to predict significant equipment breakdowns. Computer systems use precise data to interpret the physical world and communicate with one another in industrial sectors.

Industrial Revolution

Since the dawn of time, humans and machines have always had a hand-to-hand relationship. The Industrial Revolution caused a huge U-turn in world history, bringing enormous expansion in economic growth, social development, and population. As the Industrial Revolution developed, it is thought that the West's quality of life rose.

Britain was at the heart of the Industrial Revolution, architectural and technical innovations were developed there. By mid-eighteenth century, Britain had established a worldwide commerce empire with colonies in the Caribbean and North America, as well as considerable political and military power on India through East India Company's activities. The expansion of commerce as well as the emergence of business was two main factors for the Industrial Revolution.

Electricity and electrification entered a new era where development of hydro power generation in the Alps, which began in the 1890s, aided the rapid industrialization of coal-depleted northern Italy. By 1890s, these areas had become industrialised, and businesses like Bayer AG, Standard Oil, General Electric, and U.S. Steel had joined ship companies and railroad on the world's stock markets, creating the first large industrial conglomerates with increasing worldwide interests.

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