# Chapter 10
# A Comprehensive Study on Internet of Things Based on Key Artificial Intelligence Technologies and Industry 4.0

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## ABSTRACT

*Under uncertainty, understanding and controlling complex environments is only possible with an ability to use distributed computing by the way of information exchange between devices to be able to understand the response of the system to a particular problem. From transformation of raw data in a huge distribution of network into the meaningful information, to use the understood knowledge to make rapid decisions needs to have a network composed of smart devices. Internet of things (IoT) is a novel approach, where these smart devices can communicate with each other by using key technologies of artificial intelligence (AI) in order to make timely autonomous decisions. This emerging technical advancement and realization of horizontal and vertical integration caused the fourth stage of industrialization (Industry 4.0). The objective of this chapter is to give detailed information on both IoT based on key AI technologies and Industry 4.0. It is expected to shed light on new work to be done by providing explanations about the new areas that will emerge with this new technology.*

## INTRODUCTION

With the rapid advancement of technology and science, IT technology has paved new ways of research and discoveries on computational intelligence regarding large data set come from things or objects in a distributed environment. These varieties of things or objects is a network of interconnected, integrated and organized objects (Liu et al. 2017) which allows to communication between things to human, human to human, and things to things in order to analyze large amount of data to produce needed information generated by IoT to reach a certain goal (Madakam et al. 2015). In other words, instead of traditional centralized applications, IoT utilize advanced information analytics via smart devices (things or objects) to be able to integrate various components of network connected as a collaborative way to improve productivity, service ability and flexibility of companies. Based upon the analyzed literature, Figure 1 is generated to demonstrate main architecture of IoT covering basically three different levels.

The first level of IoT determined as level of Big Data that is an ability to turn data into meaningful value (**Value**). In this level, decision makers deal with vast amounts of data (**Volume**) with huge diversity (**Variety**) to control messiness or trustworthiness of data (**Veracity**) that need to analyze while it is being generated (**Velocity**). In the second level of IoT architecture is defined as AI level where each node represents an integrated things or objects which can sensing, processing, reacting and control the environment to understand current situation of the system and based on the learned knowledge providing necessary information to utilize future decisions. In the Figure 1, data exchange between Big Data level and AI level is illustrated by bi-directional arrow.

The state of environment may change at any time so each thing or object needs to have an ability to adapt to changes and learn from the experience. In this dynamic environment, intelligent and autonomous system is crucial technology in order to obtain integration is managed, coordination is provided and distributed computing is enabled. To utilize and understand intelligent system, need to focus on AI technology that encompasses wide spectrum of research field like *machine learning*, *deep learning*, *natural language processing*, *machine reasoning, visual processing, robotics* and *neural networks*. AI application range seems like unlimited. It is possible to see AI –based applications from assistance system for healthcare to smart customer service systems. In section 2 this components, applications, and issues of AI explained in detail. In third level of IoT, each node is linked into a network that composed of set of things or objects working together to make real-time, accurate and coherent decision when a specific input arrive the system.

Rising applications of the IoT caused a sweeping change that will fundamentally reconfigure industry and the Fourth Industrial Revolution is emerged. In many case, these two word are accepted as interchangeable. Mainly this two approaches focus on the ways to constant high quality by making system faster and secure at the same time but industry 4.0 is a primarily government and academic-based movement that aims to make process and products intelligent (Brettel et al., 2014). Although IoT takes place in the business world, it is one of the most important effect that trigger the fourth industrial revolution. When the previous industrial revolutions is examined; after usage of steam and steam engines, world was confronted with first industrial revolution in 18th century. Electrification was the main cause to second industrial revolution in 19th century and usage of computers and robots led to third industrial revolution in 20th century.

Today, Connecting Cyber-Physical systems (CPS) to physical and digital systems is the main idea of fourth industrial revolution (Fırat, 2016). IoT provides connection and information transfer between physical entity and its cyber twins so that control and monitoring the outcome of physical entity is

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