

# Chapter 21

## Internet of Things and Nature-Inspired Intelligent Techniques for the Future of Biomedical Engineering

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### ABSTRACT

*Along with the rise of artificial intelligence (AI), there are many different research fields gaining importance. Because of the growing amount of data and needs for immediate access to information for dealing with the problems, different types of research fields take place within the scientific community. Internet of things (IoT) is one of them, and it enables devices to communicate with each other in order to form a general network of physical, working devices. The objective of this chapter in this manner is to provide a general discussion of using nature-inspired techniques of AI to form the future of biomedical engineering over IoT. Because it is often thought that the medical services of the future will be based on autonomous machines supported with AI and IoT, discussing such a topic by considering biomedical engineering applications will be good for the related literature.*

### INTRODUCTION

Technological developments have always wide-open doors to the dream of the better future. In this context, every technology has a great effort for improving day by day and having a great influence in achieving better living standards for the humankind. In detail, especially computer, electronics and communication oriented technologies had had important roles in meeting with this output at the end. Considering that many different innovative technologies have also taken place in humankind's modern life. Here, more consideration should be given to the Artificial Intelligence (AI) because of its wide popularity and also scope leading to an unstoppable multidisciplinary approach.

Since its first introduction to the scientific literature, AI has improved more and more in time and reached to a top place with its detailed sub-research areas that can be applicable to many real world- based

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problems. In the literature, it is possible to see that AI can be used within almost all fields (Cortés et al., 2000; Nilsson, 2014; Poole & Mackworth, 2010; Remagnino & Foresti, 2005; Russell & Norvig, 2002). Although the AI can be used within almost all fields greatly, some of them are essential for achieving better life for humans and creating a better future also. Here, the field of Biomedical Engineering is one of them as including wide relations with different fields like health, computer engineering, machine engineering, electronics and many more (Bronzino, 1999; Enderle & Bronzino, 2012; Kline, 2012). Thinking about the latest developments in the AI and its early steps, it is possible to see a clear relation among AI based approaches, methods, techniques and also applications that can be examined within Biomedical Engineering.

With the past time over applications of AI, one important thing is that the more improvements in some supportive technologies have enabled AI to rise more in time. Today, AI is more discussed by people because of its more applications within different fields, by providing effective and accurate solutions. When it is thought about supportive technologies, it is possible to focus on i.e. computer or electronics technologies, as important actors in rise of AI. Especially alternative hardware oriented solutions have made it possible to think more about robots or machines, which are not just software systems but also real things that are able to provide actions – feedback according to received triggers from their environment. In detail, there are many different efforts to realize such robots or machines supported with AI (Bakhshipour et al., 2017; Craig, 2005; Geraci, 2012; Liang et al., 2016; Nolfi et al., 2016; Ziemke, 2001). But also, such research efforts have enabled some alternative sub-fields to rise and take active place in the scientific literature. Internet of Things (IoT) is one of these sub-fields and it currently has strong relations with the AI as providing alternative solutions, which are more meaningful when we think about a future with full of autonomous, intelligent systems – machines.

AI is a field with full of detailed approaches, methods, and techniques to provide effective solutions for real world based problems. Considering an intersection of the field of Biomedical Engineering and also IoT, a wide, alternative research interest of future is rapidly designed in the view of scientific community. In addition, it is also possible to think about some specific sides of AI to get an alternative theoretical view over that research interest. Taking a rapid look at to the AI, nature-inspired techniques can be seen as a specific topic to be considered for intelligent, IoT based solutions for Biomedical Engineering and in this way, an alternative discussion for the future can be drawn.

In the context of the explanations above, objective of this chapter is to provide a general discussion over using nature-inspired techniques of AI to form the future of Biomedical Engineering build over IoT. Because it is often thought that the medical services of the future will be based on autonomous machines supported with AI and IoT, discussing about such topic by considering Biomedical Engineering applications will be good for the related literature. In detail, the chapter tries to increase awareness in essential elements of the intersection including AI and IoT and leads the interested readers to have enough idea about how nature-inspired techniques of AI can be employed to achieve IoT oriented, intelligent Biomedical Engineering solutions.

As being associated with the subject of the chapter, the remaining content is organized as follows: The next section is about some brief definitions and explanations regarding main topics under the subject of the chapter. Following to it, the third section discusses some about possible application ways for intelligent IoT based solutions for Biomedical Engineering studies. Next, the fourth section focuses on future state in this manner and finally, the last section ends the chapter with final explanations on the considered subject scope.

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