

Edge Intelligence for Empowering IoT-based Healthcare Systems

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Abstract—The demand for real-time, affordable, and efficient smart healthcare services is increasing exponentially due to the technological revolution and burst of population. To meet the increasing demands on this critical infrastructure, there is a need for intelligent methods to cope with the existing obstacles in this area. In this regard, edge computing technology can reduce latency and energy consumption by moving processes closer to the data sources in comparison to the traditional centralized cloud and IoT-based healthcare systems. In addition, by bringing automated insights into the smart healthcare systems, artificial intelligence (AI) provides the possibility of detecting and predicting high-risk diseases in advance, decreasing medical costs for patients, and offering efficient treatments. The objective of this article is to highlight the benefits of the adoption of edge intelligent technology, along with AI in smart healthcare systems. Moreover, a novel smart healthcare model is proposed to boost the utilization of AI and edge technology in smart healthcare systems. Additionally, the paper discusses issues and research directions arising when integrating these different technologies together.

Index Terms—Smart healthcare, Edge computing, IoT, Artificial intelligence, Machine learning.

1 INTRODUCTION

Healthcare is one of the crucial parts of human life. Due to the rapid population growth and the rise of various diseases, there exists a drastic surge in requests for healthcare and its facilities. Also, with the technological evolution and the emergence of Internet of things (IoT) coupled with the improvement of next-generation wireless communications, the concept of smart healthcare or connected healthcare systems has been introduced as a developed version of conventional healthcare systems. In fact, smart healthcare refers to a health service that exploits technologies such as IoT, wearable devices, and advanced communication protocols to dynamically connect patients, caregivers, and health institutions and transfer information among them [1]. Smart healthcare services provide the possibility of handling and responding to medical requests remotely in an intelligent way, which diminishes hospitalization remarkably and helps people and doctors to predict, detect, diagnose, and treat diseases intelligently. Also, smart healthcare is

used for preventing and controlling the outbreak of contagious and infectious diseases such as the Ebola virus, Avian influenza, Chickungunya virus [2], and recently the Covid-19 pandemic. Taking all the above mentioned issues into account, adoption of efficient smart healthcare services would certainly improve the health level of our society.

In order to expand the healthcare facilities and satisfy the vast amount of users' requests, smart healthcare systems employ numerous smart devices and IoT technologies. Thus, a massive amount of heterogeneous medical records generated by smart devices need to be processed and evaluated accurately based on the target of the system [3]. Therefore, there is a need for effective communications among various entities of smart healthcare community and data centers to ensure low response time for emergency cases in real-time health needs, since the high response time and high latency at data centers are critical risks in smart healthcare systems and can lead to the irreparable catastrophes [1]. Keeping these facts in mind, edge computing technology, and AI are the best choices for these issues. Especially, adopting the combination of these two technologies can pave the way for solving various challenges in the scope of smart healthcare.

Edge computing technology moves some processes close to the data sources, which reduces the load of transmitted data conspicuously [4]. In fact, edge technology enables smart healthcare systems to conduct some processes and store some data near the end-users rather than transferring all the records to the cloud data centers [5]. In this way, smart healthcare systems only need to send the results of processes and some raw data to the remote cloud data centers. Various research works by utilizing edge technology in the field of smart healthcare can conduct big data analysis, store and process sensitive medical data, diminish latency, reduce energy consumption, reduce cost, reduce network congestion, and response time.

Moreover, by emulating human cognition in analyzing data through complex algorithms, AI can smooth the path of estimating the conclusions without the direct involvement of human. In fact, AI is responsible for investigating relations between the treatment, prevention, or detection techniques of diseases based on the collected data from patients. In the edge context, the resource constraints necessitate innovative and lightweight methods to be able to execute them at the edge environment. Therefore, Machine

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