Chapter 2
The Use of Artificial Neural Networks in Biomedical Engineering

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ABSTRACT

Artificial Neural Networks (ANNs) have brought a great advance in biomedical engineering with their enhanced features in data analysis, pattern recognition, and data modeling systems. Taking advantage of the computational capabilities of ANNs, scientists and engineers have designed new approaches to address some of the most difficult tasks in medicine, such as the diagnosis of diseases, the selection of appropriate treatment regimes, and the establishment of personalized medicine. Advanced numerical neural networks effectively manage diverse, high-dimensional biomedical research data like imaging data or sequences and physiological signals and can provide timely and accurate decisions. This chapter aims to cover the background, the opportunity, and the advancement of the ANNs in biomedical

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engineering and specifically how this field has and will continue to impact the future of healthcare technology.

1. INTRODUCTION

Now, artificial neural networks (ANNs) have emerged to significantly improve biomedical engineering by providing new solutions for diagnostic, therapeutic, and even predictive fields (Weiss et al., 2022). Neural networks represent a subset of ANN models designed based on human biological neural network functionality and are most suited for pattern recognition together with data analysis and adaptive learning, contributing to essential positive progress in domains such as medical imaging, disease diagnosis, and customized medication. It includes improving imaging precision in the diagnosis of brain tumors to improving the treatment process through the use of analytical and predictive tools (Park et al., 2018). For instance, the combination of ANNs and clustering algorithms, reveals a high diagnostic of 99.61% accuracy of the model in diagnosing kidney disease which is evidence of the efficiency of biomedical tasks. From Table 1 it is seen that ANNs play a very wide role in biomedical engineering where they are applied in diagnostic tools, imaging, care delivery as well as smart healthcare in a broad sense.

Furthermore, enhancements in the application of Deep Learning techniques and Hybrid models of ANNs have enhanced segmentation errors in medical imaging, especially the brain and lung cancer (Dzobo et al., 2020). Such methods lower computational complexity but at the same time ensure very high accuracy. These approaches do not only facilitate the execution of the biomedical processes but also provide patient-centered, real-time interventions which is a principle of the current health systems (Barua et al., 2024). The discussed ANNs present new research opportunities and it is essential to analyze such issues as data security, computational cost, and ethical concerns as ANNs progress. However, there is not much doubt that they possess the ability to revolutionize the concept of biomedical engineering sharping healthcare diagnostic and therapeutic strategy (Cartwright et al., 2015).