Chapter 12
Revolutionizing Biomedical Engineering With Quantum Computing and AI

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ABSTRACT

Quantum computing and AI could change biomedical engineering by enabling smart biomedical applications. Quantum computing and artificial intelligence for smart biological applications are thoroughly explained in this chapter. Combining quantum computing with AI promotes personalised healthcare, disease diagnosis, and medication discovery. The authors begin with a hardware and software review of both systems before discussing AI and quantum computing. Quantum computing and AI in personalised healthcare are then considered. The authors discuss quantum computing and AI-powered telemedicine, precision medicine, and smart wearable and medical devices. They also note that reliable qubit technologies, effective error-correction methods, and scalable quantum computing and AI architectures are needed to fully exploit quantum computing and AI for smart biomedical applications. In conclusion, quantum computing and AI could revolutionise biomedical engineering and enable intelligent biomedical applications that improve patient outcomes.

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1. INTRODUCTION

a) Overview of Quantum Computing and AI

Quantum computing and AI are rapidly growing fields that could revolutionise science and engineering (Nielsen, M. A., et al., 2010). Quantum computing employs qubits instead of classical bits for faster, more efficient calculations. However, AI involves creating intelligent algorithms that can learn and execute human-like tasks including picture and speech recognition, decision-making, and language translation. Quantum computing and AI are complementary technologies that can boost each other (Silver, D. et al., 2016). Quantum computing can speed up machine learning techniques, while AI can optimise quantum circuits and repair quantum computation mistakes. Quantum computing and AI could revolutionise drug discovery, medical imaging, and illness detection.

b) Fundamental Quantum Principles for Biomedical Engineering With Quantum Computing and AI

Quantum computers and AI can improve medicine and healthcare. This could involve developing new medications, novel disease therapies, and personalised care (Jordan, M. I., et al., 2015). Discuss quantum computing's fundamentals, how they can benefit medicine, and AI's role:

1. Superposition and Quantum Parallelism

Consider small particles with simultaneous states. Quantum computers use these particles to calculate quicker than normal computers.

i) **Finding New Medicines:** Quantum computers can aid in researching chemical interactions in the body, enabling the development of new medicines and therapies.
ii) **Optimizing Treatments:** Quantum computers can instantly determine optimal drug delivery and treatment regimens.

2. Entanglement

In rare cases, particles can form a unique connection despite their distance. Quantum computers can get increasingly powerful.

i) **Studying Genes:** Quantum linkages may aid in gene understanding, illness patterns, and personalised treatment design.
ii) **Smarter AI:** Quantum links could enhance AI perception of visuals and patterns, such as identifying medical issues in X-rays.