Chapter 4
Exploring the Potential of Quantum Computing in AI, Medical Advancements, and Cyber Security

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ABSTRACT

The modern method of computing known as quantum computing depends on incredible phenomena over quantization. Combining various domains beautifully. For controlling a way of treating microscopic elements like atoms, electrons, photons etc., it outperforms conventional computers in terms of computational power, efficiency, and speed. The fundamental ideas and concepts of quantum computing are discussed in this chapter. The chapter unitizes a history in basic computing techniques along with changes as well as improvements which were made to overcome its disadvantages up to this point. This chapter discusses structure, h/w, s/w, category, types, along protocols which are generally needed by quantization methods to comprehend overall potential as well as limitations for realistic quantum devices which can be released public manner. Moving towards the advantages regarding the general quantum computing technique as well as analyzing its potential, it is recommended to review some background information.

1. INTRODUCTION

The operations of quantum computing can take advantage of quantum mechanics peculiarities like superposition, obstruction, and trap. Quantum PCs are gadgets that can do quantum calculations. Bigger acknowledge are believed to have the option to tackle specific computational issues, like whole number factorization (the groundwork of RSA encryption), altogether quicker than old-style PCs, despite the fact that ongoing quantum PCs are excessively little to beat customary (traditional) PCs for useful applications. A subfield of quantum data science is the investigation of quantum processing.

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Quantum circuits are the most well-known quantum calculation model, yet there are a few others. The quantum Turing machine, quantum tempering, and adiabatic quantum calculation are three extra models. The quantum spot, or "q-bit," which fairly closely resembles the piece in customary calculation, fills in as the establishment for most of the models (Sánchez Martínez, S., et al., 2019) A q-touch can be in a superposition of the states 1 and 0 or in either the 1 or 0 quantum states. However, when measured, it is always either 0 or 1; the quantum state of the q-bit immediately before measurement determines the likelihood of either outcome. Continuous variable quantum computation is one model that does not make use of Q-bits.

Technologies like translations, ion traps, and topological quantum computers are the primary focus of efforts to create high-quality Q-bits for a physical quantum computer: 2–13 logic gates may be utilized in the design of these Q-bits, depending on the computing model of the complete quantum computer. Quantum computers that are practical are currently hampered by several significant obstacles. Due to their quantum de-coherence, maintaining Q-bits' quantum states is particularly challenging (Debnath, S., et al., 2020). As a result, quantum computers require error correction.

quantum computing can solve a lot of computational queries which can be solved by classical machines. In contrast, if enough time is given, various kinds of queries can be performed by quantum computing which can also be solved by a classical computer, like theoretically. Quantum computers, other words, adhere to the Church–Turing thesis. This indicates that quantum solving mechanisms used in quantum computing take less time period when compared to traditional mechanisms, even though quantum computing does not offer any extra benefits when compared in terms of performance. "Quantum supremacy" refers to the fact that quantum devices can perform any kind of task in an easy manner as well as in less time compared with traditional methods (Lysaght, T., et al., 2019) this is the technique of problems which solves harder tasks in quantum computers.

2. HISTORY OF QUANTUM COMPUTING

The author brought up an idea for a quantum mechanism for tuning devices in 1980, it marked the beginning of quantum computing. After that, another author (Calamuneri, A., Costa, A., D'Angelo, R., & Sidoti, A., 2017) brought up the idea that quantum devices can realistically manage the things that general devices cannot perform. Previous developments in quantum techniques were introduced by Feynman in 1986. Peter Shor created a quantum algorithm in 1994 that could decrypt RSA-encrypted communications by identifying the composite numbers for a set of ranges of numbers. In 1998, Mark Kubinec, Neil Gerstenfeld, and Isaac Chuang developed the first quantum computer with two Q-bits that could carry out calculations. "Identifying the faults became the hardest task compared to other tasks in the quantum environment" the majority of researchers believe, instead of performing the research after the 1990s. In 2015, research from Duke University estimated that a large fault-tolerant quantum technique with approximately 3.5 million Q-bits can perform the 2,048- set of values in 150 days. Both the public and private sectors have increased their investments in quantum computing research in recent years. Google AI and NASA defined on October 23, 2019, that they had worked on quantum technique which is impossible compared to traditional techniques. Even it is found or not the capturing is still true is the subject of ongoing research. A time line visualization is shown in Figure 1.