Chapter 11
Quantum Computing for Indoor Environmental Quality: A Leapfrogging Technology

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ABSTRACT

Quantum computing (QC) is founded on the principles of quantum entanglement and the superposition of matter. It employs advanced computation techniques rather than conventional ones. To circumvent the limitations of conventional computing, new supercomputers employ quantum mechanics knowledge, which allows for the coherence of ones and zeros. Several fields like finance, healthcare, cybersecurity, transportation, climate change, and many more are taking advantage of QC. Indoor environmental quality (IEQ) is also one of the sectors that can benefit enormously with QC. The IEQ contains several parameters. Major IEQ parameters are indoor air quality, thermal comfort, acoustic comfort, and visual comfort. These parameters are associated with several physical, chemical, and biological components, which need critical computational considerations for accurate results and better understanding as the data can be highly overlapped. This chapter contains possible forthcoming research opportunities available in the collaborative work between "indoor environment" and "quantum computing."

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"Even when quantum is in the universe, the universe is still in quantum" ~ Authors

INTRODUCTION

Every technological development that occurs on our planet advances human health, comfort, safety, and quality of life. Building various structures was the first invention created by mankind to enhance their quality of life (Kapoor et al., 2018). Subsequently, with the unprecedented inventions by humans, a new field of science and technology is discovered as a result of this evolution, known as computers. In the current era of computers and technology, advanced computing has the potential to bring about technical advances to each and every field that is leapfrogging. Modern computing techniques like quantum computing (QC) are based on the incredible occurrences of quantum physics (QP). It is a stunning fusion of information theory, computer science, mathematics, and physics. By influencing the behaviour of minute physical things, such as photons, electrons, and atoms, it outperforms conventional computers in terms of processing power, exponential speed, and energy consumption (Robbin, 2007).

Theoretical principles must be implemented physically well in real-time devices. If the input is pertinent and the set of instructions is favourable, real-time computers can solve issues quickly and accurately. The most modern electronic devices and systems we use today are a result of science and technology (S&T) increasing understanding of and control over nature and physical processes. In comparison to early computers, which were large, expensive, and require more energy, modern computers are less expensive, faster, more efficient, and even more powerful. It is made feasible by advancements in system architecture, hardware, and the software that runs on them. Quantum technology was developed with the goal of creating the tiniest computer possible by shrinking circuits alike atom size. These tiny circuits, nevertheless, would not be capable to function like switches since electrons in the atoms have the ability to live simultaneously in two different locations. They can disappear from one region of a barrier and be visible in the other (Taha et al, 2022). This phenomenon similar to teleportation is known as "Quantum Tunnelling" in QP. The law of classical physics, which provides us with the sole deterministic explanation of the Universe, may be used to describe the representation and processing of these computers. The largest advancement in physics; i.e. quantum mechanics, was discovered as a result of the failure of classical physics to predict all notable occurrences happening in nature (Frauchiger & Renner, 2018). In order to store its state in some type of physical info instead of a circuit, new computing must be developed in addition to the present conventional computing. Since the design of computers is becoming subject to additional restrictions as a result of quantum phenomena. It alters the fundamental components of a conventional computers, requiring new developments in hardware and software with new designs and functioning. New ideas are needed to make it easier for designers to construct as well as use these new developments even as their complexity increases with time. Quantum attributes must be used to guide the new design for both hardware and software (Moller & Vuik, 2017).

A novel form of computation called QC is based on QP and its behaviour with the physical world is unpredictable and stochastic (Martonosi & Roetteler, 2019). QC is a more reliable method of computing and has a larger potential to handle problems that traditional computing cannot because quantum mechanics offers a more comprehensive view of physics than classical mechanics. In contrast to other conventional computers that employ binary bits 1 and 0 independently, quantum computers employ quantum bits, "Qubits," to store and process the information. Quantum computers are the term for the