Chapter 1
Quantum Computing

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ABSTRACT

In this chapter, quantum computing concepts are discussed in detail. Discussion about qubit and allied terms is done in brief. Light is also thrown on quantum ambiguity, key distribution, quantum entanglement, quantum simulation, digital quantum simulation, etc. Further sections explore applications of quantum in image processing, wireless sensor protocol, routing protocol, and cyber security. Bibliographic analysis of research trends in quantum computing in cyber security is also discussed in detail in this chapter.

1. QUANTUM COMPUTING

Processed Data called information, is stored in computer in the form of Bits (Binary Digits) i.e., 0 and 1. Data storage in memory is related to magnetic energy. The binary bits are stored in memory by aligning the atomic magnetic dipoles permanently (Yusuf et al., 2015). Collection of many individual atoms with their magnetic moments align at certain location form a small bar magnet. Subatomic particles would behave strangely by not being localized to a specific position and not having specific momentum at a given instant of time.

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1.1 Quantum Ambiguity

Atoms or subatomic particles behave like waves would substantiate their uncertainty of being not localized. The mathematical relation describing the wavelength λ_d of the matter waves obtained using a relation of energy to momentum: p=hv/ c=h/ λ_d which implies de-Broglie wavelength λ_d = h/p.

Particle presence could only be described using probabilities, there exists a mathematical function describing particle waves called Wave Function, denoted by the Greek letter 'Ψ' (psi) (Agrawal et al., 2012) The wave function Ψ also carries the information of position or momenta, which could be obtained from $|\Psi|^2$, wherein the information would be in terms of probabilities. Finding the probabilities of the particles through the wave functions, and further running several simulations to reveal the probabilistic locations of electrons at different energy levels would lead you to get a clear understanding of different orbital structures.

At Quantum regime (atomic scale) individual atoms exist in multiple states as its electrons could exist in various available orbits (Wilhite, 2012). Quantum particles such as electrons, behaving like waves (spread around in space) substantiates their probabilistic existence at multiple locations.A given electron could exist at multiple locations, precisely getting position and momentum is not possible.

1.2 Qubit

Qubits can exist simultaneously as '0' and '1'. It encodes two complex numbers at once. A quantum computer promises to be immensely powerful because it can be in multiple states at once. Entanglement describes correlations between quantum systems that are much stronger than any classical correlations.

A given valency electron could be in outermost orbit or in the orbit within the outermost (Kumar Sharma et al., 2021). With suitable interacting field (laser), particular atomic levels could be selected for study. Excitation described in form of probabilities. At quantum regime, two level atom could be a potential device to store two data points, leading to Qubit. Excitation described in form of probabilities. At quantum regime, two level atom could be a potential device to store two data points, leading to Qubit. Apart from electron orbital locations, electron's spinning about their axis Imagine a physical process that emits two photons, one to the left and the other to the right, with the two photons having opposite polarizations – a photonic qubit in a singlet state (Li et al., 2021). The polarization of each of the photons is indeterminate until a measurement is done. At the instant the polarization for one photon is measured, the state of the other polarization becomes immediately fixed no matter how far away it is. could be chosen to store information.