Quantum Computing

Ptaiksha Pardeshi[1], Sapna Rajapkar[2], Sanket Takle[3], Hanumant Manade[4],Prof. Swati Patil[5]

[1]*Student, Computer Technology, Bharati Vidyapeeth Institute of Technology, Maharashtra, India*
[2]*Student, Computer Technology, Bharati Vidyapeeth Institute of Technology, Maharashtra, India*
[3]*Student, Computer Technology, Bharati Vidyapeeth Institute of Technology, Maharashtra, India*
[4]*Student, Computer Technology, Bharati Vidyapeeth Institute of Technology, Maharashtra, India*
[5]*Professor, Computer Technology, Bharati Vidyapeeth Institute of Technology, Maharashtra, India*

ABSTRACT

Computers reduce human effort and also focus on increasing the performance to push the technology forward. Many approaches have been devised to increase the performance of the computers. One such way is to reduce the size of the transistors used in the systems. Another very significant way is to use quantum computers. It proved to be very effective when used to factor large numbers. It was found that it could decrypt codes in 20 minutes which took billions of years with classical computers. This was a great motivation for focusing on this topic. A quantum computer uses a `quantum bit' or qubit to have three states - 0, 1, and 0 or 1. The last state is the coherent state. This enables an operation to be performed on two diverse values at the same time. However, this brings out a problem of decoherence. It becomes difficult to perform the computation using quantum computers. A quantum computer is desired to have five power - scalable system, initializable state, long decoherence time, universal set of quantum gates, high efficiency measurements. Architecture of the quantum computer is the new research area in the field of computers. It is dervied by quantum arithmetic, error management, and cluster-state computing. Without it, the quantum algorithms would not prove to be as efficient. To fully utilize the power of a quantum computer, the algorithms should be based on quantum parallelism that is a period of sequence.

Keywords: *Quantum Computing, qubits, superposition, entanglement*

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1. INTRODUCTION

Quantum computing is a computing using quantum-mechanics, such as superposition and entanglement. A quantum computer is a processor that performs quantum computing. Quantum computer is different from classic computers based on transistors. Whereas common digital computing requires that the data be encoded into binary bits, each of which is always in one of two definite states (0 or 1), quantum computer uses qubits, which can be in superpositions of states. The field of quantum computing was initiated by Paul Benioff and Yuri Manin in 1980, Richard Feynman in 1982, and David Deutsch in 1985. As of 2018, the development of actual quantum computers is still in its infancy, but experiments have been carried out by the big tech giants company such as google, IBM and startups like rigetti computing which are in the process of producing quantum computers. A small 20-qubit quantum computer exists and is available for experiments via the IBM quantum experience project that is available on the IBM website. Large-scale quantum computers would theoretically will be able to solve certain problems much more quickly than any classical computers that use even the best currently known algorithms, like integer factorization using Quantum algorithm and the simulation of quantum body systems. There exist quantum algorithms, such as Simon's algorithm, that run faster than any possible classical algorithm. A classical computer principle simulate a quantum algorithm, as quantum computation does not violate the Church–Turing thesis. On the other hand, quantum computers may be able to solve the problem more efficiently that can’t be solve by the classical computers.

2. LITERATURE REVIEW

By the birth of Quantum Physics, many new areas are opened for research and development in the world of science and technology.[1] One such field is Quantum Computing and Communication where there is room locked that once was dream in the field of computing and communication. This paper gives a brief review of what is actually happening in the field

a lot of promises in information processing systems, particularly in Big Data Analytics. In this paper, we have of quantum computing and communication.

With the skyrocketing needs of rapid processing speed and miniaturization, classical computers are not able to keep up the pace with these few necessary parameters. As classical computers work on classical mechanics there expansion is at zenith. Due to these limitation quantum mechanics is taking the role of game changer in race of computation.[2]

Big Data is a term which denotes data that is beyond storage capacity and processing capabilities of classical computer and getting some insight from large amount of data is a very big challenge at hand.[3] Quantum Computing comes to rescue by offering reviewed the available literature on Big Data Analytics using Quantum Computing for Machine Learning and its current state of the art.

This research focuses on surveying in an attractive field of quantum computing. The paper begins by highlighting a brief history of quantum mechanics. Major elements of quantum computing such as quantum superposition, quantum tunnelling and qubits[4] are addressed at next from a physics perspective. In addition, various methods and applications of quantum physics are also examined.

3. ELEMENTS OF QUANTUM COMPUTING

3.1 Qubits

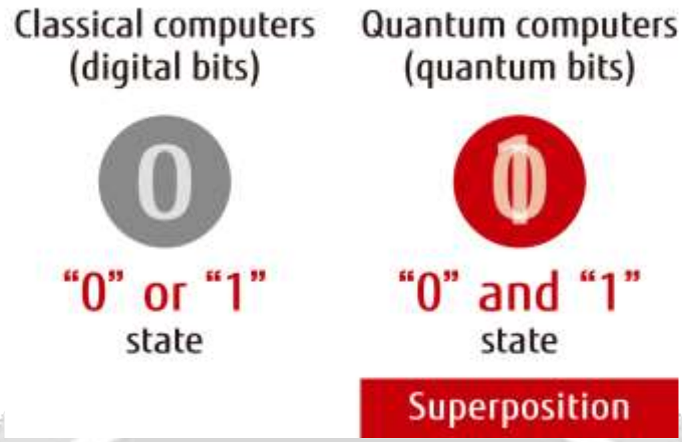
Classical computers encode information in bits. Each bit can take the value of 1 or 0. This 1 and 0 act as on and off switch that ultimately drive computer functions. Quantum computers are based on qubits, which operate according to two principles of quantum physics that are superposition and entanglement.

Using these two principles, qubits can act as more high degree of complexity switches, enabling quantum computers to function in ways that allow them to solve difficult problems that are intractable using today's computers.

Superconducting are produced by a metal on a silicon chip the metal is arranged in such a way that when you cool it down to a low enough temperature that metal becomes superconducting. All the electrons can flow without electrical resistance, they can actually take on individual quantum states. In order to cool them down they uses refrigerators for that they use something called dilution refrigerators 10-15 milikelvins. The temperature is colder than the outer space i.e. 0.051 kelvin . Microwave cables are connected to the quantum chip through which the signals are send to the chip and it process it and gives the output.

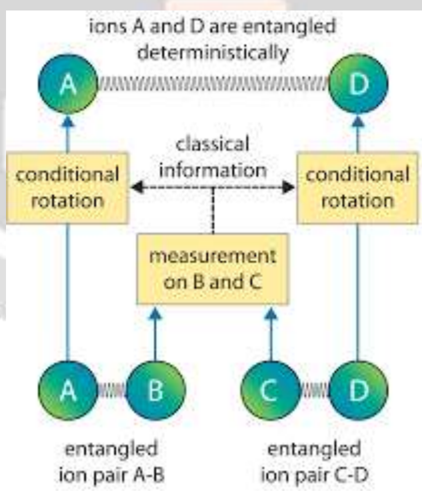
3.2 Superposition

Think of a qubit as in a electron in a magnetic field. The electron's spin may be either in arrangement with the field, which is known as a spin-up state, or opposite to the field, which is known as a spin-down state. Changing the electron's spin from one state to another is achieved by using a pulse of energy, such as from a laser - let's say that we use 1 unit of laser energy. But what if we only use half a unit of laser energy and completely isolate the particle from all external effect. According to quantum law, the particle then enters into a superposition of states, in which the qubits can behaves as if it were in both states simultaneously. Each qubit used could take a superposition of both 0 and 1. Thus, the number of computations that a quantum computer could undergo is 2^n, where n is the number of qubits used. A quantum computer generally comprised of 500 qubits that would have a potential to do 2^{500} calculations in a single step. This is an extremely impressive number - 2^{500} is infinitely more atoms than there are in the known universe this is true parallel processing - classical computers today, even so called parallel processors, still can only truly do one thing at a time: there are just two or more of them doing it. These particles will interact with each other using quantum entanglement.



3.3 Entanglement

Particles such as electrons, or qubits that have interacted with each other at some point retain a type of connection and can be entangled with each other in pairs, in a process known as correlation. Knowing the spin state of one entangled particle up or down allows one qubit to know that the spin of its mate in the opposite direction. Even more surprising is the knowledge that, due to the remarkable use of superpostition, the measured that particle has no single spin direction before being measured, but it is simultaneously in both a spin-up and spin-down state i.e. 0s and 1s. The spin state of the particle being measured is decided at the time of measurement and communicated to the correlated particle, which simultaneously assumes that the opposite spin direction to that of the measured particle. This is a real phenomenon Einstein called it "spooky action at a distance", the mechanism of which is yet to be explained by any theory - it simply must be taken as given. Quantum entanglement allows qubits that are separated by large distances to interact with each other directly not limited to the speed of light. No matter how great the distance between the mutual realted particles, they will remain entangled as long as they are isolated.



Taken together, quantum superposition and entanglement create an extremely enhanced computing power. Where a 2-bit register in an ordinary computer can store only one of four binary configurations (00, 01, 10, or 11) at any given time, a 2-qubit register in a quantum computer can store all four numbers simultaneously, because each qubit represents two values at a single time. If more qubits are added, the increased capacity is expanded rapidly.

3.4 Quantum Programming

Perhaps even more curiosity than the sheer power of quantum computing is the ability that it offers to write programs in a completely new way. For example, a quantum computer could take a programming sequence that would be along the lines of "take all the superpositions of all the prior computations" - something which is meaningless to a classical computer - which would permit extremely fast ways of solving certain mathematical problems, such as factorization of large numbers, one example of which we discuss below.

There have been two notable successes far with quantum programming. The first occurred in 1994 by Peter Shor, (now at AT&T Labs) who developed a quantum algorithm that could efficiently factorize large numbers in a very short time. It centers on a system that uses number theory to estimate the repetation of a large number sequence. The other major breakthrough happened with Lov Grover of Bell Labs in 1996, with a very fast algorithm that is proven to be the fastest possible for searching through disorganized databases. The algorithm is so efficient that it requires only, on average, roughly N square root (where N is the total number of elements) searches to find the appropriate result, as anxious to a search in classical computing, which on average needs N/2 searches.

4. Conclusion

In this we have concluded the working of a quantum computer. The importance of superposition and entanglement in quantum computing and how the quantum computing is going to change the world soon. The working of qubits in the quantum computing is also explained and what differs the qubits from normal bits.

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