

Literature Survey on Quantum Computing

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Abstract: *Change is the law of nature and the world we live in is being transformed rapidly. There has been enormous evolution from Stone Age to agrigarian to industrialization and finally to the digitize world. Since technology is influencing billion people across the globe and large chunk of data needs to be stored and accessed efficiently and quickly, modern technology needs to be upgraded and hence in this paper there have been discussion about the Quantum Computing which unlike the conventional computer that work on bit; works on Quantum Bits. The paper discusses about the Quantum Bits, Working of Quantum Computers, advantage and obstacle it posses and ways to overcome the obstacle.*

Keywords: Quantum Entanglement, Quantum Bit, Quantum State Quantum Superposition, Digital Control Unit, Analog Control Signal, Decohorence

INTRODUCTION

Quantum Computing is the study of theoretical computing system which performs operation on data based on concept of quantum phenomena like entanglement, superposition and spin. Unlike conventional computer which works on binary bits, quantum computing works on quantum bits which for every 'n' bit of system performs efficient operation and analysis of 2^n state of computer system. A conventional computer uses '8' bits to store single number

between 0-256 whereas in quantum computer each quantum bits can store all 256 number at once. The storage capacity in quantum computer increases with increase in data but due to de-coherence the movement of atoms in processor creates obstacle in its working which is discussed further in paper. Its development faces enormous challenges ahead which are also highlighted further in paper.

Quantum Bits:

Quantum bit is a quantum mechanical property having charge, magnetic dipole and spin. Charge and Spin is influenced by angular momentum and orientation in space whereas dipole is associated with spin. The concept of Quantum Bit was introduced by Stephen Wiesner. Benjamin Schumacher in his acknowledgment of his paper described a way of compressing states emitted by a quantum source of information so that they require fewer physical resources to store. The bits operate in parallel having simultaneous states '0' and '1'.

Quantum Entanglement:

It is a physical phenomena where quantum state of each particle can't be described independently rather they are described for system as whole and as an event. According to Albert Einstein: "An event at one point in a universe can spontaneously affect event arbitrarily far away." According to Quantum Mechanics, particles don't have well defined

spin, they are in fact entangled i.e. spin is completely opposite to that of particle.

Quantum State:

It refers to the state of an isolated quantum system. A quantum state provides the value of the outcome of each possible measurement on the system. It predicts the system behaviour.

Quantum Superposition:

Quantum Superposition refers to atom that can be at two positions at same time. The superposition of state is applied to any quantum particle in the universe. In fact quantum superposition is responsible for the exchange of information in quantum bit.

Let's focus on atom. Its excitation can be visualized with energy levels but when one measures it, only one of the two states is observed randomly.

If we send an electromagnetic wave on quantum object with proper frequency, the atom alternates progressively between a non-excited and excited state. If the state of the atom is measured many times and averaged, we can find some oscillation explained by Sine wave. In real life, the quantum object is never completely isolated as an atom collides with other atom and quantum object and they are compelled to electromagnetic field or to a thermal bath. Hence the superposition of states stop after a while and the oscillation disappears.

At start, the atom can really be in two states at a time but in the end the atom can be only in one state at a time randomly chosen. The time it takes for the superposition to disappear is called the decoherence time which gives valuable information about the interactions between the quantum object and its environment and also determines error probability per operation.

Working:

Unlike conventional electronics where bits propagate through wires and exchanged between memory and processor, Qubits typically stay in a place. Instead, control signals which are translation of machine language instruction are brought to the qubits and the quantum logical

gates are implemented. The translated machine language instruction is voltage pulses sent to qubits. Qubits contain information which is processed in quantum processor and the output is in the form of binary bits separated.

ADVANTAGE AND APPLICATION

Let's consider '2' bit system whose possible combination of '2' bit data system { (00)(01)(10)(11) } contain '4' possible states. Here, a '2' bit classic computer can at most simultaneously perform '1' of these '4' possible function. In order to check all of them, the computer would need to repeat function separately. Whereas due to phenomenon of superposition a '2' quantum bit quantum computer is able to analyze all of the operation at a time. '2' quantum bit system contains information about 4 states. Then a machine with 'n' quantum bit system contains information about 2^n states simultaneously. Hence, the storage, computation and analysis increase with increase in data.

Quantum Computing entirely depends upon the rule and property of quantum mechanics to solve the problem. [1.] Since quantum processor is million times faster than the conventional system, Tech Giants like Google and NASA uses it to store data and solve complex problem. Its application is wide in research of NASA. [2.] It can be useful in learning more about universe as it can accumulate and process large chunk of data efficiently in less time. [3.] Medical research require efficient processing and storage system to learn about molecules, DNA, RNA and various other metabolic activities like protein sequencing which can be useful in design of drugs to cure various disease. [4.] Meteorological department can find its use in predicting weather condition. [5.] It can be used in study of forensic, financial and stock market and Information security as well. [6.] Graphics visualization can be enhanced resulting in high definition video effect. [7.] Network and routing system can be optimized thereby allowing the systems to communicate quickly and efficiently.

OBSTACLE IN QUANTUM SYSTEM

Our surrounding is full of elementary particle and it's not cold enough which only serve to destroy the Processing. Such uncontrolled entanglement of quantum bit with the surrounding outside lead to leakage of information. This effect is called decoherence which determines error probability per operation which is responsible for leakage. Apart from this, the control signal generated by machine language needs to be propagated through system immune to environmental phenomena. Hence it is necessary to isolate and cool the quantum processor as it removes wiggling of atom to just calm down and when it can be done then these powerful magical property that exist in quantum mechanics will blossom out. However, efforts are being made at various levels to minimize error probability per operation. The target is to bring it below fault tolerance threshold. A very important development in recent year was to bring down this threshold from 10^{-4} to about 1%, a number that is either achieved or in reach with current technology. Today, no more than a dozen qubits have been integrated and operated on a chip. Control and read-out signal rely on bulky and expensive equipment. Currently built every quit has different behaviour which can be compensated by calibration and tweaking which is time consuming. In addition, Interconnects between the qubits and the control and read-out electronics present an important challenge.

CONCLUSION

Hence if quantum algorithm can be enhanced with the lower error probability per operation at the minimum tolerance threshold, the powerful magical property of quantum computing will blossom and next big transformation in the technology and life of people can be witnessed. It can be blessing in disguise for mankind as the planet is being digitized.

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