A Survey Study based on Quantum Computing

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Abstract - *Quantum computing is the new field of science that use quantum phenomena for performing operations on data. The goal of quantum computing is for finding algorithms that are faster than classical algorithms solving the identical problem. During this paper, we are going to talk about the need for quantum computation and also the advantages they provide us to compare with classical computers. We are going to discuss what the elements of Quantum computing are. Along with this, we are also going to discuss the challenges of quantum computing.*

***Keywords* - Quantum computing, phenomena, classical computers, qubits.**

1. INTRODUCTION

In 2016, quantum computers are yet to be developed, but using a small number of bits several experiments are allotted. Research within the sphere of Quantum Computing is being funded by many military agencies and national governments to develop Quantum Computers. Theoretical and practical research used for Quantum Computing. Problems that are solved by classical computers with the best possible algorithms and that are also available for solving that are used by Large-scale quantum computers more quickly. Any classical algorithm runs slower than Quantum algorithms like Simon's algorithm. Any classical computer can make use of the quantum algorithms as quantum computation doesn't violate the Church–Turing thesis.

2. LITERATURE REVIEW

Ptaiksha Pardeshi, Sapna Rajapkar, Sanket Takle, Hanumant Manade, Prof. Swati Patil in their paper "Quantum Computing" explains, By the birth of physical science, many new areas are opened for research and development within the world of science and technology. One such field is Quantum Computing and Communication where there's room locked that after was dream within the field of computing and communication. This paper gives a brief review of what is actually happening in the field.

During this paper, we've of quantum computing and communication. With the skyrocketing needs of rapid processing speed and miniaturization, classical computers aren't ready to continue the pace with these few necessary parameters. As classical computers work on classical mechanics their expansion is at zenith, due to these limitation of quantum physics is taking the role of game changer in race of computation. This research focuses on surveying in a field of quantum computing.

The paper begins by highlighting a short history of quantum physics. Major elements of quantum computing like quantum superposition, quantum tunneling and qubits are addressed at next from a physics perspective. Additionally, various methods and applications of physical science are examined

3. QUANTUM COMPUTING

In Quantum computing operations on data are performed using principle of superposition which is one of reasonably quantum natural phenomenon. While classical or digital computers are supported transistors. Quantum computers are different from them which uses the theoretical discipline. Quantum computer uses qubits and classical computer usually working on binary digits which are either 1 or 0. The qubit are often in superposition's of states i.e. it will take any value between 0 and 1. A quantum computer is known as the universal quantum computer which can be theoretical model of such computers. Quantum computers has share theoretical similarities with non-deterministic and probabilistic algorithms.

4. ELEMENTS OF QUANTUM COMPUTING

A classical computer has worst performance than quantum computer so it is smart to try and do the majority in processing on the classical machine. We'll modify a classical computer to style a quantum computer will have reasonably quantum circuit attached to it and type of interface between conventional and quantum logic.

4.1 Bits and Qubits

These are blocks which will incorporate the shape of quantum computing. It'll gives the outline of qubits, gates, and circuits. Quantum computers perform operations on qubits which might be in superposition of state which is an extra property and are same as bits employed by classical or machine. Compared with classical computer a quantum register with 2 qubits can store 4 numbers in superposition simultaneously where classical register with 2 bits stores only 2 numbers and 300 qubit register holds more numbers than the total number of atoms within the universe. This finally ends up in storage of infinite information at the time of computation but we can't get at it. The matter occurs at the time of reading out an output in an exceedingly superposition state holding numerous different values. Superposition state collapses which we get only 1 value. This tantalizes us but sometimes it can work as computational advantage for us.

4.2 The Ket | >

Part of Dirac's notation is that the ket (|>).

The ket is simply a notation for a vector. the one

qubit could be a unit vector in C2. So,

$$\begin{bmatrix} \alpha \\ \beta \end{bmatrix}$$

is a vector, and is written as follows:

$$\alpha|0\rangle + \beta|1\rangle$$

With

$$|0\rangle = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

And

$$|1\rangle = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

4.3 Entangled States

Subatomic particles are in entangled state which suggests that irrespective of distance between them they're connected to every other. They show instantaneous effect on measurement with one another. This effect is helpful for computational purposes.

Consider the subsequent state (which isn't entangled):

$$\frac{1}{\sqrt{2}}(|00\rangle + |01\rangle)$$

it will be expanded to:

$$\frac{1}{\sqrt{2}}|00\rangle + \frac{1}{\sqrt{2}}|01\rangle + 0|10\rangle + 0|11\rangle$$

Upon measuring the primary qubit (a partial measurement) we get 0 100% of the time and also the state of the second qubit becomes:

$$\frac{1}{\sqrt{2}}|0\rangle + \frac{1}{\sqrt{2}}|1\rangle$$

It will give us an equal probability for a 0 or a 1.

4.4 Quantum Gates

Single Qubit Gates

Just as one qubit is represented by a column vector, gate performing on the qubit is represented by a 2 x 2 matrix. The quantum equivalent of a NOT gate, for instance, has the subsequent form:

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}.$$

The only constraint these gates should satisfy (as required by quantum mechanics) is that they need to be unitary, where a unitary matrix satisfies the condition underneath. this permits for lots of potential gates.

$$U^\dagger U = I.$$

Multi Qubit Gates

A true quantum gate must be reversible, this needs that multi qubit gates use an impact line, where the control line is unaffected by the unitary transformation. In CNOT gate, the classical XOR with the input on the b line and also the control line a. Because it's a two-qubit gate it's represented by a 4 x 4 matrix:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

4.5 Quantum Circuits

Quantum circuit may be a quantum state which represents one or more qubits on which unitary operators i.e. quantum gates are applied in a very sequence. We now take a register and let gates act on qubits, in analogy to a standard circuit.

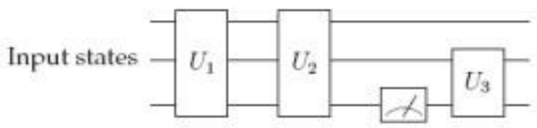

Fig: Generalized Quantum Circuit

This gives us a simple reasonably quantum circuit (above) which may be a series of operations and measurements on the state of n-qubits. Each operation is unitary and should be described by a 2 n X 2 n matrix. Each of the lines is an abstract wire, the boxes containing unitary quantum logic gates or it are often a series of gates. Meter symbol may be a measurement. Quantum algorithms implementation is all at once this gates, wires, input, and output mechanisms. It's always possible to rearrange quantum circuits so as that each one the measurements are done at the highest of the circuit. Quantum circuits are the simplest way circuits that runs once from left to right, where traditional classical circuits contain loops.

4.5 Quantum Computers

In a quantum computer, taking n input qubits, the register V, and producing n output qubits, the register W

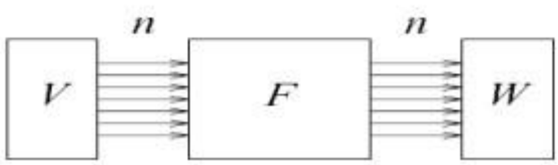

Fig: Basic Structure of Quantum Computer

The input register will be prepared as a position of states, e.g. position of all integers from 0 to 2 n can be stored in input register. The pc then calculates in parallel the function applied to any or all 2 n integers simultaneously. From QMP (Quantum Measurement Postulate), after we measure W, in keeping with resulting wave of qubits is in entangled state a Boolean value for each bit from the output register is chosen. To maximize the probability that the solution we would like and output we measure is same we've got to style F.

5. CHALLANGES

The challenges are to create a quantum computer are enormous and might be separated in physics and engineering challenges.

The physics challenges are coherence time of output bit in superposition state and qubits in entangled state and on defining ways to extend the exactness of the qubit and to complete the errors that occur during the quantum operations. The engineering challenge will be summarized by the word 'scalability'. Several articles emphasis that thanks to the above-mentioned physical challenges, we are going to need awfully large number of qubits so as to perform any meaningful quantum operation. as an example, so as to use the famous factorization algorithm developed by Shor, it is expected for the factorization of 2000 bit number in sufficiently lesser time we require around 5 billion physical qubits. But we all know that on today's date we will creating and controlling maximum of 10 physical qubits, it immediately becomes clear that several breakthroughs are needed to realize the goal of building a quantum computer. This is often further illustrated by the speed at which qubit technology must evolve to succeed in the goal of billions of qubits in 30 years from now.

The engineering challenges are focused on the scalability by preservation of exponential computing power of qubits which suggests qubits are needed to be corrected and controlled. Sometimes we want to manipulate the qubit.

The quantum state of the qubit is incredibly fragile because a qubit is in entangled. Any interaction with the environment that cause superposition state to decohere lead by phase shift error. additionally, the superposition state gets destroyed while measuring the quantum state. This destructive reading further because the duration and breaking of the superposition state i.e. decoherence time are the vulnerabilities of quantum computing. This qubit behaviour disturbs the proper operation which could be a main challenge for any quantum computer.

6. CONCLUSION

Quantum computation promises the flexibility to compute solutions to problems for all practical purposes that are insoluble by classical computers. However, the quantum promise continues to be a protracted way from achieving practical realization. Some properties of quantum physics that enable quantum computers superior performance also make the look of quantum algorithms and therefore the construction of functional hardware extremely difficult. We need to imply some solutions to enhance the standard of qubit technology to increase the coherence time of qubits and therefore the speed of quantum operations. We have to correct the state of the qubit for quantum error correction

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