INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Quantum Computing

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Abstract:
Quantum computer, a single quantum processor is able to perform multiple operations on its own by utilizing the fact that the qubit exists in multiple states simultaneously. This gives the Quantum computer much greater raw computation than conventional computers. In the long term, even if the semiconductor technologies will be replaced by quantum computing technology the general trends of increasing miniaturization and digitization of enlarged functionality and applicability will continue and be able to enhance and advance the ICT based applications.

Keywords*: Qubits, Miniaturization, Quantum Physics, Fuzzy logic, Hybrid intelligent system*

1. Introduction

Every so often a new technology surfaces that enables the bounds of computer performance to be pushed further forwards. The pace of technological advancements has been relentless, right from the valve technology to the continuing development of VLSI design.
Hybrid intelligent systems are those that use more than one intelligent system. By integrating various systems, their individual weaknesses can be greatly reduced and their strengths greatly increased.
The Hybrid intelligent system incorporates the following features:

- Learning ability
- Adaptation to changes
- Explanation capability
- Flexibility in dealing with imprecise and incomplete information.

The intelligent system collectively employs a combination of methods and techniques from the field of artificial intelligence e.g

- Neuro-fuzzy systems
- Hybrid-connectionist symbolic model
- Fuzzy expert systems
- Connectionist expert systems
- Evolutionary neural networks
- Genetic fuzzy systems
- Rough fuzzy hybridization.

2. Quantum Computer

A quantum computer is a computer design which uses the principles of **quantum physics** to increase the computational power beyond what is attainable by a traditional computer.

3. Quantum Physics

Quantum physics is the study of the behavior of matter and energy at the molecular level, atomic, nuclear and even smaller microscopic levels.
'Quantum' comes from the Latin word 'quantus' which means 'how much'. It refers to the discrete units of matter and energy that are predicted by and observed in quantum physics. The quantum property proves matter can go from one spot to another without moving through the intervening space is applied for information movement instantly across vast direction.

4. Origin

Richard Feynman long ago in the year 1959 suggested the effects of miniaturization and exploiting the quantum effects to create more powerful computers. While computers have been around for the majority of the 20th century, quantum computing was first theorized less than 30 years ago, by a physicist at the Argonne National Laboratory. **Paul Benioff** is credited with first applying quantum theory to computers in 1981. Benioff theorized about creating a quantum Turing machine.

In 1985, the idea of 'quantum logic gates' was put forth by David Deutsch, University of Oxford, as a means of harnessing the quantum realm inside a computer. In 1994, Peter Shor of AT & T devised an algorithm that could use only 6 qubits to perform some basic factorizations. In 1998, a 2-qubit quantum computer was built, which could perform simple calculations. In 2000, 4-qubit and 7-qubit quantum computer were successfully built.

5. Principle & Working

A quantum computer is a computation device that makes direct use of quantum-mechanical phenomena, such as superposition and entanglement to perform operations on data.

Quantum computers are different from digital computers that are based on transistors.

Quantum computation uses quantum properties to represent data and perform operations on these data.

A conventional computer is able to do one thing at a time, that is, read a piece of information (a 'bit') and perform a few basic logic operations on it. These very simple processes form the basis of everything that current computers can do.

Quantum computers are different from conventional computers, in that they use electrons and atoms to store information ('qubit') rather than chips. As a result, they can handle billions of pieces of information simultaneously, and so avoid the inevitable limitations of conventional computers to sequentially process one piece of information at a time.

A quantum computer would store information as either a 1, 0 or a quantum superposition of the two states. Sucha quantum bit is called a qubit, which allows for far greater flexibility than the binary system.

Specifically, a quantum computer would be able to perform calculations on a far greater order of magnitude than traditional computers ... a concept which has serious concerns and applications in the realm of cryptography & encryption. Some fear that a successful & practical quantum computer would devastate the world's financial system by ripping through their computer security encryptions, which are based on factoring large numbers that literally cannot be cracked by traditional computers within the life span of the universe. A quantum computer, on the other hand, could factor the numbers in a reasonable period of time.

If the qubit is in a superposition of the 1 state and the 0 state, and it performed a calculation with another qubit in the same superposition, then one calculation actually obtains 4 results: a 1/1 result, a 1/0 result, a 0/1 result, and a 0/0 result. This is a result of the mathematics applied to a quantum system when in a state of de-coherence, which lasts while it is in a superposition of states until it collapses down into one state. The ability of a quantum computer to perform multiple computations simultaneously is called quantum parallelism.

The exact physical mechanism at work within the quantum computer is somewhat theoretically complex and intuitively disturbing. Generally, it is explained in terms of the multi-world interpretation of quantum physics, wherein the computer performs calculations not only in our universe but also in other universes simultaneously, while the various qubits are in a state of quantum decoherence.

6. Field of Application

Fuzzy logic is a form of many-valued logic; it deals with reasoning that is approximate rather than fixed and exact. Compared to traditional binary sets (where variables may take on true or false values), fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false.

A temperature measurement for anti-lock brakes might have several separate membership functions defining particular temperature ranges needed to control the brakes properly. Each function maps the same temperature value to a truth value in the 0 to 1 range. These truth values can then be used to determine how the brakes should be controlled.

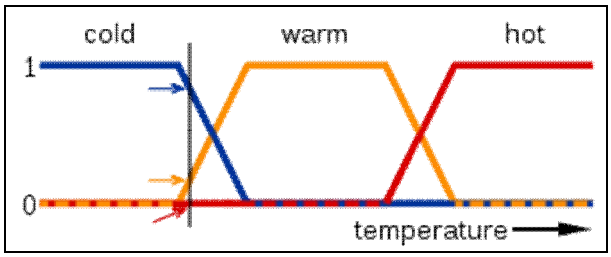

Figure 1: Fuzzy logic temperature

In this image, the meanings of the expressions *cold*, warm, and hot are represented by functions mapping a temperature scale. A point on that scale has three "truth values"—one for each of the three functions. The vertical line in the image represents a particular temperature that the three arrows (truth values) gauge. Since the red arrow points to zero, this temperature may be interpreted as "not hot". The orange arrow (pointing at 0.2) may describe it as "slightly warm" and the blue arrow (pointing at 0.8) "fairly cold".

- IF temperature IS very cold THEN stop fan
- IF temperature IS cold THEN turn down fan
- IF temperature IS normal THEN maintain level
- IF temperature IS hot THEN speed up fan

Algorithms developed so far for quantum computers have typically focused on problems such as breaking encryption keys or searching a list, tasks that normally require speed but not a lot of intelligence.

7. Quantum Cryptology

Quantum cryptography describes the use of quantum mechanical effects to perform cryptographic tasks or to break cryptographic systems.

8. Quantum Teleportation

Quantum Teleportation is a process by which quantum information can be transmitted from one location to the other with the help of classical communication and previously shared quantum entanglement between sending and receiving location.

9. Conclusion

This Super Computer with more memory would make life easier and solve any complex problem which is not possible by classical computer.

Despite the simplicity of the idea of quantum computers, it is still very difficult to build such a computer. This is because electrons and atoms can be easily disturbed by their environment, causing the breakdown of information stored in the quantum computer and thus errors in computation. But having already built basic quantum computers, such as 7-qubit quantum computer, Physicists around the world are racing to get there.

Quantum computers of the future will have the potential to give artificial intelligence a major boost.

Though it is a very new and advanced technology, Quantum computers would allow mankind to do work and solve problems at unbelievable speed compared to today's conventional computers.

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