Overview of Computer Architecture Development Direction Breaking Through Von Neumann Architecture

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Abstract

Von Neumann Architecture is the foundation of modern computer. In the first half of this paper, several characteristics of von Neumann architecture are discussed in detail. Due to the tradition of von Neumann computer architecture.Natural limitations limit the development of computers. In recent years, people strive to break through the limitations of the traditional von Neumann system, and the research on various non-Neumann computers is booming. In the second half of this paper, four typical non-von Neumann architectures are introduced, which are Harvard architecture, photon computer, quantum computer and neural computer. This paper discusses the four research directions that may break through the von Neumann architecture at present, and analyzes some characteristics of the four different research directions. At last, the overall content of the article is summarized profoundly, which affirms the important role of von Neumann architecture, and believes that the research of non-von Neumann architecture has made great progress. Looking forward to the advent of non-von Neumann computers in the future.

Keywords

Von Neumann Architecture; Harvard Structure; Photonic Computer; Quantum Computer; Neural Computer.

1. Introduction

Von Neumann structure, also known as Princeton structure, is a computer design conceptual structure that stores programs (sets of instruction sequences) and data in different addresses of the same memory. This is based on von Neumann's principle, that is, programs can be regarded as a special kind of data, which can be processed and stored in the same way, so they can be stored in the same memory. Adopt a single address bus and data bus. The key points of von Neumann architecture are: the computer number system adopts binary system; Computers should follow procedures Sequential execution. This theory of von Neumann is called von Neumann architecture [1].

Neumann Architecture is the foundation of modern computers. Now most computers are still the organizational structure of Von Neumann computers, but only some improvements have been made, without fundamentally breaking through the shackles of Von Architecture. Therefore, von Neumann is called "the father of computers". However, due to the traditional von Neumann computer the limitations of nature fundamentally limit the development of computers [2].

According to von Neumann architecture, the computer must have the following functions: send the required programs and data to the computer. Must have the ability to memorize programs, data, intermediate results and final operation results for a long time. Ability to complete various data processing such as arithmetic, logical operation and data transmission. The program direction can be

controlled as required, and can control the coordinated operation of all parts of the machine according to the instructions. The processing results can be output to users as required. Storing instructions and data in memory at the same time is one of the characteristics of Von Neumann's computer program. The computer consists of five parts: controller, arithmetic unit, memory, input device and output device. The computer architecture proposed by von Neumann has laid the structural concept of modern computers.

2. Research direction of non-von Neumann architecture computer

The limitations of Von Neumann's architecture constrain the further development of modern computers, while the non-numerical processing applications require higher and higher computer performance, so it is necessary to break through the framework of traditional computer architecture and seek new architectures to solve practical application problems. There have been significant changes and improvements in the architecture, Such as photon computers, quantum computers, neural computer Other non-Von computers, which are partially or completely different from the traditional Von Neumann computers, greatly improve the computing performance of computers.

2.1 Harvard structure

Harvard Structure is a memory structure that separates the program instruction store and data storage. Harvard Structure is a parallel architecture that is mainly characterized by storing procedures and data in different storage spaces, namely the program memory and data storage is two separate memories, each memory independently, independently. Corresponding to two memories: 4 buss of the system: the data bus and address bus of the program and data. This separate program bus and data bus allows the instruction word (from program memory) and operands (from data memory) to improve the execution speed, improved data throughput. Also because the procedures and data are stored in two separate physical spaces, the addressing and execution can overlap. The central processor first reads the program instruction content in the program command memory, decoding the data address, and then read the data in the corresponding data memory, and perform the next operation (usually executed). Program instruction storage and data storage are separated, and the instructions and data can have different data widths.

Compared with von Norman architecture processor, Harvard architecture processor has two obvious characteristics:

I) Two independent memory modules are used to store instructions and data respectively, and each memory module does not allow instructions and data to coexist;

II) Two independent buses are used as special communication paths between CPU and each memory, and there is no connection between these two buses.

Improved Harvard structure, its two structures:

I) Two independent memory modules are used to store instructions and data respectively, and each memory module does not allow instructions and data to coexist in order to realize parallel processing;

II) It has an independent address bus and an independent data bus, and uses the common address bus to access two memory modules (program memory module and data memory module), while the common data bus is used to complete the data transmission between the program memory module or data memory module and CPU.

The microprocessor of Harvard structure usually has high execution efficiency. The program instructions and data instructions are separated and stored, and the next instruction can be pre-read.

2.2 Photon computer

A photonic computer is a new computer that performs digital operation, logic operation, information storage, and processing by optical signals. It consists of a laser, an optical mirror, a lens, a filter, and the like, by the array of laser beams into the mirror and the lens, in place of electron, and light calculations. Parallel, high speed, natural determination of the parallel processing capacity of the

photon computer, and has a super high operational speed. The photon computer also has a fault tolerance similar to a human brain. When a component is damaged or error in the system, it does not affect the final calculation results. Photon is transmitted in the optical medium, the distortion is small, the light transmission, and the energy consumption of energy and the amount of heat are extremely low, and the requirements for environmental conditions are much lower than the electronic computer. With the combination of modern optical technology, microelectronics technology, in the near future, photonic computers will become a popular tools [3].

I) The main feature of the photon computer: Ultra-high speed calculation speed. The photon computer has strong parallel processing capabilities, with higher computation speed. The transmission speed of electrons is 593km / s, and the speed of the photon reaches $3 \times 10 ^ 5$ km / s. For electronic computers, electronic is the carrier of information, which can only be conducted by some mutually insulated wires, even In the best case, the operation speed of electrons in the solid is far from light speed, although the current electronic computer operation is constantly increasing, its ability limit is limited; in addition, as the assembly density is constantly increasing, it will make The electromagnetic effect between the conductors is constantly increasing, and the amount of heat dissipated is gradually increased, thereby constaling the operational speed of the electronic computer; the operation speed of the photon computer is much faster than the electronic computer, and the requirements for the use of environmental conditions are also higher than the electronic computer. Low much lower.

II) Super-size information storage capacity. Compared with the electronic computer, the photon computer has a large-scale information storage capacity. The photon computer has an extremely desirable light radiation source-laser, and the conduct of photons can not require wires, and even if they intersect, they do not generate slitting interactions between them. The photon computer wireless wire delivery information parallel channel, the density is actually infinite, a five-point coin size mirror, its information is actually a number of times the world's existing telephone cable channel.

III) The energy consumption is small, and the amount of heat is low is a energy-saving product. The driving of the photon computer, only a small portion of the electronic computer driving energy of the same type, which not only reduces the power consumption, which greatly reduces the heat distributed by the machine, but also develops the microcation and portability of the photon computer, it provides convenient condition. Scientists are experimenting with traditional electronic converters and photons, making a "hybrid" computer, which can process information faster, and overcome the internal overheating of the giant electronic computer.

At present, many key technologies such as photonal computers, such as optical storage technology, light interconnect technology, and optoelectronic integrated circuits have obtained breakthroughs, and maximize increasing the calculation capabilities of photonal computers are the current research projects facing. The introduction and further development of photonal computers will provide infinite power for human beings to more beautiful tomorrow.

2.3 Quantum computer

Quantum computers are a physical device that follows the quantum mechanics to perform high speed mathematics and logic operations, store and process quantum information. When a device processing and calculate quantum information, when the quantum algorithm is run, it is a quantum computer. The concept of quantum computers is derived from research on reversible computers. The purpose of research reversible computers is to solve the problem of energy consumption in the computer. Quantum calculations are primarily applied to complex large-scale data processing and computing challenges, as well as quantum-based network security services. Based on its own advantages in calculation, quantum calculations have a broad market in the fields of financial, medical, artificial intelligence, etc.

The main features of quantum computers:

I) Accuracy of the operation: Quantum computer has a powerful quantum information processing power, for the current changeable information, can extract effective information to process processing

make it a new useful information. The process of quantum information first requires the quantum computer to be stored, and then the information given is quantum analysis. Using this way, it can accurately predict weather conditions. At present, the accuracy of the weather conditions of computer prediction receives 75%, but use quantum computers to predict, accurate rates can further increase, more convenient for people's travel [4]

II) Information security: The current computer is usually attacked by the virus, directly caused computer paralysis, which will also cause personal information to be stealing, but quantum computers do not exist because of the quantum principle of uncomfortable, can use quantum computers Rest assured, don't be afraid to disclose [5].

III) The application ranges: quantum computers have powerful computing power, can analyze a large number of different data at the same time, so it is possible to accurately analyze the financial trend in the financial crisis; It is possible to play a large role, which can simulate the composition of new drugs, more precisely developed drugs and chemicals, which can ensure the cost of the drug and the drug resistance of the drug [5].

IV) Save time. First quantum computer processing data is not as follows like a traditional computer, but is completed, which saves a lot of time and is suitable for large-scale data calculations. Traditional computers increase the difficult linear shape of the number of data bits, to break down a 129-bit number requires 1600 supercomputer networking for 8 months, and it is necessary to break down a 140-bit number. year. But using a quantum computer, the results can be obtained in a few seconds.

2.4 Neural computer

Nervous computers are also known as biocompators, and its main raw materials are proteins produced by bioengineering techniques (especially protein engineering) to use it as a biological integrated circuit-biocontrol. In the biological chip, the information is transmitted in the form of wave. When the wave is propagated along the protein molecular chain, a change in protein molecular chain monochronous and double bond structure sequence is caused. Its functionality is mimicing the human brain judgment capabilities and adaptability, and has a neural network computer that can handle multiple data functions in parallel. Unlike the fifth generation computer mainly based on logic processing, it itself can determine the nature and state of the object, and can take corresponding actions, and it can simultaneously process a large amount of data in real-time changes, and lead conclusions. The conventional information processing system can only handle data clear and meridian. The human brain activity has the flexibility to handle zero, vague clear information, and the sixth generation electronic computer will like the wisdom and flexibility of human brain.

The main features of the neural computer:

I) The sixth generation computer core is a decimal, and it is very obvious that the binary is very obvious is the decimal of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and the decimal method of calculating the method. , China's bead calculations and other algorithms.

II) The circuit intensive, heat dissipation problem of semiconductor silicon wafers is difficult to completely resolve, affecting the further development and breakthroughs of computer performance. Biotefry is better than silicon wafer computers in speed and performance, which is considered a sixth generation computer that is very developing.

III) Since the protein molecule is much smaller than the electronic components on the silicon chip, it is very close to each other, and therefore, the biological elements can be small to billions of nine meters, and the intensity of the components can reach 10 to 1 million per square centimeter. 100 million, even 1 million trillion door circuit. Unlike ordinary computers, since the raw materials of the biocontrol are protein molecules, the biological computer chip has both self-repairing functions, but also binds directly to the biological living body. At the same time, the biocon chip has the advantages of less heat generation, low function, no signal interference between the circuit.

3. Conclusion

The hardware foundation of the development of Fengnoiman's computer is affected by the restriction of integrated circuit production technology, and the method of storing control flow drive tasks in the structural system has not satisfied that people have more high speed, smart and use more convenient requirements for computers. The road structure improvement has come to an end, only breaks through the constraints of existing architecture and seeks new substances as a computer basis for computers, in order to make computer qualitative leaps, photon computers and neural computers will be the most developed exploration. Feng Nyman computer is a crystallization of all human wisdom. Due to the technical maturation, low price, software rich and people's habits, Feng Niman's computer will continue to play an important role in human work and life. Of course, there will be commercialized non-Fengnuiman computers in the future, we will usher in a variety of information about all types of computers.

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