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ADVANCED ARCHITECTURE

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ABSTRACT:
This paper is focused on the advanced architecture, micro programs and the Applications of Microprogrammed Control Unit.
Keywords: Micro Program (MP), Control Unit (CU), Control Word (CW), Emulation.

1. Introduction

A Microprogrammed Control Unit produces control signals by using micro-instructions.

Micro program:

Is a program with a set of instructions. Instruction requires a set of micro-operations.
Micro-operations are performed using control signals. These control signals are generated using micro-instructions. This simply implies that every instruction requires a set of micro-instructions. A set of micro-instructions are called micro-program. The small memory that stores all instructions of Microprograms is called control memory and it is present inside the processor.

The Control Unit is a component of the processor that generates ***Control Signals*** that are essential in the function of the processor. To design a control unit, two approaches are needed: Hardwired Control Unit and Microprogrammed Control Unit.
We can differentiate these two approaches on the basis that the Hardwired Control Unit is designed using hardware components such as logic gates, flip flops, and other digital

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components. The RICS style processor is designed with a hardwired control unit, and it generates control signals faster than the microprogrammed control unit.

The Hardwired control unit doesn't do well with complex instructions, and it is difficult to amend modifications. Given in the case of the microprogrammed control unit, it doesn't have these drawbacks.

WHAT IS CAN I SAY IS A MICROPROGRAMMED CONTROL UNIT?

Microprogrammed Control Unit is a control unit whose binary values are saved as words in memory.

The software approach to generate the control signals is used by the microprogrammed control unit. These generated control signals are determined with the help of the program. This program is stored in the special memory of the processor which is smaller and faster. The memory is called microprogram memory or control store and the program is called the microprogram.

Subsequent instruction words are fetched into the instruction register in a normal way in a microprogrammed control unit. Thus, the operation code of each instruction is not directly decoded to enable immediate control signal generation, but it comprises the initial address of a microprogram contained in the control store.

Microinstructions: every word in a control unit contains microinstructions and specifies one or more microoperations.

Control Word: These are strings of 0's and 1's which represent the control variable.

FEATURES:

- The Control Address Register: It specifies the address of the microinstruction operation to be executed.
- The Control Memory: It is a read-only memory and only stores data. Control Memory consists of microinstructions that generate microoperations.

The Functions of Control Memory

- Fetch instructions from the main memory
- Evaluate effective address.
- Execute specified operations.

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- Control Buffer Register/ Control Data Register: It holds (stores) the ROM microinstruction from the control memory. It allows the execution of microoperations specified by the control rule.

The Steps Followed by the Microprogrammed Control

- It can execute any instruction, while the CPU should divide it down into a set of sequential operations. These set of operations is called microinstruction. Sequential micro-operations need the control signals to execute.
- Control signals saved in the ROM are created to execute the instructions on the data direction. These control signals can control the micro-operations concerned with a microinstruction that is to be performed at any time step.
- The address of the microinstruction is executed next is generated.
- The previous 2 steps are copied until all the microinstructions associated with the instruction in the set are executed.

The supported address used for the control ROM originates from the micro counter register. The inputs received by the micro counter from a multiplexer that chooses the output of an address ROM, a current address incremental, and an address that is saved in the next address field of the current microinstruction.

A single-level control store:

In this, the instruction opcode from the instruction register is sent to the control store address register. Based on this address, the first microinstruction of a microprogram that interprets the execution of this instruction is read to the microinstruction register. This microinstruction contains in its operation part encoded control signals, normally as few bit fields. In a set of microinstruction field decoders, the fields are decoded. The microinstruction also contains the address of the next microinstruction of the given instruction microprogram and a control field used to control activities of the microinstruction address generator. The last-mentioned field decides the addressing mode (addressing operation) to be applied to the address embedded in the ongoing microinstruction. In microinstructions along with conditional addressing mode, this address is refined by using the processor condition flags that represent the status of computations in the current program. The last microinstruction in the instruction of the given microprogram is

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the microinstruction that fetches the next instruction from the main memory to the instruction register.

With a two-level control store:

In this, a control unit with a two-level control store, besides the control memory for microinstructions, a nano-instruction memory is included

EXAMPLE: Consider an instruction that is fetched from the main memory into the instruction Register (IR). The processor uses its unique opcode to identify the address of the first micro-instruction. That address is loaded into CMAR (Control Memory Address Register). This address is decoded to decide the corresponding memory instruction from the control Memory. Micro-instructions will only have a control field. The control field Indicates the control signals to be generated. Most micro-instructions will not have an address field. Usually µPC will simply get incremented after every micro-instruction.

This is as long as the micro-program is being executed sequentially. If there is a branch micro-instruction only then there will be an address filed. If the branch is unconditional, the branch address will be directly loaded into CMAR. For conditional branches, the branch condition will check the appropriate flag. This is done using a MUX which has all flag inputs. If the condition is true, then the mux will inform CMAR to load the branch address. If the condition is false CMAR will simply get incremented.

The control memory is usually implemented using flash ROM as it is non-volatile.

Advantages of Microprogrammed Control Unit

- It can more systematically design of the control unit.
- It is simpler to debug and change.
- It can retain the underlying structure of the control function.
- It can make the design of the control unit much simpler. Hence, it is inexpensive and less error-prone.
- It can orderly and systematic design process.
- It is used to control functions implemented in software and not hardware.
- It is more flexible.
- It is used to complex function is carried out easily.

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Disadvantages of Microprogrammed Control Unit

- Adaptability is obtained at more cost.
- It is slower than a hardwired control unit.

Applications of Microprogrammed Control Unit: Microprogramming has many advantages like flexibility, simplicity, cost-effectiveness etc.
Therefore, it has a major contribution in the following applications.
Development of control units: Modern processors have very large and complex instruction sets. Microprogramming is used for making control units of such processors, because it is far less complex and can be easily modified.
High level language support: Modern high-level languages have more advanced and complex data types. Microprogramming can provide support for such data types directly from the processor level. Therefore, the language becomes easy to compile and also faster to execute.
User tailoring of the control unit: As the control Unit is developed using software, it can be easily reprogrammed. This can be used for custom-made modifications of the Control Unit. For this purpose, the control memory must be writeable like RAM or flash ROMs.
Emulation:
Emulation is when one processor (say A) is made to emulate or behave like another processor (say B). To do this, a must be able to execute the instructions of B. If we re-program the control memory of A, same as that of B, then A will be able to emulate the behavior of B, for every instruction. This is possible only in microprogrammed control units. Used generally when a main processor has to emulate the behavior of a math co-processor.
Improving the operating system: Microprogramming can be used to implement complex and secure functions of the OS. This not only makes the OS more powerful and efficient, but more importantly secure, as it provides the OS a higher degree of protection from malicious virus attacks.
Micro-Diagnostics or error debugging: As Microprogrammed Control Units are software based, debugging an error is far more easy as compared to doing the same for a complex hardwired control unit. This allows monitoring, detection and repairs of any kind of system errors in the control unit. It can also use as a runtime substitute, if the corresponding hardwired component fails

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Development of special purpose processors: All processors are not general purpose. Many applications require special purpose processors like **DSP** (Digital Signal Processors) for communication, **GPU** (Graphic Processor Unit) for image processing.

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