ICT 6641
Embedded System Design and Development

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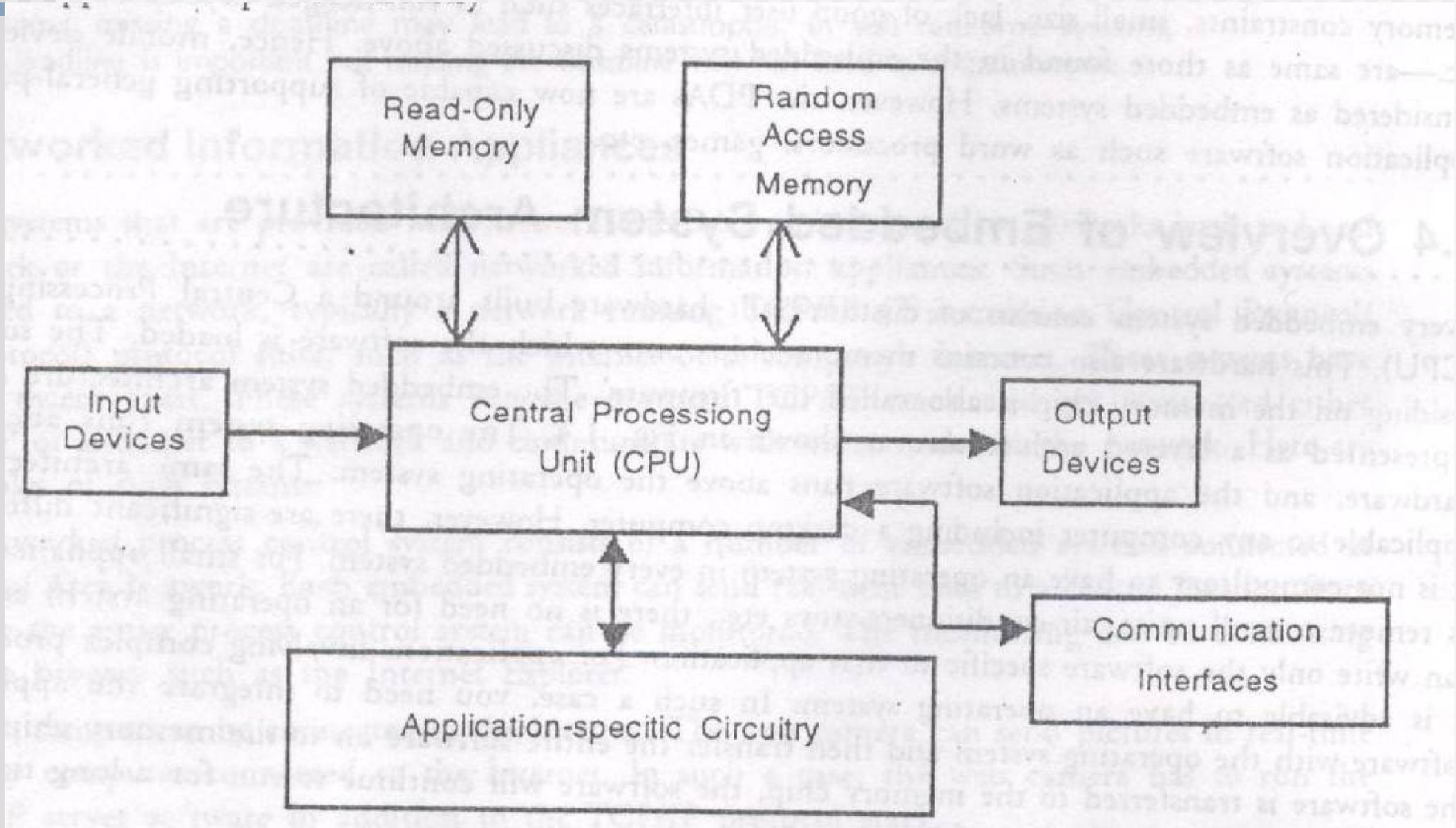
Embedded System Architecture



Building Blocks of Embedded System

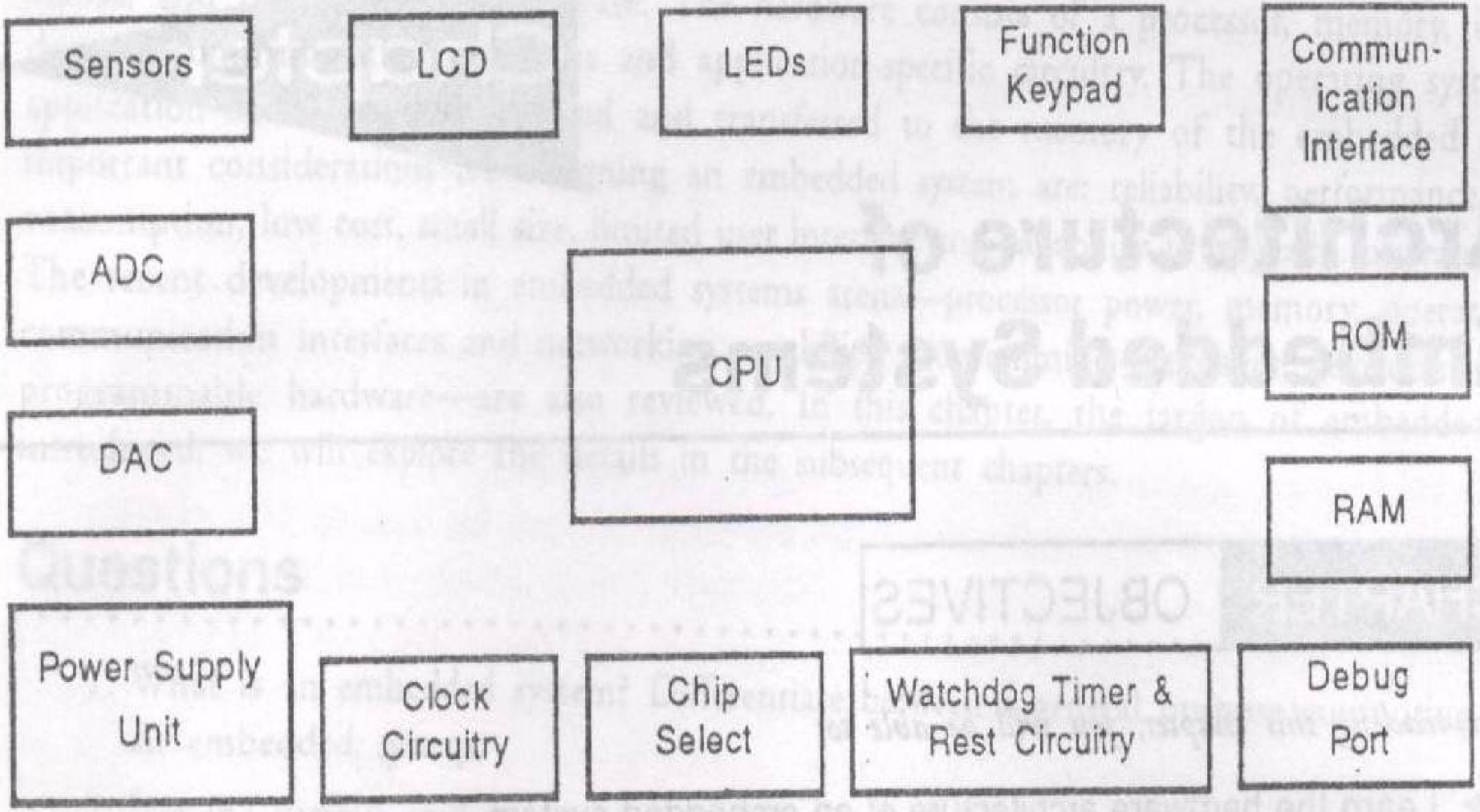


Fig. 2.1: Building Blocks of the Hardware in an Embedded System

Difference between GPP and MC

Micro Processor	Micro Controller
CPU is stand-alone, RAM, ROM, I/O, timer are separate	CPU, RAM, ROM, I/O and timer are all on a single chip
Designer can decide on the amount of ROM, RAM and I/O ports.	Fixed amount of on-chip ROM, RAM, I/O ports
Expensive	For applications in which cost, power and space are critical
General-purpose	Single-purpose (control-oriented)
High processing power	Low processing power
Instruction sets focus on processing-intensive operations	Instruction sets focus on control and bit-level operations
Typically 32/64 – bit	Typically 8/16 bit
Typically deep pipeline (5-20 stages)	Typically single-cycle/two-stage pipeline
Microprocessor = cpu	Microcontroller = cpu + peripherals + memory Peripherals = ports + clock + timers + uarts + adc converters +lcd drivers + dac + other stuff Memory = eeprom + sram + eprom + flash
A microprocessor requires an external memory for program/data storage. Instruction execution requires movement of data from the external memory to the microprocessor or vice versa. Usually, microprocessors have good computing power and they have higher clock speed to facilitate faster computation.	A microcontroller has required on-chip memory with associated peripherals. A microcontroller can be thought of a microprocessor with inbuilt peripherals.
A microcontroller does not require much additional interfacing ICs for operation and it functions as a stand alone system.	Microcontrollers are also called embedded controllers. A microcontroller clock speed is limited only to a few tens of MHz. Microcontrollers are numerous and many of them are application specific.

Why MC for ES

- Very much low cost
- Availability
- Many Vendors
- Good for the Beginners

How to Choose MC

Choosing a microcontroller

There are five major 8-bit microcontrollers. They are: Freescale Semiconductor's (formerly Motorola) 68HC08/68HC11, Intel's 8051, Atmel's AVR, Zilog's Z8, and PIC from Microchip Technology. Each of the above microcontrollers has a unique instruction set and register set; therefore, they are not compatible with each other. Programs written for one will not run on the others. There are also 16-bit and 32-bit microcontrollers made by various chip makers. With all these different microcontrollers, what criteria do designers consider in choosing one? Three criteria in choosing microcontrollers are as follows: (1) meeting the computing needs of the task at hand efficiently and cost effectively; (2) availability of software and hardware development tools such as compilers, assemblers, debuggers, and emulators; and (3) wide availability and reliable sources of the microcontroller. Next, we elaborate on each of the above criteria.

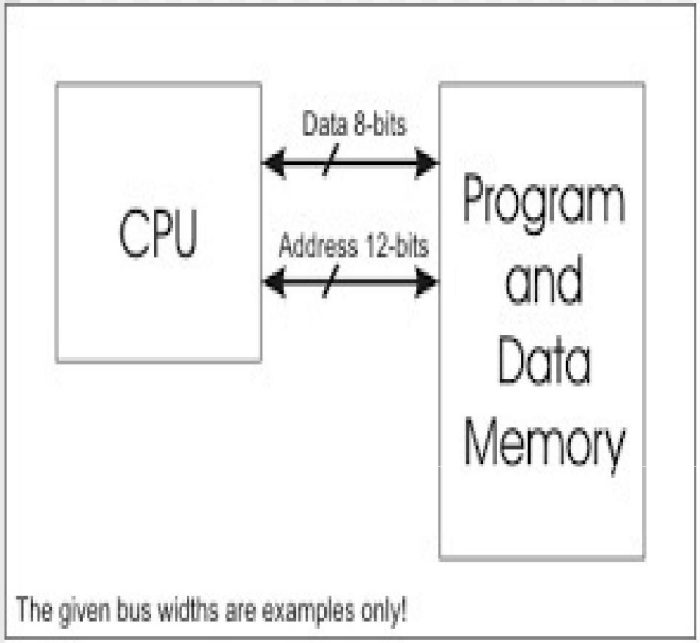
Other Criteria

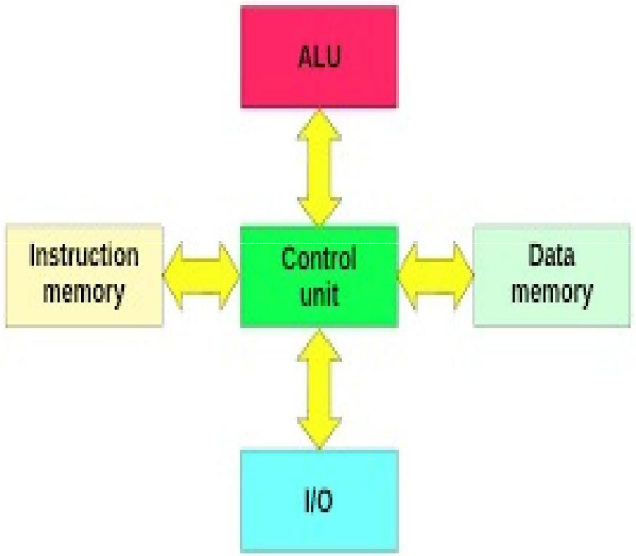
- Speed
- Packaging
- Power Consumption
- Amount of RAM and Rom
- I/O pins
- Cost
- How easy to develop

CISC vs RISC

CISC	RISC
Emphasis on hardware	Emphasis on software
Multiple instruction sizes and formats	Instructions of same set with few formats
Less registers	Uses more registers
More addressing modes	Fewer addressing modes
Extensive use of microprogramming	Complexity in compiler
Instructions take a varying amount of cycle time	Instructions take one cycle time
Pipelining is difficult	Pipelining is easy

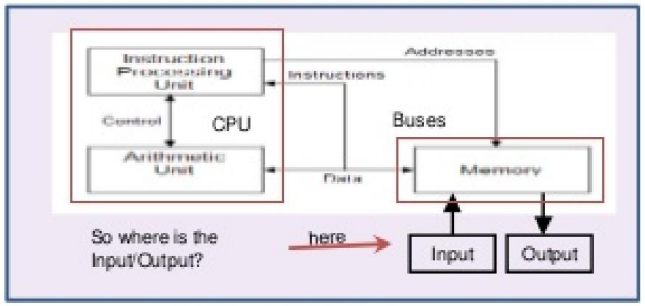
Architecture of Micro-Pro





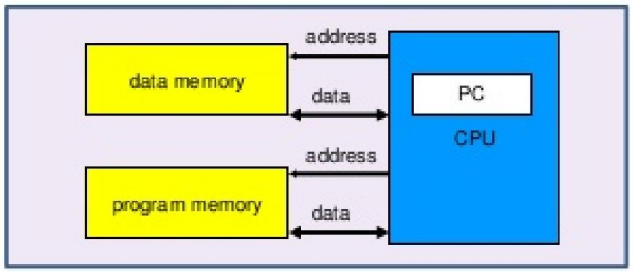
Von Neuman Vs Harvard

Kind of Architectures



Von Neumann

- Named after the mathematician and computer scientist John Von Neumann.
- The computer has single storage memory (data & program)
- Processor needs two clock cycles to complete an instruction.
- Pipelining the instructions is not possible with this architecture.
- This is a relatively older architecture and was replaced by Harvard architecture.



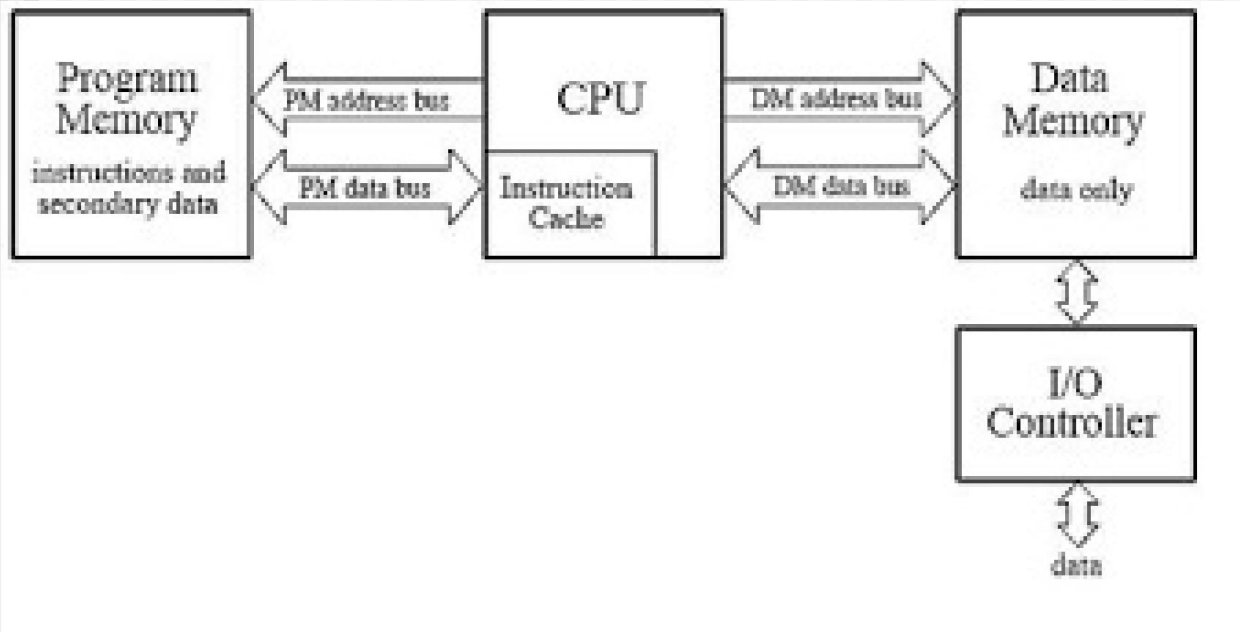
Harvard

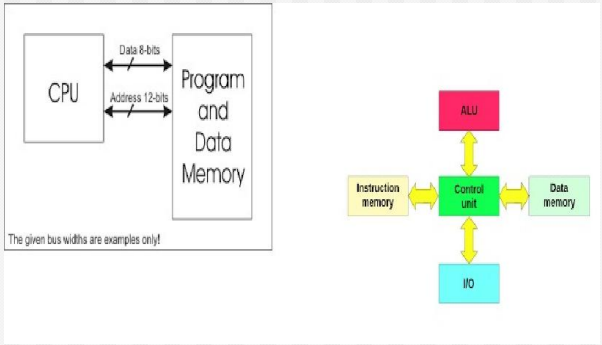
- Named after "Harvard Mark I" a relay based old computer.
- The computer has two separate memories for storing data and program.
- Processor can complete an instruction in one cycle if appropriate pipelining strategies are implemented.
- Most of the modern computing architectures are based on Harvard architecture. But the number of stages in the pipeline varies from system to system.

Von Neuman Vs Harvard

VAN-NEUMANN ARCHITECTURE	HARVARD ARCHITECTURE
Used in conventional processors found in PCs and Servers, and embedded systems with only control functions.	Used in DSPs and other processors found in latest embedded systems and Mobile communication systems, audio, speech, image processing systems
The data and program are stored in the same memory	The data and program memories are separate
The code is executed serially and takes more clock cycles	The code is executed in parallel
There is no exclusive Multiplier	It has MAC (Multiply Accumulate)
Absence of Barrel Shifter	Barrel Shifter help in shifting and rotating operations of the data
The programs can be optimized in lesser size	The program tend to grow big in size

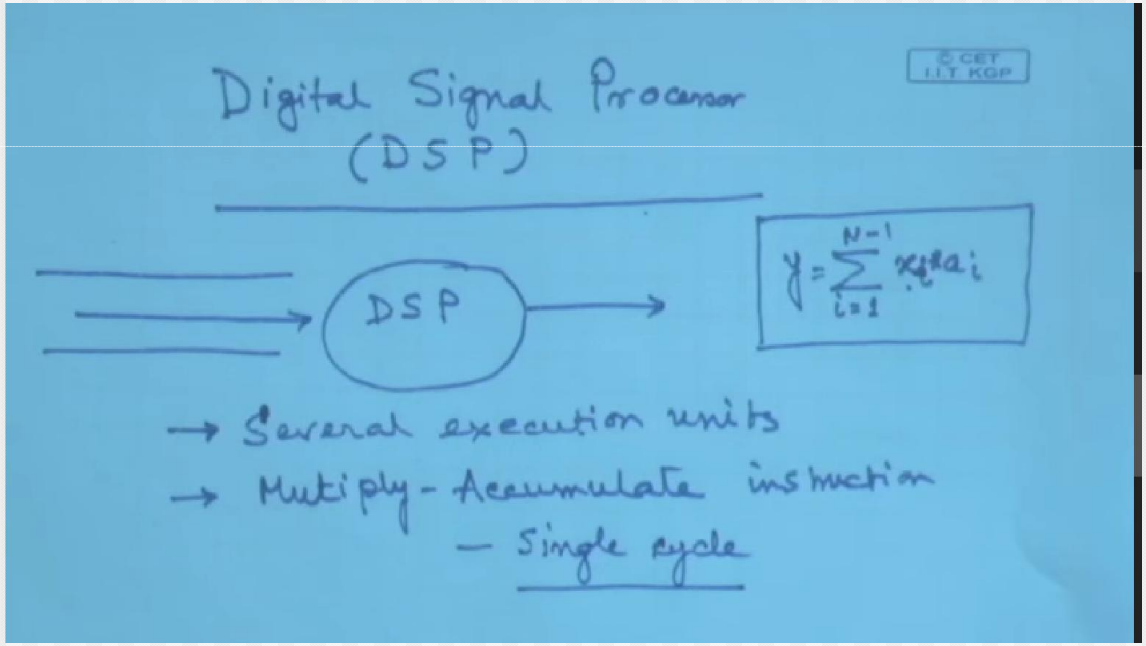
Super Harvard Architecture of Micro-Pro

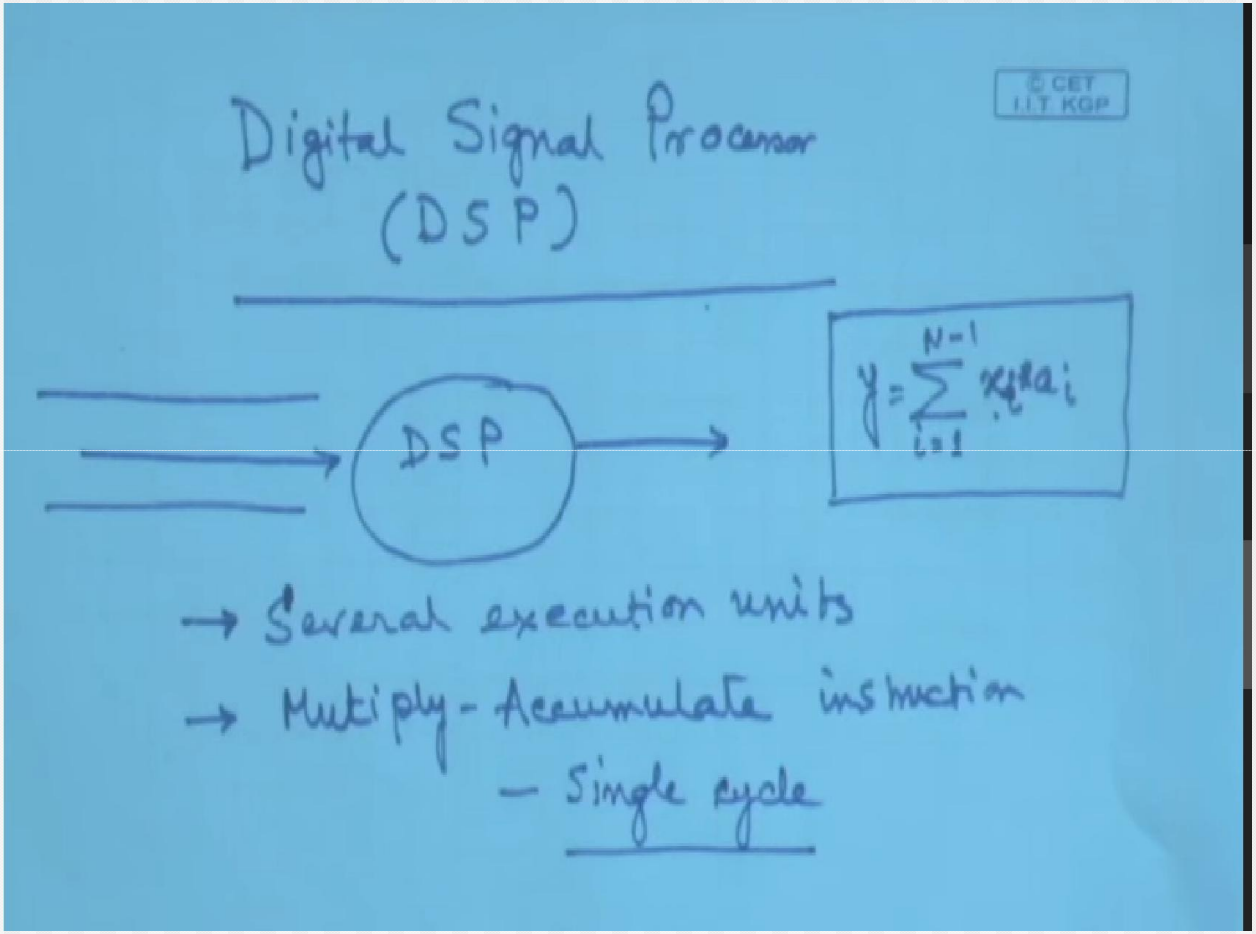




Specialized Processor

- ASIP
- DSP

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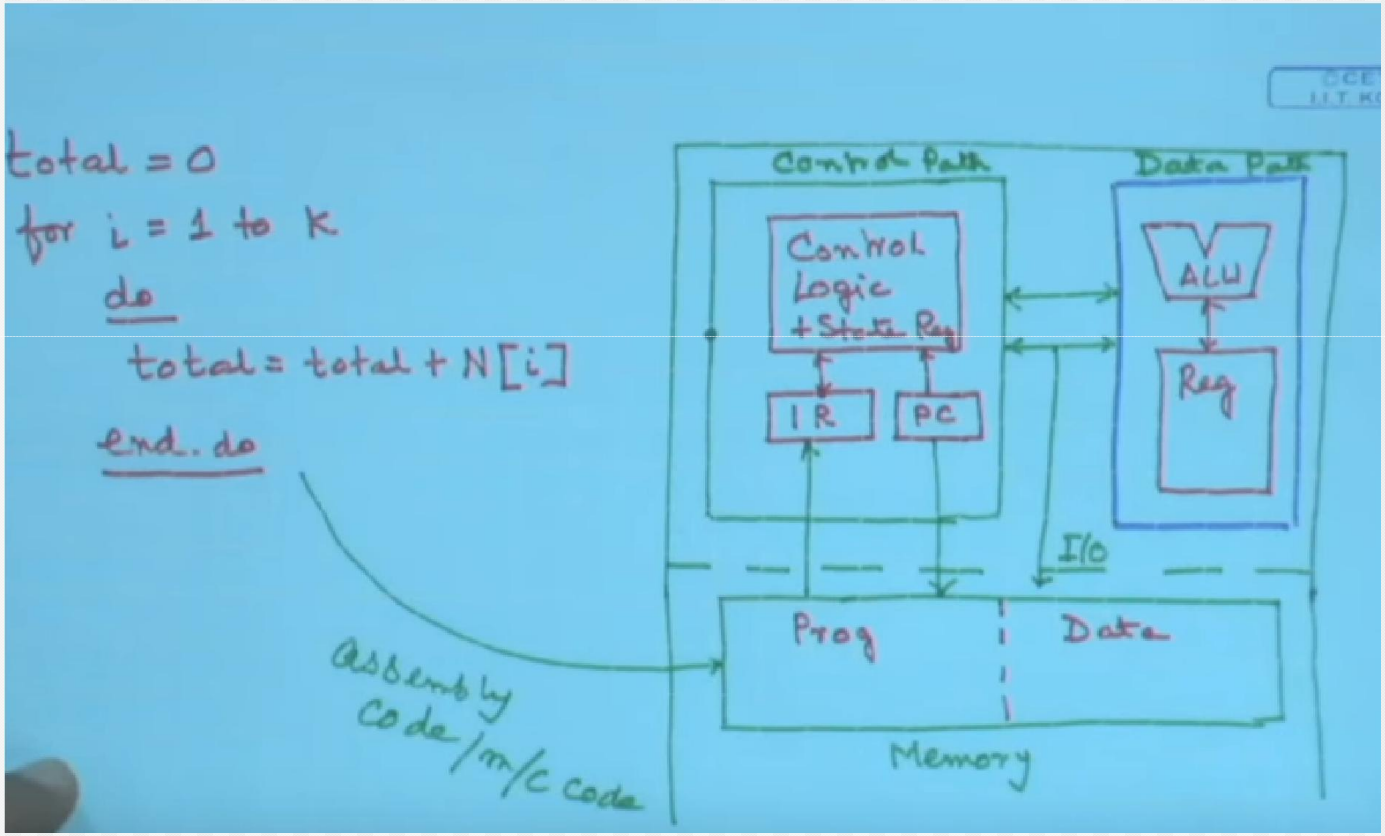
I.I.T KGP
Digital Signal Processor
(DSP)
DSP
$y = \sum_{i=1}^{N-1} x_i a_i$
→ Several execution units
→ Multiply - Accumulate instruction
– Single cycle


total = 0
for i = 1 to K
do
total = total + N[i]
end. do
Assembly Code / m/c code
Control Path
Data Path
Control Logic + State Reg
ALU
Reg
IR
PC
I/O
Prog
Data
Memory

RELAX! Have a Good day

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Thanks a lot
to
All the Participants

welcome to the Exciting World of Embedded System

Q & A