

* اياه هو : هاردوير ينفذ اوامر (software) بشكل دوري لا

حاجة مينة تحصل

بالظبط زي الfunction لها غرضه معين عند استعمالها في الكود

* مكوناته : ① هاردوير : Microcontroller في العقل

② i/o : input : داتا هيستفدها ال software
output : indicators : عشانه نتعرف اياه الى يحصل

③ OS (مش دايم) : مهمته تنظيم ال flow وزيادة ال efficiency

ممكن يكونه مصحوب ر interface لل user

④ سوفتوير : ال instructions الى هيست عليها

Characteristics:

* Single-Functioned

* Reactive & Real time

* Microprocessor based

* Tightly constrained

* limited memory

* Connected to I/O

Advantages :

- * Easily customizable
- * Low power consumption
- * Low cost
- * Enhanced performance

Disadvantage ::

- * Limited memory & Low speed processors & resources ^{ex. bins}
- * High development effort

General purpose systems

Embedded systems

← I/O etc

MicroProcessors:

Integrated circuit performs logical, arithmetic & controlling operations

* CPU \Rightarrow brain

\Rightarrow It's responsible for executing all instructions

Components of microcontroller

- ALU → Performing arithmetic & logical operations
- Registers → Type of memory (Fast & small size)
- Control unit → Controlling flow
- Interconnections → Wiring (التوصيلات)

(Data / address / control) bus

Registers

General purpose Registers: Used in assembly language

At least 8 registers & up to 32, numbered as R1, ..

Special purpose Register:

- * Status register → consists of flags describing the state of processor
- * Program counter → مسؤول عن ترتيب التعليمات
- * Accumulator → زي الياش بيخزن مخرجات المعالجة
- * Instruction register → بيخزن الكود بتاع التعليمات

Instruction cycle

① Fetch :

قراءة ال instruction

يأخذ ال instruction من ال program memory ويحفظها في ال IR

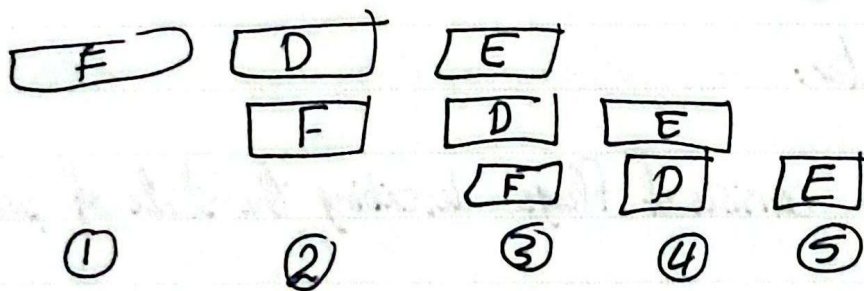
لأن ال PC يكون مشاوير عليه

② CU تتبع ال read signal عن طريق ال control bus ال PM

③ ال instruction يروح يتخزن في ال IR عن طريق ال data bus

④ Decode : ال ALU جواه ال decoder ليفهم ال instruction

⑤ Execute : ال ALU task

~~pipelining~~ pipelining

hardware arrangement

Instead of 9 cycles to execute 3 instructions

* باختصار شغل على التوازي بدل التوالي

Pipeline hazards

- * Structural hazard \rightarrow resource access \rightarrow Instruction
- * Data hazard \rightarrow data is not available
- * Control hazards \rightarrow delay between fetches

كل ذا اننا نضيف delay بين التعليمات

Memory

- * Registers > Caches > Main memory > Flash memory > traditional memory
- السرعة والقدرة في ال capacity

Registers :

- * Consists of flip-flops (Gates)
- * Flip-flop stores one bit
- * 8-bit register consists of 8 flip-flops

types : Shift/counter register

ROM

old ones ←

- Non-Volatile (Permenant) & Read only memory

Rom types:

logical circuit

MROM: Maskable ROM, unprogrammable

PROM: Programmable ROM (one time only) because of fuses

EPROM: Erasable PROM, erasable by UV

EEPROM: Electrically EPROM, electrically erased

Flash: EEPROM with larger ^{Page} size →

RAM

Volatile memory with read/write ops

Types :

تحتفظ بالقيمة المخزنة على مر الوقت

Static SRAM :

Faster / more power needed / larger physical size

Smaller capacity / Area

DRAM :

عكس

لا تحتفظ بالقيمة المخزنة بسبب المكنف (discharging)

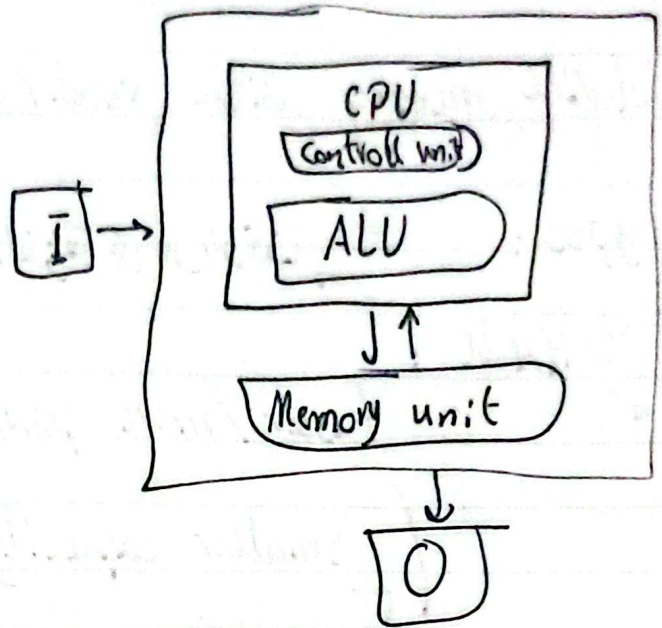
لها يتفق في precharging قبل القراءة لو أقل من threshold

ودا الى يقل سرعة القراءة

Non-Volatile RAM ← رام عادية محدودة بالطاقة

عيبها الوحيدة حاجتها الدائمة للبطارية

Computer architecture



Instruction set architecture (ISA)

بتعرفك ال processor يقدر يعمل ايه

بتعرفك ال hardware design و operation الى يقدر support لها

ال maximum length ال instruction عشان تمل حسابها ال register

ال instruction format

Classification → على حسب نوع ال instruction

* Complex instruction set computing (CISC)

* Reduced " " " (RISC)

Von Neumann arch :

Only one memory for Program and data

الشكله انه ال memory يتعمل عليها ال read او write في cycle

واحدة ودا بيخلي ال performance وخص وخصيه رديه جدا

Solution : Harvard Architecture

SRAM

This arch contains separated storage and buses for data
and program instruction → flash

Microcontroller

Small low cost microcomputer consists of CPU, memory, peripherals

→ GPIO → General purpose input/output ~~pins~~ Pins

controls
pins ال signal ال يوصل ال

can be programmed by specific registers

Timers

Type of register incremented by feeding clock signal

Uses:

→ delays

→ PWM signals

→ Counting external events \Leftarrow Used in shift calculations ^{Phase}

→ Generate system tick for RTOS

Watchdog → reset ال mc لو حصل تهييج
ياها ال mc و reset له هو مستقلاً

Timers might be 8-bit, 16-bit

← تفرقه في ال resolution