Machine Language

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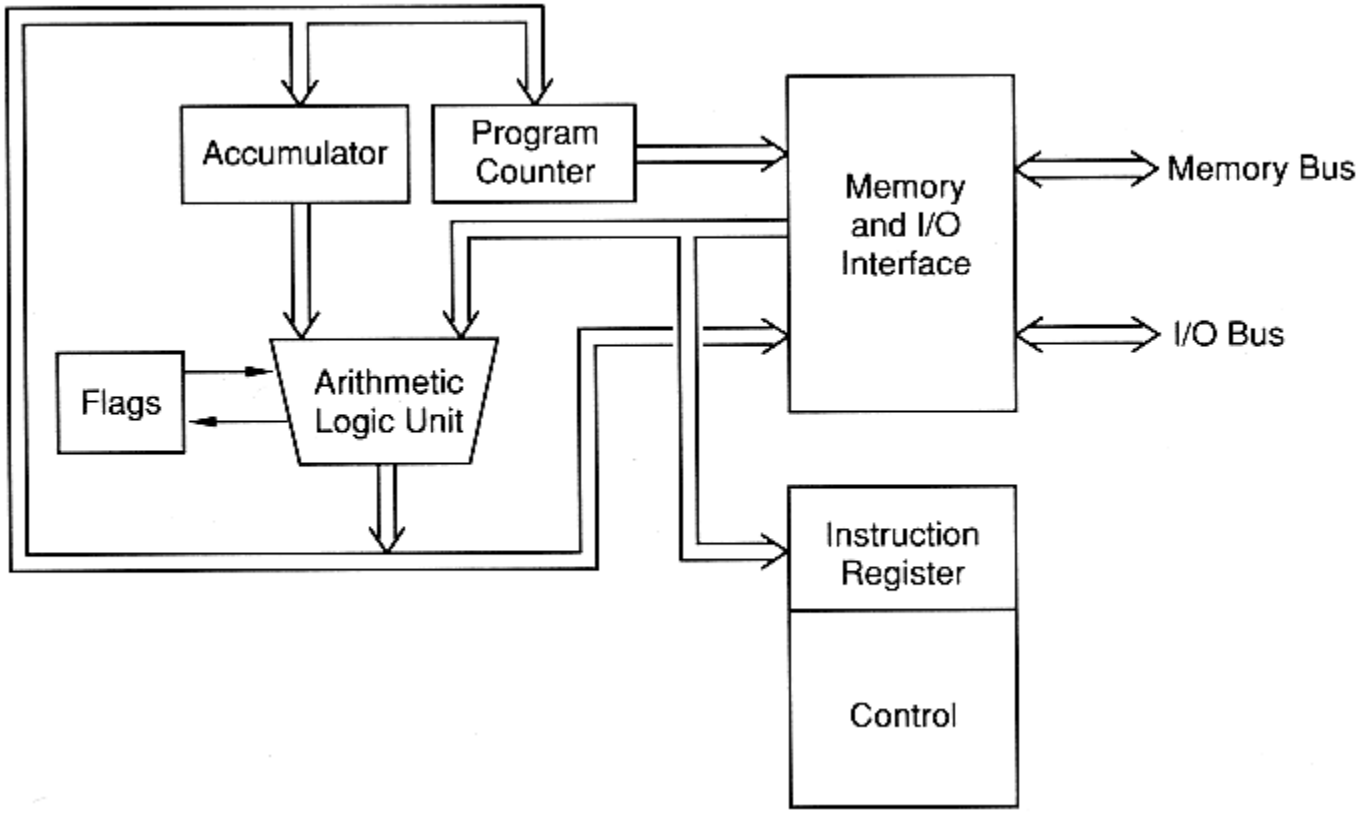
Block Diagram of a Simple Processor



Main Elements of a Processor (Central Processing Unit, CPU)

• *Memory*, *main memory, RAM (Random Access Memory)*: Storage for *instructions* **and** *data*.
• *Bus*: Wires for information transfer. *Input/Output (I/O) Bus*: For communicating with *peripheral devices*, such as monitors, printers, hard disks, etc. Memory and peripherals often use the same bus.
• *Arithmetic/Logic Unit (ALU)* performs basic arithmetic and logical operations. The ALU operates on *words*. ALUs have *registers* (special storage units). Each register contains one word (32 bits for Pentium 4). Early computers were *accumulator machines*: Arithmetic and logical operations took place in a single register, called an *accumulator*. *Flags = condition bits* register.
• The *control unit* is in charge of the *fetch-execute cycle*. The *instruction register (IR)* and the *program counter (PC)* (yet another register) are in it.

Machine Language Simulator

A Java applet was built to simulate execution of machine language commands on a simple processor. You can access it at

http://www.itss.brockport.edu/~trao/csc120/Machine3.html

The Problem of Menkaure

King Menkaure decided to build himself a pyramid with a square base of 200x200 royal cubits. He requested that the ratio of the length of a base side to the pyramid's height must not deviate from the magical Golden Ratio (≈1.618034) by more than 1.2%. The ratio is chosen to be 8:5, that of two suitable Fibonacci numbers. Merenptah, son of Hemiunu, is now given the task of computing the projected height of Menkaure's pyramid. Unfortunately, Merenptah's computer is ancient. Its primitive machine language does not have separate commands for division and multiplication.

The Ancient Program

21C8 load r1 w/ 200
2003 load 3 to r0
A100 rotate r1 right 3 (from r0!) times
221F load mask 00011111 to r2
8312 complete division by 8, put result in r3
2103 load 3, the # of iterations minus 1, to r1
22FF load FF to r2
2580 load 10000000 to r5 for future computation
2000 load 0 to r0 for future comparison
33FF store the increment in FF
14FF load the increment to r4
5334 increment r3 by content of r4
5112 decrement counter by 1
8615 mask counter by 80, store in r6
B616 repeat while counter not negative: jump to 16
E300 print r3
C000 end program

Merenptah's Report

Sire, the height of your pyramid will be $7D_{16}=125_{10}$ royal cubits.