# Embedded C Programming

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## Introduction, IDE Installation, and Setting

It is a combination of MP/MC-based hardware and software with some mechanical parts to perform a specific task is called an embedded system

Desktop VS embedded system

Eg:- printers, mouse, and refrigerator (it do only the specific test)

What is the program?

* A program is a series of instructions that cause a computer or a microcontroller to perform a particular task.
* It also contains data and various memory addresses on which the instructions work to perform a specific task.

Programming languages in embedded systems

* C and C++
* Rust
* Assembly
* Java
* Python
* C, C++ is the most widely used if you take microcontrollers. If you take microprocessors the most widely used language is python.
* Raspberry pi,jestsen nano you use python.

Microcontrollers

* A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory, and input/output (I/O) peripherals on a single chip.

Microprocessors

* The microprocessor is the central unit of a computer system that performs arithmetic and logic operations, which generally include adding, subtracting, transferring numbers from one area to another, and comparing two numbers. It's often known simply as a processor, a central processing unit, or as a logic chip. It's essentially the engine or the brain of the computer that goes into motion when the computer is switched on. It's a programmable, multipurpose device that incorporates the functions of a CPU (central processing unit) on a single IC (integrated circuit).

Types of processors and controllers

1. microprocessors/microcontrollers(8data bit/16data bit/32databit)

Web site:-Digi-key

Manufacturers eg:-Dallas, Philips, Renesas, Freescale, texas, microchip

1. DSP( Digital signal processor)
2. CPLD(complex programmable logic devices)/FPGA(field programmable gate arrays)
3. General purpose processors(GPU,AMD processor, 4,media GPU,graphic processing)
4. ASIC(application-specific integrated circuit)
5. soc(system on a chip)

Eg:-snapdragon, raspberry pi

Microprocessor basic

The microprocessor must have external peripherals to interact with the outside.

Program memory, and data memory an external.

Microcontroller

Program memory, data memory, timers, ADC, can, parallel port internal.

Basic features of DSPs

* A Digital signal processor is mathematics on the chip.
* DSPs usually run applications with hard real-time constraints.
* DSPs usually process infinite continuous data streams.
* MAC capability.
* DSP processors are microprocessors designed for efficient mathematical manipulation of digital signals.
* A microcontroller cannot do DSP applications. if you want to implement an image. processing applications or speech applications or audio applications you could go for a DSP processor.
* Your number sim misses a deadline that may cause havoc so that is hard for real-time.
* Embedded systems Two kinds of real-time systems are real-time and soft real-time and hard real-time.
* Real-time missing a deadline may cause havoc or a soft real-time uh missing a deadline may degrade the performance so that’s uh soft real-time.
* Microprocessor everything is external microcontroller everything is on-chip microcontroller is used for control logic and whereas DSP processor is for algorithms if you want to implement a complex mathematical.
* Dsp has mac capability muti-plane accumulated capability DSP processors are again microprocessors uh designed for efficient mathematical calculations so that’s the advantage of DSP.
* Two kinds of DSP are fixer point DSP and floating point DSP.foating point Mathematica calculations.

Example of hard real-time system is a nuclear reactor, aeronautics, and aerospace.Soft real-time systems mobile phone.

Why do we need DSP processors?

* Microcontrollers are control-oriented, and DSPs are data path oriented.
* Use a GPP processor when the following are required:

-large memory.

-advanced operating systems.

* Use a DSP processor when the following are required:
* Precision.
* Cost saving.
* Smaller size.
* Low power consumption.
* Processing of signals in real-time.

CPLD Vs FPGA

FPGA:-data path-oriented

CPLD:-control-oriented

CPLD architecture

* Logic blocks
* I/O blocks
* Clock routing
* Routing matrix

FPGA architecture

* Logic blocks
* I/O blocks
* Clock routing
* Routing matrix
* Memory
* Multipliers /DSP blocks

There are two types of core in FPGA one is softcore and the other is hardcore. Softcore software is fine, architecture like FPGA Xilinx FPGA supports microplate architecture, which is a 32-bit RISK architecture microprocessor that you can implement inside an FPGA and if PowerPC is a hardcore processor, it means it is built in xylink’s company's fab. Generate code on FPGA, a hardcore processor.

When to use DSP in FPGA

* Higher performance

Parallel algorithm implementation

* Customizable design

System Integration

* Less board real estate
* Less chips could mean less system co

Traditional embedded system design using DSP

* CPU
* Power supply
* CLK
* Audio codec
* Ethernet MAC
* GP I/O
* Address decode unit
* Memory controller
* CLK
* SRAM
* SDRAM
* Display controller
* UART
* Custom IF-logic
* Timer
* Interrupt controller
* Timer
* LC

Multicare processor-SOC

2 or more independent processors in 1 package

Symmetric multiprocessing

* Number of identical processors
* Common shared memory
* On operating system

Asymmetric multiprocessing

* Different processors, instruction sets
* Different operating systems
* Possibly without shared memory

CPLD difference FPGA

* CPLD wherever you use a microcontroller(control path oriented) DSP processor you can use a FPGA. DSP uses sequential FPGA and supports parallel processing FPGA much faster than DSP.

AMP-TI OMAP

* Processors need not be identical
* Processor specialization may increase performance.
* T>I>’s OMAP.general purpose processor+digital signal processor.

Arm core can control applications. entry thing is embedded.DSP can do a DSP application.

How FPGA is different from ASIC

ASIC(application-specific integrated circuit)

* Special chip purpose-built for an application

e.g:-ASIC bitcoin miner,inte neural network accelerator

* A function cannot be changed once expensively built

FPGA can be field-programmed

* the function can be changed completely whenever.
* FPGA fabric emulates custom circuits.

Isp:-image signal processing

If your application involves speech audio you use a DSP processor if it’s simple IoT applications or sensor applications you go for microcontrollers if you’re designing an application for mobile kind of applications terrible kind of application then you can use soc(system on chip) FPGA for high-end applications.