Different microcontroller families and brands

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B.N : 20

Abstract:

Today’s technology has been evolved into stand-alone systems which can do all necessary processes by itself without any additional hardware. Advance microcontrollers have become microcomputers that are also known as single board computers. These systems take their power from powerful microcontrollers. These microcontrollers have many integrated circuits onboard so they can achieve many different processes by themselves. They are being used in many applications, from powerful industrial devices to simple home appliances. On today’s market, there are many different microcontrollers with different structure and capabilities. Therefore, understanding the concepts related to the microcontrollers is really important for choosing the best hardware. This paper presents the main concepts of microcontrollers and reveals the basis of their structure. Their components and abilities have been discussed and comparation of well-known single board computers has been given to them. This allows for a reduction in power consumption, more compact designs, and cost savings. Additionally, microcontrollers can provide functional safety and security for embedded systems.

There are families such as AVR, PIC, ARM Cortex-M, and 8051 are examined in terms of processing power, memory architecture, power efficiency, and peripheral interfaces. Each family has its different requirements, such as low-power applications, real-time control, and advanced processing capabilities. Understanding the strengths and weaknesses of these families enables us to choose the most appropriate microcontroller for specific tasks, optimizing system performance and cost-effectiveness.

Introduction:

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys, and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make digital control of more devices and processes practical. Mixed-signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. In the context of the Internet of Things, microcontrollers are an economical and popular means of data collection, sensing and actuating the physical world as edge devices.

Microcontroller families share a common architecture, instruction set, and often a similar pinout. This means that devices within a family are generally compatible with each other and can be used interchangeably in many applications.

8051:

The one of the oldest and most widely used families. It was designed in the 1980s by Intel. Its foundation was on Harvard Architecture and was developed principally for bringing Embedded Systems into play. At first, it was created using NMOS technology but as NMOS technology needs more power to function therefore Intel re-intended Microcontroller 8051 employing CMOS technology and a new edition came into existence with a letter ‘C’ in the title name, for illustration: 80C51. These most modern Microcontrollers need a fewer amount of power to function in comparison to their forerunners

PIC:

PIC microcontroller is a fast and easy to implement program when we compare other microcontrollers. The ease of programming and easy to interface with other peripherals PIC became a famous microcontroller.

PIC also supports protocols like CAN, SPI, UART for interfacing with other peripherals. PIC mainly used modified Harvard architecture and also supports RISC (Reduced Instruction Set Computer) by the above specification RISC and Harvard we can easily that PIC is faster than the 8051 based controller which is made-up of Von-Newman architecture.

Advantages of PIC Microcontroller:

- They are reliable and malfunctioning of PIC percentage is very little. And performance of the PIC
- is very fast because of using RISC architecture.
- Power conception is also very small when compared to other microcontrollers.

Disadvantages of PIC Microcontroller:

- The length of the program will be big because of using RISC (35 instructions).
- Program memory is not accessible and only one single accumulator is present

AVR:

High reliability, high functionality, high speed, low power consumption, and low price are the important indicators to measure the performance of microcontrollers, and the necessary conditions for microcontrollers to occupy the market and survive.

Mainly due to the process and design level, power consumption, and anti-interference performance, the early microcontroller took a conservative program: that is, the use of a higher frequency division factor on the clock division, making the instruction cycle long and slow execution speed. Although later CMOS

microcontrollers use measures such as increasing the clock frequency and reducing the crossover coefficient, this state has not been completely changed (51 as well as 51 compatible). In the meantime, although there are some streamlined instructions set microcontrollers (RISC), they still follow the practice of clock division.

The AVR microcontroller completely broke this old design pattern and abandoned the complex instruction computer (CISC). It adopts a streamlined instruction set, using a word as the instruction length unit, and arranges the content-rich operands and opcodes in a word (most of the single-cycle instructions in the instruction set are like this). The short fetch cycle and the ability to pre-fetch instructions enable high-speed execution of instructions. Of course, this leap in speed is backed by high reliability.

ARM:

Arm architecture provides the foundations for the design of a processor or core, things we refer to as a Processing Element (PE).

The architecture exposes a common instruction set and workflow for software developers, also referred to as the Programmer's model. This helps to ensure interoperability across different implementations of the architecture, so that software can run on different Arm devices.

ARM processors are found in numerous market segments, including networking, automotive, mobile and consumer devices, mass storage, and imaging. Within each segment ARM processors can be found in multiple applications.

For example, the ARM processor is found in networking applications like home gateways, DSL modems for high-speed Internet communication, and 802.11 wireless communication. The mobile device segment is the largest application area for ARM processors because of mobile phones. ARM processors are also found in mass storage devices such as hard drives and imaging products such as inkjet printers—applications that are cost sensitive and high volume.

In contrast, ARM processors are not found in applications that require leading-edge high performance. Because these applications tend to be low volume and high cost, ARM has decided not to focus designs on these types of applications.

Summer training microcontroller and this course microcontroller:

PIC16F877A

- **Architecture**: It's an 8-bit microcontroller, which means it processes data in 8-bit chunks. This makes it simpler and easier to use for basic applications.
- **Performance**: Runs at a maximum speed of 20 MHz, which is decent for small tasks but slower compared to modern microcontrollers.
- **Memory**: Has 14 KB of Flash memory for storing programs and 368 Bytes of RAM for data. This is enough for basic applications but limits complexity.
- **Typical Uses**: Great for controlling simple motors, reading basic sensors (like temperature or light), and running straightforward gadgets. Think of things like a thermostat, basic remote controls, or small robotic systems.

ARM Cortex-M4

- **Architecture**: This is a 32-bit microcontroller. It's designed for performance and efficiency.
- **Performance**: it is much faster and able to execute more instructions per second than the PIC.
- **Memory**: Typically comes with much more memory allowing for more complex programs and data processing.
- **Typical Uses**: Perfect for smart devices, IoT applications, advanced motor control, and real-time data processing