Microcontroller introduction pdf

I'm not robot!

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. Sometimes referred to as an embedded controller or microcontroller unit (MCU), microcontrollers are found in vehicles, robots, office machines, medical devices, mobile radio transceivers, vending machines and home appliances, among other devices. They are essentially simple miniature personal computers (PCs) designed to control small features of a larger component, without a complex front-end operating system (OS). A microcontroller is embedded inside of a system to control a singular function in a device. It does this by interpreting data it receives from its I/O peripherals using its central processor. The temporary information that the microcontroller receives is stored in its data memory, where the processor accesses it and uses instructions stored in its program memory to decipher and apply the incoming data. It then uses its I/O peripherals to communicate and enact the appropriate action. Microcontrollers are used in a wide array of systems and devices. Devices often utilize multiple microcontrollers that work together within the device to handle their respective tasks. For example, a car might have many microcontrollers that control various individual systems within, such as the anti-lock braking system, traction control, fuel injection or suspension control. All the microcontrollers communicate with each other to inform the correct actions. Some might communicate with a more complex central computer within the car, and others might only communicate with other microcontrollers. They send and receive data using their I/O peripherals and process that data to perform their designated tasks. The core elements of a microcontroller are: The processor (CPU) -- A processor can be thought of as the brain of the device. It processes and responds to various instructions that direct the microcontroller's function. This involves performing basic arithmetic, logic and I/O operations. It also performs data transfer operations, which communicate commands to other components in the larger embedded system. Memory -- A microcontroller's memory is used to store the data that the processor receives and uses to respond to instructions that it's been programmed to carry out. A microcontroller has two main memory types: Program memory, which stores long-term information about the instructions that the CPU carries out. Program memory is non-volatile memory, meaning it holds information over time without needing a power source. Data memory, which is required for temporary data storage while the instructions are being executed. Data memory is volatile, meaning the data it holds is temporary and is only maintained if the device is connected to a power source. I/O peripherals -- The input and output devices are the interface for the processor to the outside world. The input ports receive information and send it to the processor in the form of binary data. The processor receives that data and sends the necessary instructions to output devices that execute tasks external to the microcontroller. While the processor, memory and I/O peripherals are the defining elements of the microprocessor, there are other elements that are frequently included. The term I/O peripherals itself simply refers to supporting components that interface with the memory and processor. There are many supporting components that can be classified as peripherals. Having some manifestation of an I/O peripheral is elemental to a microprocessor, because they are the mechanism through which the processor is applied. Other supporting elements of a microcontroller include: Analog to Digital Converter (ADC) -- An ADC is a circuit that converts analog signals to digital signals. It allows the processor at the center of the microcontroller to interface with external analog devices, such as sensors. Digital to Analog Converter (DAC) -- A DAC performs the inverse function of an ADC and allows the processor at the center of the microcontroller to communicate its outgoing signals to external analog components. System bus -- The system bus is the connective wire that links all components of the microcontroller together. Serial port -- The serial port is one example of an I/O port that allows the microcontroller to connect to external components. It has a similar function to a USB or a parallel port but differs in the way it exchanges bits. A microcontroller's processor will vary by application. Options range from the simple 4-bit, 8-bit or 16-bit processors to more complex 32-bit or 64-bit processors. Microcontrollers can use volatile memory types such as random access memory (RAM) and non-volatile memory types -- this includes flash memory, erasable programmable read-only memory (EPROM) and electrically erasable programmable read-only memory (EEPROM). Generally, microcontrollers are designed to be readily usable without additional computing components because they are designed with sufficient onboard memory as well as offering pins for general I/O operations, so they can directly interface with sensors and other components. Microcontroller architecture can be based on the Harvard architecture or von Neumann architecture, both offering different methods of exchanging data between the processor and memory. With a Harvard architecture, the data bus and instruction are separate, allowing for simultaneous transfers. With a Von Neumann architecture, one bus is used for both data and instructions. Microcontroller processors can be based on complex instruction set computing (CISC) or reduced instruction set computing (RISC). CISC generally has around 80 instructions while RISC has about 30, as well as more addressing modes, 12-24 compared to RISC's 3-5. While CISC can be easier to implement and has more efficient memory use, it can have performance degradation due to the higher number of clock cycles needed to execute instructions. RISC, which places more emphasis on software, often provides better performance than CISC processors, which put more emphasis on hardware, due to its simplified instruction set and, therefore, increased design simplicity, but because of the emphasis it places on software, the software can be more complex. Which ISC is used varies depending on application. When they first became available, microcontrollers solely used assembly language. Today, the C programming language is a popular option. Other common microprocessor languages include Python and JavaScript. MCUs feature input and output pins to implement peripheral functions. Such functions include analog-to-digital converters, liquid crystal display (LCD) controllers, real-time clock (RTC), universal synchronous/asynchronous receiver transmitter (USART), timers, universal asynchronous receiver transmitter (UART) and universal serial bus (USB) connectivity. Sensors gathering data related to humidity and temperature, among others, are also often attached to microcontrollers. Common MCUs include the Intel MCS-51, often referred to as an 8051 microcontroller, which was first developed in 1985; the AVR microcontroller developed by Atmel in 1996; the programmable interface controller (PIC) from Microchip Technology; and various licensed Advanced RISC Machines (ARM) microcontrollers. A number of companies manufacture and sell microcontrollers, including NXP Semiconductors, Renesas Electronics, Silicon Labs and Texas Instruments. Microcontrollers are used in multiple industries and applications, including in the home and enterprise, building automation, manufacturing, robotics, automotive, lighting, smart energy, industrial automation, communications and internet of things (IoT) deployments. One very specific application of a microcontroller is its use as a digital signal processor. Frequently, incoming analog signals come with a certain level of noise. Noise in this context means ambiguous values that cannot be readily translated into standard digital values. A microcontroller can use its ADC and DAC to convert the incoming noisy analog signal into an even outgoing digital signal. The simplest microcontrollers facilitate the operation of electromechanical systems found in everyday convenience items, such as ovens, refrigerators, toasters, mobile devices, key fobs, video game systems, televisions and lawn-watering systems. They are also common in office machines such as photocopiers, scanners, fax machines and printers, as well as Smart meters, ATMs and security systems. More sophisticated microcontrollers perform critical functions in aircraft, spacecraft, ocean-going vessels, vehicles, medical and life-support systems as well as in robots. In medical scenarios, microcontrollers can regulate the operations of an artificial heart, kidney or other organs. They can also be instrumental in the functioning of prosthetic devices. The distinction between microcontrollers and microprocessors has gotten less clear as chip density and complexity has become relatively cheap to manufacture and microcontrollers have thus integrated more "general computer" types of functionality. On the whole, though, microcontrollers can be said to function usefully on their own, with a direct connection to sensors and actuators, where microprocessors are designed to maximize compute power on the chip, with internal bus connections (rather than direct I/O) to supporting hardware such as RAM and serial ports. Simply put, coffee makers use microcontrollers; desktop computers use microprocessors. The Microchip Technology ATtiny817 microcontroller. Microcontrollers are less expensive and use less power than microprocessors. Microprocessors do not have built-in RAM, read-only memory (ROM) or other peripherals on the chip, but rather attach to these with their pins. A microprocessor can be considered the heart of a computer system, whereas a microcontroller can be considered the heart of an embedded system. There are a number of technology and business considerations to keep in mind when choosing a microcontroller for a project. Beyond cost, it is important to consider the maximum speed, amount of RAM or ROM, number or types of I/O pins on an MCU, as well as power consumption and constraints and development support. Be sure to ask questions such as: What hardware peripherals are required? Are external communications needed? What architecture should be used? What sort of community and resources are available for the microcontroller? What is the market availability of the microcontroller?

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