iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 2 **Issue:** XII **Month of publication:** December 2014

**DOI:**

www.ijraset.com

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ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

# Overview and Comparative Study of Different Microcontrollers

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***Abstract*—A microcontroller is a small and low-cost computer built for the purpose of dealing with specific tasks, such as displaying information on seven segment display at railway platform or receiving information from a television's remote control. Microcontrollers are mainly used in products that require a degree of control to be exerted by the user. Today various types of microcontrollers are available in market with different word lengths such as 8bit, 16bit, 32bit, and microcontrollers. Microcontroller is a compressed microcomputer manufactured to control the functions of embedded systems in office machines, robots, home appliances, motor vehicles, and a number of other gadgets. Therefore in today's technological world lot of things done with the help of Microcontroller. Depending upon the applications we have to choose particular types of Microcontroller. The aim of this paper to give the basic information of microcontroller and comparative study of 8051 Microcontroller, ARM Microcontroller, PIC Microcontroller and AVR Microcontroller***

**Keywords**— ***Microcontroller, Memory, Instruction, cycle, bit, architecture***

## I. INTRODUCTION

Microcontrollers have directly or indirectly impact on our daily life. Usually, But their presence is unnoticed at most of the places like:
At supermarkets in Cash Registers, Weighing Scales, Video games ,security system , etc.
At home in Ovens, Washing Machines, Alarm Clocks, paging, VCR, LASER Printers, color printers etc.
At Toys, Cellular phones, Climate control, Fax Machine, Musical instruments, Stereo Equipment, etc.
At office in Typewriters, Photocopiers, Elevators, Transmission control, etc.
In industry in Industrial Automation, safety systems, Sewing Machine, Camcorder, etc
Traffic Signals, Railways platform etc
What inside them makes these machines smart? The answer is microcontroller.
Creating applications for the microcontrollers is different than any other development job in electronics and computing. Before selecting a particular device for an application, it is important to understand what the different options and features are and what they can mean with regard to developing the application [1].

### *A. How is Microcontrollers Classified?*

The microcontrollers are characterized regarding bus-width, instruction set, and memory structure. For the same family, there may be different forms with different sources. This paper also is going to describe some of the basic types of the Microcontroller that newer users may not know about.

*1) Classification according to number of bits*

a) *The 8-bit microcontroller:* Means CPU or ALU can process 8 bit data at a time. The examples of 8-bit microcontrollers are Intel 8031/8051. These are used in position control, speed control applications [2].

2) *The 16-bit microcontroller:* It performs greater precision and performance as compared to 8-bit. These are developed for the purpose of high speed applications such as servo control system, Robotics etc. Some examples of 16-bit microcontroller are 16-bit MCUs are extended Intel 8096 and Motorola MC68HC12 families [2].

3) *32-bit microcontroller:* It uses the 32-bit instructions to perform the arithmetic and logic operations These are developed for the purpose of very high speed application in Image processing, Telecommunications , Intelligent control system etc [3]. Some examples are Intel/Atmel 251 family, PIC3x, ARM.

### *B. Classification according to memory devices*

1) *Embedded memory microcontroller:* When an embedded system has a microcontroller unit that has all the functional blocks available on a chip is called an embedded microcontroller. For example, 8051 having program & data memory, I/O

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

ports, serial communication, counters and timers and interrupts on the chip is an embedded microcontroller[2].

2) *External Memory Microcontroller*: When an embedded system has a microcontroller unit that has not all the functional blocks available on a chip is called an external memory microcontroller. For example, 8031 has no program memory on the chip is an external memory microcontroller [2].

*C. Classification according to instruction set*

1) *CISC architecture:* CISC means complex instruction set computer, it allows the user to apply 1 instruction as an alternative to many simple instructions [6].

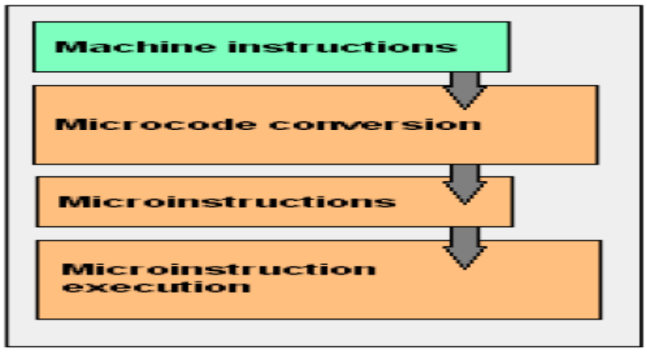


Fig. 1 CISC architecture

2) *RISC architecture*: RISC means Reduced Instruction Set Computers. RISC reduces the operation time by shortening the clock cycle per instruction. The RISC gives a better execution than the CISC [6].

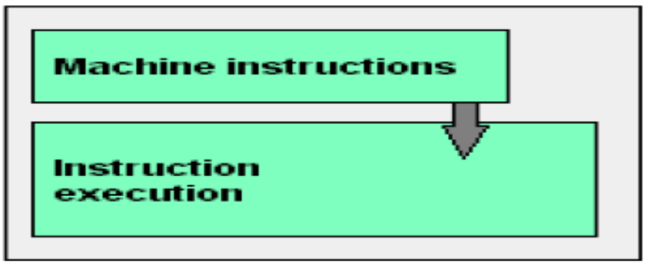


Fig. 2 RISC architecture

*D) Classification according to memory architecture*

*1) Harvard Memory Architecture Microcontroller:* The point when a microcontroller unit has a dissimilar memory address space for the program and data memory, the microcontroller has Harvard memory architecture in the processor. The RISC gives a better execution than the CISC[8].

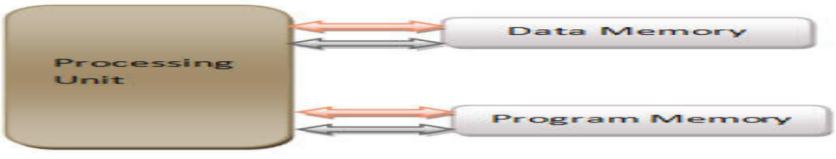


Fig.3 Harvard architecture

*2)Princeton Memory Architecture Microcontroller*: The point when a microcontroller has a common memory address for the program memory and data memory, the microcontroller has Princeton memory architecture in the processor [8].

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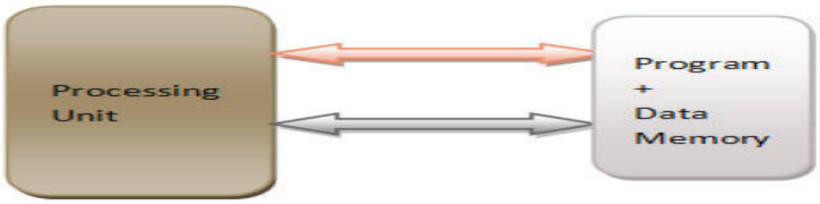


Fig. 4 Princeton architecture

## II. TYPES OF MICROCONTROLLER

### A. 8051 Microcontroller

8051 microcontroller is an eight bit microcontroller invented in 1981 by Intel Corporation. It is available in 40 pin DIP i.e. dual in line package. This is the basic Microcontroller but still many companies are manufacturing such types of Microcontroller. The older types of 8051 have 12 clocks per instruction that make it sluggish whereas the recent 8051 have 6 clocks per instruction. The 8051 microcontroller does not have an in built memory bus and A/D converters and such Microcontrollers are CISC processors, also 8051 uses Von Neuman architecture [8].

Fig.5 Intel 8051 Microcontroller

Various features of 8051 microcontroller are given as follows.

1) 8-bit CPU
2) 16-bit Program Counter
3) 8-bit Processor Status Word (PSW)
4) 8-bit Stack Pointer
5) 4K bytes internal ROM (program memory).
6) 128 bytes internal RAM (data memory).
7) Special Function Registers (SFRs) of 128 bytes
8) 32 I/O pins arranged as four 8-bit ports (P0 – P3)
9) Two 16-bit timer/counters : T0 and T1
10) Two external and three internal vectored interrupts
11) One full duplex serial I/O [7].

### B. PIC Microcontroller

Peripheral interface controller is a family of Microcontrollers by Microchip technology USA with Havard architecture. Originally this was developed as supporting device for PDP (program data processor) computers to support for its peripheral devices and therefore named as PIC. PIC Microcontrollers are RISC processors. An interesting thing about PIC is that its machine cycle consists of only 4 clock pulses in contrast with 12 clock pulses in Intel 8051 Microcontroller. PIC microcontrollers are finding their way into new applications like smart phones, audio accessories, video gaming peripherals and advanced medical devices [5].

Fig.6 PIC 16F877

Various features of PIC 16F877 microcontroller are given as follows

1) High-performance RISC CPU
2) Up to 8K x 14 words of FLASH program memory
3) 35 Instructions (fixed length encoding-14-bit)
4) 368×8 static RAM based data memory
5) Up to 256 x 8 bytes of EEPROM data memory
6) Interrupt capability (up to 14 sources)
7) Three addressing modes (direct, indirect, relative)
8) Power-on reset (POR)
9) Harvard architecture memory
10) Power saving SLEEP mode
11) Wide operating voltage range: 2.0V to 5.5V
12) High sink / source current: 25mA
13) Accumulator based machine[5].

### C. *ARM Microcontroller*

ARM is 32 bit Microcontroller whose core is designed by ARM Limited with RISC architecture. ARM has von Neumann architecture (program and RAM in the same space). ARM Microcontrollers are extremely used in power saving and operate in very low power consumption. ARM MicrocontrollersWidely used in modern handset for mobile communications. These are also used in various other embedded sysstem likes iPOD,hand held gaming unit,disk driver and so on. 8051 and PIC need multiple clock cycles per instruction. AVR and ARM execute most instructions in a single clock cycle [4].

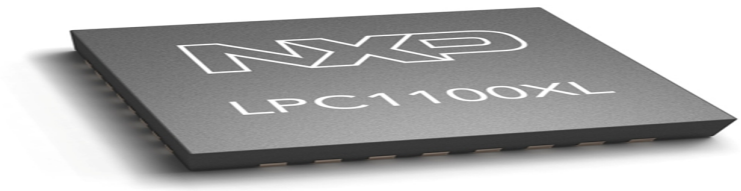


Fig. 7 ARM microcontroller

Various features of ARM microcontroller are given as follows

1) Maximum single cycle functioning
2) Constant 16×32 bit register file.
3) Load or store architecture.
4) Preset instruction width of 32 bits so as to simplify pipe-lining and decoding, at minimized code density.
5) For misaligned memory access there is no support [4].

### D. *AVR Microcontroller*

The AVR is a modified Harvard RISC architecture 8-bit RISC single-chip microcontroller, which is developed by Atmel in 1996. The AVR is stands for Alf-Egil Bogen and Vegard Wollan's RISC processor. AVR takes only one clock per instruction

1) *AVR Microcontrollers are classified into three types*

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

*a)* TinyAVR – Less memory, small size, suitable only for simpler applications.
*b)* MegaAVR – These are the most popular ones having good amount of memory (up to 256 KB), higher number of inbuilt peripherals and suitable for moderate to complex applications.
*c)* XmegaAVR – Used commercially for complex applications, which require large program memory and high speed [5].

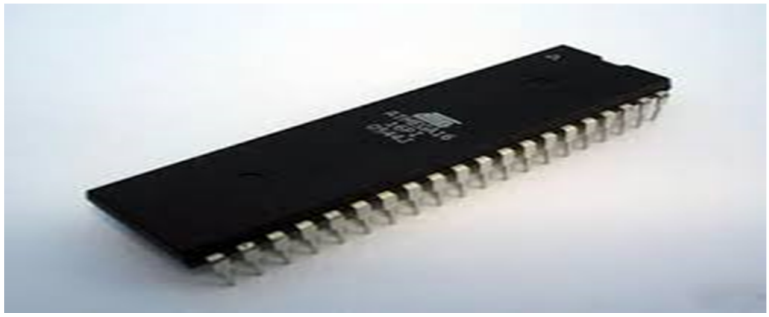

Fig. 8 ATMEGA 16

Some of the features of Atmega16 are:

*a)* 16KB of Flash memory
*b)* 1KB of SRAM
*c)* 512 Bytes of EEPROM
*d)* Available in 40-Pin DIP
*e)* 8-Channel 10-bit ADC
*f)* Two 8-bit Timers/Counters
*g)* One 16-bit Timer/Counter
*h)* 4 PWM Channels
*i)* In System Programmer (ISP)
*j)* Serial USART
*k)* SPI Interface
*l)* Digital to Analog Comparator [5].

## III. CONCLUSION

There are different microcontroller products are available, It is clear that these devices can be applied to many embedded system designs from the simple hardware control applications to signal processing applications. The choice of devices available today is vast. Therefore we must know what type of Microcontroller suitable for particular applications. This paper will help us to select a particular Microcontroller for specific applications.

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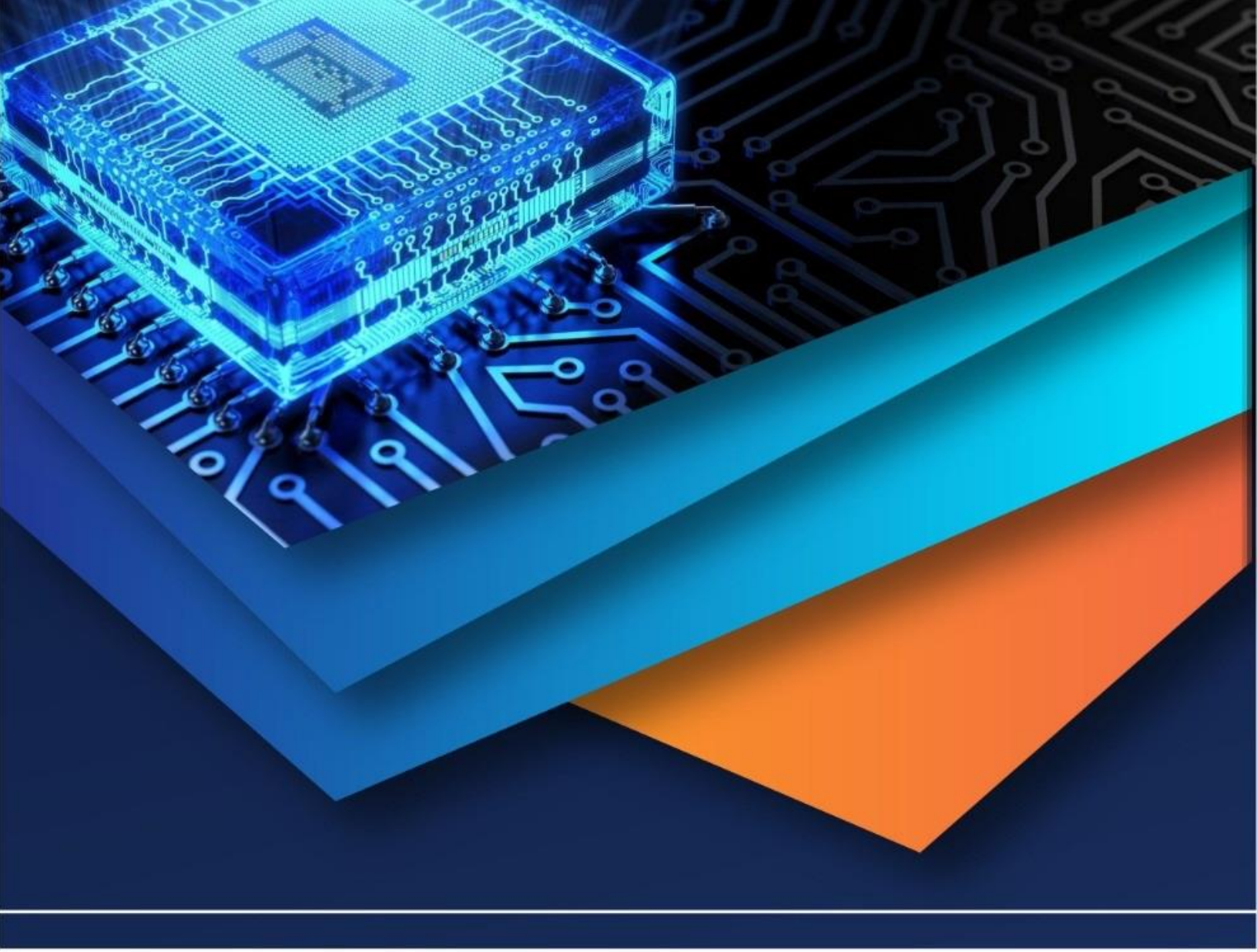

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