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# Emerging Trends in Embedded Processors

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**ABSTRACT**
An Embedded Processors is simply a µProcessors that has been "Embedded" into a device. Embedded systems are important part of human life. For illustration, one cannot visualize life without mobile phones for personal communication. Embedded systems are used in many places like healthcare, automotive, daily life, and in different offices and industries.Embedded Processors develop new research area in the field of hardware designing.
*Keywords*—Embedded Processor, ARM, AVR, PIC, processors today

## I. INTRODUCTION

This Paper provides a brief introduction toembeddedsystems, including their main componentsand application areas. It also provides an overview of theemerging trends and the related implications in thedesign and development of these systems.

An Embedded Processors is simply a µProcessors that has been "Embedded" into a device. It is software programmable but interacts with different pieces of hardware. It performs both control and computation, more performance than a µController but not as much as a general purpose processor.

The main reason for using embedded processors is their cost and size, so they don't take up much die area and thus they are cheap to fabricate. Embedded processors are verified system. Embedded processors run software, the key part of that is the SOFT – deal with changing specs. The three most important design criteria are power, performance, and cost.

## II. MARKET OF EMBEDDED PROCESSOR

Embedded systems are important part of human life. For illustration, one cannot visualize life without mobile phones for personal communication. Its presence is practically unavoidable in almost all facets of human endeavor. While we search on configurations in each of these application spaces, we can clearly recognize the trend as to where the future of embedded systems is heading. [5]

### 1. Automotive

Embedded systems are clearly the ways and means of achieving multiple objectives from infotainment systems, engine control unit, fuel management,Car-area-network, safety systems. Traffic management and prediction systems are being developed for big cites. The media oriented systems transport (MOST) is one of the technologies being deployed by OEMs for multimedia and infotainment networking.

### 2. Healthcare

Electronic medical device and other technological innovations with the convergence of nanotech, biotech,communication tech and device,manufacturing tech, sensor technologies are making breathtaking transformations in healthcare delivery. Interestingly the convergence of wireless communication with the sensors created the BAN – body area network which is today used to monitor, heart –pulse rate, ECG,temperature, oxygen, blood pressure etc., sleep disorders can also be monitored using a clip device fixed to head band. Wireless cardiovascular solutions offer unprecedented visibility into a patient's health status – anytime, anywhere across the world.

### 3. Consumer Electronics

While, mobiles, iPods,handhelds, etc., have changed the landscape of the personal entertainment in the world in the contemporary past, the emerging trend is adding more intellect in thecommunication devices by converging the social networks, personal entertainment,location based services and choices city information, and profile of the users. Nowadays set-top boxes used in television are also using microprocessors.

### 4. Industrial Control

Mostly industries are working on embedded systems, some of the examples are, Control Systems,

various cards, Artificial Satellites, Missiles, Space stations, Nuclear reactors and shuttles.

## III. PROCESSORS TODAY

### 1. ARM (Advanced RISC Machine)

The ARM architecture has evolved a lot from its first version ARM1 to the latest ARM11 Processor core.ARM1, ARM2, ARM3, ARM4 & 5, ARM6, ARM7, ARM8, StrongARM, ARM9, ARM10 and ARM11 are the product families from ARM since its introduction to the market. Some ARM processor extensions like Thumb, Jazelle, Debugger, multiplier, etc are also introduced by ARM during its journey from ARM1 to ARM11. Some ARM processors are compared in terms of their features. [1]

**Table 1: Key Features of ARM family Microprocessor**

| Key Features | ARM 7 | ARM 9 | ARM 10 | ARM 11 |
|---|---|---|---|---|
| Core | 32-bit RISC | 32-bit RISC | 32-bit RISC | 32-bit RISC |
| Pipelining Stages | 3 | 5 | 6 | 8 |
| Architecture | Von-Neumann | Harvard | Harvard | Harvard |
| Code Density | High | High | High | High |
| Die Size | Small | Small | Small | Small |
| Max. Operating Frequency( in MHz) | 80 | 150 | 260 | 335 |
| MIPS/MHz | 0.97 | 1.1 | 1.3 | 1.2 |
| mW/MHz | 0.06 | 0.19 + cache | 0.5 + cache | 0.4 + cache |
| Buses | AHB | AMBA | - | - |
| Multiplier | 8X32 | 8X32 | 16X32 | 16X32 |
| Memory Coupling | No tight coupling | No tight coupling | - | - |
| Power Performance | Very low | Very low | Medium | Optimum |

### 2. AVR

These are microcontrollers designed by ATMEL with modified Harvard architecture. Some of the variants of AVR used nowadays are:[4]

- Tiny AVR – ATtiny Series
    16KB Program Memory
    6-32 Pin package
    Limited peripheral set

- Mega AVR –ATmega
    512KB Program Memory
    28-100 Pin package
    Extended instruction set (multiply instructions and instructions for handling larger program memories)
    Extensive peripheral set

- XMEGA AVR –ATxmega
    16-384 KB Program Memory
    44-64-100 Pin package
    Extensive peripheral set with ADCs

- Application specific AVR
    512KB Program Memory
    28-100 Pin package
    LCD Controller
    USB Controller
    Advanced PWM
    CAN

- FPSLIC - (AVR with FPGA)
    FPGA 5K to 40K gates
    SRAM for the AVR program code, unlike all other AVRs
    AVR core can run at up to 50 MHz

- 32 bit AVR
    This includesDSP and SIMD instructions, along with other video and audio processing features. This 32-bit family of devices is projectedto compete with the ARM based processors. It is not compatible with the original AVR or any of the various ARM cores, but the instruction set is similar to other RISC cores.

### 3. PIC (Peripheral Interface Controller)

The first generation of PICs with EPROM storage is almost totally replaced by chips with Flash memory. Similarly, theoriginal 12-bit instruction set of the PIC1650 and its direct descendants has been old-fashioned by 14-bit and 16-bit instructionsets.Microchip still trades OTP (one-time-programmable) and windowed (UV-erasable) versions of some of its EPROM based PICs for volume orders or legacy support.

- Baseline core devices (12 bit)
    These are characterized by the PIC10 series, as well as by some PIC16 and PIC12 devices.
        12-bit wide code memory
        32-byte register file
        Twotinylevel deep call stack
        6-pin to 40-pin packages

- ELAN Microelectronics clones (13 bit)
    ELAN Microelectronics Corp. makes a series of PICmicro-like microcontrollers with a 13-bit instruction word. The instructions are limited to a 6-bit register address and a 10-bit (1024 word) program space, but mostly compatible with the mid-range 14-bit instruction set.

- Mid-range core devices (14 bit)
  The mid-range core is presented in the majority of devices labeled PIC16 and PIC12.
  14-bit wide code memory
  Improved 8 level deep call stack
  Instruction set differs very slightlyfrom the baseline devices
  2 additional op-code bits allow 128 registers
  2048 words of code to be addressed directly
  Two additional 8-bit literal instructionsadd and subtract.

- Enhanced mid-range core devices (14 bit)
  These devices introduce additional reset methods, deeper hardware stack, 'C' programming language optimizations and 14 additional instructions.

- PIC17 high end core devices (16 bit)
  The 17 series never became popular and has been superseded by the PIC18 architecture.
  Memory mapped accumulator
  Read access to code memory
  Direct register to register moves External program memory interface
  8-bit × 8-bit hardware multiplier
  Second indirect register pair
  Auto-increment/decrement

- PIC18 high end core devices (16 bit)
  Call stack is 21 bits wide and considerably deeper
  Call stack may be written and readconditional branch instructions
  Indexed addressing mode
  Extending the FSR registers to 12 bits
  Addition of another FSR register

- dsPIC16 and PIC 24-bit microcontrollers
  Hardware MAC (multiply–accumulate)
  Barrel shifting
  Bit reversal
  (16×16)-bit single-cycle multiplication and other DSP operations
  Hardware divide assist (19 cycles for 16/32-bit divide)
  Hardware support for loop indexing
  Direct memory access

- PIC32 32-bit microcontrollers
  The highest execution speed 80 MIPS Flash memory: 512 kByte
  One instruction/clock cycle execution
  First cached processor
  Allows execution from RAM
  Full Speed Host/Dual Role
  OTG USB capabilities

Full JTAG
2-wire programming and debuggingReal-time trace

### 4. Arduino

It is a single-board microcontroller, proposed to make the application of interactive objects or environments more manageable. The hardware consists of an open-source hardware board designed around a 32-bit Atmel ARM or an 8-bit Atmel AVR microcontroller. Current models an 8-bit Atmel AVR microcontroller, a USB interface, as well as 14 digital I/O pins which allow the user to attach numerous extension boards. [3]

Various processors for different fields are also available in the market,

- DSP Processors
- Media Processor
- Graphic Processor Unit
- Application Specific Instruction Processors (ASIPs)
- Multiprocessor Systems using GPPs
- Customizable Processors
- System-on-a-Chip (SoC)

### IV. FURTHER ENHANCEMENT

The requirement of embedded processors are grooving rapidly due to its use in our day today life. Thus a lot of variants of microprocessors and microcontrollers are so frequently available. Some of embedded processors further enhancements are: VLIW processors which consist of features like multiple issue machines and Scheduling done by the compiler, Customized Processors which allows more cost effective design as we now pick, Instruction Compaction with Thumb is good, but we need to do better as more and more functionality moves to software.Pipeline lengths are starting to get very long and Intel's XScale has branch prediction tables with an estimated growth on Embedded Processors.

### V. CONCLUSION

Embedded Processors are available with the ease of use. Now many Embedded Software's are also available, which make easier to work on it. The uses of microcontrollers or microprocessors are expanding very fast all over the World. Thus we conclude that a lot of variants and different processors for many different fields will take their place in the upcoming phase.

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