Embedded System: The Brain Of Electronic Based Systems

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ABSTRACT-Embedded Systems is simply the brain of most electronics based systems to access, process, store and control the data. Few simple electronics circuits can be intelligently hardware designed without a microprocessor or microcontroller but is not worth the economics except for simple passive operations. So it’s a silicon brain, which the engineers named as “microcontroller”. Embedded systems are used in many critical applications of our daily life. The increased complexity of embedded systems and the tightened safety regulations posed on them and the scope of the environment in which they operate, are driving the need of more dependable embedded systems. Therefore, achieving a high level of quality and dependability to embedded systems is an ultimate goal. But very few people are aware of the term “Embedded system”. So, this paper deals with showing the importance of embedded systems, its application areas and its internal architecture.

Keywords- Microprocessor, Bread Machine, Digital Signal Processors, Anti-Lock Braking System (ABS), Electronic Stability Control (ESC/ESP), Traction Control (TCS)

1.INTRODUCTION

There are at about eight microprocessor (a piece of silicon chip)-based devices for every person. You will wonder how this could be. Is it really that many computers surrounds us? Let’s think about it and start making a list of the things we use that contains a microprocessor. And certainly all of your list will contain these ten items: television, stereo, coffee maker, alarm clock, VCR, microwave, washing machine, remote control, bread machine, and digital watch and may be many more.

Almost every household has one, and tens of millions of them are used every day, but very few people realize that a processor and software are involved in their daily life.

“An embedded system is a component within some larger system. For example, modern cars and trucks contain many embedded systems. One embedded system controls the anti-lock brakes, another monitors and controls the vehicle's emissions, and a third displays information on the dashboard”

Embedded systems are controlled by one or more main processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task. They may require very powerful processors and extensive communication, for example air traffic control systems.

Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.
2. VARIOUS APPLICATION AREAS

Embedded systems span all aspects of modern life and there are many examples of their use.

- **Telecommunications systems** employ numerous embedded systems from telephone switches for the network to mobile phones at the end-user. Computer networking uses dedicated routers and network bridges to route data.

- **Consumer electronics** include mp3 players, mobile phones, videogame consoles, digital cameras, DVD players and printers etc. Many household appliances, such as microwave ovens, washing machines and dishwashers, are also including embedded systems. Advanced HVAC systems use networked thermostats to more accurately and efficiently control temperature that can change by time of day and season. Home automation uses wired- and wireless-networking that can be used to control lights, climate, security, audio/visual, surveillance, etc., all of which use embedded devices for sensing and controlling.

- **Transportation systems** from flight to automobiles increasingly use embedded systems. New airplanes contain advanced avionics such as inertial guidance systems and GPS receivers that also have considerable safety requirements. Various electric motors — brushless DC motors, induction motors and DC motors — are using electric/electronic motor controllers. Automobiles, electric vehicles, and hybrid vehicles are increasingly using embedded systems to maximize efficiency and reduce pollution. Other automotive safety systems include anti-lock braking system (ABS), Electronic Stability Control (ESC/ESP), traction control (TCS) and automatic four-wheel drive.

- **Medical equipment** is continuing to advance with more embedded systems for vital signs monitoring, electronic stethoscopes for amplifying sounds, and various medical imaging (PET, SPECT, CT, MRI) for non-invasive internal inspections.

3. FEATURES

- Embedded systems do a very specific task, they cannot be programmed to do different things. Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time. In some embedded systems, called real-time systems, the deadlines are important. Missing a deadline may cause a catastrophe i.e. loss of life or damage to property.

- Embedded systems are constrained for power, as many embedded systems operate through a battery, the power consumption has to be very low. Embedded systems need to be highly reliable. Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

- Embedded systems that address the consumer market (for example electronic toys) are very cost-effective. Even a reduction of Rs.10 is lot of cost saving, because thousands or millions systems may be sold. Unlike desktop computers in which the hardware platform is dominated by Intel and the operating system is dominated by Microsoft, there is a wide variety of processors and operating systems for the embedded systems. So, choosing the right platform is the most complex task.

4. COMPONENTS OF EMBEDDED SYSTEM

An embedded system has three main components:

1. **Hardware**
   - Power Supply
   - Processor
   - Memory
   - Timers
   - Serial communication ports
   - Input/Output circuits
o System application specific circuits

o **Software**: The application software is required to perform the series of tasks.

An embedded system has software designed to keep in view of three constraints:

o Availability of System Memory

o Availability of processor speed

o The need to limit power dissipation when running the system continuously in cycles of wait for events, run, stop and wake up.

2. **Real Time Operating System (RTOS)**: It supervises the application software and provides a mechanism to let the processor run a process as per scheduling and do the switching from one process (task) to another process.

5. **INTERACTION WITH THE OUTSIDE WORLD**

Embedded designers are concerned with choosing the right processors, OSs, development environments, and I/O for their applications. Their objective is to meet their application specifications while striking a balance with system size, cost, and time to market. They incur costs, which are very much volume-driven, in development, time to market, and system components, which includes hardware and software costs.

Embedded Systems talk with the outside world via peripherals as shown below:

6. **PROGRAMMING BEHIND THE EMBEDDED SYSTEM**

Assembly language was the pioneer for programming embedded systems till recently. Nowadays there are many more languages to program these systems. Some of the languages are C, C++, Ada, Forth, and Java together with its new enhancement J2ME. The presence of tools to model the software in UML, SDL is sufficient to indicate the maturity of embedded software programming. The majority of software for embedded systems is still done in C language. Recent survey indicates that approximately 45% of the embedded software is still being done in C language. C++ is also increasing its presence in embedded systems. As C++ is based on C language, thus providing programmer the object oriented methodologies to reap the benefits of such an approach.

**CONCLUSION**

From an implementation viewpoint, there is a major difference between a computer and an embedded system. Embedded systems are often required to provide Real-Time response. A Real-Time system is defined as a system whose correctness depends on the timeliness of its response. Examples of such systems are flight control systems of an aircraft, sensor systems in nuclear reactors and power plants. For these systems, delay in response can cause a huge problem. A more relaxed version of Real-Time Systems is the one where timely response with small delays is acceptable. Example of such a system would be the Scheduling Display System on the railway platforms. Hence embedded systems are playing important roles in our day-today lives, even though they might not necessarily be visible. Some of the embedded
systems we use every day control the menu system on television, the timer in a microwave oven, a cellphone an MP3 player or any other device with some amount of intelligence built-in. Embedded systems is a rapidly growing industry where growth opportunities are numerous. Lastly, the future of embedded lies in how faster people adapt to the changes offered by convergence – communications, manufacturing and develop “super” applications that advance the society and human needs, let’s hope that our future is also embedded into it.

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