AN INTRODUCTION TO EMBEDDED SYSTEMS

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We are living in the age of information revolution, with computers of astonishing power available for our use. Computers find their way into every realm of activity. Some are developed to be as powerful as possible, without concern for price, for high-powered applications in industry and research. Others are designed for the home and office, less powerful but also less costly. Another category of computer is little recognized, partly because it is little seen. This is the type of computer that is designed into a product, in order to provide its control. The computer is hidden from view, such that the user often doesn't know it's even there. This sort of product is called an embedded system and those little computers we generally call microcontrollers.

1.0 What is an Embedded System?

The basic idea of an Embedded System is a simple one. If we take any engineering product that needs control, and if a computer is incorporated within that product to undertake the control, then we have an embedded system. An embedded system can be defined as: A system whose principal function is not computational, but which is controlled by a computer embedded within it.

These days embedded systems are everywhere, appearing in the home, office, factory, car or hospital. Table 1 lists some example products that are likely to be Embedded Systems, all chosen for their familiarity. While many of these examples seem very different from each other, they all draw on the same principles as far as their characteristics as an embedded system are concerned. The vast majority of users will not recognize that what they are using is controlled by one or more embedded computers. Indeed, if they ever saw the controlling computer they would barely recognize it as such. Most people, after all, recognize computers by their screen, keyboard and disc drives and so on. This embedded computer would have none of those.

Home	Office and commerce	Motor car
Washing machine	Photocopier	Door mechanism
Fridge	Printer	Engine control
Microwave oven	Scanner	Brake control

Table 1 - Some familiar examples of embedded systems

2.0 Some essentials of an Embedded System

When designing Embedded Systems we usually need to understand in some detail the features of the embedded computer (microcontroller) that we are working with. This is quite unlike working with a desktop computer used for word processing or computer-aided design, where the internal workings are skillfully hidden from the user. As a preliminary to developing an Embedded System we should have to consider about the major parts of an Embedded System. For clear understanding let us consider a simple example system that we use daily in our homes, a domestic refrigerator.

A simple domestic refrigerator is shown in Figure 1. It needs to maintain a moderately stable, low temperature Within it. It does this by sensing its internal temperature and comparing that with the temperature required. It lowers the temperature by switching on a compressor. The temperature measurement requires one or more sensors, and then whatever signal conditioning and data acquisition circuitry that is needed. Some sort of data processing is required to compare the signal representing the measured temperature to that representing the required temperature and deduce an output. Controlling the compressor requires some form of electronic interface, which accepts a low-level input control signal and then converts this to the electrical drive necessary to switch the compressor power.

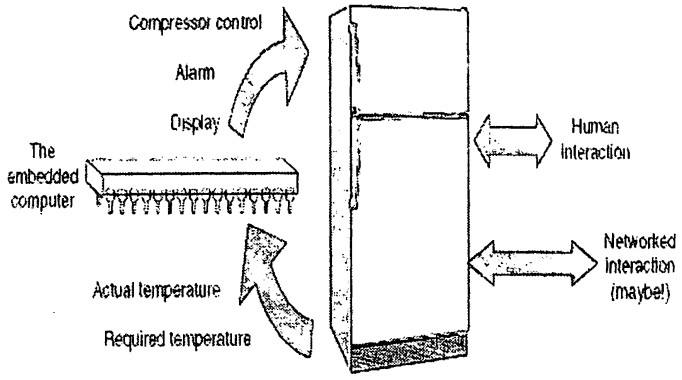

Figure 1 - A domestic refrigerator

This process of control can be done by a conventional electronic circuit or it can be done by a small Embedded System. If used, the Embedded System could be designed simply to replicate the minimalist control process described above. Once a little computer is in place, however, there is tremendous opportunity for added value. With the signal in digital form and processing power now readily available, it is an easy step to add features like intelligent displays, more advanced control features, a better user control mechanism and so on.

Taking the idea of added value one step further, once an Embedded Computer is in place it is possible to network it to other computers, embedded or otherwise. This opens up big new horizons, allowing a small system to become a subset of a much larger system and to share information with that system. This is now happening with domestic products, like the refrigerator, as well as much more complex items. The diagram of Figure 1, while specific for a fridge, actually represents very well the overall concept of an Embedded System. There is an embedded computer, engaged in reading internal variables, and outputting signals to control the performance of the system. It may have human interaction (but in general terms does not have to) and it may have networked interaction. Generally, the user has no idea that there's a computer inside the fridge!

In more general way we can divide any Embedded System in to following parts.

1.Sensors (or Input Devices)
2.A Control computer (or Microcontroller)
3.Some indicating units such as displays, alarms etc. (or Output Devices)

2.1 Sensors

Sensors are playing major role in any embedded system. They are responsible for data acquisition of the system. In above example Temperature sensors, Door sensors, Voltage level sensors are used to acquire data that need to control the overall process.

2.2 A Control computer

This unit is the heart and the brain of any Embedded System. Control computer is totally responsible for acquire loss-less data from sensors and other input devices and take the necessary dictions about controlling its output devices according to the instructions given to it. According to above example system, temperature controllers, automatic door closing motor controlling unit, power stabilizer are the output devices.

2.2.1 Microprocessors vs. Microcontrollers

Microprocessors were amazing devices, which for the first time put a computer CPU onto a single IC. For the first time, significant processing power was available at rather low cost, in comparatively small space. At first, all other functions, like memory and input/output interfacing, were outside the microprocessor, and a working system still had to be made of a good number of ICs

While people quickly recognized and exploited the computing power of the microprocessor, they also saw another use for them, and that was in control. Designers started putting microprocessors into all sorts of products that had nothing to do with computing, like the fridge or the car door that we have just seen. Here the need was not necessarily for high computational power, or huge quantities of memory, or very high speed. A special category of microprocessor emerged that was intended for control activities, not for crunching big numbers. After a while this type of microprocessor gained an identity of its own, and became called a microcontroller. The microcontroller took over the role of the embedded computer in embedded systems.

2.3 Some indicating units

As mentioned above example, temperature controllers, automatic door closing motor controlling unit, power stabilizer are the output devices or devices controlled by the Control computer. Also there are some other units or devices use to give more flexibility to the system. They are called "user interface devices" such as LCD displays, alarms etc. Above example LCD panel or 7-segment display panel is use for visualizing the temperature for users and an alarm indicates that if door is not properly closed.