**Embedded Systems**

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**Introduction**

Engineering is the STEM field addressed in this essay. Specifically, the field of embedded systems. The term embedded refers to something which is implanted within another. Consequently, embedded systems are designed to carry out specific tasks and are usually microprocessors or microcontrollers. Good examples are alarm systems which only detect smoke and nothing else, fingerprint sensors, and object detection systems. Embedded systems are often characterized by traits such as the presence of hardware such as chips and the integration of software (usually used to program the hardware). Real-time operation (RTOS), though optional, is also a component of some large-scale embedded systems. Generally, an embedded system can be referred to as software-based, microcontroller-integrated, efficient, and timely system.

**General Characteristics of Embedded Systems**

* **Functionality**

Embedded systems carry out one function at a time efficiently. As such, a smoke alarm system can never be used for object detection.

* **Size**

For the utilization of space efficiently, embedded systems are designed to occupy the least space possible. This makes embedded systems come in handy when the desired output is to be lightweight.

* **Performance**

Embedded systems have high performance. This is often due to their ability to store data of large sizes and process them; all while occupying a small space and providing continuous outputs.

* **Real-time**

A majority of embedded systems are continuous in the detection of certain things such as smoke. Their real-time nature enables them to minimize the delay witnessed detection. For instance, GPS systems output geographical location data continuously and changes as per the consumer’s movement from one place to another.

* **Memory**

Embedded systems have memory (volatile or non-volatile) and are capable of storing the programs embedded in them.

* **Hardware System**

The hardware facilitates the connection of external devices. These devices may be inputs, for instance sensors and keypads; and outputs such as solenoids, motors, and displays. At the center of it all lies the microcontroller or microprocessor. Microcontrollers are devices that have the CPU, serial ports, memory, input and output ports, interrupt control systems, and many others on a single chip.

Microprocessors, on the other hand, have all these features but have additional chips or components to supplement some of these features; making them larger. They are often used in personal computers due to their ability to be upgraded easily in case of failure. A good example is the RAM chip being replaced do as to boost laptop performance. For embedded systems, microcontrollers are preferred so as to make economical products even though microprocessors are more powerful.

**Advantages of using microcontrollers in embedded systems**

1. They are self-sufficient since they have all necessary features on one chip.
2. Once programmed, microcontrollers can only carry out one task at a time.
3. They are power-saving devices since they do not consume a lot of power.
4. Microcontrollers are economical.

* **Software System**

The software plays the role of controlling the hardware while ensuring that the task allocated to the system is achieved and the efficiency is kept high.

**Embedded Systems Structure**

A majority of embedded systems have the structure above. The sensors and actuators are external devices. Once physical quantities such as temperature or pressure are detected by an embedded system, the sensor converts the measured quantities to current or voltage. Since microcontrollers only comprehend digital signals, A-D (analog to digital) converters, are necessary. Most microcontrollers have A-D converters. Embedded systems incorporate both flash (non-volatile) memory and volatile. Simply put, flash memory stores the program permanently and is not affected by the system rebooting or power outages. Their volatile counterparts erase instructions in case of any interruptions.

**Types of Memory Used in Embedded Systems**

Flash memory is the most common memory type used in embedded devices. They have the additional advantage of being reprogrammable a block at a time. A block is a combination of bytes. Flash memory is also economical and are useful in the storage of large firmware.

**Advantages of Embedded Systems**

* High speed performance in carrying out tasks since embedded systems have sufficient memory
* Less space is required due to their small size hence less bulky products are made
* Significantly lesser power is consumed
* Embedded systems are reliable and accurate
* Economical to purchase since the components used are usually locally available
* Embedded systems can be integrated with other technologies such as IoT and machine learning; thus, making it flexible.

**Disadvantage of Embedded Systems**

* When working with some microcontrollers, accurate data sheets may be difficult to come across, making the development process even more complex.

**Conclusion**

In a nutshell, embedded systems are at the heart of modern devices today. From washing machines to microwaves; all devices require these small devices to function. As such, learning embedded systems as an engineering field in STEM is necessary if one is to understand electronics truly. One should understand and appreciate how fascinating these tiny systems are, for in comprehending them comes great knowledge and wisdom in the field of electronics.