Introduction

System

A system is a way of working, organizing or doing one or many tasks according to a fixed plan, program, or set of rules. A system is also an arrangement in which all its units assemble and work together according to the plan or program.

Example: Watch; A Time Display System

Parts:

Hardware, Needles, Battery, Dial, Chassis and Strap.

Rules:

All needles move clockwise only.

A thin needle rotates every second.

A long needle rotates every minute.

A short needle rotates every hour.

All needles return to the original position after 12 hours.

Time Display

Embedded System

A general-purpose definition of embedded systems is that they are devices used to control, monitor or assist the operation of equipment, machinery etc.

Some other definitions include:

An embedded system is a system that has software embedded into computer-hardware, which makes a system dedicated for an application or specific part of an application or product or part of a larger system.

It is a dedicated computer based system for an application or product. It may be an independent system or a part of large system. Its software usually embeds into a ROM (Read Only Memory) or flash.

CYBER-PHYSICALSYSTEMS

A collaboration of computational and communication entities controlling physical entities and processes. Such systems bridge the cyber-world of computing and communications with the physical world.

This intimate coupling between the cyber and physical worlds is a key enabler for future technology developments. Opportunities and research challenges include the design and development of next-generation airplanes and space vehicles, hybrid gas-electric vehicles, fully autonomous urban driving, and prostheses that allow brain signals to control physical objects.

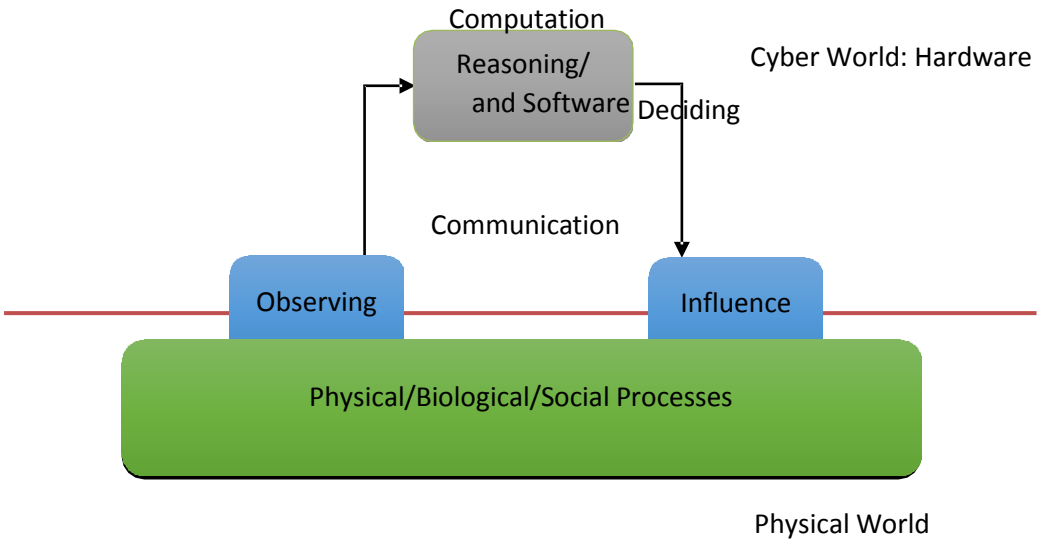

Figure 1: A Cyber-Physical System uses feedback to influence the dynamics of a Physical Process by taking decisions in the Cyber-World.

At the core of the cyber component is the communication network that includes sensor networks for communication between the sensors and computational units, and computational units and actuators for controlling the physical system. The computational units perform the computations for estimating the system state (e.g. location of a UAV and the direction of its movement) and generation of appropriate control signals for the actuators. The human-computer interfaces (HCIs) permit the humans to take overriding control decisions based on state estimates and thereby become a part of the CPS. The physical component of a CPS includes the entities that are closer to the physical system under observation e.g., sensors that take measurements related to the physical system dynamics (e.g. turbulence caused on the fuselage due to

wind), and the actuators that affect the physical system or its dynamics (e.g. balancing the UAV against the turbulence).

BASIC WORKING PRINCIPLE: EMBEDDED SYSTEM

Embedded systems are basically designed to regulate a physical variable (such as Temperature) or to manipulate the state of some devices by sending some signals to the **actuators** or devices connected to the output port system, in response to the input signal provided by the end users or **sensors** which are connected to the input ports.

An embedded system is generally supposed to provide a single functionality using a combination of 3 things:

1. Hardware
2. Software
3. Electro-Mechanical Components

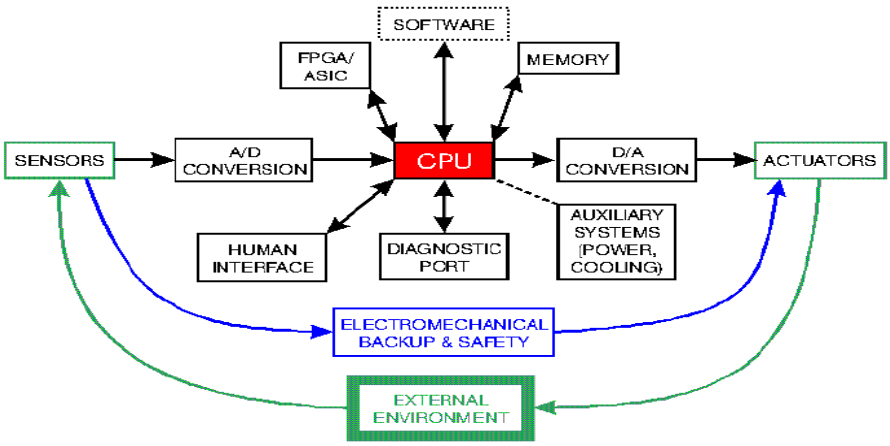

Figure: Implementation of Embedded System

EXAMPLE:

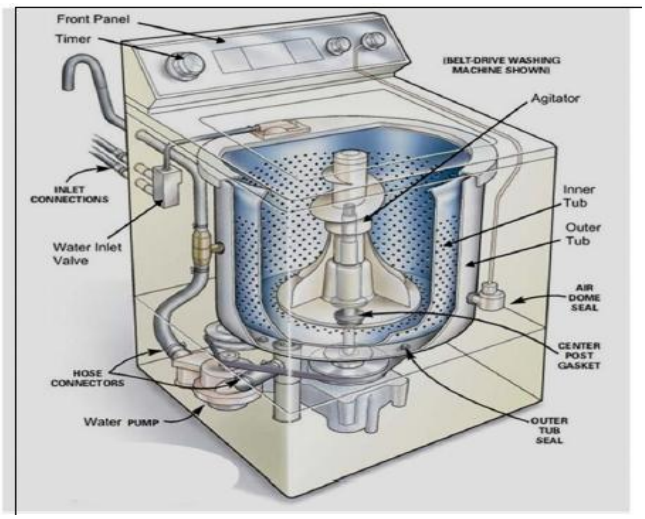

Fig: A Washing Machine

General purpose computer vs Embedded system

General purpose Computing	Embedded Computing
Combination of generic hardware and operating system for executing a variety of applications	Combination of special purpose hardware and embedded OS for executing a specific set of applications
Contains a general purpose operating system (GPOS)	May or may not contain an operating system for functioning
The software is alterable by the user and may also involve hardware expansions	The firmware of ES is pre-programmed and non-alterable by the user (except in certain cases where flashing or resetting may be supported)
Usually selected on the basis of performance. *Faster is better*	Usually selected on the basis of application-specific requirements (power requirements, memory usage, size, weight, latency)
Response requirements are not time critical	Certain embedded systems like mission critical systems aim to meet high response time
Need not be deterministic in execution behavior	Execution behavior is deterministic for certain types of embedded systems like 'Hard Real Time' systems