Embedded Systems

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Embedded Systems are Everywhere

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Missiles

Vacuum Cleaner

Access Control

Monitor

Keyboard

Headphone

Tablet

Camera

Ipod

Mobile

Printer

Gaming Console

Home Automation

From Big Aeroplane to Small Smartwatch

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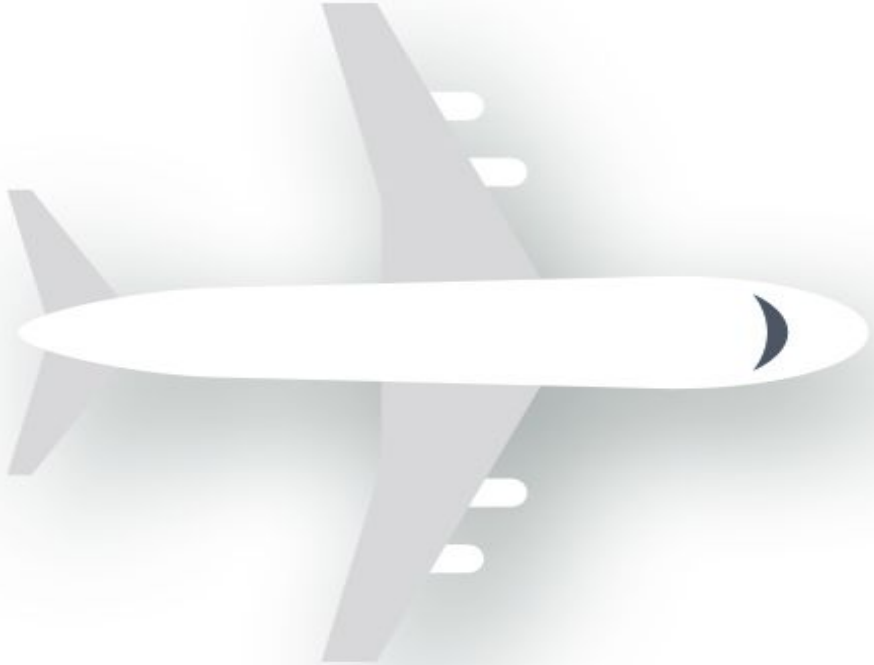

Aeroplane

Smart Watch

Then, What is Embedded System ?

Any sort of device which includes a programmable computer but itself is not intended to be a general purpose computer

- Marilyn Wolf

Computing systems are everywhere

Most of us think of "desktop" computers

- PC's
- Laptops
- Servers

But there's another type of computing system

- Far more common...

Embedded computing systems

- Computing systems embedded within electronic devices
- Hard to define. Nearly any computing system other than a desktop computer
- Billions of units produced yearly, versus millions of desktop units
- Perhaps 50 per household and per automobile

How many embedded systems we use ?

- **Average middle-class American home has 40 to 50 embedded processors in it**
  - Microwave, washer, dryer, dishwasher, TV, VCR, stereo, hair dryer, coffee maker, remote control, humidifier, heater, toys, etc.

- **Luxury cars have over 80 embedded processors**
  - Brakes, steering, windows, locks, ignition, dashboard displays, transmission, mirrors, etc.

- **Personal computers have over 10 embedded processors**
  - Graphics accelerator, mouse, keyboard, hard-drive, CD-ROM, bus interface, network card, etc.

Types of Embedded Systems

- **General Computing**
  - Applications similar to desktop computing e.g smart phones
  - Video games, set top boxes, wearable devices, ATM's
- **Control Systems**
  - Closed loop feedback control for real time system
  - Vehicle engine, electric power control & flight control systems
- **Signal Processing**
  - Computations involving large data
  - Image, music processing, Radar, video compression
- **Communication & Networking**
  - Telephone systems, GSM, CDMA devices
  - Computer networking devices. (Modem, Routers etc)
  - Internet

Embedded System (Block Diagram)

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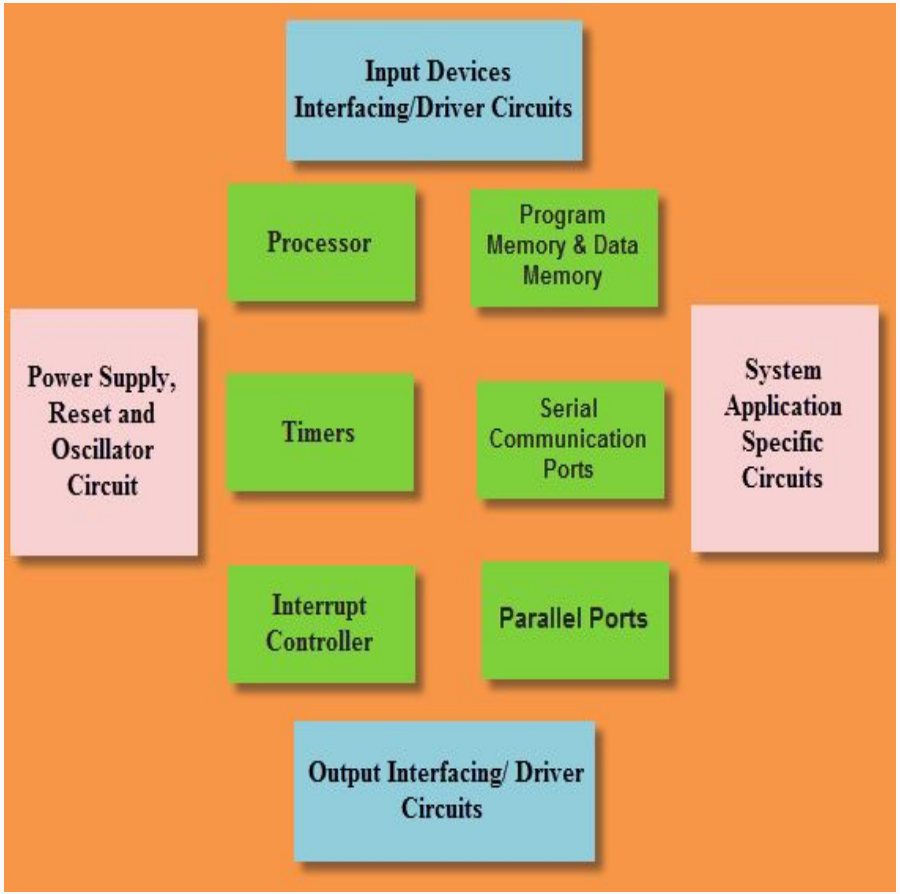

- Processor - Computational Unit / Brain
- Memory - Storage
- Input - Can be sensors, Keyboard etc.
- Output - Display / User Reporting

Embedded Systems building blocks

- Hardware - Electronics
- Software - Computational Logic

So, Embedded System is a combination of Hardware & Software

Task / Assignment

- Research for the 10 Embedded Systems which you use in your daily life
- Identify who are the manufacturers / companies of these embedded systems
- Visit these companies websites and understand their products
- List their contacts for your future job references.

Day 2

- Revision of Day 1 Assignment

Processors

Processor is a Brain of Electronics

1. Microprocessor
2. Microcontroller

1. Microprocessors for PCs

2. Embedded processors or Microcontrollers for embedded systems
    a. Often with lower clock speeds
    b. Integrated with memory and
    c. I/O devices e.g. A/D D/A PWM CAN
    d. Higher environmental specs

Common Characteristics of Embedded Systems

- Single-functioned
  - Executes a single program, repeatedly
- Tightly-constrained
  - Low cost, low power, small, fast, etc.
- Reactive and real-time
  - Continually reacts to changes in the system’s
- Environment
  - Must compute certain results in real-time without delay

Characteristics of Embedded Systems

- Application-specific functionality – specialized for one or one class of applications
- Deadline constrained operation – system may have to perform its function(s) within specific time periods to achieve successful results
- Resource challenged – systems typically are configured with a modest set of resources to meet the performance objectives
- Power efficient – many systems are battery-powered and must conserve power to maximize the usable life of the system.
- Form factor – many systems are lightweight and low volume to be used as components in host systems
- Manufacturable – usually small and inexpensive to manufacture based on the size and low complexity of the hardware.

Design Constraints of Embedded Systems

- Small Size, Low Weight
  - Handheld Electronics
- Low Power
  - Battery Powered
- Harsh Environment
  - Heat, Vibration, Shock
  - Power Fluctuations, Open in field
- Safety Critical Operation
  - Must Function Correctly
- Extreme Cost Sensitivity
  - Even small increase in cost, may add large amount as number of Unit increases

Basic Microcontroller Block Diagram

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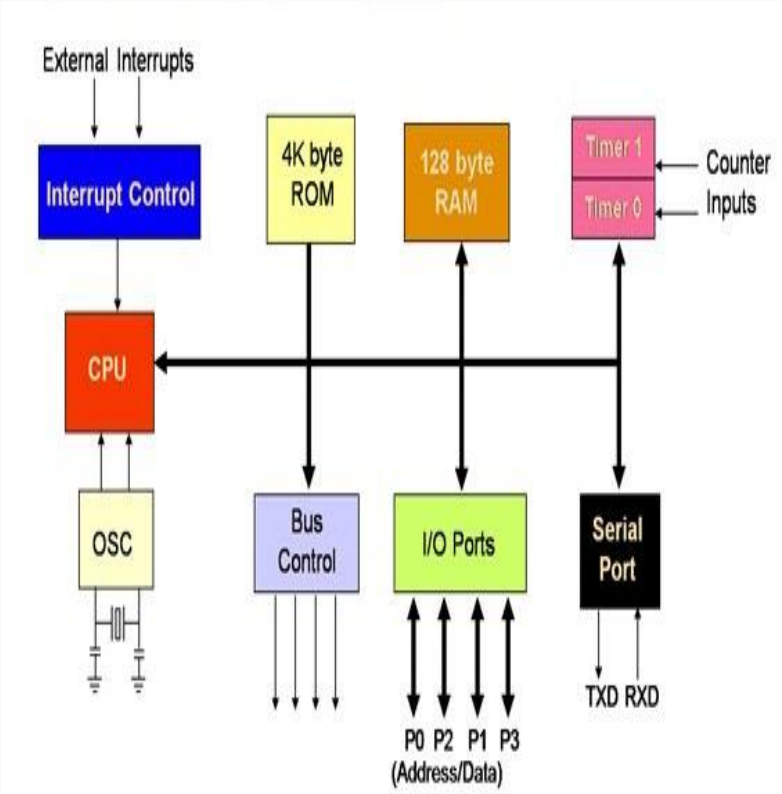

- Microcontroller
- ROM
- RAM
- I/O Controllers
- Timers
- Interrupt Controllers
- Serial Port

Advanced / Modern Microcontrollers

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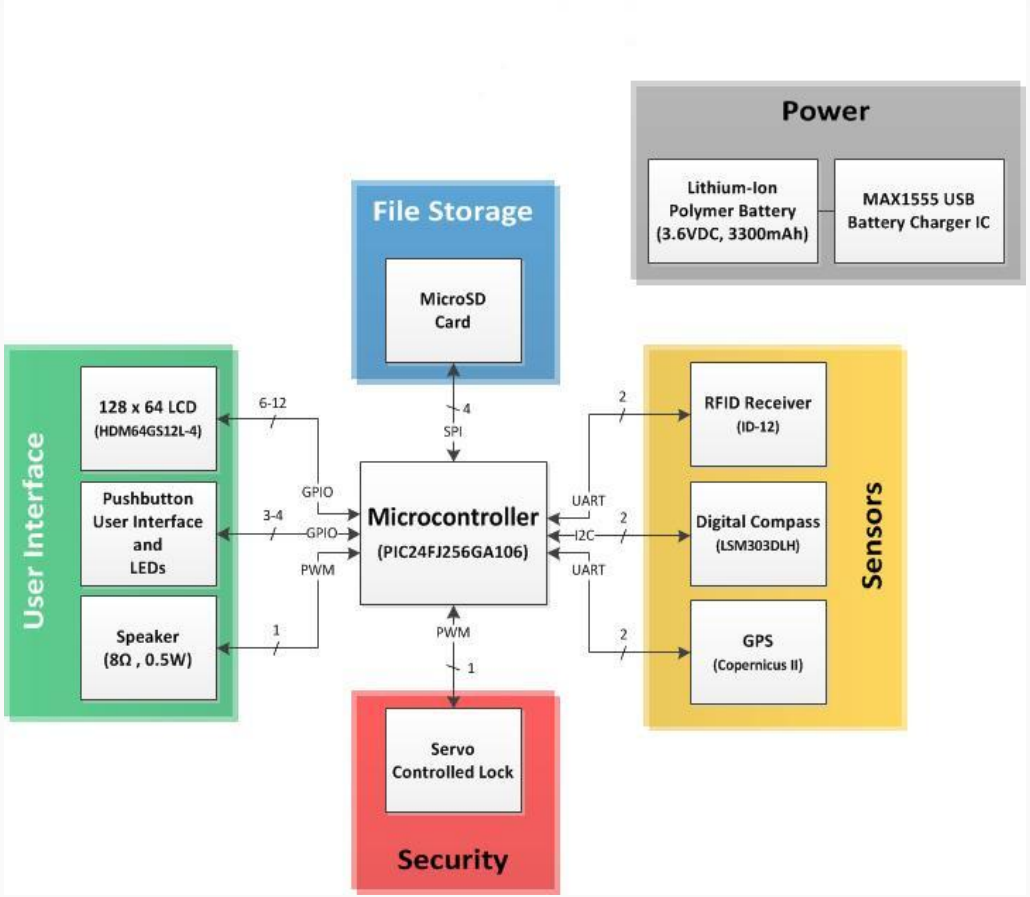
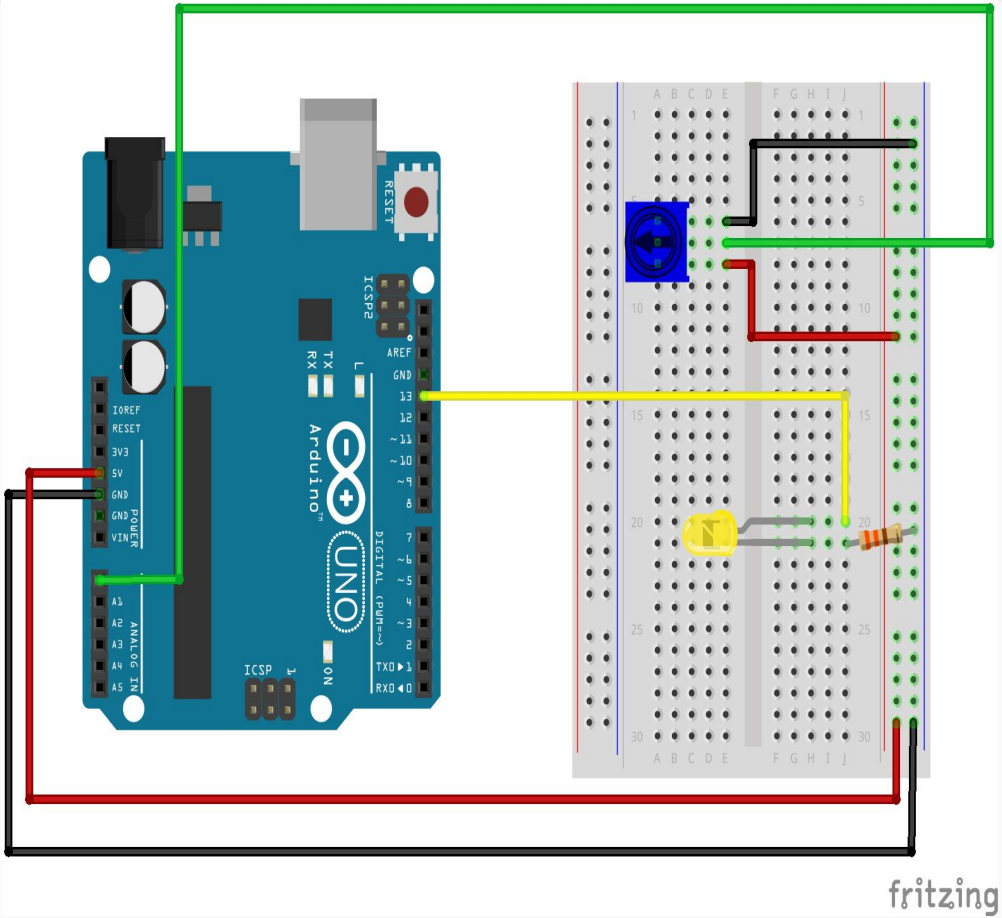


Apart from Basic features such as, ROM, RAM, I/O Controllers, Timers, Interrupts there are advanced features such as,

- Power Management
- User Interface
- Sensors
- File Storage
- Security Features

Simple Example of Microcontroller Use Case



Change the Intensity of LED according to reading from Variable resistor

- Value Resistor value feeds variable current as input to Analog Pin
- Output LED connected to Output Pin
- 5V supply and Ground is connected

Highly popular general purpose 8-bit microcontroller
Has a basic set of useful peripherals
Respectably low power consumption
Useful current drive strength (40mA @ 5V)
Great per-clock performance

Day 2 - Assignment

- Install Ubuntu
- Type commands
- Record Output of commands

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