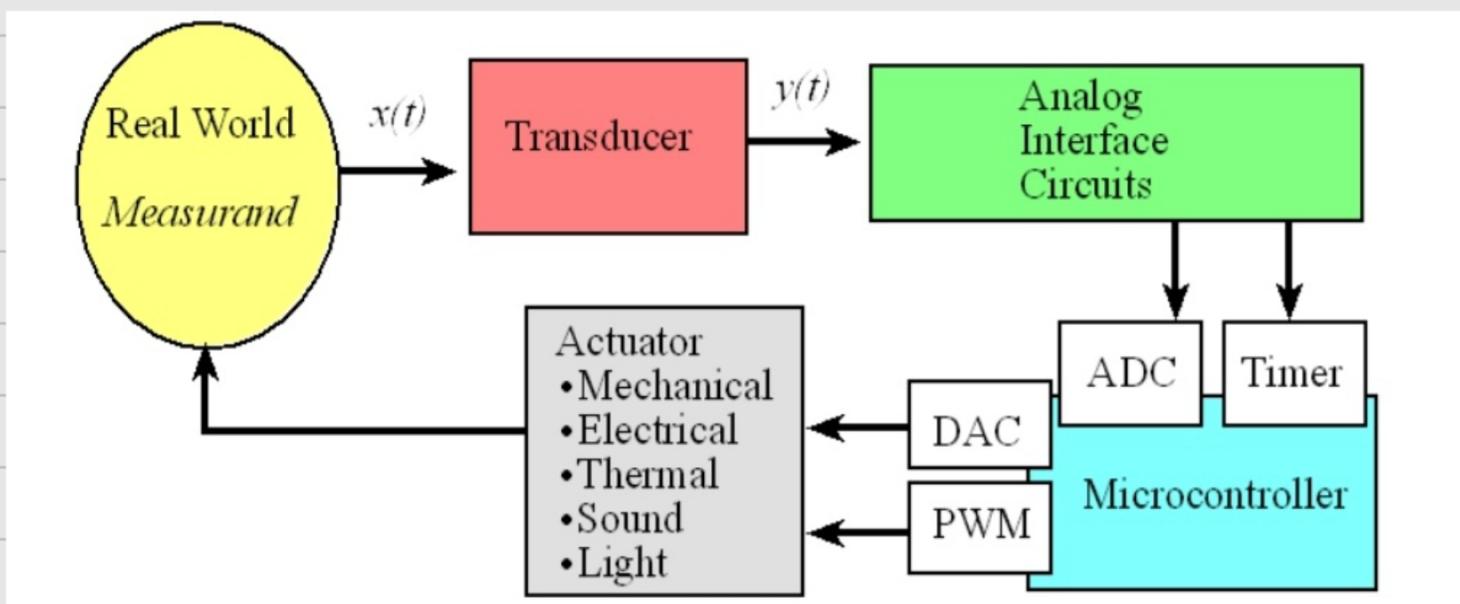


# Data Aquisition and control system:

measurand  $\rightarrow$  real world signal  
 $\rightarrow$  a quantity that need to be measure.

For example: Sound, distance, temperature.

Force, mass, pressure, flow, light and acceleration.



## Control System:-

control system uses an actuator to drive a measurand to real world to desire value.

## Data acquisition :-

Has no actuator because it simply measure the measurand in non-intrusive manner

considering the whole system collects data there are limitations while sampling data

i) Amplitude Resolution :-

→ smallest change in input that can be distinguishable.

ii) Amplitude Range:- ( $x_{\min} - x_{\max}$ )

→ No of distinct values from which measurement is select

For ex: If 12 bit precision

$$2^{12} = 4096 \text{ distinct values}$$

For slide pot to measure distance

if range = 0 to 1.5 cm

So, resolution

$$\frac{1.15}{4096} = 0.0004 \text{ cm}$$

iii) Time Quantization:

Time difference between two samples.

iv) Time Interval:

smallest to largest time we collect

Samples :

For ex; if we use 10Hz systic interrupt to sample ADC

Sampling rate  $f_s = 10\text{Hz}$

$$\text{Time quantization} = \frac{1}{10}\text{Hz} = 0.1\text{sec}$$

If we use memory buffer of 500 element

Time interval = 0 to 50 sec

① precision  $\frac{N}{x_{max} - x_{min}}$

For  $N-1$  differences  $= \frac{x_{max} - x_{min}}{dx+1}$

precision in n bits  $= \log_2 N$

② 12 bit ADC

store data in array of uint16-t

$f_s$  = Sampling rate

T = total time interval required to collect sample

$$\text{Total Needed Memory} = 2 * f_s * T$$

① 8 bit ADC

Store data in array of type uint16\_t  
 $f_s = 100 \text{ Hz}$

memory used = 20,000 of available  
32,768 bytes of RAM

$$T = ??$$

i.e How many second of data you can record ??

$$\Rightarrow \text{Memory Needed} = f_s * T$$

$$20000 = 100 T$$

$$T = \frac{20000}{100} = 200 \text{ sec.}$$

② 4 bit DAC used to play sound

$$f_s = 11 \text{ kHz}$$

you can pack two samples in one byte  
you allocate 128 kbytes of data  
of 256 kb of ROM to store data

T = ??

\* Sensors :

Measurand	sensor
Sound	Microphone
Pressure, mass, force	Strain gauge, Force sensitive register
Temperature	Thermistor, thermocouple, IC
Distance	Ultrasound, lasers, IR
Flow	Doppler ultrasound
Acceleration	Accelerometer
Light	Camera
Biopotentials	Silver-silver chloride electrode

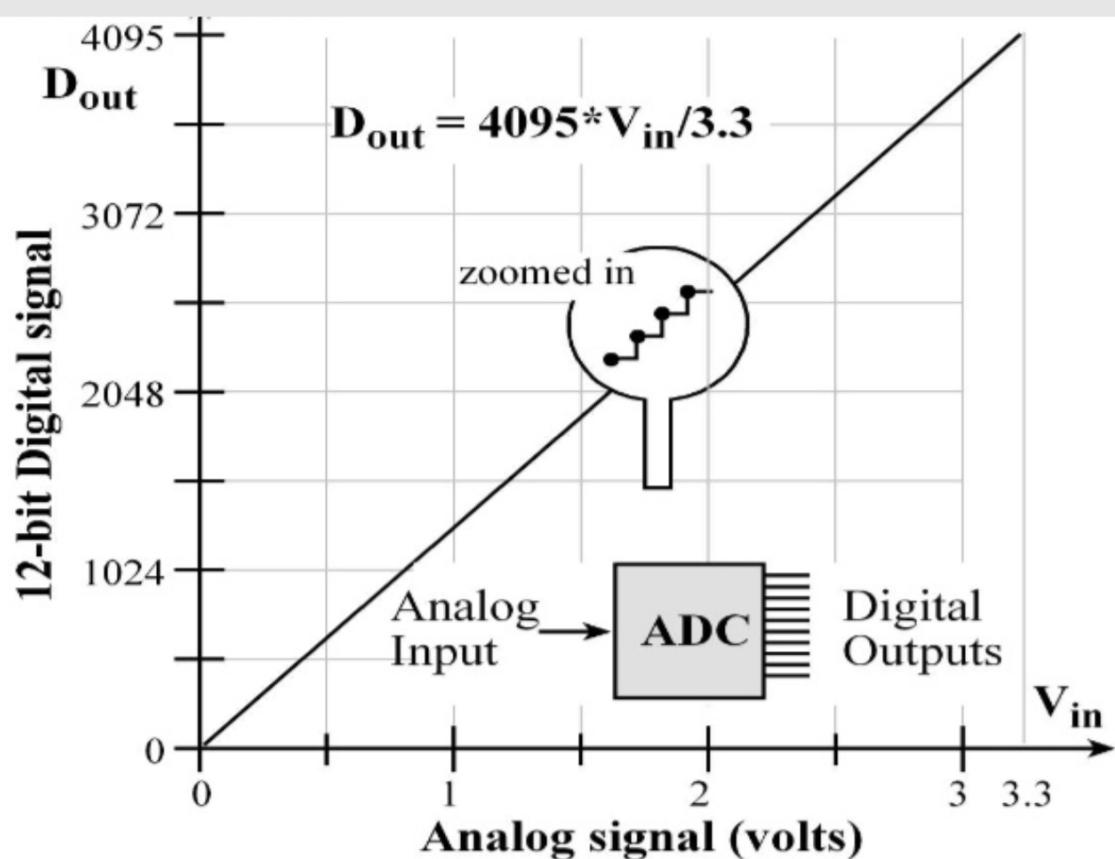
# Analog to Digital Converter :-

- Convert Analog signal to digital form
- Input - analog Voltage
- Output - binary numbers
- 12 bit ADC =  $2^{12} = 4096$

Voltage levels = 0 - 3.3V

$$\text{Resolution} = \frac{3.3V}{2^{12}-1} = \underline{0.81mV}$$

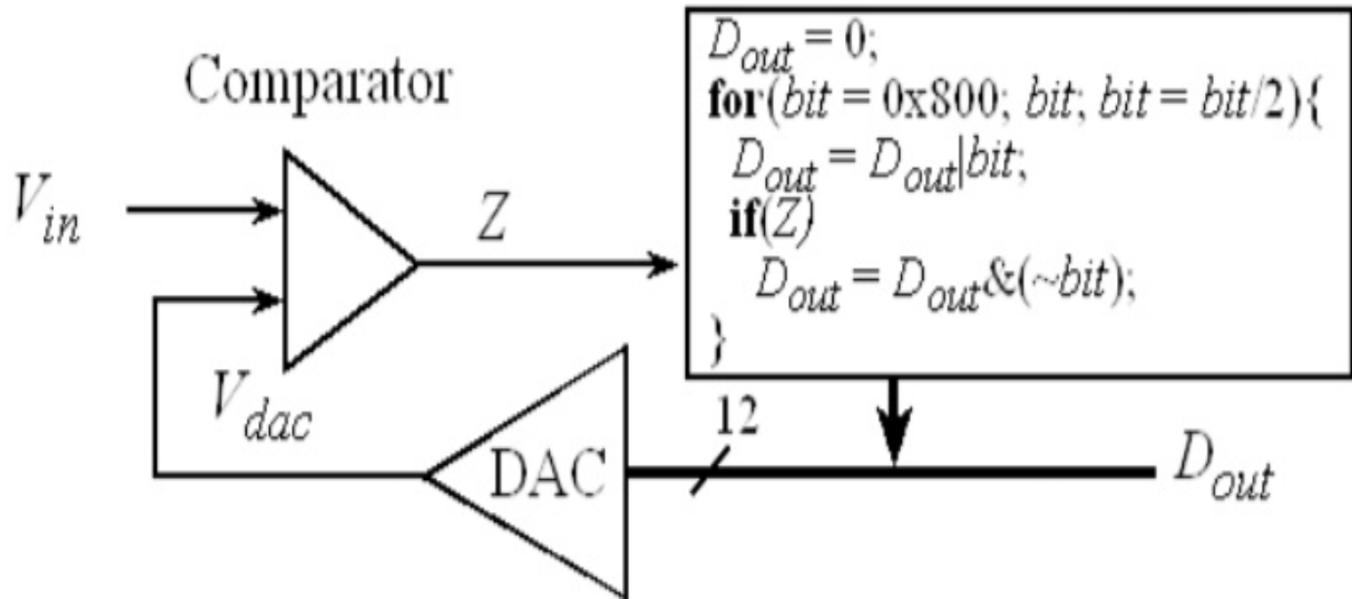
$$\rightarrow \text{Range} = \text{Precision} \cdot \text{Resolution} \quad (\text{Volts})$$



## ① Successive approximation:-

→ 12 bit successive approximation ADC  
will be clocked =

→ For each clock new guess =



→ bit under test = "1"

→ if  $V_{dac} > V_{in}$   
bit under test = 0  
else  
bit under test = 1