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INTRODUCTION TO ACCELEROMETERS AND USE OF IT IN ADVANCED EMBEDDED SYSTEMS COURSEWORK

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ACCLERATION FUNDAMENTALS:

- Acceleration is defined as time rate of change of velocity and is given as,

$$a = \frac{d}{dt}(v)$$

- Velocity is defined as time rate of change of distance and is given as,

$$v = \frac{d}{dt}(x)$$

Therefore, $$a = \frac{d}{dt^2}(x)^2$$

Units of acceleration:

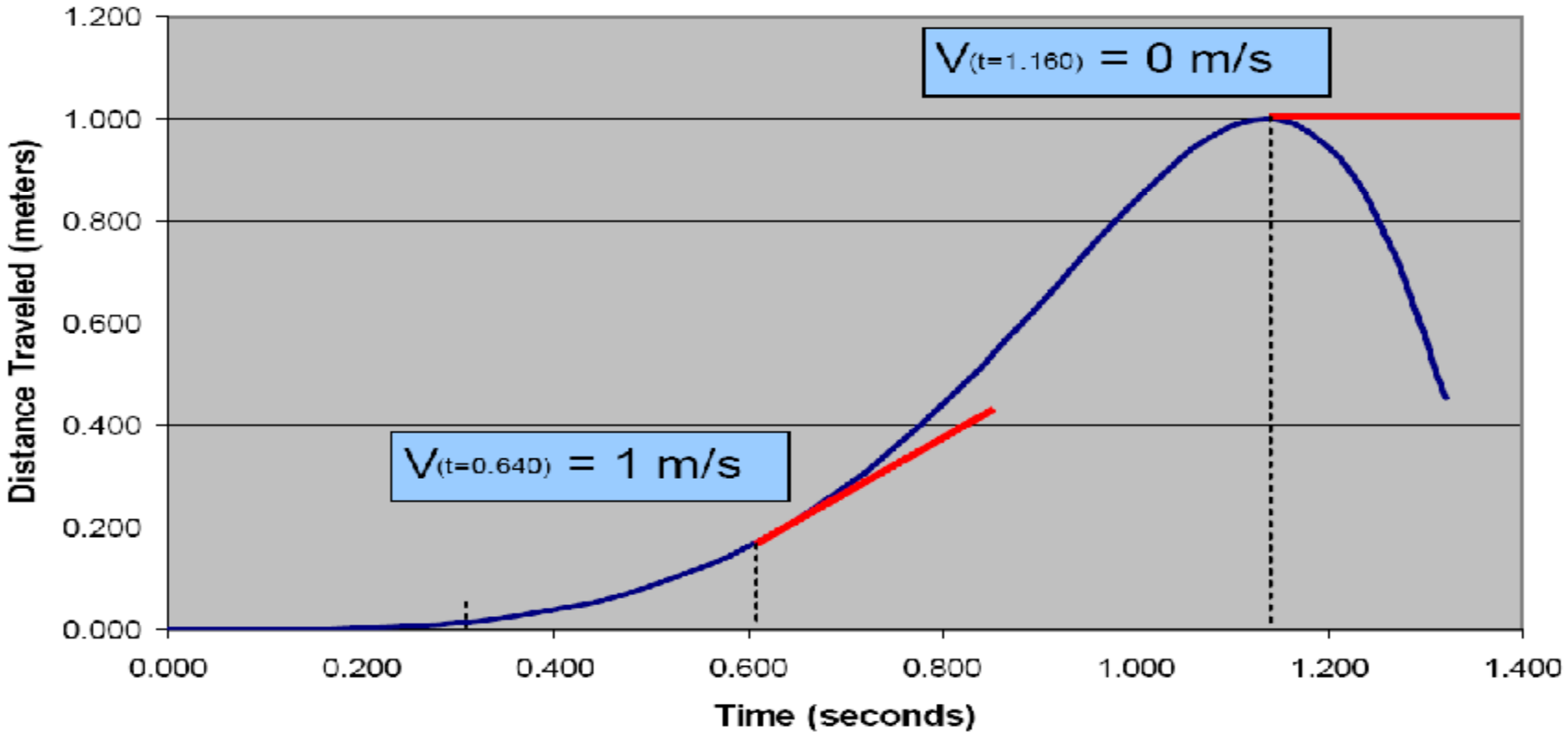
- Acceleration is measured in (ft/s)/s or (m/s)/s.

Importance of g:

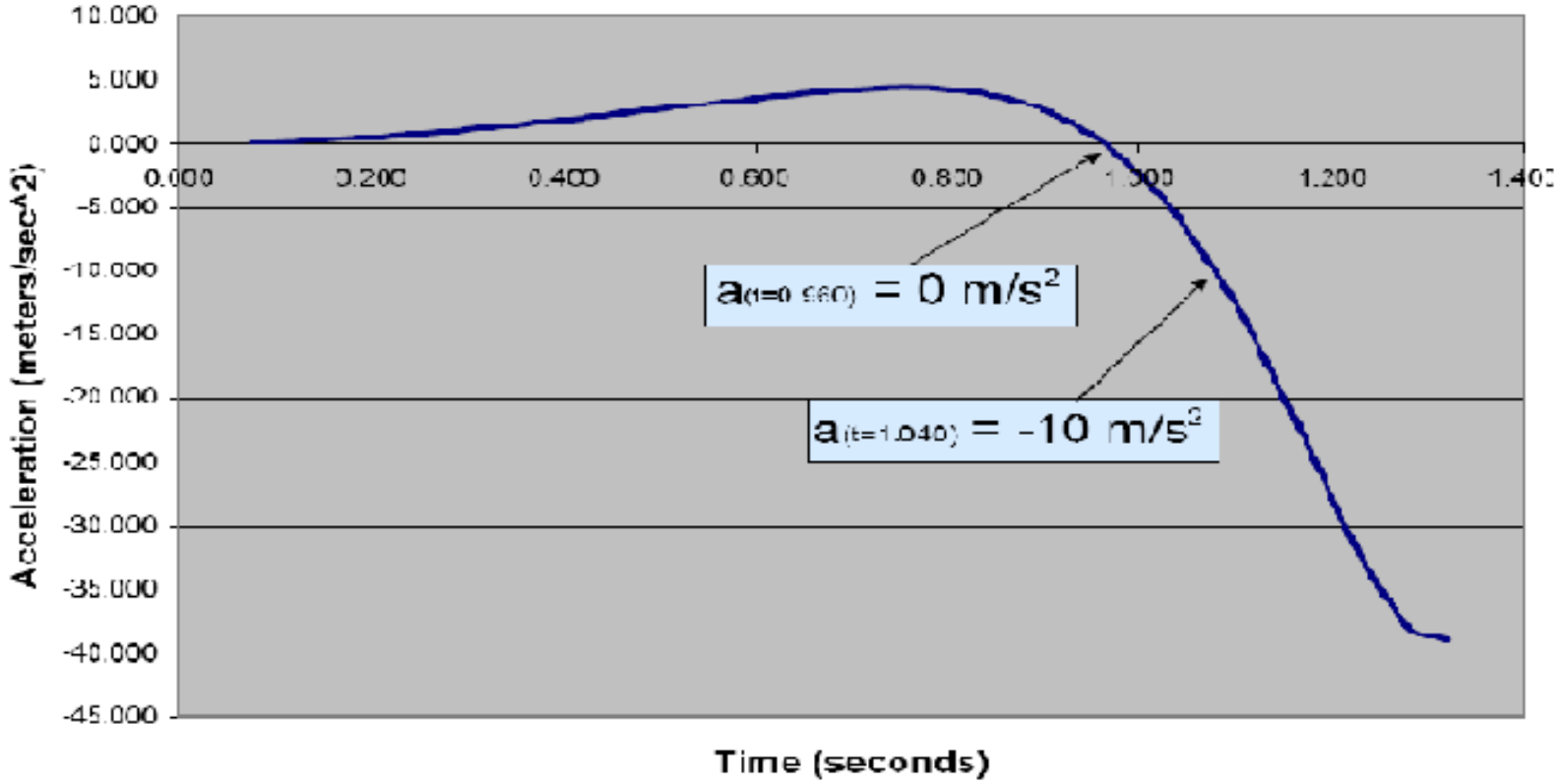
- “g” is a unit of acceleration equal to Earth’s gravity at sea level.
- “g” = 9.81 m/s^2

Graphical methods of measuring Acceleration:

- Acceleration is measured as slope of graph plotted as velocity VS time, at any given point on graph.



- Velocity is measured as slope of graph plotted as distance VS time, at any given point on graph.



Need for measuring acceleration:

- Measured acceleration is used as an Input into some control systems, to correct the changing dynamic conditions.

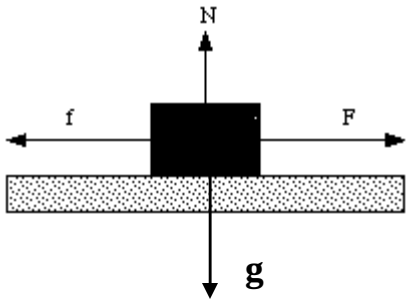
- Measuring amount of static acceleration to measure the tilt of any device.

- Measuring amount of dynamic acceleration, one can analyze the way a device is moving.

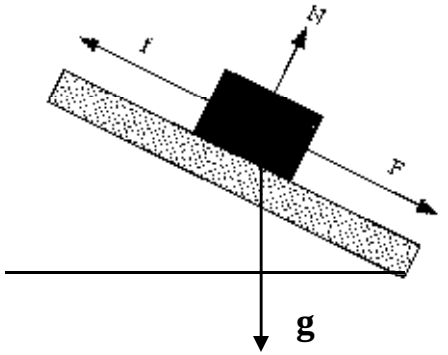
ACCELEROMETER:

Definition:

- Accelerometers are electro-mechanical devices that measure acceleration forces.
- Static: Constant force of gravity pulling at your feet.
  Dynamic: Caused due to motion or vibration of accelerometer.



a. Static acceleration



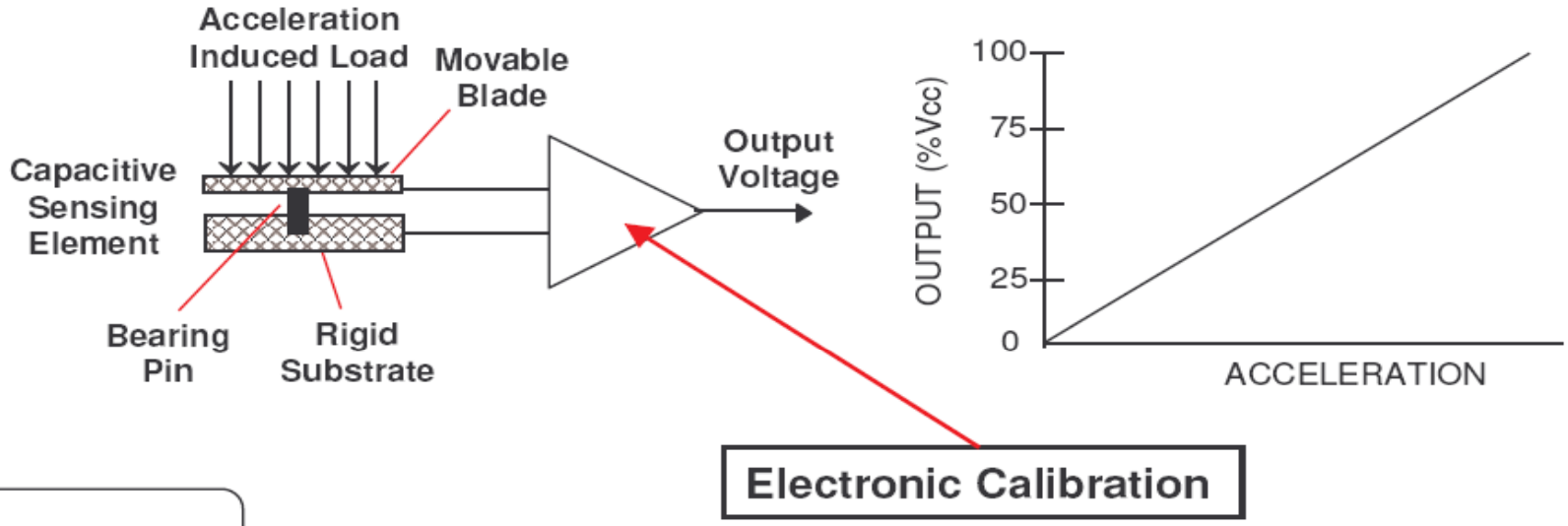
b. Dynamic acceleration

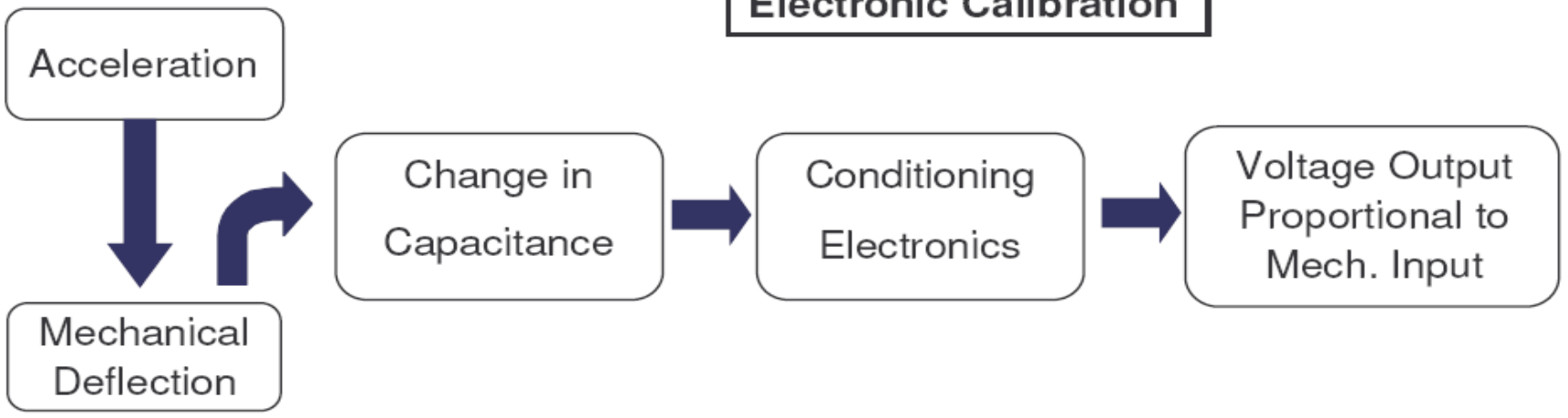
TYPES OF ACCELEROMETERS:

Sensor Category	Key Technologies
Capacitive	-Metal beam or micromachined feature produces capacitance; change in capacitance related to acceleration
Piezoelectric	-Piezoelectric crystal mounted to mass – voltage output converted to acceleration
Piezoresistive	-Beam or micromachined feature whose resistance changes with acceleration
Hall Effect	-Motion converted to electrical signal by sensing of changing magnetic fields
Magnetoresistive	-Material resistivity changes in presence of magnetic field
Heat Transfer	-Location of heated mass tracked during acceleration by sensing temperature

CAS - Capacitive Acceleration Sensor

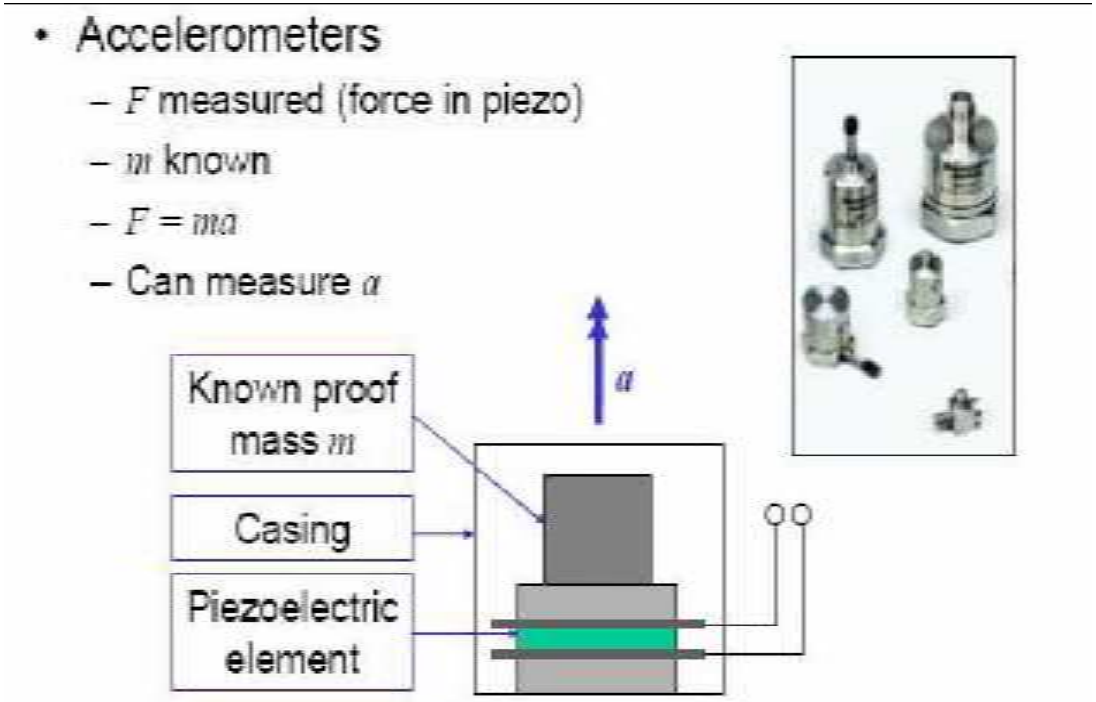
Conceptual Design

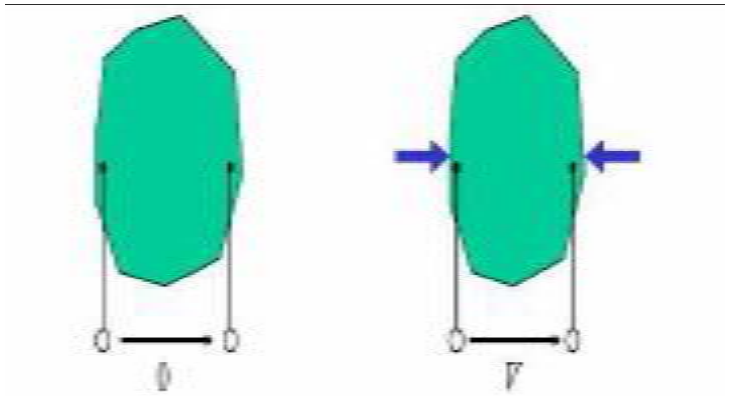




PIEZOELECTRIC SENSOR:

- Diagram:





Applications:

- Tilt / Roll
- Vibration / “Rough-road” detection:

  Can be used to isolate vibration of mechanical system from outside sources.
- Vehicle skid detection:

  Often used with systems that deploy “smart” braking to regain control of vehicle.
- Impact detection:

  To determine the severity of impact, or to log when an impact has occurred.
- Computer Security.

Use of Accelerometer for Advanced Embedded systems lab:

Reading the X and Y values and performing ADC

- **if(admux==0)** **//detect x movement**

```
{
 adst=1;
x_new=ad2;  // read x-coordinates from AN2 (port 10 pin 2)
if(x_new == x_previous)
        {
        x_input=0;
        }
 if(x_new > x_previous)
        {
        if((x_new -x_previous)>2)
                {
                x_input=5;
                 lcd_text1[2]='+';// detects the motion is upwards
         }
         }
 if(x_new < x_previous)
         {
         if((x_previous-x_new )>2)
                {
                x_input=5;
                lcd_text1[2]='-';// detetcs the motion is downwards   }
        }
```

Reading the X value (contd.):

```
x_previous=x_new;                          //Convert measured AN2 (x-coordinate) value for LCD.

IntToAsciiDec(lcd_text,4,x_input);         //Now write value to LCD  starting on the 1st position on line 1

 DisplayString( (char)(LCD_LINE1 ), lcd_text);
 lcd_text1[7]=0x20;
     lcd_text1[6]=lcd_text[3];
         lcd_text1[5]=lcd_text[2];
             lcd_text1[4]=lcd_text[1];
                 lcd_text1[3]=lcd_text[0] ;
                     lcd_text1[1]='=';
                         lcd_text1[0]='X';

                              for(i=0;i<7;i++)
                                     {
                                     if(!Q_Enqueue(&tx_q,lcd_text1[i])){}
                                                 while(!ti_u0c1);
                                                         u0tbl = Q_Dequeue(&tx_q);
                                     }//END for
                              admux=1;   // read for y-coordinate
                  }// END if admux
```

References:

- http://www.dimensionengineering.com/accelerometers.htm
- http://www2.usfirst.org/2005comp/Manuals/Acceler1.pdf
- http://www.analog.com/UploadedFiles/Data_Sheets/39398238692761ADXL311_a.pdf
- http://archives.sensorsmag.com/articles/0200/41/index.htm

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Questions: