

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

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

Units of acceleration:

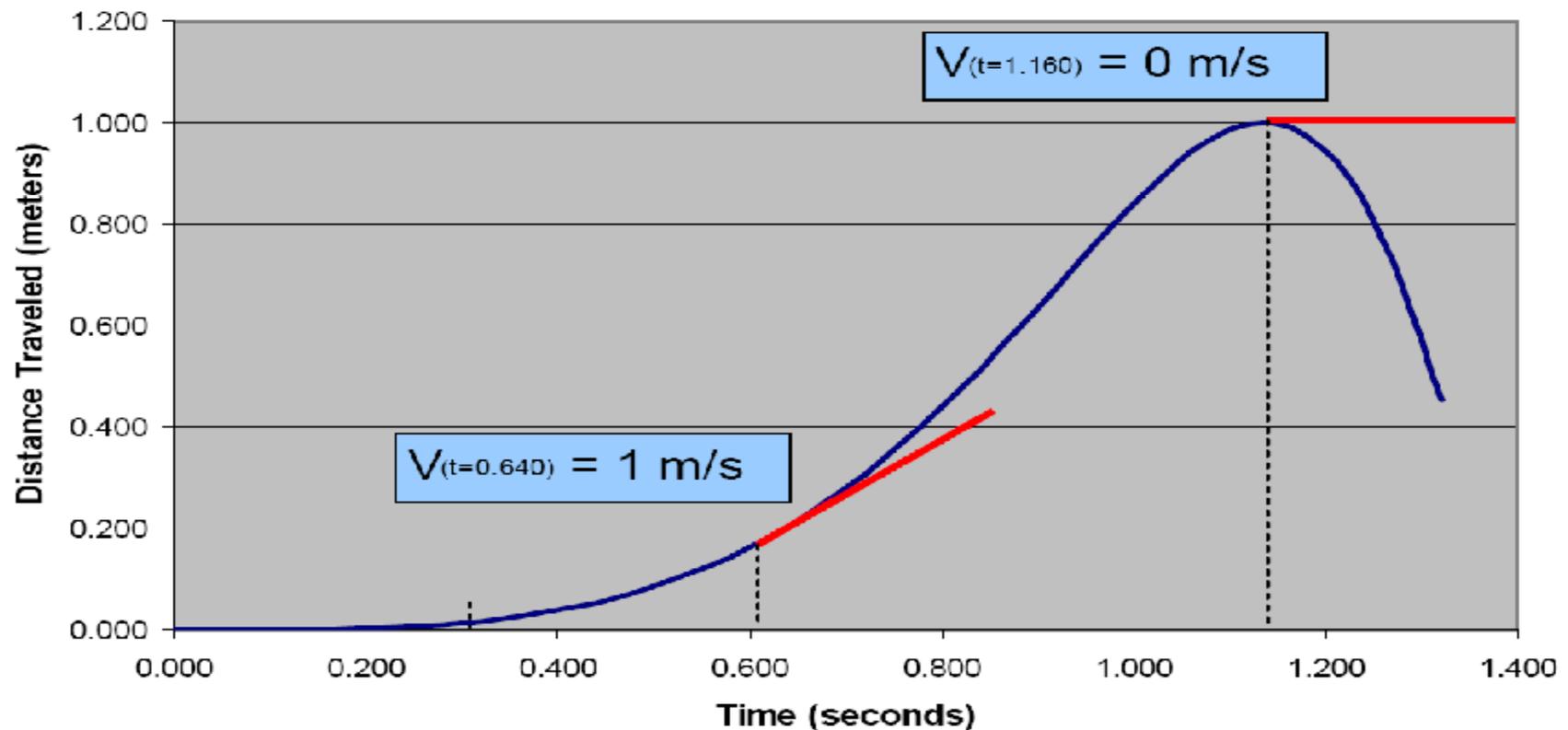
- Acceleration is measured in (ft/s)/s or (m/s)/s.

Importance of g:

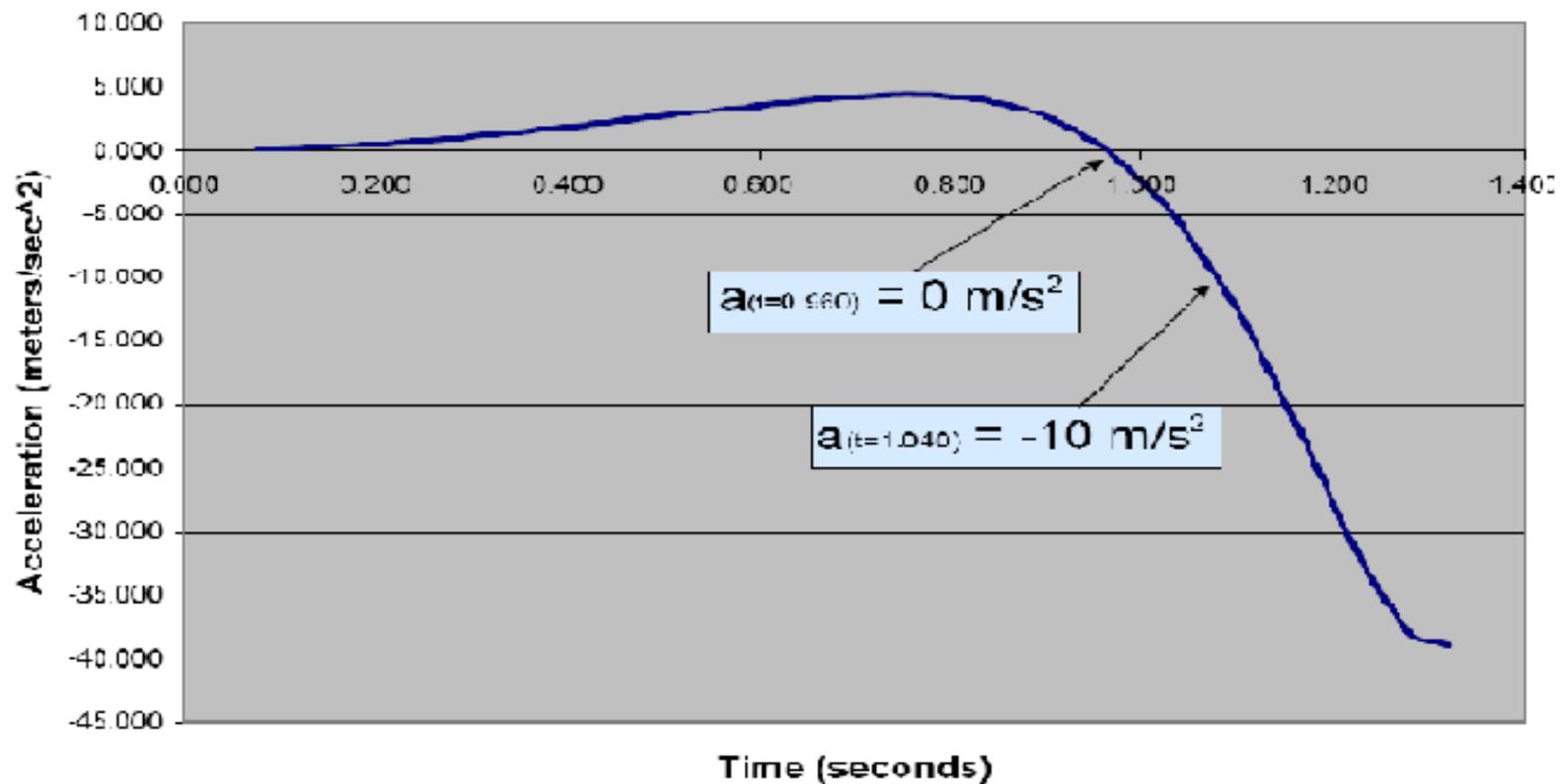
- “g” is a unit of acceleration equal to Earth’s gravity at sea level.
 - “g” = 9.81 m/s²
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Graphical methods of measuring Acceleration:

- 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.



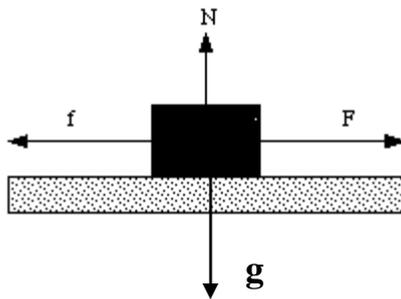
Need for measuring acceleration:

- 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.
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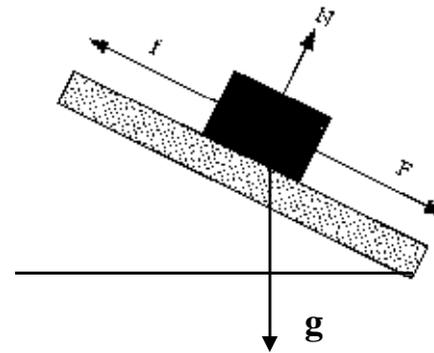
ACCELEROMETER:

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

Capacitive

Piezoelectric

Piezoresistive

Hall Effect

Magneto-resistive

Heat Transfer

Key Technologies

-Metal beam or micromachined feature produces capacitance; change in capacitance related to acceleration

-Piezoelectric crystal mounted to mass – voltage output converted to acceleration

-Beam or micromachined feature whose resistance changes with acceleration

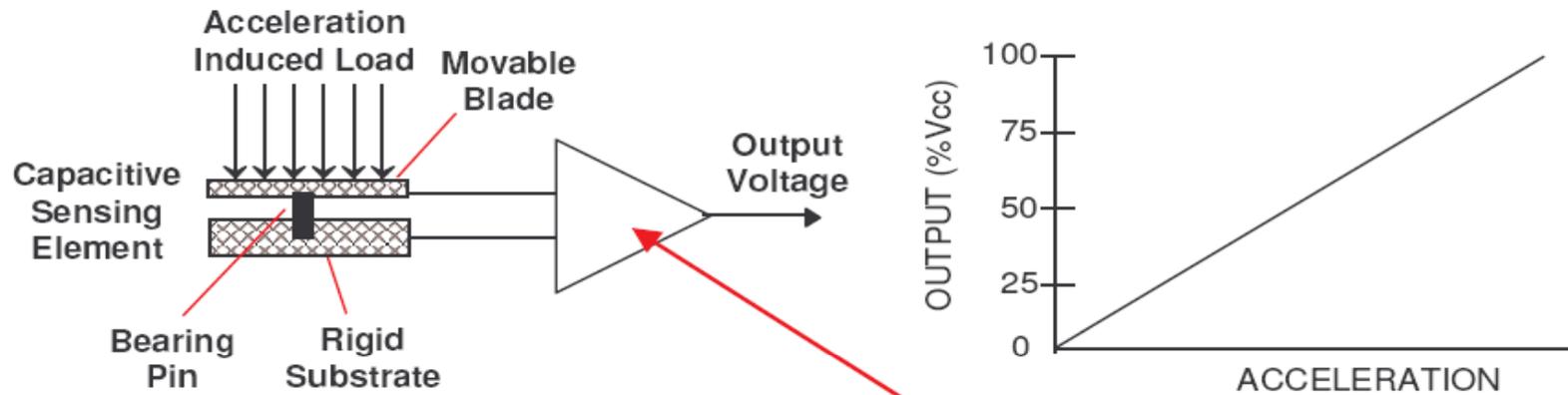
-Motion converted to electrical signal by sensing of changing magnetic fields

-Material resistivity changes in presence of magnetic field

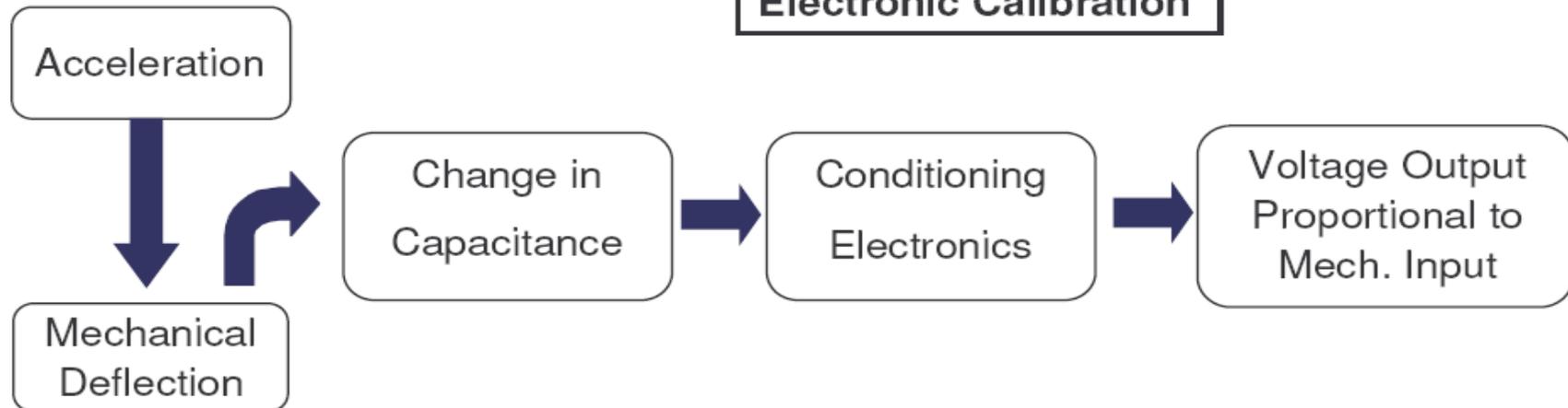
-Location of heated mass tracked during acceleration by sensing temperature

CAS - Capacitive Acceleration Sensor

Conceptual Design



Electronic Calibration

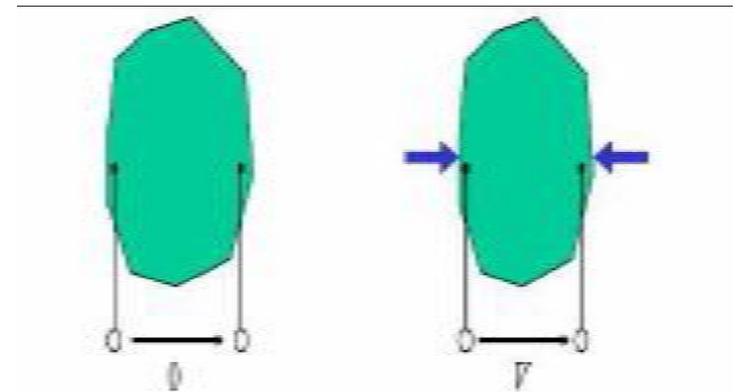
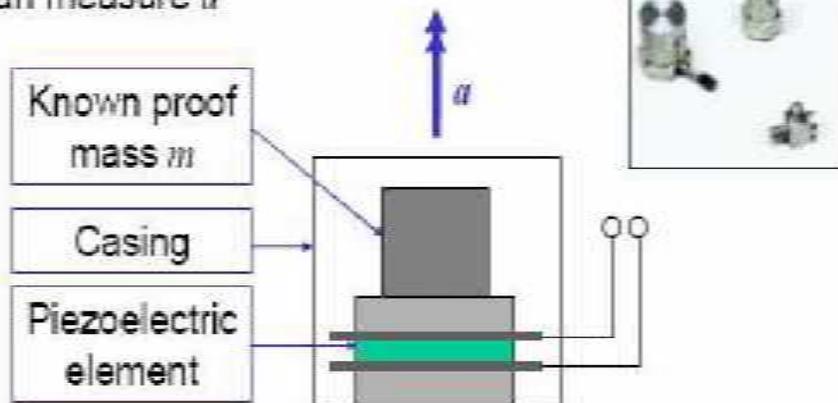


PIEZOELECTRIC SENSOR:

- Diagram:

- Accelerometers

- F measured (force in piezo)
- m known
- $F = ma$
- Can measure a



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.
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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.sensormag.com/articles/0200/41/index.htm>
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Questions:
