MECH420

Sensors and Actuators

Laboratory Exercise #1:
Data Acquisition and Proximity Sensors for Object Detection

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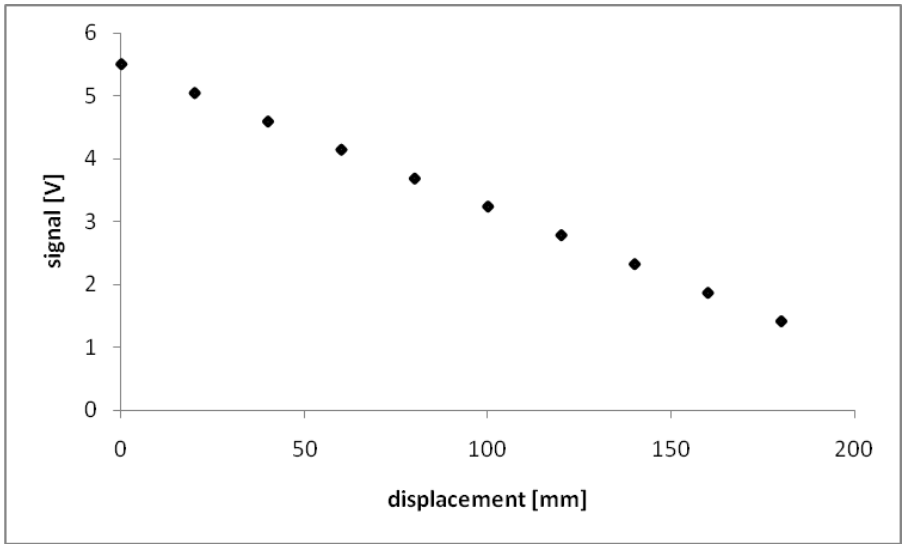
Part A: Calibration of the Linear Potentiometer

1. Average values and standard deviation for all voltage values measured for the different positions:

pos [mm]	V_average [V]	V_std [V]
0	5.507416	0.000265
20	5.048602	0.000248
40	4.595103	0.000239
60	4.146688	0.00022
80	3.687689	0.000235
100	3.24178	0.000253
120	2.7874	0.000251
140	2.32705	0.000251
160	1.869762	0.000234
180	1.417173	0.000251

2. Sensor signal as a function of linear position



3. End-points-based linear calibration curve of the sensor signal as a function of position:

$$V(x) = 5.507\ V - 0.0227\ V/mm * x$$

4. maximum absolute non-linearity error for the sensor signal:

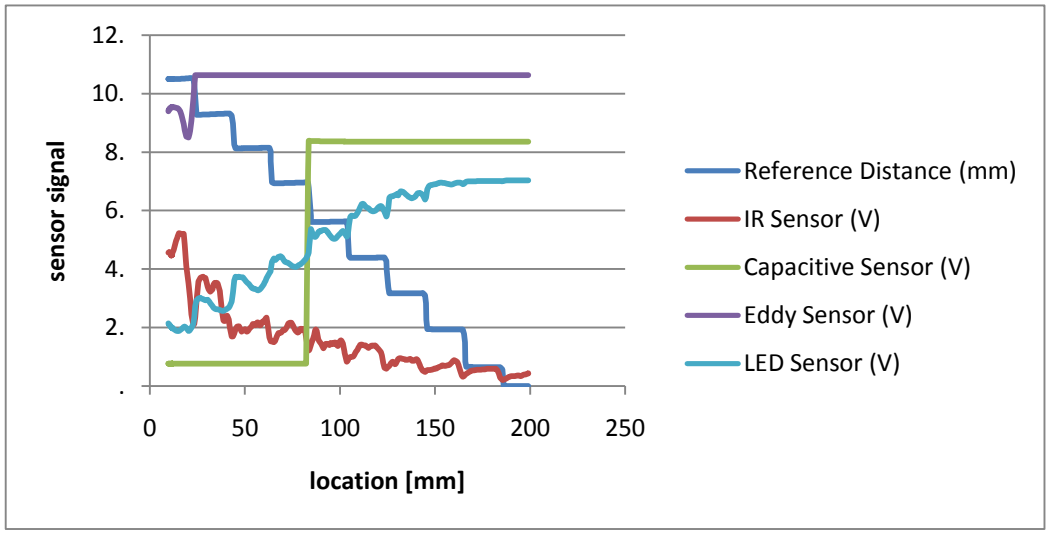
$$E_{max} = 0.006826\ V$$

This non-linearity error of the sensor signal corresponds to a position error of

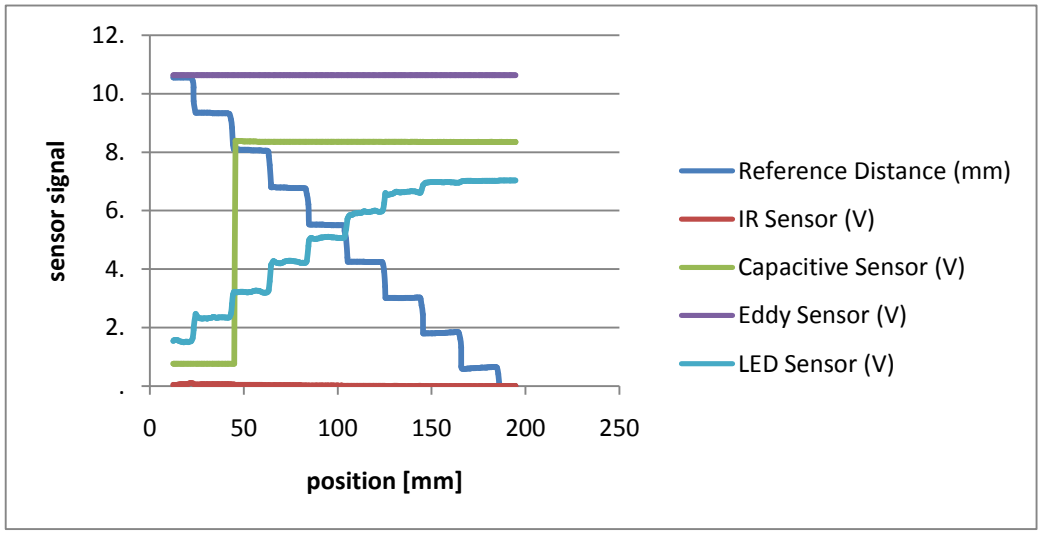
$$E_{x,max} = E_{max} / 0.0227\ mm/V = 0.300\ mm.$$

Part B: Calibration and Application of the Proximity Sensors

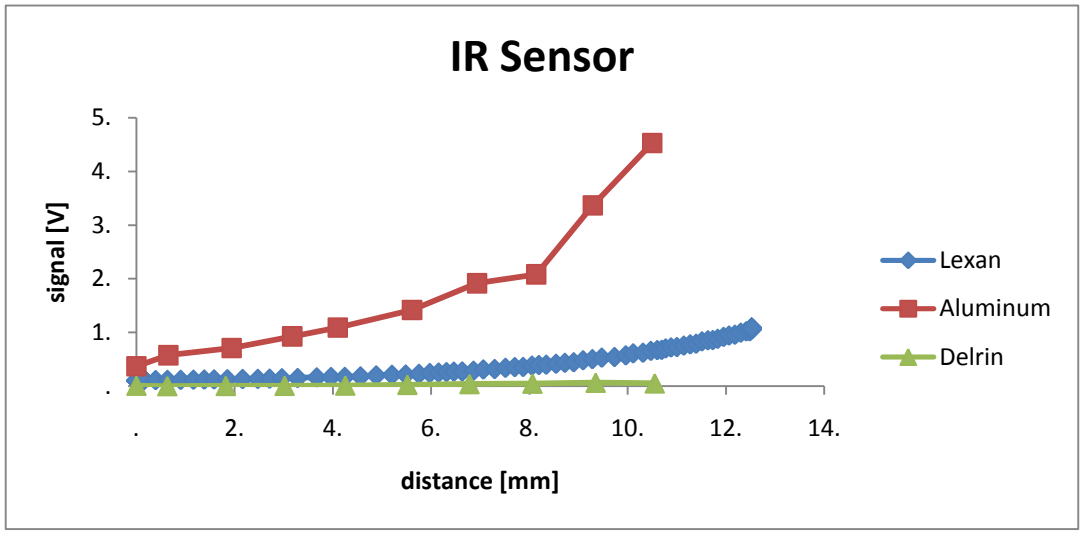
1. Aluminum step profile

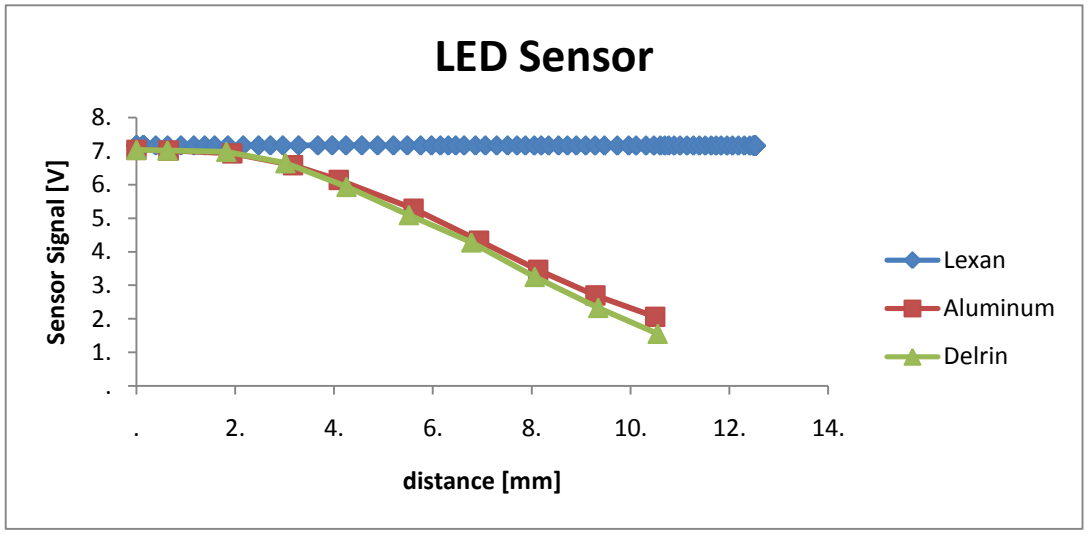


Delrin step profile



2. Calibration of the different sensors





3. Calibration equations

LED sensor

For the distance range 4 mm < x <10.5 mm the LED sensor signal is nearly linear for the aluminum profile and for the Delrin profile. The sensor does not respond to the presence of the Lexan sample.

Aluminum: $x(V) = 13.74\ \text{mm} - 1.57\ \text{mm/V} \cdot V$

Delrin: $x(V) = 12.80\ \text{mm} - 1.44\ \text{mm/V} \cdot V$

4. Compare results to data sheets

IR sensor

The sensor response in the data sheet (collector current vs. object distance) is qualitatively well reproduced in our measurements.

Capacitive switch

The switch point seems to be in the operating distance of this switch.

Eddy current sensor

The sensing range (0-10 mm) of this sensor is very small – this explains the measured response (only at small distances).

LED sensor

The LED sensor has a total range of 8 mm; this explains its signal at large distances.

The signal (4-20 mA) corresponds to the range of 8 mm. With a 300 Ohm resistor, this should result in a signal change of 1.67 mm/V.

5. Selection of sensors.
    a) Detecting the presence of a conductive object. → eddy current sensor
    b) Determining the approximate thickness of an opaque object. → LED sensor