MECH420

Sensors and Actuators

Laboratory Exercise #3:
Dynamic Transducer Transfer Characteristics – Time Domain

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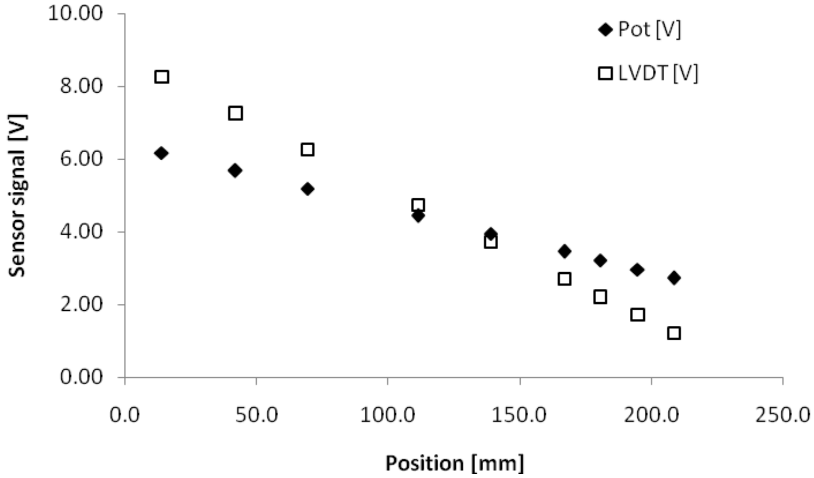
Part A: Calibration of the Rotary Potentiometer and the LVDT

1. Position sensor signals as a function of position:



2. Linear sensor transfer characteristic:

Potentiometer: $V_{POT} = 6.416\ \text{V} - x \cdot 0.017748\ \text{V / mm}$

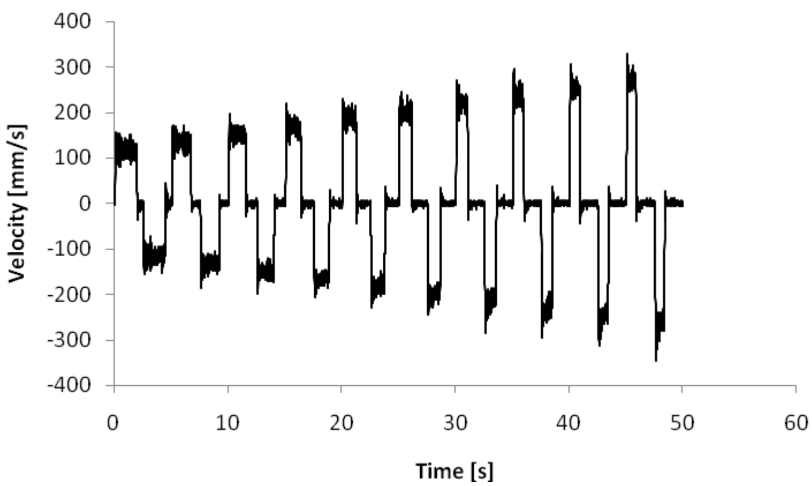
LVDT: $V_{LVDT} = 8.77\ \text{V} - x \cdot 0.03622\ \text{V / mm}$

Part B: Calibration of the DC tachometer

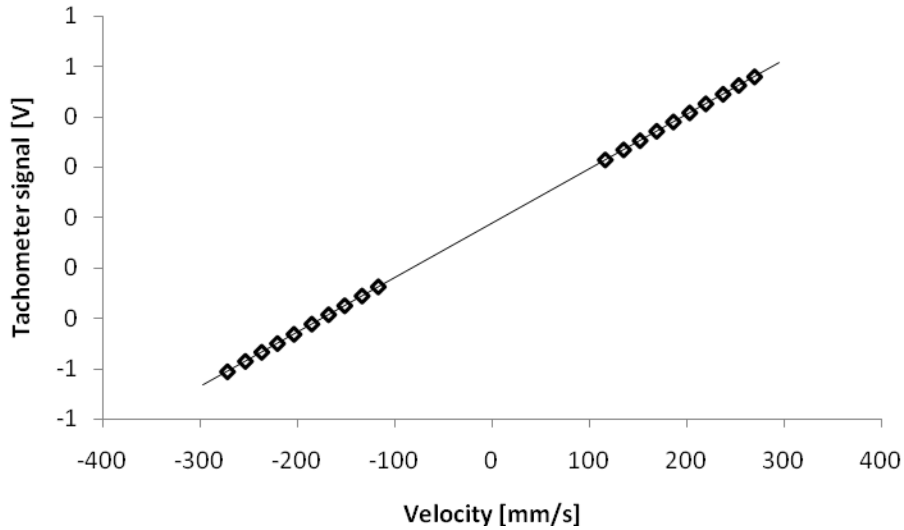
1. The displacement

$$x = 361.5\ \text{mm} - V_{POT} \cdot 56.34 \frac{\text{mm}}{\text{V}}$$

is obtained by rearranging the sensor transfer characteristic from the previous part. The difference in position for each time increment is then multiplied by 1/200 s to obtain the velocity. The following graph shows the velocity over time; the velocity signal is quite noisy.



2. Tachometer voltage as a function of velocity:



3. Liner transfer function for the tachometer:

   The linear transfer function for the tachometer voltage as a function of velocity v

   $$V_{Tach} = 0.00217 \frac{\text{V}}{\text{mm/s}} \cdot v - 0.025\ \text{V}$$

   is obtained from the values in the graph above.

   According to the manufacturer, the sensitivity of the tachometer is 7 V / 1000 RPM. For the pulley system of the setup this translates to

   S = 7 V / 1000 RPM * 1 RPM / (360° / 60 s) * 360° / 200 mm

   $= 2.1 \cdot 10^{-3}$ V / mm/s,

   which is very close to the sensitivity found through calibration.

Part C: Transient Sensor Response

1. The tachometer signal is converted into velocity

   $$v = (V_{Tach} - 0.025\ \text{V}) / 0.00217\ \text{V / mm/s}$$

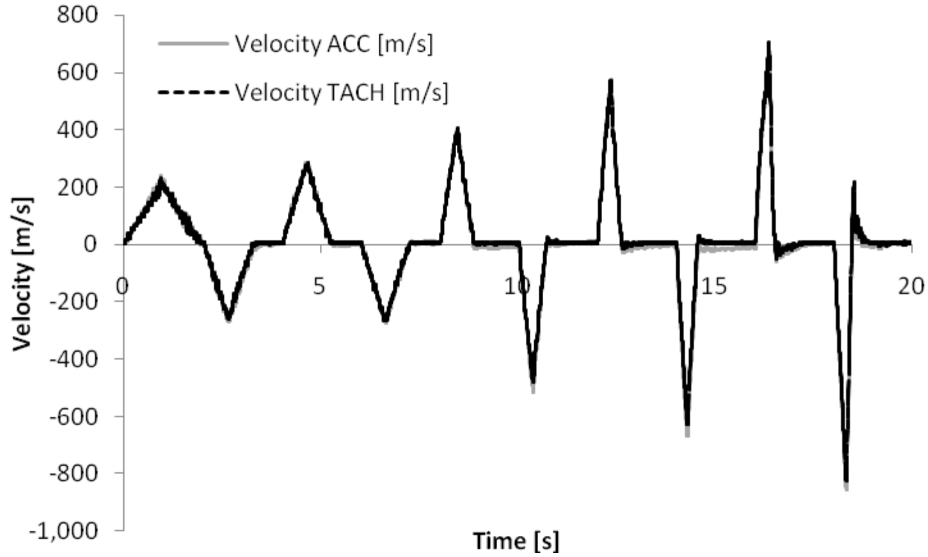
   by rearranging the calibration equation from above.

   Accelerometer signal:

   The signal from the accelerometer has an offset at around $V_0 = 2.572$ V, which is slightly different from the value given in the data sheet (2.5 V). The acceleration

   $$a = (V_{Acc} - 2.572\ \text{V}) \cdot 9810\ \text{mm/s}^2$$

   is calculated using the average sensitivity given in the data sheet. The accelerometer signal is then numerically integrated to obtain a velocity signal.



The velocities measured by accelerometer (after integration) and tachometer are in good agreement.

2. Position measurement:

   Both, the position data from the tachometer and from the accelerometer show a drift. While the drift for the tachometer seems linear, the drift for the accelerometer seems rather quadratic. This both might be due to an offset of the signals that was not entirely taken into account for sensor calibration. The accelerometer signal was integrated twice, the tachometer signal was integrated once only.