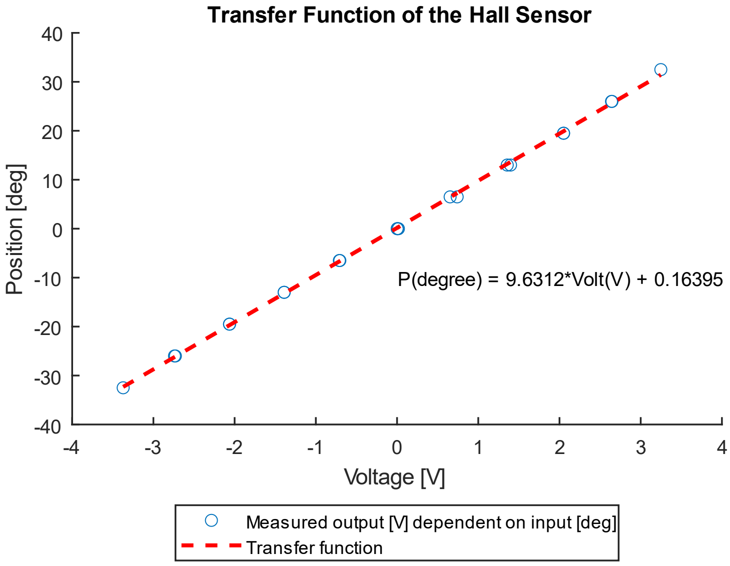
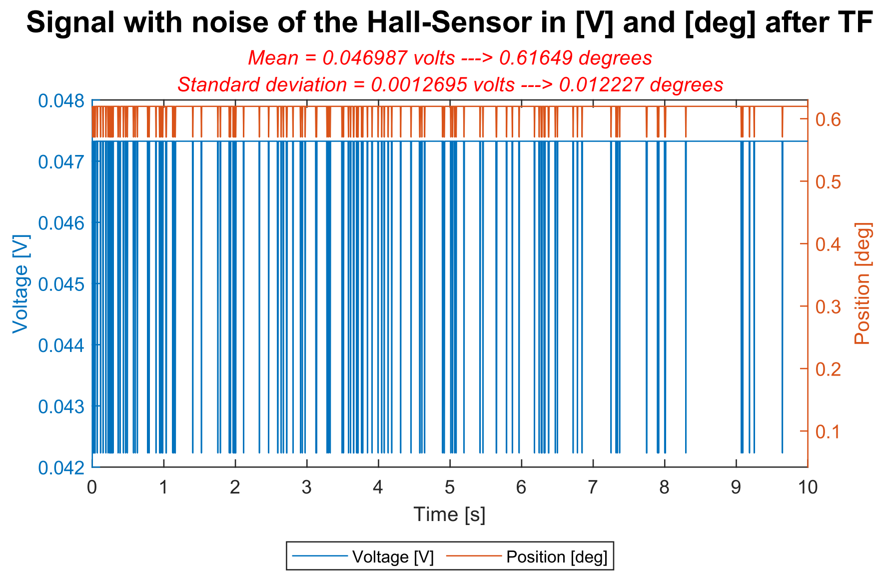
Lab report 2: Hall Sensor and Actuation

Hall sensor charasterization

The voltage dependent on the angular position of the haptic paddle was recorded and the transfer function [volts → degrees] was derived. Further, the noise characterization with mean and standard deviation in volts and degrees was recorded.



$$Transfer\ Function: Position\ [deg] = 9.6312 \cdot\ Position\ [V]\ + 0.1640$$

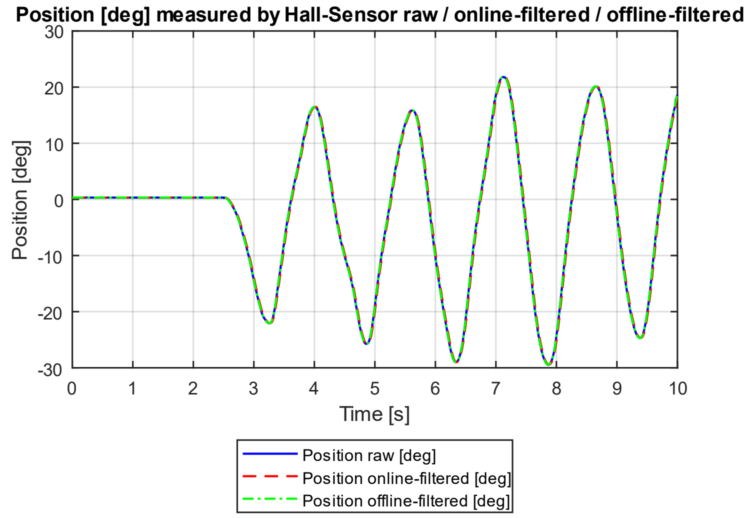


Mean amplitude of signal with noise: 46.987 mV → 0.616 °
Standard deviation: 1.270 mV → 0.012 °

Hall sensor noise characteristics were analyzed in Voltage signal (V) and position values(deg) calculated using the derived transfer function. Both are plotted in the same graph.

Position, Velocity, and Acceleration

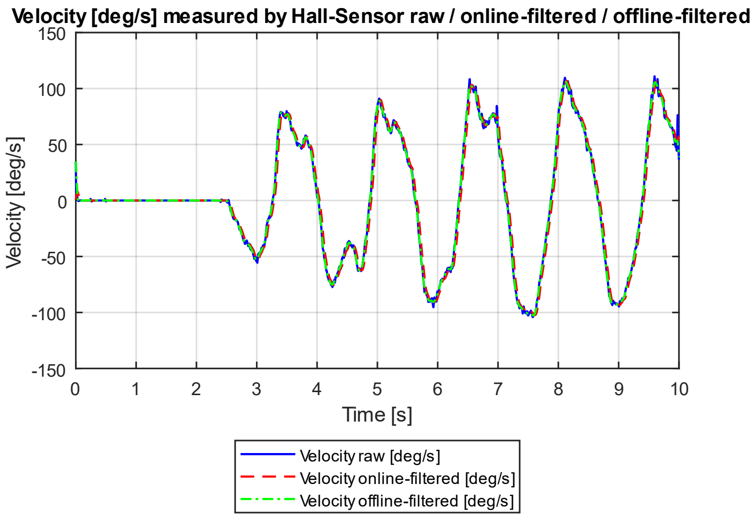
The raw position signal was recorded and used to calculate velocity and acceleration of the haptic paddle. All signals were filtered online (in LabView) and offline (in MATLAB) and were being recorded.



To define our low cutoff frequency for our position signal, we decided to go with twice the amount of a humans frequency, which is 10 Hz → 20Hz. For the velocity and the acceleration we tried different frequencies and decided to go with 10Hz and 5Hz.

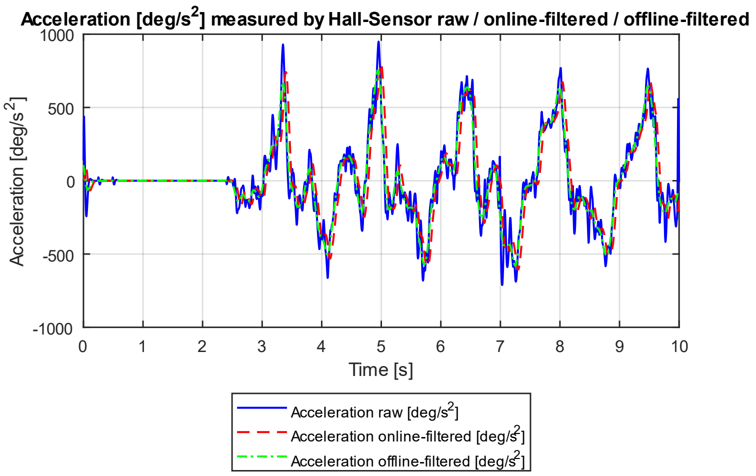
Position Filter:

Filter type: Butterworth Lowpass
Low cutoff frequency: 20Hz
Sampling frequency: 200Hz



Velocity Filter:

Filter type: Butterworth Lowpass
Low cutoff frequency: 10Hz
Sampling frequency: 200Hz



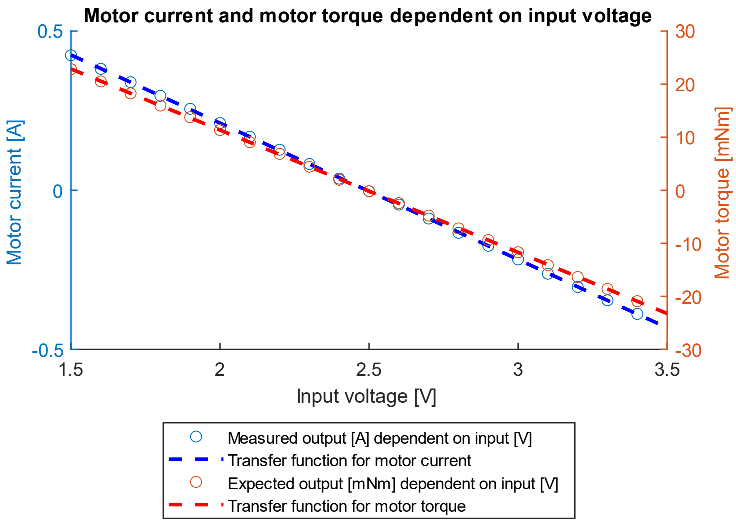
Acceleration Filter:

Filter type: Butterworth Lowpass
Low cutoff frequency: 5Hz
Sampling frequency: 200Hz

Discussion: The online-filtered signal is slightly time shifted to the right in comparison to the raw signal and also the offline-filtered signal. This time delay is caused by the real-time filtering of the signal. The delay can be corrected if the shift is the same amount over the hole signal. The MATLAB function *filtfilt* does exactly this correction. That is why our offline-filtered signal is not delayed.

Measuring the relationship between motor control voltage and motor current

For part 2B motor current and motor torque both dependent on input voltage were recorded and the transfer functions [volts → amps] and [volts → milli-newtonmeters] were derived.



To define our low cutoff frequency for our motor current signal, we decided to go with 30Hz.

Motor current Filter:

Filter type: Butterworth Lowpass
Low cutoff frequency: 30Hz
Sampling frequency: 1Hz

$$Transfer\ Function: Motor\ current\ [A] = -0.4285 \cdot Input\ voltage\ [V] + 1.0677$$
$$Transfer\ Function: Motor\ torque\ [mNm] = -23.0541 \cdot Input\ voltage\ [V] + 57.4414$$

Without the lowpass filtering of the motor current signal, the linear fits of the two signals had been far off. The first rising and then suddenly changing direction signals (nonlinear region) were responsible for the too flat linear fits. By trying out different cutoff frequencies we managed to get this quite linear input-output relationship and were able to derive the transfer functions of motor current and motor torque.