FILTERING OPTIONS IN D-FLOW

Introduction

There are three different ways to filter data in D-Flow:

- Via the Mocap module
- Via the Filter module
- Via the Configuration tool

This document describes the similarities and differences between those filters.

Similarities between the filters

Filter type

All filters are 2nd order low pass Butterworth filters of which the cut-off frequency can be set by the user.

Latency

Please note that latency in the output data is inherent to the use of any filter. This lag becomes strongly noticeable when using a very low corner frequency. The lower the corner frequency, the bigger the lag in the output signal.
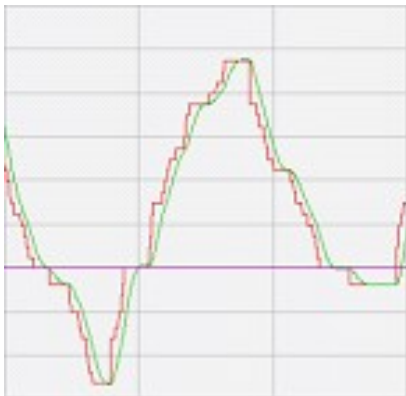
Red line: raw analog data, green line: filtered data; the green line is lagging the red line.

Differences between the filters

Moment of application

One of the differences between the filters of D-Flow is the moment that the filter is applied. The Filter module applies its filter <u>after</u> the incoming data is downsampled. The same applies for a few of the MoCap module's filter. However, other filters inside the Mocap module and the filters from the configuration tool are applied <u>before</u> the incoming data is downsampled. The parapgraphs below will address each separate filter and their moment of application.

Filter of the configuration tool

Filtering via the configuration file offers the possibility to filter <u>individual</u> analog channels. As mentioned in the introduction, this filter is applied before the incoming data is downsampled. For every separate analog channel it is possible to set the channel type using the drop down list. The different channel types are: "None", " Force Plate", "EMG", and "Other". It is important to know in which order the channels are connected to the system.

- **None**: None will be used in case there is no hardware connected to that channel number.
- **Force plate**: Select Force plate channel type when analog force plate signals are send to D-Flow through these channels. This will apply the force plate filter to the signals (a 2nd order Butterworth low pass filter). The cut-off frequency can be set in the Mocap module. By default GRAIL and CAREN systems the force plates are connected to channel 1-12.
- **EMG**: Select EMG for each EMG sensor that is connected to the system. This will apply the EMG filter to these channels (a rectified 2nd order Butterworth filter, with a band pass range that can be defined at the bottom of the tab and can be changed in the EMG Settings in the Hardware tab of the Runtime Console). More information about EMG filter settings can be found in the Knowledge base article: Configure EMG setting.
- **Other**: Select this option if other channels (than EMG or Force plates) are connected to D-Flow. This will allow the operator to choose a filter type and cut-off frequency for that channel.

Filtering via the Mocap module

The Mocap module contains several tabs where data can be filtered: the Analog tab, the HBM tab and the Out tab. All filters are 2nd order low pass Butterworth filters of which the cut-off frequency can be set by the users. The differences between those filters are described below. Further in the File tab there is an option to 'write analog data to separate file'. This file contains the unfiltered raw data at their original frequency.

Analog tab filter

The filter option in the Analog tab applies only to the force plate data. In the analog tab can the cut-off frequency set for the force plate channels. This filter is applied to the channels which are selected as force plate in the configuration tool. The filter is applied before the incoming data is downsampled and captured in the File tab. So the filter applies to the original frequency of the force plate data.
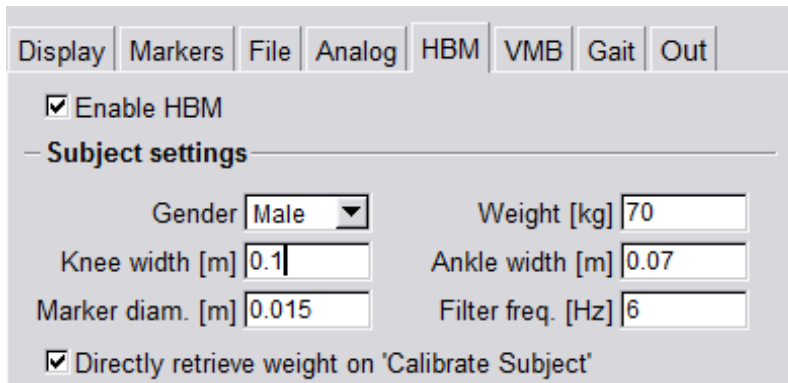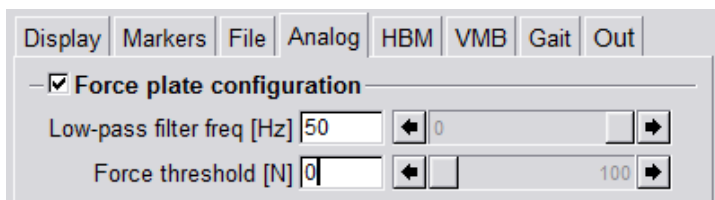

Force plate filter on Analog tab

HBM tab filter

The filter of the HBM tab is used to filter the data before the HBM model calculations (kinematics, kinetics and powers) are done. The filter frequency is set at the moment HBM is calibrated and cannot be adjusted during a session. This filter only affects the HBM outputs on

the Out tab (HBM muscles, HBM joints and HBM COM) which can be used
real-time by one of the modules or can be recorded to a .mox file. All the other outputs on the
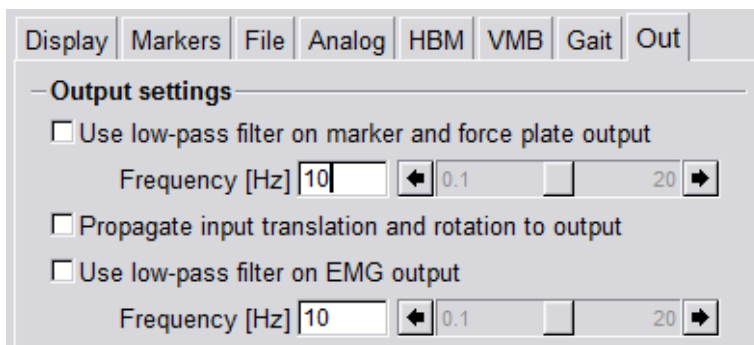Out tab and the recorded data on the File tab are not affected by this filter.

Filter of HBM tab

Out tab filter

The filter options in the Out tab filters the data before they are used by other modules in the
application. There are two filters to set: one for marker and force plate data and one for EMG
data. Data from the Out tab can be used to visualize or it can be recorded by the Record Data
module. This filter only applies to data output from the Out tab. The data recorded on the File
tab is not affected by this filter.

Note: Some of the outputted data is already filtered by the filter of the configuration tool or/and
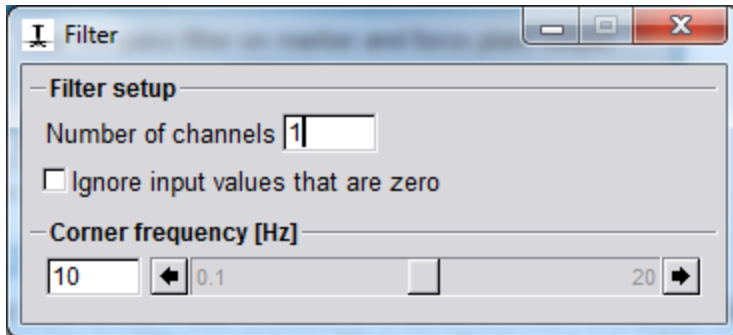the filter of the Analog tab or HBM tab.

Filters of the Out tab

Filter module

The Filter module uses a second order low-pass Butterworth filter. Data connected to the input of the module is filtered with the set cut-off frequency and comes out filtered.

This data can then be recorded with the Record Data module or can be used by other modules in D-Flow. Furthermore, the Filter module is useful in cases when the 1st and 2nd derivatives of every channel need to be computed, since these values are also outputted by the module. More information about using the Filter module can be found in the D-Flow reference manual.

Filter module