SK Filters User Guide

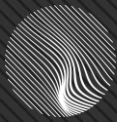| Version	6.0
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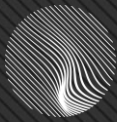
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1   What are SK filters?

SK filters are software algorithms which can help DepthSense camera users in achieving better quality of depth images from the cameras. On one hand these algorithms are generic for any camera giving similar depth-related information, but on the other hand they are specifically optimized for DepthSense camera images with different use-cases in mind.

SK filters use different techniques to control noise in raw DepthSense images. Depending on camera use-case, users can optionally enable these filters and also fine-tune filter behavior with a control on its parameters. For example, in a close-range use-case, if user is interested only in partial range of the camera (and not the full range), these filter parameters can be tweaked to make sure that pixels out of a certain range are not exposed to the user.

These filters can be mainly categorized in two types: noise removal and noise smoothing. As the names suggest, first type of filters try to find and remove noisy pixels whereas noise smoothing filters try to smoothen variations of pixel values due to noise (e.g. useful in getting a smooth surface).

As mentioned before, depending on use-case, user can enable or disable a particular filter. If enabled, user can fine-tune different filter parameters to achieve optimum depth images from the camera.

2   Description of SK filters and their parameters

This section gives brief description of filters that are exposed to DepthSense clients. Each filter description also mentions ranges for different parameters to be set and their impact on behavior of the filter.

2.1 Filter1 = Noise removal filter 1

- What it does: Removes noisy pixels with the help of confidence map.

- Parameters:
    - Parameter1
        - Range: 0 – 32000
        - Like a cut-off – the higher the parameter, the more distant pixels will be checked for noise condition.
    - Parameter2
        - Range: 0 – 100000
        - The higher the parameter, the more pixels will be filtered as noisy pixels.
    - Parameter3
        - Range: 0 – 32000
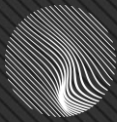
- - The higher the parameter, the more pixels will be filtered as noisy pixels. Like a lower bound for a noise condition check.
  - o Parameter4
    - Range: 0 – 32000
    - The higher the parameter, the more pixels will be filtered as noisy pixels. Like an upper bound for a noise condition check - this parameter should be greater than Parameter3.

2.2 Filter2 = Noise removal filter 2

- What it does: Removes noisy pixels by looking at distribution of noisy pixels.

- Parameters:
  - o Parameter1
    - Range: 1-8
    - The higher the parameter, the lower the chance is of removing noisy pixels. But by lowering this number too much, one might also remove good pixels.

2.3 Filter3 = Noise smoothing filter 1

- What it does: Smoothens noise while preserving edges.

- Parameters:
  - o Parameter1
    - Range: 0.0 – 1.0
    - Increases the strength of the filter, reducing noise on flat surfaces.
  - o Parameter2
    - Range: 0.0 – 1.0
    - Increases the robustness of the filter, control how edges are preserved.
  - o Parameter3
    - Range: 0.0 – 4000.0
    - Like a cut-off range (distance) for a filter to work with. The higher the value, the further away pixels (including noisy ones) will be considered during smoothing. A higher value might also slow down the filter execution. But too low values might discard desired noise smoothing for far pixels.

2.4 Filter4 = Noise removal filter 3

- What it does: Removes noisy pixels by looking at variation of pixel values.

- Parameters:
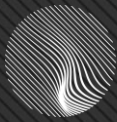
- o Parameter1
  - ▪ Range: 0-32000
  - ▪ The higher the parameter, the lower the chance is of removing noisy pixels. But by lowering this number too much, one might also remove good pixels especially at edges of individual objects in the image

2.5 Filter8 = Noise removal filter 4

- What it does: Removes noisy pixels by looking at variation of pixel values; similar to Filter4.

- Parameters:
  - o Parameter1
    - ▪ Range: 0-32000
    - ▪ The higher the parameter, the lower the chance is of removing noisy pixels. But by lowering this number too much, one might also remove good pixels especially at object edges.

2.6 Filter9 = Noise smoothing filter 2

- What it does: Smoothens noise – better quality of smoothing than Noise smoothing filter 1, but at the cost of more processing power and time.

- Parameters:
  - o Parameter1
    - ▪ Range: 1-100
    - ▪ Higher parameter values increase the quality of smoothing, but at the cost of more processing and filtering time. Higher values may also result in loss of small details.
  - o Parameter2
    - ▪ Range: 0.01 – 100.0
    - ▪ This parameter is the most important one. Higher values increase the amount of smoothing at edges, but may smoothen nearby edges (and hence degrade image quality). Lower values preserve edges more, but eliminate less noise at their locations. Its optimal value is dependent on the actual use case.
  - o Parameter3
    - ▪ Range: 0.01 – 10.0
    - ▪ Higher parameter values increase the quality of smoothing, but may result in loss of small details.
  - o Parameter4
    - ▪ Range: 0.01 – 2.0
    - ▪ This parameter only has a limited impact and is mainly meant for fine-tuning. Its optimal value is dependent on the actual use case.