KEYENCE

Image Processing

Image Filters: Part 1

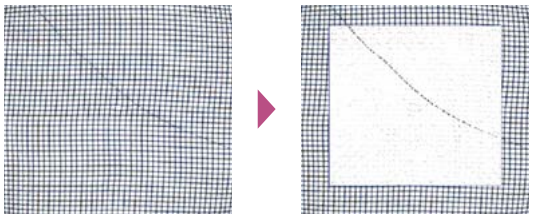
This technical document introduces the idea of image processing from the basics. The topic covered in this document is image filters, which aids in achieving a stable image. Image filters can also bring out details that may help make the inspection easier and more robust.

1. Image filter effects

Various types of image filters are available to meet the needs of different applications. To successfully stabilise inspections, it is important to be familiar with the different types of filters and their effects on an image.

Inspection of foreign particles on mesh

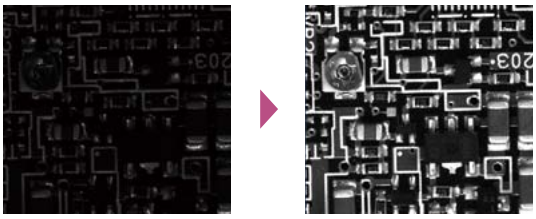
Ignore the gridline caused by the mesh and only bring out the thing flaw



Original image　　After image filter

Emphasis of PCB components

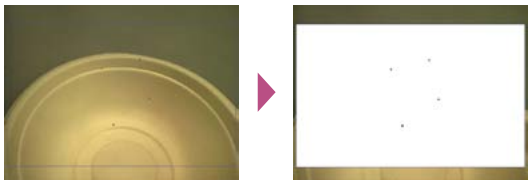
Increase contrast and emphasise edges of the components mounted on PCB for presence/absence inspection



Original image　　After image filter

Inspection of foreign particles in a cup

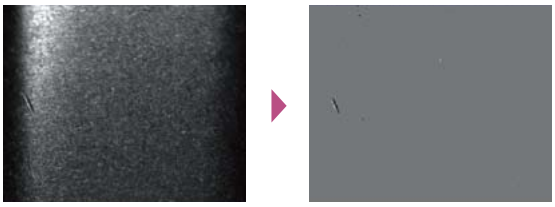
Detect any foreign particles inside the cup while ignoring the contour of the cup and the shape of the cup against the background



Original image　　After image filter

Inspection of cylindrical metal part

Ignore uneven lighting and texture on the surface and bring out the defect



Original image　　After image filter

2. Image filter basics

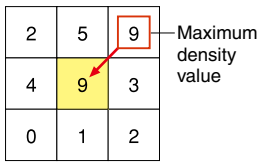
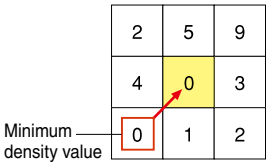
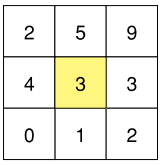
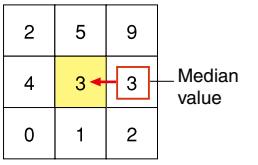
This section explains four types of image filters that are most commonly used. A 3 x 3 pixel array is used to find the value of the centre pixel and is applied to every pixel in the image.

3 x 3 pixel array

2	5	9
4	7	3
0	1	2

Example of original image

Image

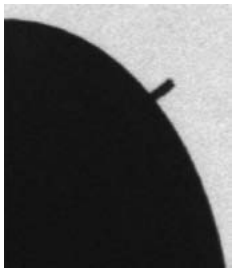
	Principle of a 3 x 3 pixel	Filtered image
Expansion filter	In this filtering process, the centre pixel of the 3 x 3 pixel array becomes the maximum value found within the array. The expansion filter is effective in removing dark noise.	 Maximum density value	
Shrink filter	In this filtering process, the centre pixel of the 3 x 3 pixel array becomes the minimum value found within the array. This filter is effective at enhancing black pixels.	 Minimum density value	
Averaging filter	In this filtering process, the centre pixel of the 3 x 3 array is replaced with the average value of the array. This filter is effective at reducing noise and adds blur to the image.		
Median filter	In this filtering process, the centre pixel of the 3 x 3 array is replaced with the median value of the array. This filter is effective at reducing noise and adds blur to the image.	 Median value	

Filtering needs are different for every application, but having an understanding of how these image filters work can be advantageous.

\Filtering Tips/ Filtering techniques

Example 1 **Outline smoothing** **Expand and shrink**

By applying expand and shrink the same number of times, it can remove the burr on the edge while leaving the original shape of the target.



Original image

Filtered image

3. Edge extraction filters

Edge extraction filters are useful for bringing out the edge when the details of the edge are low. There are numerous edge extraction and enhancement filters which can help increase the contrast of an edge. Each type of filter has different benefits.

Original image

[Sobel and Prewitt filters]

Both the Sobel and Prewitt filters work by extracting edges by separately filtering in the X (horizontal) and Y (vertical) directions, then combining the two results.
A 3 x 3 central pixel is replaced with the combined density value after multiplying each of the nine pixels by a set coefficient. The Sobel filter is better at enhancing edges with less contrast than the Prewitt filter, because the pixel at the centre is multiplied by 2. Although these filters are good at extracting edges, unwanted noise may also be enhanced.

Sobel filter

-1	-2	-1
0	0	0
1	2	1

+

-1	0	1
-2	0	2
1	0	1

Prewitt filter

-1	-1	-1
0	0	0
1	1	1

+

-1	0	1
-1	0	1
-1	0	1

Edge-extraction filter in a specified direction

Some edge extraction filters can be applied in just the X or Y direction. This can help bring out flaws that occur in a certain direction.

Sobel in X

-1	0	1
-2	0	2
-1	0	1

Sobel in Y

-1	-2	-1
0	0	0
1	2	1

[Edge extraction filters]

	Derivation	Horizontal direction	Vertical direction	Diagonal	Others
Prewitt filter	Firstderivation	○	○	△	
Sobel filter	Firstderivation	◎	◎	○	
Roberts filter	Firstderivation	△	△	○	
Laplacian filter	Second derivation	△	△	△	Direction-independent

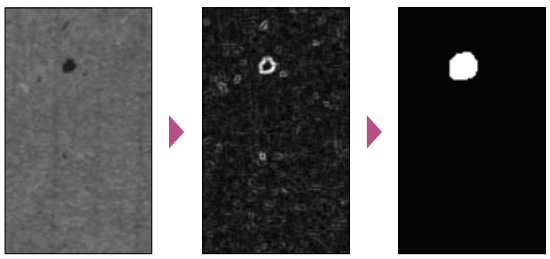
Symbols: ◎=best ○=good △=fair

\ Filtering Tips / Technique for using image filters

Example 2 Emphasis of small surface flaws

Sobel filter + binary conversion + expansion

Flaws are enhanced while minimising noise


Original image

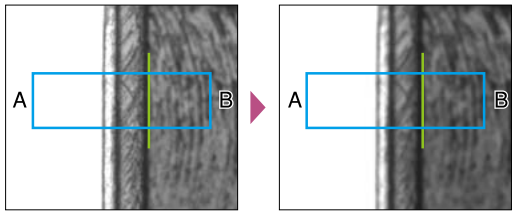
Sobel filter

Binary conversion + expansion

Example 3 Stable measurement by noise reduction

Averaging and median

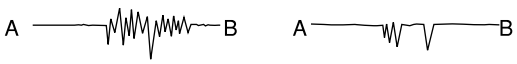
By applying the averaging and median filter together, the surface roughness is minimised for stable measurement



Original image

Average + median filter

Waveforms of edge strength



An introduction to lineup of image processing

XG-8000 / XG-7000 Series

Best solution meeting every need

All of lineup of cameras including line scan cameras, high speed using distributed processing on multicore DSP, a wide variety of flexible inspection tools, interface that allows users to create on their own make a precise response to customers' needs.

CV-X100 Series

Offering tools having the same ability to judge as the judgement of human. Anyone can use it easily.

The "Auto-teach inspection tool" which recognises those items that are different from conforming items as non-conforming items is incorporated into the series. This tool allows human-like inspection. This series can be globally deployed and used by anyone by setting and operating by just selecting and clicking.

Lineup of lights that support a wide range of inspections


Direct ring light


Multi-angle round light


Multi-angle square light


Bar light


Dome light


Backlight


Coaxial light


Spot light


Low angle light


Square bar light


Line light


Controller for LED light

Lineup of lenses that can be selected based on the camera types and accuracy requirements


Super high resolution/low distortion lenses


High resolution/low distortion lenses


CCTV lenses


Macro lens


Compact camera lenses


Line scan camera lenses

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Please read the instruction manual carefully in order to safely operate any KEYENCE product.

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