KEYENCE

Image Processing

Edge Tool

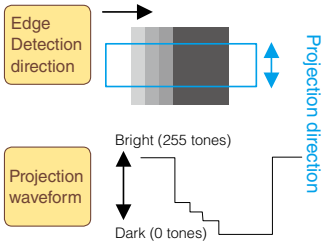
This technical document allows you to efficiently learn image processing from the basics. The topic covered in this section is the Edge mode. Dimensional inspection using an image sensor can measure the position, width and angle of a target by capturing the target in 2D to detect edges. This section provides explanations about the principle of edge detection along with the processes. By understanding the principle, ideal conditions for detection can be set.

1. Edge mode algorithm

The edge is the border which separates a bright area from a dark area within an image. Detecting an edge means detecting this border of different shades through image processing. Edges can be obtained through the following 4 processes.

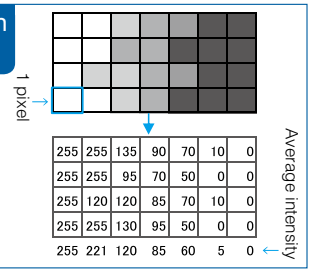
1 Perform projection processing

Perform projection processing on the image within the measurement area. Projection processing scans the image vertically to the detection direction in order to obtain the average intensity of each projection line. The waveform of each projection line is called the projection waveform.



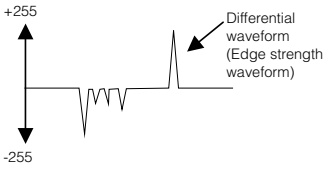
What is the projection processing?

Projection processing is used to obtain the average intensity of the projection direction.
This minimises false detection caused by noise within the measurement area.



2 Perform differential processing

Differential processing is performed based on the projection waveform. Larger deviation values are obtained when the difference in intensities which form edges is distinct.



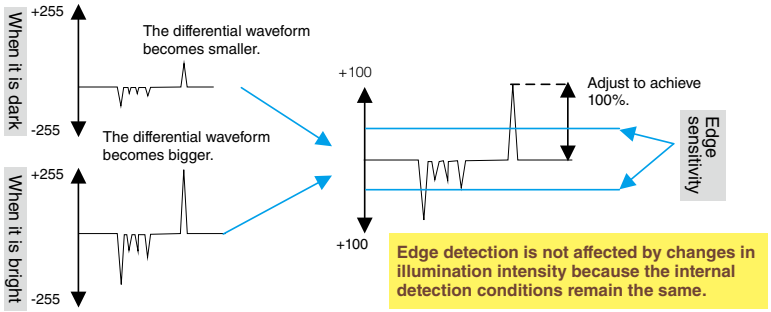
What is the differential processing?

Variation in shade (intensity) is obtained by this process.
All influences caused by changes in absolute intensity values within the measurement area are eliminated.

(Example) The absolute intensity value is "0" if there are no changes in shade.
If colour changes from white (255) to black (0), the variation is -255.

3 Adjust the maximum deviation value to be 100%

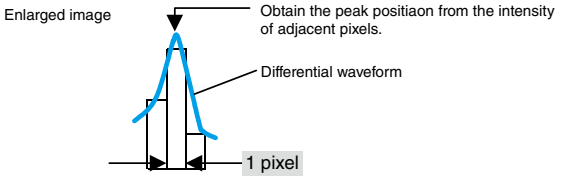
In order to stabilise the edge for the actual production line, compensation needs to be performed so that the maximum deviation value is always maintained at 100%. Then, the edge position is determined from the peak point of the differential waveform which exceeds the preset "edge sensitivity (%)".
Because the peak point of changes in shade is detected, reliable edge detection is realised even for production lines where illumination intensity frequently changes.



Edge detection is not affected by changes in illumination intensity because the internal detection conditions remain the same.

4 Sub-pixel processing

Sub-pixel processing focuses on the adjacent three pixels of the maximum differential waveform and performs interpolation calculations. The process measures the edge position in units down to 1/100 of a pixel (sub-pixel processing).



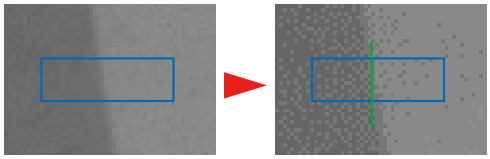
2. Edge mode parameter setting

Sometimes the default values are not suitable to detect a slanted edge or any specific edge from multiple choices. This section explains how to adjust two commonly used parameters to obtain a stable detection in cases such as this.

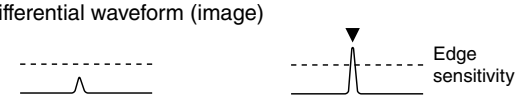
1 To detect an edge where variation in shade is small

An edge can be detected on a part with less variation in shade by increasing the “filter width”.

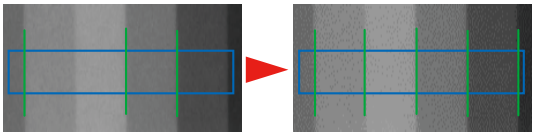
For a slanted edge



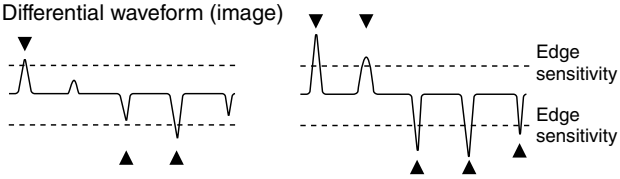
Differential waveform (image)



For small variation in shade



Differential waveform (image)

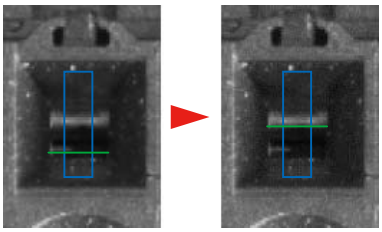


What is the filter width?

This is a coefficient for a filter process to emphasise relatively larger variation in shade within the measurement area.
Edges can be detected easier by setting the filter width larger to emphasise the variation in shade even for an image with lower contrast.

2 Technique to avoid detecting unnecessary edges

Any weak edges with smaller variation in shade can be ignored by setting the “edge strength lower limit” larger.



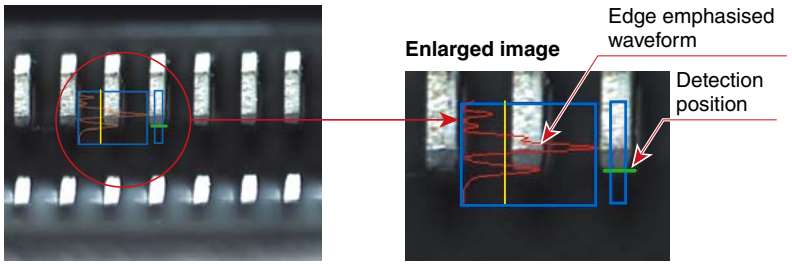
What is the edge strength?

This is a differentiated value after projection processing.
It shows the change of average intensity of each projected pixel. Small edge strength means less variation in shade.
Any weak edges can be ignored by setting an edge strength lower limit.

Detection can be visually checked (edge strength waveform display)

Edge detection level can be adjusted while watching the edge strength waveform during setting. The edge strength or detection can also be checked during the operation because the edge strength waveform can be displayed on a screen in real-time.

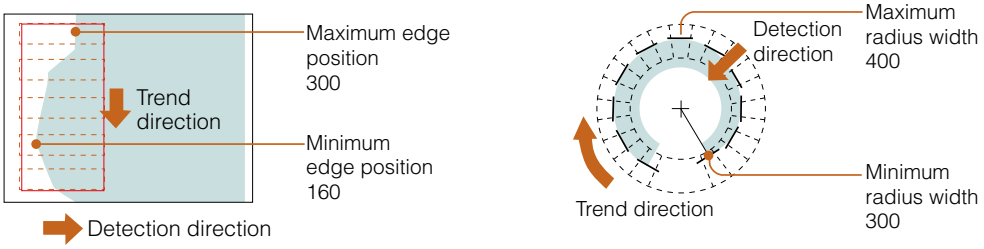
Inside dimension measurement for upper and lower pins



3. Trend edge mode

Trend edge mode scans the measurement area in target segments in the specified direction for edge detection. Because multiple edge position information can be measured in one measurement area, a circle or line formed by a point group of individual measurement results can be detected. This can also be done using entire detection results such as average, maximum and minimum results.

Detection principle image

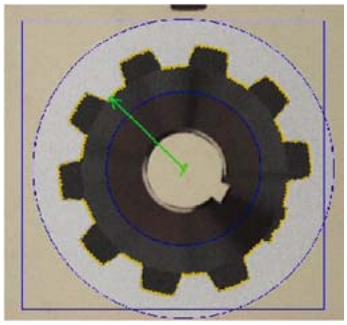


- If highly accurate position detection is required ..... Reduce the segment size.
- If short process time is required ..... Reduce the shift width of the segment.
- What is the trend direction? ..... The direction towards which the segment is moved.

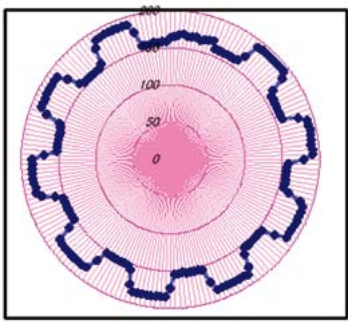
Benefit — Maximum, minimum and average inspections with multipoint data and external output of entire data

Because the position data for multiple points can be processed together in one window and the inspection can be judged by the positions and width data of the maximum, minimum and average values, high-speed process is possible. Additionally, because the position and width data of each point can be externally output, multipoint data management is possible.

[Gear teeth position measurement]



[Data development graph in Excel]

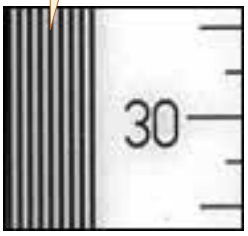


4. Pre-processing filter to stabilise the edge detection

In edge detection, it is very important to suppress the variations of edges. “Median” and “average” filters are effective at stabilising edge detections. This section explains the characteristics of these pre-processing filters and effective selection method.

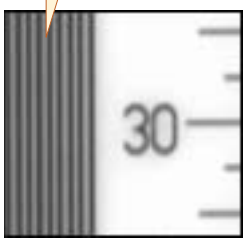
Original image

Repeat accuracy = 0.080 pixel



Averaging

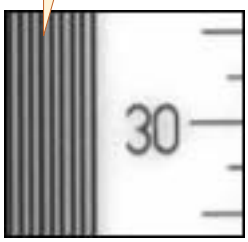
Repeat accuracy = 0.045 pixel



Averaging filter with 3 x 3 pixels.
This filter is effective in reducing the influence of noise components.

Median

Repeat accuracy = 0.057 pixel



Median filter with 3 x 3 pixels.
This filter reduces the influence of noise components without blurring the image edge.

Image Processing Lineup

XG-8000 / XG-7000 Series

Ultimate Vision Solution

Vast lineup of area & line scan cameras using high speed distributed processing with a wide variety of flexible interfaces that can be fully customised to meet the exact customer requirements.

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Power Meets Simplicity

The Auto-Teach inspection tool recognises any differences on the target that do not conform to the trained good data. Multi-language support is incorporated for world-wide use by almost any user.

Lineup of lights that support a wide range of inspections


Direct ring light


Multi-angle ring light


Multi-angle square light


Bar light


Dome light


Backlight


Coaxial light


Spot light


Low angle light


Square bar light


Line light


LED light controllers

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


Super high resolution/ low distortion lenses


High resolution/ low distortion lenses


CCTV lenses


Macro lenses


Compact camera lenses


Line scan camera lenses

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