KEYENCE

Image Processing

Pattern Search Tool

This technical document covers the Pattern Search which is a common tool that is used in many vision applications that involve position and angle measurement. This tool is also used with the position correction function to relocate other vision tools based off the misalignment of work-pieces. This section provides detailed explanations of the principles & techniques to obtain stable pattern detections.

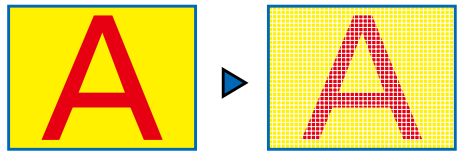
1. Pattern Search algorithm

In order to obtain a high accuracy pattern search, the full 256 level grayscale intensity data should be used. Typical search algorithms use a lot of data and the search speed is slow preventing a high speed inspection. KEYENCE realises a high speed and high accuracy search using the following method:

Pattern Search process

Process 1 Compress the pattern and search images to reduce data volume.

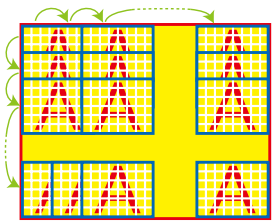
Because pattern searching (normalised correlation) processes a large amount of data, it takes a significant amount of time to perform all the necessary calculations on the image data. Therefore, limiting the number of pixels for calculation shortens the process time generating less amount of data. This is called “thinning” or “compression”.



Pattern window for input image　　Pattern window after thinning

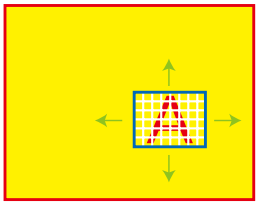
Process 2 Initial rough search

A coarse search is performed on the compressed image to find the best matching candidate with the highest correlation value. The search continues at all possible angles as well when rotation is set.



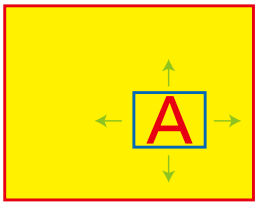
Process 3 Intermediate searches

A search is performed on a less compressed image only in the area where the highest correlation was found in the rough search. This searching process is repeated while continuing to reduce the compression rate each time.



Process 4 Final detection

A final pattern search is performed on the uncompressed image data to obtain the final position calculated to the sub-pixel level.

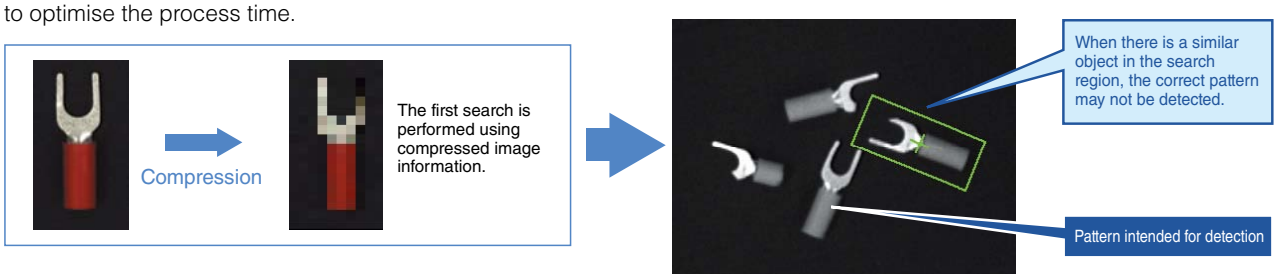


2. Avoiding search errors

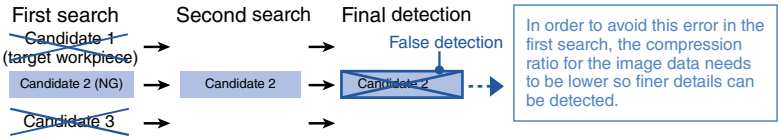
When incorrect detection occurs, it is helpful to know the cause in order to avoid mistakes by setting the optimum parameter settings.

1 Cause for a searching mistake

As explained for the algorithm section, the first search detects the approximate position using a compressed image in order to optimise the process time.

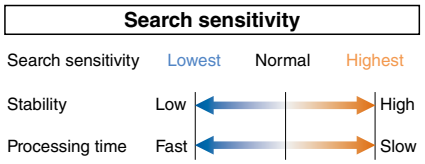


The main cause of searching errors is detecting the wrong candidate in the first search on the compressed image when there are similar object in the area.

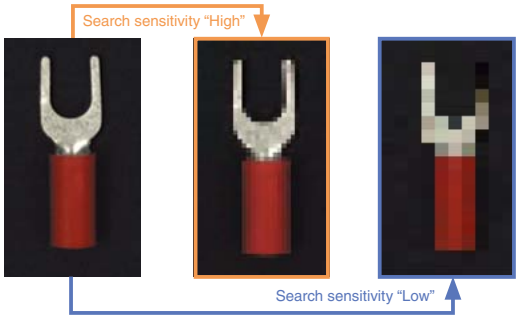


2 Changing the Compression Ratio

In the KEYENCE Pattern Search tool, the compression ratio can be changed without requiring expert knowledge of the algorithm. The compression ratio can be set using the Search Sensitivity setting which has seven levels: Lowest to Highest



The images on the right illustrate the change of search sensitivity (compression ratio) from high to low on a terminal connector. By using a higher sensitivity, false detection of similar objects can be avoided.



3 Stabilise the search by improving accuracy

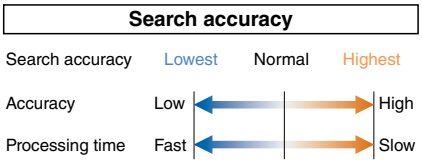
The search sensitivity should prevent most mistakes, but higher accuracy may be required for the search to reduce variation. The ultimate accuracy is determined by how finely the search is performed in the final steps.

Effective techniques to improve the result accuracy

(1) Increase the amount of intermediate searches for the final process
(2) Use image enhancement filters

(1) Increase the amount of intermediate searches for the final process.

The Search Accuracy setting can be used to determine the amount of repetitive searches that are performed in the intermediate and final processes of the search algorithm.



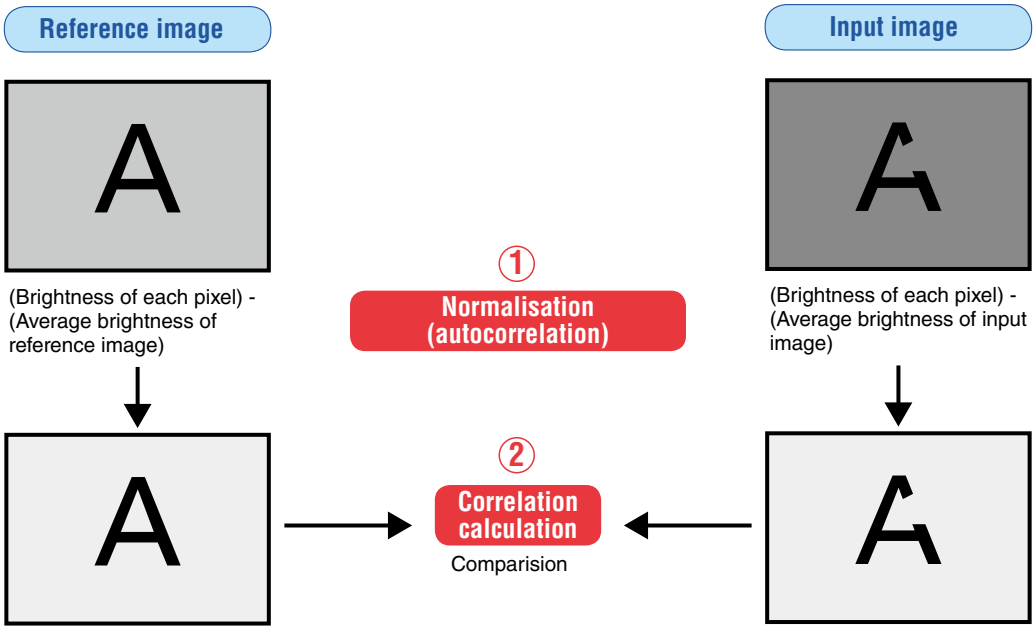
To improve the final result accuracy of the search, the number of times of the intermediate and final searches can be increased by setting the search accuracy.

(2) Use Image Enhancement Filters

There are numerous image enhancement filters that can be used to stabilise the image in order to make the pattern search more reliable.

3. Normalised correlation principle

The CV/XG Series utilises a normalised correlation method for the pattern searches. Normalisation basically subtracts the average brightness of the whole image from each pixel in both the reference and input images. This makes pattern searching stable even if the new image has a different brightness compared to the reference image. Then a correlation calculation is performed to determine the matching rate.



Benefit

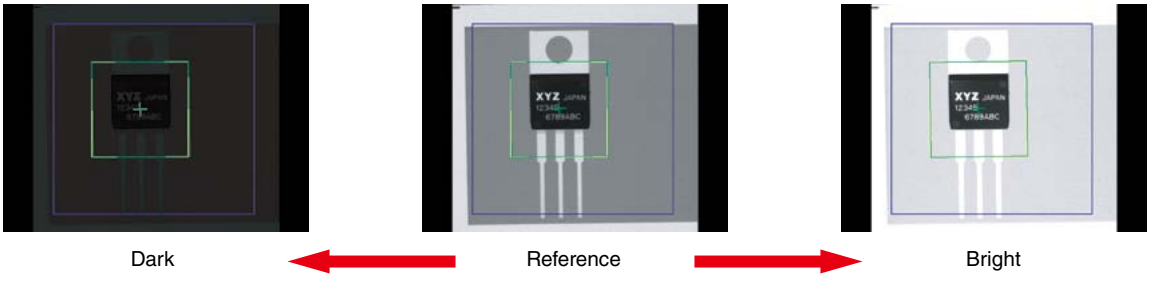
Since absolute values of the data are not used, searches will not effected by overall changes in illumination brightness or if small parts of the target are missing. This method also allows for accurate sub-pixel processing of the data.

Disadvantages

A heavy processing burden is required due to large amounts of data to be analysed. However, the CV/XG Series incorporate dedicated processors that offer high performance and speed to perform searches in as little as a few milliseconds.

Effect of normalised correlation search

Stable searches can be performed regardless of changes in overall ambient brightness of the image area.



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

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