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Vision System VS-580: Advantages of a 4-camera system over a 3-camera system for 360 degree inspection of cables, pipes, hoses, round steel, etc.

1) Smaller inspection area per camera - more precise focusing

In a 3-camera system, each camera must inspect at least 120 degrees of the profile circumference in order to cover 100% of the surface. This means that each camera has to monitor a larger area, which increases the required depth of field.

By contrast, in a 4-camera system each camera covers only 90 degrees of the profile circumference. This significantly reduces the required depth of field because each camera monitors a smaller circular segment. A lower depth of field makes precise focusing easier and results in clearer, more detailed images.

2) Lower object distortion

The greatest advantage of a 4-camera system is the reduction of object distortion. A defect is visible at its full size only when it is positioned directly perpendicular to the camera. The further the defect rotates away from this position, the smaller it appears. This effect increases rapidly at the edges of the field of view. In a 3-camera system, a defect can be rotated by up to 60 degrees (120 degrees / 2) from the perpendicular position before it is captured by the next camera. In a 4-camera system this is only 45 degrees (90 degrees / 2), which significantly improves the accuracy of defect detection.

Figure 1 illustrates this effect. It shows a defect of the same size at different positions around the circumference.

It is easy to see that defects are compressed horizontally the closer they are to the edge. The originally round defect becomes strongly elliptical. The two vertical green lines show the capture area of one camera in a 4-camera system. The red lines show the same for a 3-camera system.

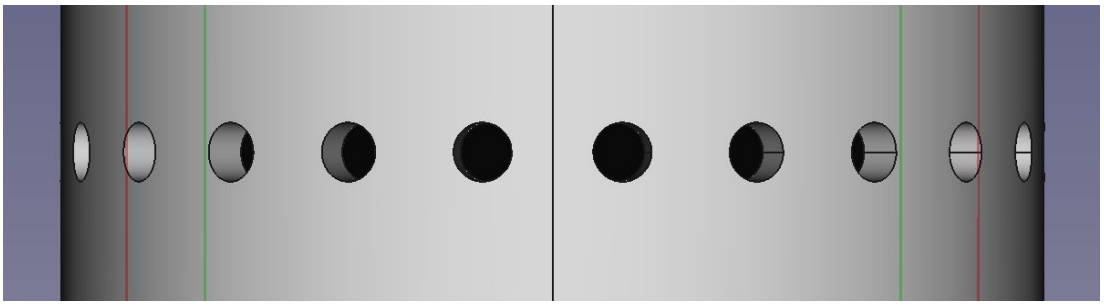

Figure 1: Defect at different positions

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This advantage is particularly important when defects are located in recesses of the round profile.

In Figure 1 this is illustrated by the black base inside the defect. It is very clear how the black area becomes rapidly smaller the further it is located toward the edge. In this example it is no longer visible in the 3-camera system, while it is still visible in the 4-camera system.

Due to the smaller angular deviation, such defects are detected earlier and more reliably. This increases the probability that even smaller and less conspicuous defects will be detected, improving the overall efficiency of quality control.

3) Less intense image rectification for defect-size correction

In addition, the apparent reduction in defect size caused by rotation is taken into account mathematically. The image is rectified before the actual processing step. However, this rectification does not create any new image information. It only stretches the existing pixels (image data) accordingly. This function ensures that the detected defect size is independent of its position in the image. Otherwise, the same defect would appear significantly smaller near the edge. Here too, a 4-camera system requires less intense rectification.

4) Advantages of color evaluation

The VS-580 vision system works with color cameras. Although the inspected products are mostly monochrome (white-gray), the use of color cameras still offers advantages over conventional grayscale cameras. A color image contains significantly more information than a grayscale image. This additional information can be used to improve image processing and analysis. This can be particularly beneficial for detecting contamination or material variations that might not be as clearly visible in a grayscale image.

Summary of advantages

- **Reduced depth of field:** Because each camera only has to cover 90 degrees of the profile circumference, the required depth of field is lower. This leads to better image quality.
- **Lower object distortion:** With a 4-camera system, the maximum rotation of a defect is reduced to 45 degrees before it is captured by the next camera. This significantly increases the accuracy of defect detection.
- **Improved defect detection:** Especially for defects in recesses, the 4-camera system offers clear advantages because these defects are detected faster and more precisely.
- **Less intense computational rectification:** Computational rectification of the image data makes defect-size detection independent of the position in the image. This prevents defects at the edge from appearing smaller than defects in the center.
- **Higher information density through color evaluation:** The use of color cameras enables more accurate and more comprehensive inspection because color images contain a higher density of information. This is particularly advantageous when detecting subtle surface irregularities and contamination.

Overall, a 4-camera system offers significant improvements in the inspection of 360 degree surfaces by reducing the required depth of field, minimizing object distortion and optimizing defect-size detection. The additional color evaluation provides an even more precise inspection. This leads to more accurate and efficient quality control, ultimately resulting in higher product quality and lower reject rates.