Report

Defect Detection on OD of Cylinders

1 Background

1.1 Customer's Problem Statement

Cylindrical components produced by manufacturer are subject to a series of flaws including pits, dents, scratches, voids, and grinder flat spotting and in some cases oxidations.

Current method of inspection is a manual visual inspection of the surfaces of the cylinder.

Required automated inspection system is required to be designed in such a manner as to provide a robust dependable inspection system that can operate in a factory environment. A turn key material handling system is required to feed and inspect as well as reject non conforming components.

2 Initial Proof of Concept Testing

PVI conducted the following study with the following results observed. Findings were that a robust system could be produced for the types of flaw detection requested by the customer. below.

2.1 Background of Study

PVI developed an image capture system for OD of the cylindrical surface. The OD was imaged using a digital line scan camera, with 1024 pixels. In the case of the study, the ends of the part were also inspected. Since additional defect types, which might be of interest to Die Molding, were present on the ends of these samples, those results are included as well, even though the ends of the brake cylinder pistons are not to be inspected.

The part was rotated about the axis of the cylinder while the line scan camera captured image data. In this manner the OD of the cylinder was flattened to a rectangular surface as shown in

the images in Section 3.1. This method of images yields a high resolution, well-lit image enabling robust detection of various types of surface defects.

The images and corresponding detected defect overlays for the ends of the cylinders are shown in Section 3.2.

Existing image processing and additional custom processing modules are integrated using the LabVIEW and IMAQ Vision toolset from National Instruments to process the images collected. This process of manual image collection, followed by semi-automated or manual image processing, is typical of demonstration projects of this nature. Using this method PVI offers our customers free evaluation and demonstration of system concepts for a number of complex and difficult imaging problems. In this phase, we do not try to solve all of the special cases, nor do we attempt to handle every defect type or condition. The purpose of this type of study is to demonstrate, with reasonable certainty, that a solution is possible. Additional development work and algorithm refinement is generally required, after contract award, to complete the core of the production quality software. Similarly, significant engineering usually remains on the mechanical aspects of the system design.

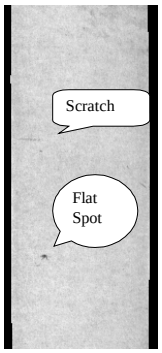
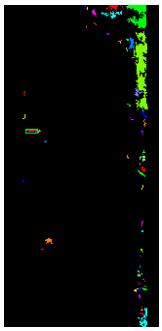
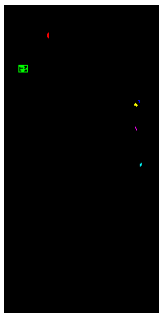
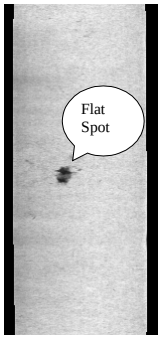
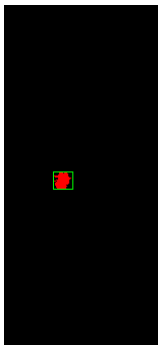
3 Results of the Testing on OD of Samples

3.1 OD Inspection Results

The images and notes in the following table are the results of the image capture and processing performed on a set of cylinders. Only a small subset of the results is shown here, for brevity.

[The images have been scaled in Word, to improve readability of the document. To view a selected image at full resolution, use the picture's property to set the size back to 100%.]

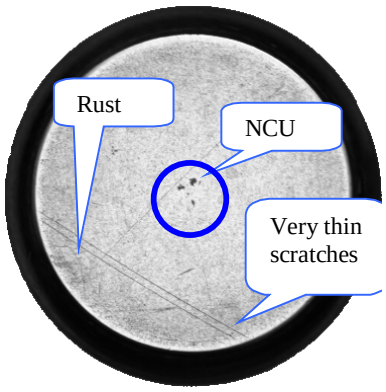
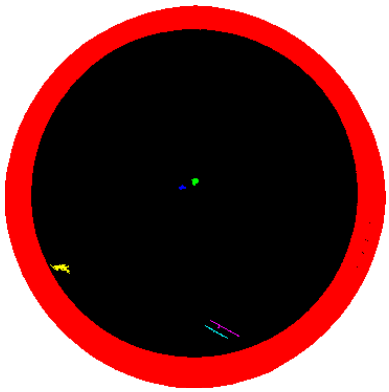
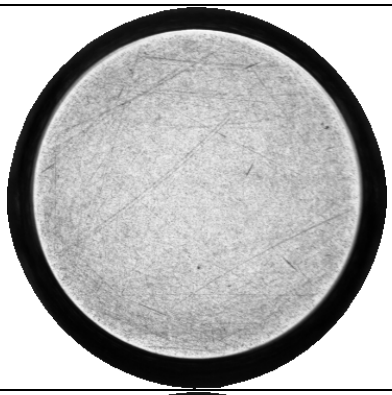
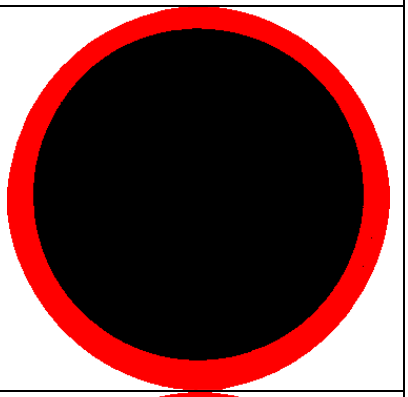
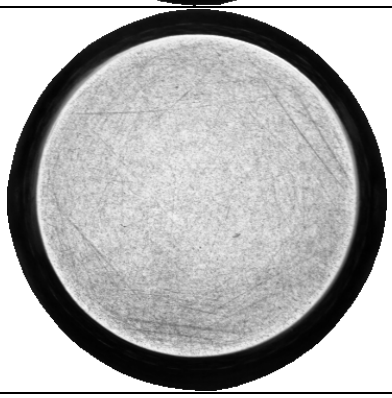
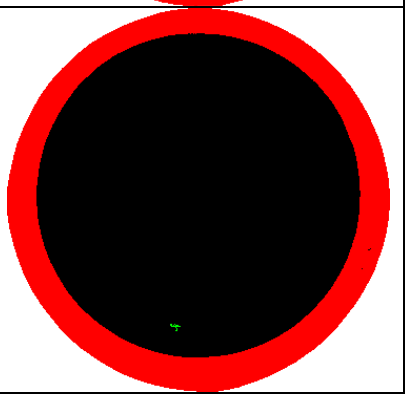
Table 1:Results of Image Processing for OD Surface

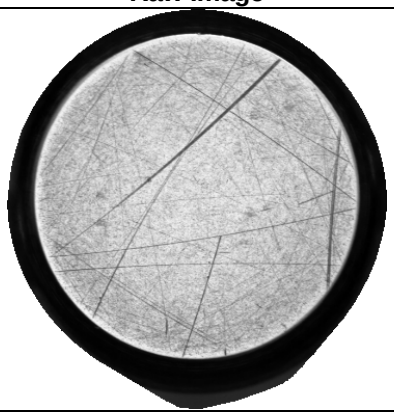
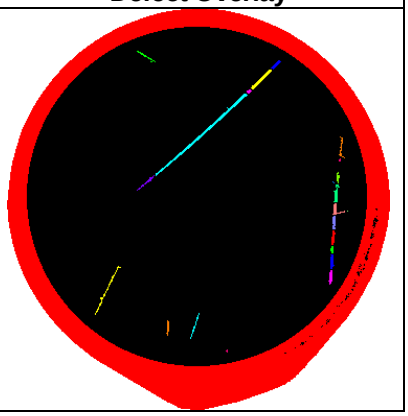
Notes	Raw Image	Defect Overlay
Sample **5** Expected Defect: Flat on OD Flat spots show up as dark patches, as highlighted at right. Maximum dimension is 0.010". The scratch would not fail the part, being 0.0013" wide and only 0.021" long. Some evidence of rust also present in upper right corner and right edge.		
Sample **9** Expected Defect: None Results of particle processing. Highlighted pit is a borderline defect, at a max dimension of 0.0098". As long as this particle is below 0.010", up to 3 particles are allowed, so the part would pass.		
Sample **12** Expected Defect: Flat on OD Flat spot shows up as dark patch, as highlighted at right. Maximum dimension is 0.020".		

3.2 End Inspection Results

The images and notes in the following table are the results of prototype image capture and processing performed on the *ends* of a set of 50 cylinders (5 mm diameter). Only a small subset of the results is shown here, for brevity. A more fully developed processing system would be required to process the results from all samples for all defect types. The dark ring (red in the overlays) is the breakout on the corner of the roller. The typical measured diameter of the top of the bearing was about 0.1615".

Table 2: Sample of the End Inspection Results

Notes	Raw Image	Defect Overlay
Sample 01 Expected Defect: NCU NCU shows up as pits in the center of the end. Two of three such pits were large enough to be detected as shown in overlay at right. In addition, we detected small rust area and 2 very thin scratches. The width of the scratches was only about 0.0005", so they were not have counted as defects.		
Sample 02 Expected Defect: Good No defects detected.		
Sample 03 Expected Defect: Good One small defect detected. Size of defect was only 0.005" in diameter. A single pit of 0.010" is allowed.		

Notes	Raw Image	Defect Overlay
Sample 39 Expected Defect: Grind line The two widest scratches measure about 0.0015” wide, at the widest point. There are clearly several other scratches. Using the scratch processing in FiberQA, we could identify and measure each scratch visible in this image		

4 Conclusions

The results presented in Section 3 clearly demonstrate that PVI has successfully developed a machine vision system capable of detecting small pits, scratches, and other surface defects on both the OD and ends of cylinders. The reported results were in excellent agreement with the customer’s operators manual inspection results.