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Why is the VisionGauge® Digital Optical Comparator Much More Accurate Than Traditional Optical Comparators?

Real-world tests, carried out by both the manufacturer and by users, have shown that the VisionGauge® Digital Optical Comparator is significantly more accurate & repeatable that traditional optical comparators. Measurement accuracy, measurement repeatability, measurement reproducibility, Gage R&R results: all are much better with VisionGauge®. In this article, we'll look into the main underlying reasons for this.

1. Completely Different Optical System

Traditional optical comparators magnify a small portion of the part being inspected onto a large projection screen. Let's consider, for example, a 10X, 30" comparator. A 10X magnification means that this comparator will project a 3" portion of the part onto its 30" projection screen. A traditional optical comparator does this using an optical system that is comprised of prisms, lenses & mirrors. These are difficult to manufacture and all have a certain level of defects. The large lenses used in the lower magnification traditional optical comparators (such as 5X) are especially difficult to manufacture and are the ones that suffer from the most inaccuracies and non-uniformities.

The VisionGauge® Digital Optical Comparator works very differently. If we stay with this 10X example, VisionGauge® takes this same 3" field-of-view, but instead of "blowing it up" to 30" it reduces it to a (roughly) 1" camera sensor. Lenses to do this are much easier to manufacture, much more defect-free.

This means that, right out of the gate, VisionGauge® starts off with a much better, more geometrically accurate image.

And this fundamental difference in the optical systems of traditional optical comparators and of the VisionGauge® Digital Optical Comparator brings about another important added benefit. It's well know that traditional optical comparators have very low contrast, which makes it even more difficult for operators to (subjectively) determine if a part is within tolerance or not. Historically, attempts to address this contrast issue have involved putting a screen or curtains around the operator's station to try to "dim" ambient illumination and allow the operator's eyes to adjust. This low contrast issue with traditional optical comparators is related to the fact that they take the light from the smaller area being inspected and disperse it over a much larger projection screen (in our example above: light from a 3" area is dispersed over a 30" area).

Since it uses a completely different approach, with a completely different optical system, the VisionGauge® Digital Optical Comparator doesn't have to deal with any of these contrast issues. Because it collects the light from a larger area onto a much smaller camera sensor, VisionGauge® isn't light-starved like traditional optical comparators can be. With VisionGauge®, there are no contrast issues to overcome.

Finally, it's interesting to note that VisionGauge®'s re-thought optical system also provides another benefit: a much larger depth-of-field. This means that in most cases "everything is in focus at once" and the operator doesn't need to continually refocus as he does with traditional optical comparators that have a very thin depth-of-field. This doesn't contribute to an increased accuracy per se, but it certainly is a benefit from the user's practical perspective.

2. Mathematical Digital Image Correction

We've seen why the image that reaches VisionGauge®'s camera sensor is much better and more geometrically accurate than the one that reaches traditional optical comparator's projection screen. But things don't stop there.

At this point, VisionGauge® is working with a digital image. And there's lots that can be done when the image is in digital form, especially in the case of a high-contrast super-high-resolution digital image such as the one produced by VisionGauge®. VisionGauge® takes this better, more geometrically accurate image, and makes it… even better & more geometrically accurate. Specifically, VisionGauge® - using a proprietary calculation scheme - carries out real-time (i.e. on the live image video stream) full 2D non-linear distortion correction. This eliminates the last remaining small geometric inaccuracies in the image, which even further increases the system's final precision and accuracy.

3. Digital Image Processing

VisionGauge® can also carry out digital processing of the image, which is a further advantage over traditional optical comparators. For example, VisionGauge® can apply edge sharpening, electronic noise reduction, or any of the digital image processing & enhancement techniques that are now so widespread and used by our cell phone cameras and all of the other cameras that are now so prevalent in everyday life.

4. Works Directly With The Part's CAD Data (No Overlays!)

Traditional optical comparators use templates, Mylars™, overlays or transparencies to compare a part to its drawing. These are printed out on transparent material that is then laid on the comparator's screen. Of course, no printer is perfect and the printing errors reduce accuracy. And, over time, this overlay material can stretch and distort slightly, which leads to a further reduction in accuracy.

The VisionGauge® Digital Optical Comparator compares a part to its CAD data directly. The CAD data is the mathematical description of the part. The data to which VisionGauge® compares the part is completely error-free. With VisionGauge®, there are absolutely no inaccuracies introduced at this stage of the process.

5. Powerful Sub-Pixel Accurate Edge Detection

With traditional optical comparators, pass/fail determinations are subjective & operator-dependent. I think the part is good, you think it's bad… let's go ask a 3rd person…

The VisionGauge® Digital Optical Comparator uses sub-pixel accurate edge-detection. This completely eliminates operator subjectivity. Furthermore, you & I can only measure from pixel-to-pixel. But because its edge detection tool is sub-pixel accurate, VisionGauge® can actually locate

edges very accurately between pixels. This further increases the precision and accuracy of the system's results.

6. Patented CAD Auto-Align™

With traditional optical comparators, the alignment of the overlay to the part and its datums are subjective, and that can be a huge source of errors and – obviously – results are operator-dependent.

The VisionGauge® Digital Optical Comparator has a powerful patented CAD Auto-Align™ tool that automatically aligns the CAD to the part along one or multiple datums or as an overall best-fit. Results are extremely repeatable and completely operator-independent. This is a huge advantage over traditional optical comparators!

Furthermore, VisionGauge®'s CAD Auto-Align™ tool is not limited to the system's field-of-view, i.e. what the system "sees" at a given moment in time. It can actually travel down the length of long parts, capture images at different locations and carry out a CAD Auto-Align™ over the entire length of the part. The automatic CAD-to-part alignment is not limited to small parts and can be carried out over even very large parts, to very high accuracy. That's just about impossible to do on a traditional optical comparator, even in a subjective & operator-dependent fashion.

7. Patented CAD Auto-Pass/Fail™

Finally, with traditional optical comparators, the determination of whether or not a part is in tolerance is subjective and – again – results are operator-dependent.

The VisionGauge® Digital Optical Comparator has a powerful patented CAD Auto-Pass/Fail™ tool that automatically determines if the part is within tolerance, either at point locations or across entire geometric entities. This provides much higher accuracy and completely eliminates operator subjectivity.

And, here also, VisionGauge®'s CAD Auto-Pass/Fail™ tool is not limited to the system's field-of-view. It can carry out a fully automated very high accuracy pass/fail determination over the entire length of the part, regardless of its size.

The VisionGauge® Digital Optical Comparator is a drop-in replacement for traditional optical comparators that remains a very general-purpose and easy-to-use system that is widely applicable across a wide range of industries.

However, The VisionGauge® Digital Optical Comparator represents a great technological leap forward from traditional optical comparators. It has innovative and up-to-date technology that, in many instances, completely does away with inaccuracies that plagued traditional optical comparators. As a result, the accuracy, precision, repeatability and reproducibility of the VisionGauge® Digital Optical Comparator's results are significantly better. Customer accuracy studies and Gage R&R studies have shown this time and time again.