3D Visualization of Defects in Railroad Wheels

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Category:
Automated Test

Products Used:
NI LabVIEW 2010
NI OPC Server
NI USB-6008

The Challenge:
Enhance an industry standard non-destructive test that inspects railroad wheels as they exit the production line to visually illustrate the location and nature of any detected defects.

The Solution:
A control application was developed in LabVIEW that utilized the NI OPC server to monitor and control the production line. Ultrasonic inspection permitted locating the defects and the new 3D graph facilitated imaging the results.

Abstract:
CScan and BScan displays are an industry standard for non-destructive ultrasonic testing. The test involves scanning the surface of the wheel with ultrasonics and reading the reflected signal to characterize the health of the unit. Due to the 2D nature in which the current system displays data to the user, interpreting the scans require specialized training. Data Science Automation combined the magnitude and the time-of-flight (TOF) information from multiple scans and rendered images of the defects in a manner similar to what would be possible if the wheels were transparent and we could "look into" the wheel.

Bringing Data into Focus
The system was developed using the NI LabVIEW 3D Graph. Using a customer supplied CAD file (the system will run on any type of railcar wheel given the 3D data), the item to be inspected was visualized. DSA then mapped the data collected from the probes onto the virtual wheel making the defect data come to life.

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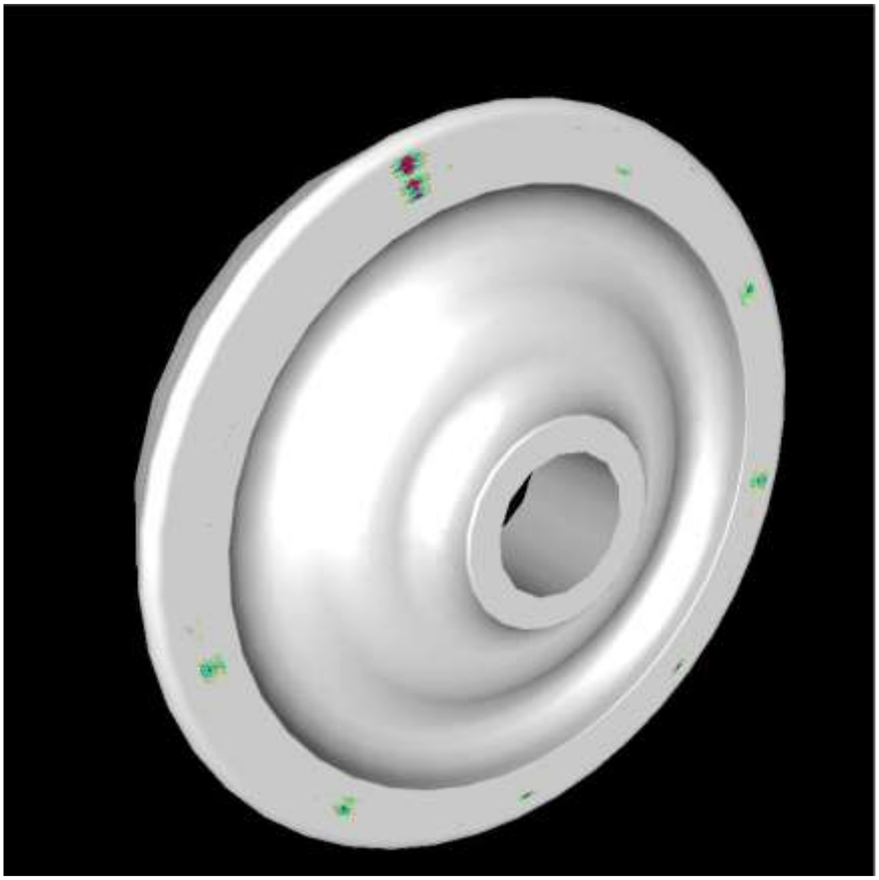

Figure 1 - A 3D Visualization

Figure 1 shows a test wheel that has been tested and shows several defects, the most significant of which can be seen at the top. By placing the defect data on the surface of the rendered wheel, the CScan data can be visualized.

Bringing the defect data to the surface of the wheel can then allow the user to see the type and severity of the defect. Figure 2 illustrates how the defect runs thru the entire wheel structure. This gives you an appreciation of how complex reading the data in 2D would be.

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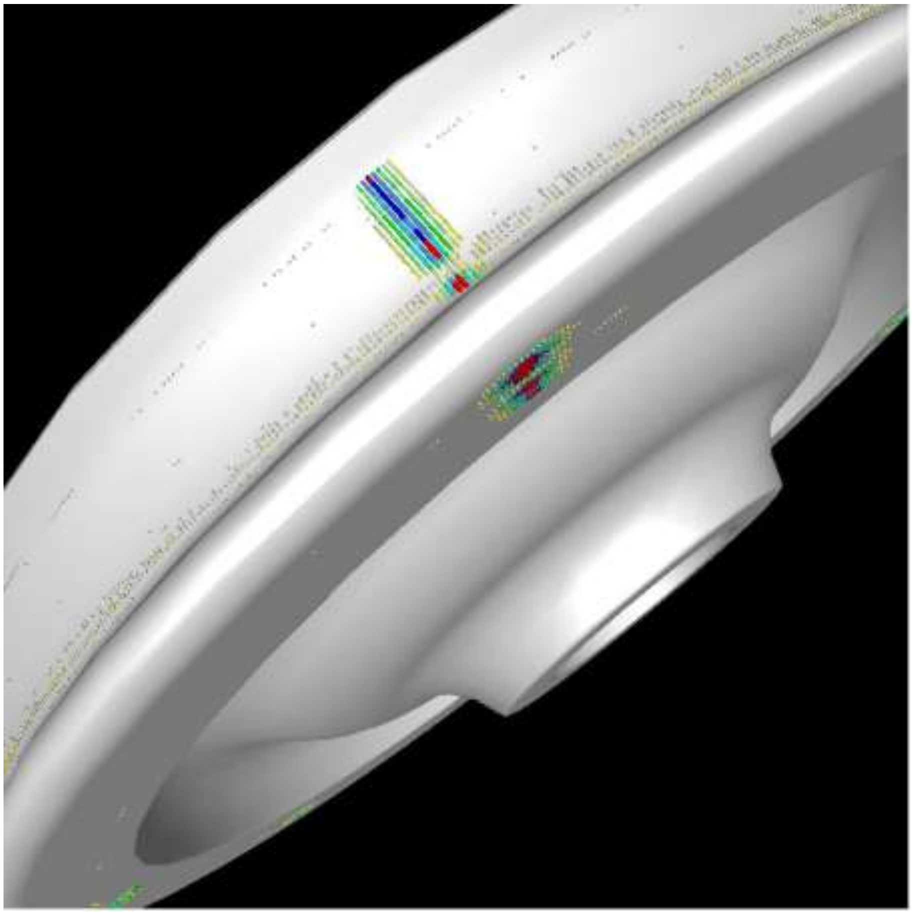

Figure 2 - Defect Shown on the Surface of Visualization

Enhancements Make the User Grow Fonder

While the 2D representation allows the skilled user to detect defects, the 3D visualization allows for a number of enhancements that give the user more information in a more compact format. The colors of the defects are derived from a user defined color spectrum allowing the system to highlight different aspects of the non-conformities.

The size of the 'sphere's shown in the image reflect the amplitude of the CScan value. They are sized such that the large reflections appear as larger spheres. The display must take multiple factors into consideration: a) the distance between the samples read and b) the amplitude of the reflected signal. Synchronization of the probe position data is combined with the geometry of the wheel to properly map the data to the surface.

Using the 3D control, the user can rotate around and zoom in on the shape providing complete freedom of motion to visualize the defect.

Figure 3 is a zoomed in picture of the major feature seen at the top of the wheel. Multiple factors are brought together to characterize the defect reducing the time to train the user to interpret the results.

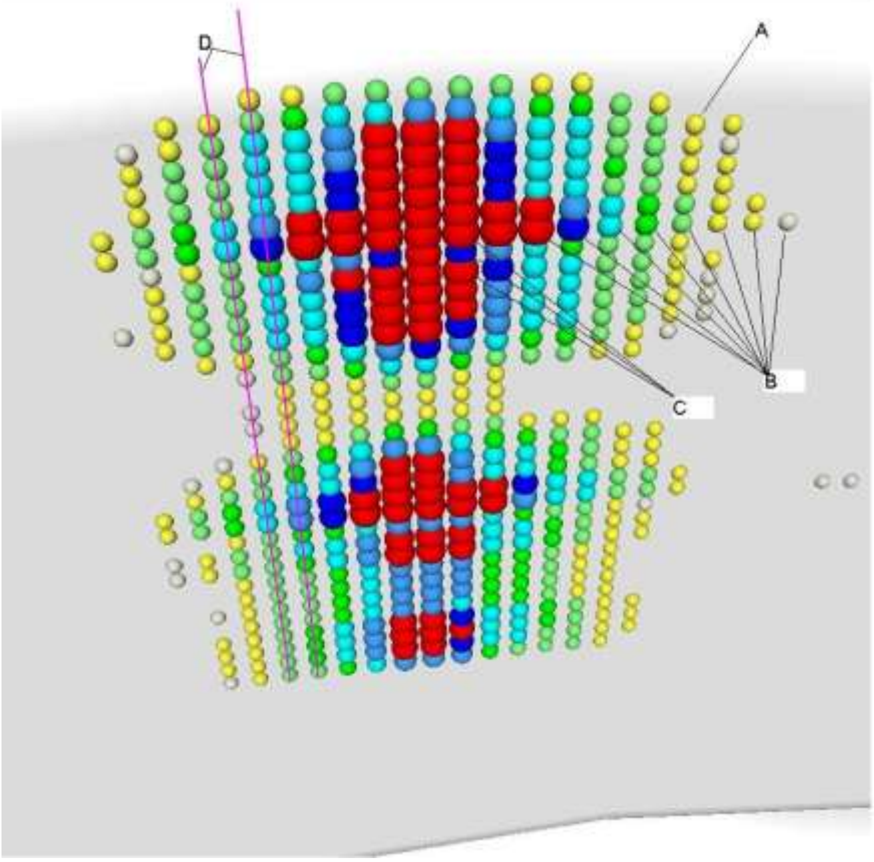

Figure 3 - CScan on Surface, Zoomed in to Show Detail

Into the Looking Glass (Wheel)

Showing the defect data on the surface of a 3D rendering allows the user to see the location of the defect and to some degree the severity. To truly visualize the depth of the defect the user needs to see into the wheel. When the data is interpreted to only show surface defects (defects occurring some small distance from the outer surface) the outline of the deformity can been seen (see Figure 4).

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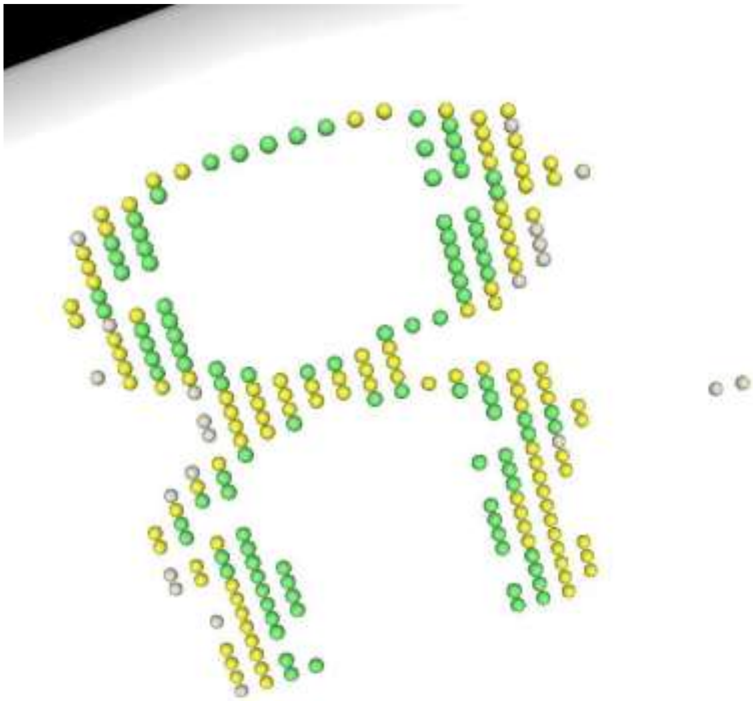

Figure 4 - Just the Surface Defects

When the wheel is made transparent, the imperfection can be seen in 3D. Suddenly depth comes into view. How close internal defects are to each other, the depth of the defect compared to the thickness of the wheel, and the internal shape can all be visualized as multiple sets of scan data are combined together. When the reflections are shown in 3D space the user can better visualize the defect.

Finally, Figure 5 shows the transparent wheel and the defect data. The edges of the wheel, detected by the scan or a 3D scaffolding of the CAD data are shown to allow the user to still reference the 3D geometry. The same colors are used on the defects to help the user match the surface drawn defect with the transparent view. The user can now see depth. In the case of this defect, the application user was able to correctly identify that a hole had been drilled into the wheel, identifying the diameter and depth of the damage.

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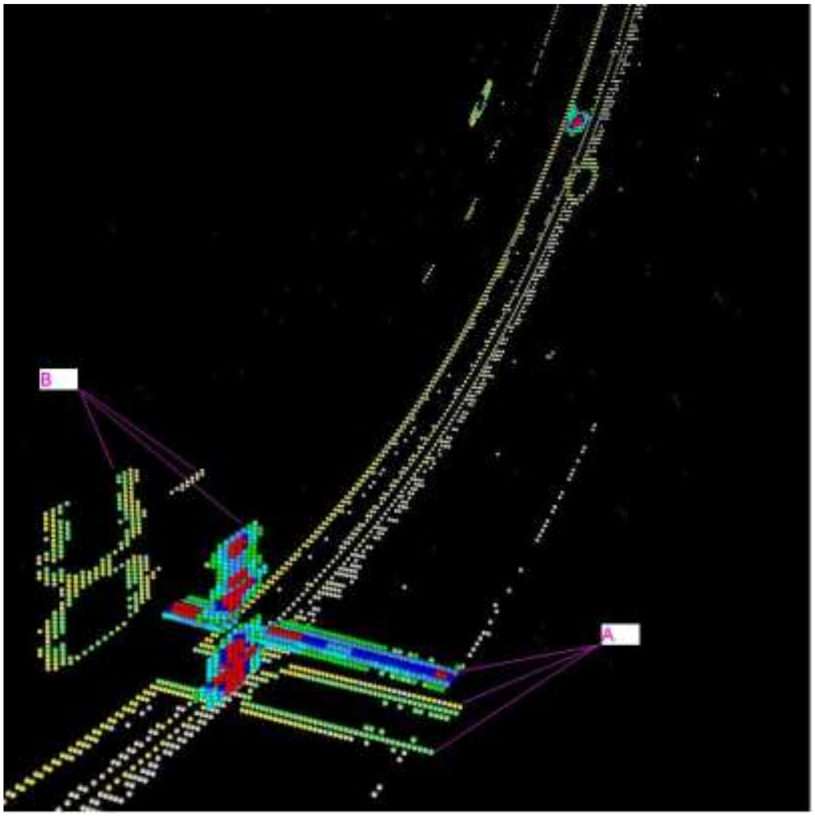

Figure 5 - Defect Data 'Inside'

Conclusion
This new application of 3D visualization, made possible by LabVIEW and the 3D picture control, will revolutionize the way railroad wheels are inspected in the future. The rendering will improve the customer's ability to characterize defects and better predict the impact on wheel performance.

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