

Application Report – Balancing of crankshafts with high-precision 3D images

Precision to one hundredth of a millimeter

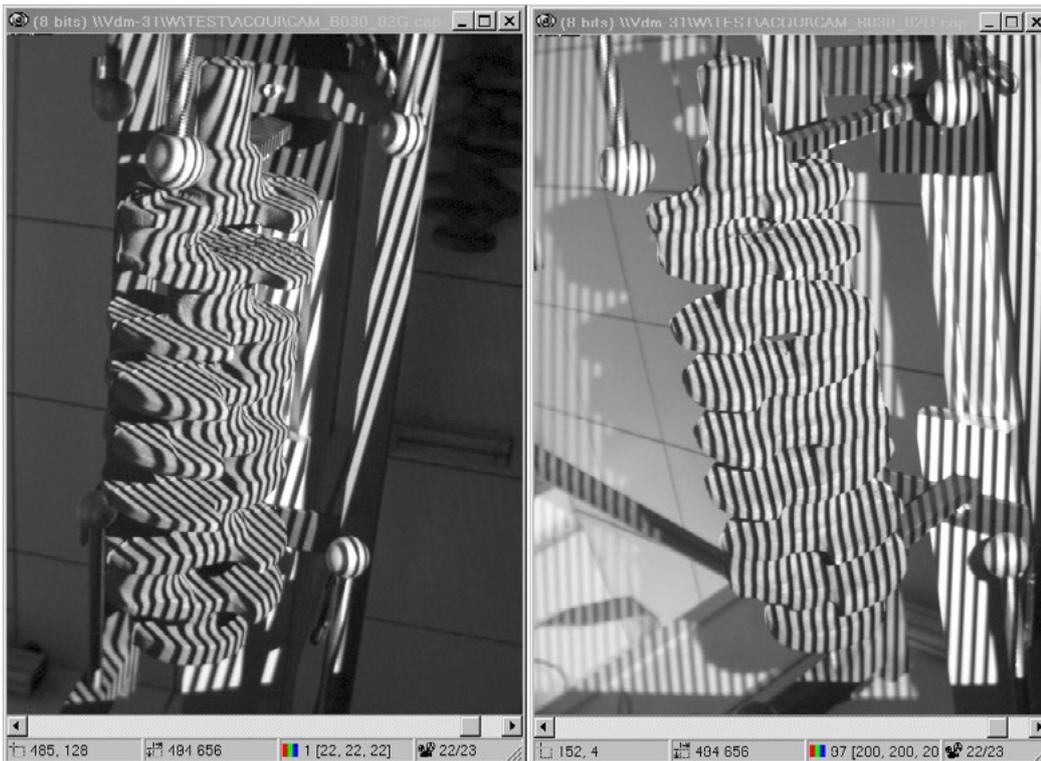
An image processing-based system developed in France sets new benchmarks in crankshaft balancing. Within a mere 37 seconds and with precision to one hundredth of a millimeter, the method by Videometric will reconstruct a digitized 3D image of the crankshaft to be balanced. Simulating tooling operations on this 3D shape allow to define the ideal tooling axis and determine in advance whether the part can be finally balanced.

Crankshafts in the automotive industry convert the linear stroke movement of the engine pistons into rotational motion and transfer it to the gearbox. Even slight imbalance caused by manufacturing tolerances would lead with increasing speed to bearing loads and vibrations. Crankshaft balancing is therefore required. Conventionally, the crankshafts are brought to a high rotational speed. The vibrations caused are used to identify the location of any excess material along the crankshaft's axis that is to be removed by later drilling or milling operations. "Such conventional crankshaft

balancing systems could be strongly improved with 3D vision tools usage", says Olivier Bommart, Sales Manager at Videometric. For several years, the 3D vision expert company has been committed to the development of innovative solutions for the automotive industry. The 3D experts spent several months in their labs to work out an innovative approach of crankshaft balancing with the digitizing process taking center stage. The new method had to ensure 100% digitizing and evaluation of even complex crankshafts within 45 seconds which is the current industry standard, but overcoming



The image processing-based system comprises 16 carbon-fiber arms, each one holding two VGA Baumer cameras and a LED video projector. The system can be flexibly adapted to the size or complexity of a crankshaft.
Photo: VIDEOMETRIC



The fringe patterns projected onto the crankshaft surface by the LED video projectors are captured by the TXG03 cameras at 60 fps. To acquire data for a fully digitized 3D image, the crankshaft is "scanned" three times with rotated rotation angle of 120°. Photo: VIDEOMETRIC

all shortcomings of conventional techniques. "Conventional systems require tooling operations without giving the guarantee that in the end the crankshaft will be perfectly balanced. Worst case, after tooling the crankshaft is still unsatisfactorily balanced and may need to be scrapped because some part defects were not identified early enough. This is a waste of time and money," Mr. Bommart explains.

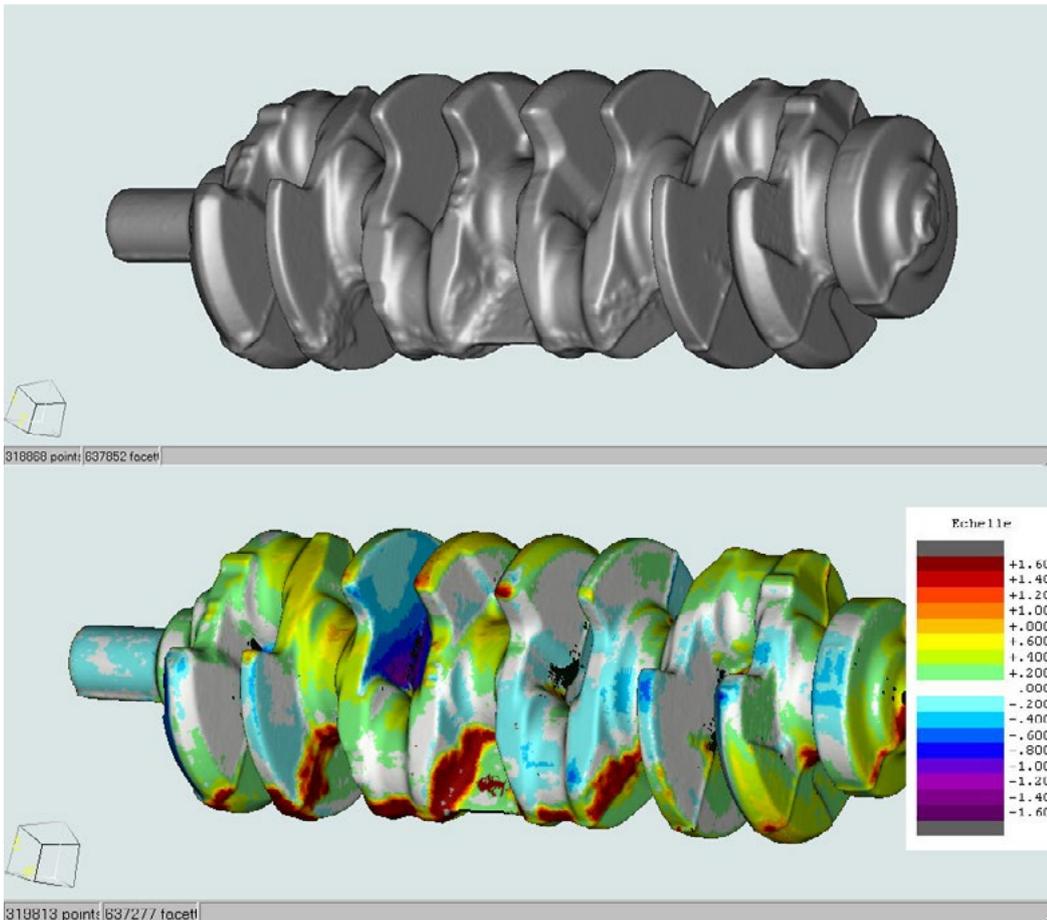
Only 37 seconds to a fully digitized 3D image

Videometric's method is currently demonstrated on an image processing-based GigE system comprising among others 32 industrial cameras, 16 LED video projectors and several PCs. The crankshaft is digitized with utmost precision within a mere 37 seconds. For the digitizing operation, a set of each eight offset mounted carbon-fiber arms are aligned to point on the crankshaft surface. Each arm holds a LED video projector and two VGA cameras of the Baumer TX series. Alternating sinusoidal fringe patterns of non-coherent light with spatially varying intensity are projected onto the crankshaft surface by sequentially triggered video projectors. The sequence of geometrically distorted fringe patterns is captured by the cameras at 60 fps. To obtain a complete 3D image, the crankshaft is "scanned" three times while being turned by 120°. "We do not use high-resolution cameras,

which produce very extensive data volumes that would slow down image acquisition pace. Using a resolution of 640×480 pixel instead, we obtain greyscale images of mere 300 kilobytes which enable quick transmission to the PC via GigE", says Mr. Bommart. Why Videometric has been relying on the practice-proven Baumer TX cameras is obvious to him: "The VGA resolution combined with high frame rates and with being low-noise, they are perfect for our application. Furthermore, we have been deploying Baumer cameras for many years and are very satisfied. They ensure solid 24/7 performance even under demanding conditions and in harsh environments, for example in production of hot metal components."

Image processing with precision to one hundredth of a millimeter

For their new method, Videometric uses proprietary internal high-performance software comprising several algorithms for digitizing, 3D-processing, volume calculation and comparison against CAD. The set of images acquired by each arm is processed to produce a 3D point cloud which may consist of more than 1.6 million points. Depending on the crankshaft's complexity, between 11 and 20 million 3D points can be captured. Next, the 16 point clouds are used to reproduce a very dense 3D digitized image of the entire crankshaft



The Videometric software compares the CAD/CAM model in the data base against the 3D digitized image of the crankshaft to be balanced (top) and will highlight any shape defects in color according to their severity of discrepancy in millimeters (bottom).

Photo: VIDEOMETRIC

with precision to one hundredth of a millimeter. This is compared with the CAD/CAM model of the original crankshaft design stored in the data base in order to identify any non-conformity. Discrepancies between these two images are identified by calculating the individual moment of inertia. Any excess or deficit material is marked in color. The software can simulate the tooling operations

required for successful balancing by determining the moment of inertia and weight distribution after just one tooling operation. If the feedback is positive, the software provides the ideal tooling axis coordinates to the tooling machines. This way, faulty crankshafts can be removed prior to further processing and incurred tooling costs. Mr. Bommart is convinced: "Our new method



Baumer TX series GigE cameras are available in many model variants and with resolutions up to 5 megapixel or 210 fps – for the most diverse applications in any industry.

enhances product quality and profitability. Our current prototype is capable of performing the 100% 3D scan and balancing analysis of the part within 37 seconds which is less than the current industry standard in a production line – and with the same accuracy of conventional systems.” Since the shape of crankshafts can be very complex, the number of arms can be correspondingly adapted. Furthermore, the method may also be used in other applications with rotating parts. “At all times, we are open for new partnerships and further enhancements in the existing system”, Mr. Bommart says.

More information:

www.baumer.com/cameras



AUTHOR

Nicole Marofsky
Marketing Communication
Vision Competence Center