INDUSTRIAL PHOTOGRAMMETRY FOR APPLICATIONS IN AUTOMOTIVE AND AEROSPACE INDUSTRY

Werner Bösemann, AICON 3D Systems GmbH, D-38114 Braunschweig/Germany

New production technologies like 3D printing and other adaptive manufacturing technologies have changed the industrial manufacturing process, often referred to as next industrial revolution or short industry 4.0. Such Cyber Physical Production Systems combine virtual and real world through digitization, model building process simulation and optimization. It is commonly understood that measurement technologies are the key to combine the real and virtual worlds.

This change from measurement as a quality control tool to a fully integrated step in the production process has also changed the requirements for 3d metrology solutions. Key words like MAA (Measurement Assisted Assembly) illustrate that new position of metrology in the industrial production process.

At the same time it is obvious that these processes not only require more measurements but also systems to deliver the required information in high density in a short time. Here optical solutions including photogrammetry for 3D measurements have big advantages over traditional mechanical CMM's.

Many successful installations of photogrammetric solutions exist in industrial measurement applications, Especially the automotive and aerospace industries have been pioneering in the integration of such technologies, but also research facilities like particle accelerators or emerging technologies like renewable energy. Other camera based optical technologies like laser line triangulation sensors, fringe projection systems or digital image correlators use photogrammetric methods as well or are in fact photogrammetry systems just under a different name. An overview of technologies used and the relevance of photogrammetric solutions in the different applications and sectors is presented in the first part

State of the art and recent developments in camera technology, calibration, software and tooling utilized in industrial photogrammetric systems are described in the second part. Special emphasis is given on systems for dynamic measurements with regard to the growing demand in in-line, tracking and positioning applications. With the unique possibility to track multiple points, or objects even in real-time new applications in MAA (Measurement Assisted Assembly) are possible and already have been realized. Another focus is on systems and solutions for measurement of 3-dimensional surface geometry. There is a significant shift in industry from CMM-type single point measurements towards 3D surfaces, also in regards to new technologies like 3D printing.

Requirements for industrial testing and inspection relating to robustness, speed, accuracy and handling, but also in post-processing like CAD or GD&T analysis and reporting do not always match specifications and features of photogrammetric solutions. Many inspection processes and dimensioning schemes, as well as tolerances and thus required measurement accuracies, are designed for classical CMM-measurements and are not easily adapted to new technologies. That also includes the selection of features to be measured. Some of these features like natural edges are hard to define accurately with large scale optical technologies.

Another topic in this part is related to acceptance and certification of optical technologies. Here the definition of standards like VDI 2634 has led to a significant improvement. Also the perception of photogrammetry as a tool used by experts has changed, mainly due to advances in simplified handling and user interaction. In some areas photogrammetric measurements are even an industry standard today, especially in large volume measurements

Numerous successful installations of photogrammetric systems in industrial applications have been delivered. Several examples from different fields demonstrate the variety of installations. These application reports include the technical background of the application, technical realization and a summary of the benefits to the users compared to other technologies. Photogrammetry is no longer an exotic tool anymore, but far from replacing the uncounted number of CMM's, articulated arms or laser trackers.

But strong and growing demand for fast on-site quality control and the availability of mature system solutions has significantly improved both the need and the confidence of the industrial system users and decision makers in the use of photogrammetric solutions in aerospace and automotive industries.

Available standards for traceability and certification, available tooling as well as interfaces to common inspection software have turned photogrammetry into a standard tool in many industrial measurements, combined with unique additional features, like the capability to measure multiple points simultaneously at high frequencies. The application examples shown in this paper can only give a glimpse on the future possibilities for industrial photogrammetric solutions.

The main drawback at the moment is still the requirement to use targets for highest accuracy. This topic is partly addressed by white light scanning systems with their ability to deliver high resolution geometry data but the challenge remains to develop algorithm for direct feature measurement. The possibility to develop solution-oriented systems, like installations addressing MAA applications, will further increase the number of photogrammetry installations in industrial measurements.

Other techniques light time of flight cameras or structure from motion (SFM) still lack the accuracy required in industrial inspection and are limited to deliver starting values for precise measurements systems or observation tasks like collision detection.

Yet the conclusion is that, especially in consideration of the market share of white light scanners, photogrammetry systems are no longer a niche application but an accepted tool in many areas of industrial manufacturing.