PRESS RELEASE

Measuring fiber orientation for composite parts

Apodius introduces the new innovative AVS 3D for optical measurements of both composite parts' geometry and fiber orientation.

The Apodius Vision Systems (AVS) are first choice for composite series production when dry fiber preform structures are involved. So far, the automotive industry has used them predominantly for machine setup and statistical process control. In the past years the AVS family has grown with the addition of AVS Custom solutions, offering customized systems for individual production integration, direct machine integration, unique materials, or incorporated customer-defined defect detection tasks.

This year Apodius presents the new AVS 3D vision system that brings a third dimension to the standard AVS. It comes equipped with a robot or another system for global referencing used to digitize complete fiber structures. The strength of the metrology solutions developed by Apodius is the model-based measuring approach which brings the required robustness to all AVS optical measurement systems that are developed for use in factories and are not restricted to laboratories or other special surrounding conditions. The AVS 3D goes one step further: a geometric measurement sensor module was integrated and combined with the AVS through a new sensor data fusion model.

Digitizing fiber structures using optical metrology systems is a challenge, especially when carbon fibers with their demanding optical characteristics are involved. Special illumination setups are required to handle the mixed reflection properties. In the direction of the fibers, specular reflection occurs, while a diffuse reflection can be observed perpendicular to the fibers' course. In general, the type of fabric or textile structure causes current 3D digitizing systems to fail without destructive preparations or to operate with a high level of uncertainty during measurements.

3D digitization

The AVS 3D uses a special diffuse illumination well known from the AVS standard system to operate with complex fiber structures. Choosing the right combination of texture and geometric measurements is crucial. To integrate 3D digitizing for geometric measurements the AVS was combined with a light-section sensor. Since this is a physical contradiction a data fusion system for both texture and geometry sensor modules was additionally implemented. With the fiber course information incorporated a special acquisition technique was developed to ensure successful modeling. The laser-light section sensor itself plays a subordinate role combined with the effects of data fusion. The robot-based AVS 3D solution uses standard sensors and already enables the leading customers of Apodius to automatically scan their parts. The main features demanded are the part's three-dimensional geometry and the local fiber orientation. The results are directly fed back into the customers' simulations and their products' lightweight design, last but not least to save carbon fiber material wherever possible.

A global reference system such as a robot with precise position and alignment accuracy is needed to combine local measurements of geometry and fiber

orientations in order to digitize complete parts.

Fiber orientation

With ±0.1° uncertainty in fiber orientation measurement the regular AVS is already best in class for 2D measurements in statistical process control and automation for fiber composites production. To bring a third dimension to this sensor new software modules for both digitizing and hand-eye calibration have been developed. Especially the calibration is demanding. Each local measurement of geometry and fiber orientations has to be put together to digitize complete parts or assemblies. Investigations according to the GUM (ISO/IEC Guide 98-3:2008: Uncertainty of measurement) showed extraordinary results. The uncertainty of the in-plane results could be approved to ±0.1° and the geometry measurements showed variations of ±0.1 mm, which directly affects the out-of-plane effect on the final 3D fiber orientation measurement. So far, these first studies with different materials are very promising and lead to the conclusion that 3D fiber orientations for complex textile structures are possible with an uncertainty of ± 0.3°. From the start of the AVS product family, Apodius focused its development on meeting the demands of the automotive industry that currently allow fiber orientation tolerances from ±3° to ±5° for structural composite parts. A rule of thumb in metrology (called the Metrology Golden Rule) says that the measurement uncertainty should not exceed a tenth, at most a fifth, of the tolerance.

Various applications

Apart from this focus during the development stage the AVS 3D works fine without loss of generality for different materials in various applications. The knowledge derived from the measurements is crucial for cost reduction in both product design and production. The valid and available simulation results can be fed back into consistent lightweight product design. In the production of textile fiber structures there are still many manual steps with no quality traceability.

Apodius customers have already discovered that the knowledge derived from measurements adds further value to their high-value parts. In addition to reduced cycle times, reproducible component quality is achieved so that scrap and rework rates are minimized. With AVS, and now AVS 3D, reaching stable processes becomes possible – the previously required over-dimensioning of components can be reduced. Moreover, raw material and time savings immediately improve production efficiency.

Apodius GmbH

Dennewartstr. 27
52068 Aachen
Germany

info@apodius.de
www.apodius.de
Phone: +49-241-5652-0609-0
Fax: +49-241-927-89541