



Measuring lens implants accurately

Reducing micropart size allows new functionality in smaller spaces, but confirming the accuracy of tiny dimensions is extremely challenging. Often simple shapes are used to calibrate instruments measuring miniscule features, increasing the match between these shapes and the real measurement would improve accuracy. One area where this is critical is for instruments used to measure the eyes corneal curvature to aid lens implant selection during sight restoration after cataract surgery.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

Cataract surgery saves millions of people from blindness and is one of the most common surgical procedures in the EU, with 4.2 million operations performed a year. To restore sight surgeons replace the eye's lens with a synthetic replica, but to achieve the best possible outcome this must be carefully matched to the dimensions of the patient's eye.

Advanced manufacturing processes, such as those producing medical devices or telecommunication components, rely on ever smaller and more complex parts to introduce new functionality to their products. The instruments used to measure these parts must do so accurately, but confirming measurement performance routinely uses simple objects like spheres, which do not reflect the complexity of the items to be measured. This undermines confidence in the quality of complex shaped parts. Without calibration artefacts resembling the features to be measured, it is hard to know if measurement parameters are being correctly determined. New ways need to be developed to precisely characterise the dimensions of complex reference shapes, so that these can be used to confirm the accuracy of industrial and medical measurement instruments assessing small scale size variations.

Solution

The EMRP project, *Multi-sensor metrology for microparts in innovative industrial products*, improved the accuracy with which complex shapes can be measured and developed robust links between different measurement techniques.

The project developed new smaller probes for surface scanning techniques used to map surface features and measure unusual or hard to reach component features. Researchers compared surface scanning and light-based measurements to create better ties between the techniques. Through these activities they also acquired a greater understanding of measurement error sources for both techniques.

These advances have enabled Swiss Federal Institute of Metrology (METAS) to launch a new service for confirming the dimensions of complex reference components for use as 'gold standard' artefacts, which enable the accuracy of measurements made by industrial instruments to be robustly linked to the international system of units - the SI.

Impact

Haag-Streit, a leading manufacturer of precision instrumentation for eye care professionals and researchers, was one of the first to benefit from using the improved measurement service resulting from the project. Haag-Streit have been able to confirm the accuracy of EYESTAR 900, an innovative new instrument for improved eye curvature measurements, used by surgeons to select the best lens implant to restore sight during cataract surgery.

Calibration of their instrument relies on an accurately characterised meniscus-shaped object, with curvatures matched to the shape of the eye. This now forms a 'gold standard' reference replacing the simpler glass sphere Haag-Streit previously used. The new instrument uses a laser imaging technology called Optical Coherence Tomography to measure both the front

and back surfaces of the eye's cornea and lens, giving more information about how light is focussed on the retina to surgeons performing cataract operations. Armed with this information and assisted by the on-board lens implant database, the surgeon can now more easily select candidate implants from the shortlist the system provides.

The ability to transfer measurement accuracy to instruments via high quality well characterised artefacts is key when assessing complex microparts, greater accuracy in this area will help spur innovations in European industry and healthcare.

Multi-sensor measurement for innovation

The EMRP project *Multi-sensor metrology for microparts in innovative industrial products* developed a reliable framework by linking data from tactile probes and optical sensors using reference artefacts with complex shapes to increase 3D measurement accuracy. To support the greater use of X-ray computed tomography (CT) for determining inaccessible dimensions the project developed a simulation to identify systematic measurement errors. This has resulted in a 50 % increase in the accuracy of determining dimensions using CT.

The precise manufacture of miniscule parts is essential for the smooth operation of a wide range of small mechanisms in the automotive, medical and telecommunications industries. Products, such as micro gears, fuel injection and drug delivery systems, all rely on accurate and reliable measurements in 3D.



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Ulrich Neuschaefer-Rube

PTB, Germany
+49 531 5925311 | ulrich.neuschaefer-rube@ptb.de