

Ensuring precision component quality

The automotive and aerospace industries, worth billions of Euro, use precision engineering production processes in which robotic arms carrying machine tools make complex small-scale movements in 3D. Ensuring that the parts made meet specification relies on confirming their dimensions and also that machine tools precisely follow pre-set moves. Automation, based on identifying movement errors early, has the potential to increase precision engineering productivity and so boost European competitiveness.

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

Ever smaller components in high value manufacturing industries, such as automotive and aerospace, require highly accurate machine tools to produce very precise features, sometimes at the nanoscale. Such tools make small, complex movements in a 3D space, known as 'six degrees of freedom'. But their accuracy can drift due to temperature variations in production environments, so manufacturers need to check these tools regularly to ensure they are operating with the required precision.

In the past, this would be done by stopping production, mounting the component away from the production line, and measuring it with a coordinate measurement machine to confirm the machine tool is working correctly. This creates production downtime and costs. If a fault is found, whole batches may need to be scrapped.

New measurement technologies are needed to ensure that machine tool movements are precise without halting the production process. Introducing automated quality control measurements and implementing immediate changes if machines drift, has great potential for improving component precision and reducing machining errors.

Solution

The EMRP Project, *Metrology for movement and positioning in six degrees of freedom*, upgraded an existing one-dimensional interferometry-based measurement technique to be suitable for 3D measurements.

Interferometry can be used to determine exact distances and precise movements by attaching reflective targets to objects that move, such as precision machine tool robotic arms. It works by splitting light beams in two, one beam is used as a reference and the other travels to and is reflected back from targets on the machine tool. Recombining the beams creates an interference pattern that is processed to determine the small changes in a machine tool's position in a specific direction during use.

The project combined three interferometers, into a single system for determining locations in 3D. The system was made easier to use by the addition of a camera to capture interference patterns, so enabling digital image analysis. The interferometry systems stability to air turbulence and temperature changes, common in precision engineering workshops, was assessed during the project and its accuracy reliably confirmed against existing measurement methods.

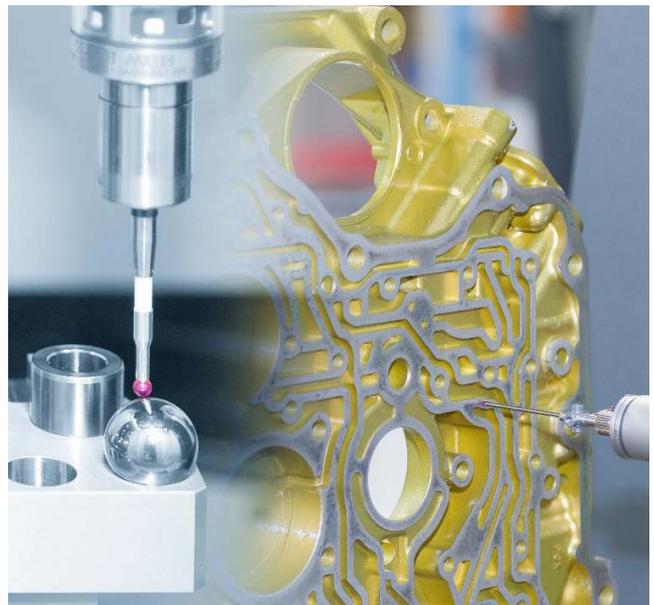
Impact

Mpro GmbH, a precision measurement instrument start-up company, is developing a prototype micro coordinate measurement machine using the project's 3D interferometry system to supply its vital positioning accuracy. To increase the system's suitability for use, Mpro is making it more compact and looking at ways to increase its operating speed. A feedback system is being added to instigate corrections to tool positioning in real time, improving the reliability of quality control and eliminating the need to shut down production to perform measurements. The new Mpro micro coordinate measurement machine will allow in-process verification of nanoscale 3D movements made by production machine tools.

Innovation in machine tool position detection has the potential to increase product quality and manufacturing efficiency in the electronics, aerospace and automotive industries. This will assist in maintaining Europe's reputation for quality products and has the potential to contribute towards future economic growth.

Accurate positioning in three dimensions

The EMRP project *Metrology for movement and positioning in six degrees of freedom*, has increased the accuracy for determining machine tool or positioning stage micro-movements and developed ways to increase the usability of rapid and extensive scanning probe microscopy measurements. The project developed a mobile, easy to use measurement system for characterising the motion of precision machine tools, and strategies to decrease the effects of tip wear and instrument drift during extended or rapid scanning of surface features using atomic force microscopy. Traceable nanometre measurements of position, angle and straightness, are essential in many industries and research fields, for example the precise positioning stages used in semiconductor manufacture or for manipulating samples during analysis using electron microscopy.



EMRP

European Metrology Research Programme
► Programme of EURAMET



The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

www.euramet.org/project-IND58

Jens Flügge

PTB, Germany
+49 531 592 5200 | jens.fluegge@ptb.de