European Metrology Research Programme
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Trusting complex software

Complex software is key to analysing measurements used to assess quality. It turns huge measurement datasets into the information needed to check products, from cars to microchips, have been manufactured correctly. But such software contains vast amounts of complex code, so confirming it works as intended is extremely challenging. As products become more complex, manufacturers need greater confidence in measurement accuracy and new independent methods to verify software are required.

Challenge

Modern cars must be manufactured with great precision to ensure they meet design specification. Grooves in the pistons or ripples on body surfaces affect the car's performance and appearance. Most engineering industries face similar issues, as ever greater accuracy is required to produce more precisely engineered parts.

Co-ordinate measuring machines (CMMs) measure components to check they correspond to design. A CMM runs a probe along the surface, and the machine's software turns the miniscule movements of this probe into detailed three dimensional information which can be used to determine the dimensions of the product. Manufacturers rely on software to accurately process and analyse that data.

The software is hugely complex and runs numerous statistical analyses, using multiple subroutines, to generate results. Small errors in the code can cause problems. But the complexity of the software means checking every line of code is extremely difficult. Manufacturers of CMMs – and the customers who rely on them - need new robust procedures to ensure that software works as expected.

Solution

The EMRP project *Traceability for computationally-intensive metrology (TraCIM)* has developed an internet-enabled system for verifying mathematical software; such as that used within CMMs.

This project applied the verification approach used for measurement instruments – using a certified reference object to check performance - to software calibration, with the certified object being replaced by data sets.

The project developed a range of 'golden' data sets and corresponding 'known' results to enable software validation. The data sets were created using ideal measurement results to generate accurate input data. Using these, the internet based *TraCIM Software Verification System (TraCIM SVS)* was created. This compares results generated by software under test to 'known' results and issues a test report on the degree of agreement. Users of complex measurement software now have a new tool for validating its performance or identifying routines that need improvement.

Impact

Mitutoyo, the world's leading manufacturer of precision measuring equipment, used the *TraCIM SVS* system for an independent evaluation of its co-ordinate measuring machine software.
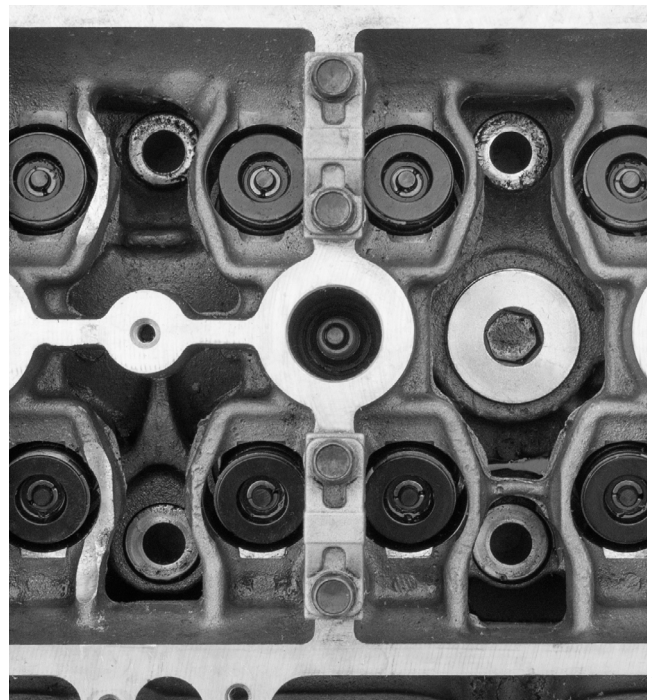
Mitutoyo has in-house methods for testing the performance of software but independent assessment is highly prized as it enables the company to demonstrate via a test report that their software is fit for use and will not generate inaccurate dimension measurements.

One of the first users of the *TraCIM SVS,* Mitutoyo downloaded the system's golden data sets and used its software to analyse them. The results were submitted for comparison with the corresponding 'ideal' results and a test report generated giving the degree of agreement between the results. The report provides independent verification of Mitutoyo's software and enables both Mitutoyo and its customers to have increased confidence in the results generated. The test report can now be used by Mitutoyo to demonstrate to customers that its software is fit for purpose.

Test reports confirming software performance provide much needed confidence to manufacturers that their products match specification, an increasingly important issue as more complex products require ever greater precision and smaller tolerances.

Improved traceability for complex measurement software

Developers of software implementing complex calculations increasingly require independent testing to demonstrate that results are accurate. The EMRP project *Traceability for computationally-intensive metrology (TraCIM)* identified calculations in a number of metrology applications and developed approaches and associated test data to assess the performance of software implementing these calculations. The *TraCIM Software Verification System*, that allows mathematical software to be verified using the internet, was developed. Software developers now have a recognised route for independent product verification reducing risks associated with errors, while customers benefit from increased confidence in the software's ability to produce reliable results.

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