

Title: Filtration in surface form metrology - Specification of filters depending on workpiece function

Abstract

New data processing methods in surface metrology, versatile for procedures of form deviation assessment, are necessary for ISO/TC 213 and ISO/TC 4 initiatives and liaisons. Form deviation estimation procedures require appropriate pre-processing for data preparation. For minimum-zone algorithms, filtration is used to minimise bias due to outliers and measurement artefacts. Form metrology requires filtration procedures to process non-uniform sampling points, to non-rectangular and multiply connected areas. A guideline is necessary to appropriately assign filter types to measurement tasks accordingly, and to perform tests on implemented filtration software, suitable for these requirements.

Keywords

Morphological filters for work piece features, pre-processing in coordinate metrology, linear and robust filters for irregular sampling, software measurement standards, software comparisons, surface metrology, data processing, ISO 16610

Background to the Metrological Challenges

In industrial manufacturing, narrower tolerance specifications demand better measurement precision. While instrument resolution is improving, the relative contribution to measurement uncertainties caused by a bias due to data processing becomes more significant. The influence of effects caused by inappropriate utilisation of filter algorithms on form tolerance assessments must be decreased accordingly. Pre-processing strategies for form measurement will reduce an overestimation of form deviations thus reducing false rejection of parts in industries. In line with this, experts on 'form and coordinate metrology and conformity assessment of the geometry of machine parts' require good practice guides for appropriate filtration methods. ISO/TC 213/WG 15 (GPS extraction and filtration techniques) provides specifications on a variety of different filter algorithms in the ISO 16610 series applicable to form metrology, however, currently a link between the various requirements of applications of form and coordinate metrology and the provided processing 'toolbox' is lacking, resulting in non-uniform procedures for assessing and addressing deviations from form.

The most urgent needs of ISO/TC 4 and ISO/TC 213 working groups on coordinate metrology addressing ISO/TC 213/WG 15 both include pre-processing for roundness testing (influence of probing ball size and eccentricity of turning table axis). The growing requirements on uncertainty reduction demand clear definitions of default filters and appropriate tolerance definitions. Furthermore, electro-mobility requires ultra-precise gear teeth polished with Ra values below 50 nm. Therefore, artefacts caused by data processing can no longer be accepted. An appropriate filtration as pre-processing for roughness measurements on involute and cam geometries must be guaranteed.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the development of metrological capacity in pre-processing strategies for form measurement by making data filtration algorithms of the ISO16610 Series applicable to form metrology.

The specific objectives are

1. To increase the versatility of the data-filter toolbox defined in the ISO 16610 Series for form and coordinate metrology by adapting them to specific needs in industry. To include a generalisation of filters for non-uniformly sampled data points and an investigation to select the most appropriate filter types for specific applications, thereby improving workpiece functionality assessment. To enhance morphological filters for arbitrary probing directions and for arbitrary distributions of sampling positions (non-rectangular areas, multiply connected areas).
2. To develop generators of data sets representing different functional parts such as round, involute and cam surfaces for testing pre-processing procedures that cover coordinate transformations and filtration procedures. To assess, validate, and make available data sets as software measurement standards on platforms such as TraCIM.
3. To develop filters for use with data of sampling distributions different from planar, rectangular, or regular grids. To test various filter implementations by comparisons employing the software measurement standards from objective 2, addressing the recently developed filter algorithms for uniformly sampled areal data sets, and including comparisons of filtration software. To include in the comparisons algorithms extended to account for non-uniform data points and in case of morphological filters for arbitrarily distributed points.
4. To collaborate with the technical committee ISO/TC 213/WG 15, and the users of the standards they develop (ISO 16610 Series) to ensure that the outputs of the project are aligned with their needs, including the provision of a Good Practice Guide and recommendations for incorporation of this information into future standards at the earliest opportunity.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Regulatory body or Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects. The proposal must name a “Chief Stakeholder”, not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The “Chief Stakeholder” should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMRP project NEW06 TraCIM and EMPIR project 15SIP06 ValTraC and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.8 M€, and has defined an upper limit of 1.0 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution across all selected projects in this TP.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the industrial manufacturing sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.