Computed tomography: Influence of part position on measurement results

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Abstract:
Computed tomography (CT) is a relatively new method in the field of dimensional measurement. It is a non-destructive, non-tactile coordinate method for dimensional measurements. Its advantage compared to other coordinate measurement methods is that it provides insight into internal geometry of measured parts without destroying them. However, due to large number of influential factors, measurement uncertainty is not yet defined and measurement traceability is still not achieved. One of the approaches to achieve traceability is to identify and determine all influential factors as well as their impact on measurements.

In this paper, one of the uncertainty components - the position of the measured part - was observed. Standard uncertainty was calculated based on observations obtained under repeatability and reproducibility conditions. Measurements were conducted in three different object orientations and repeated four times. In accordance with the document JCGM 100 201X cd (revised Guide to the expression of uncertainty in measurement) from the year 2015 the Bayesian approach was used to evaluate the type A standard uncertainty component. The test sample was an aluminium cylinder specially shaped and manufactured so that, apart from the dimensional characteristic (length), two geometrical characteristics (flatness and parallelism) were investigated. Scanning was conducted on Nikon XTH 225, while the measurements of the scanned model were done in the software Volume Graphics StudioMAX 2.2. Finally, the results were compared with those obtained using the tactile coordinate measurement machine.

COMPUTED TOMOGRAPHY IN DIMENSIONAL MEASUREMENT [1, 2]

Advantages:
- Non-destructive inspection of internal features
- Measurement of components in assembled state
- Inspection of complex and internal features produced by additive manufacturing
- Enabled simultaneous inspection of both, external and internal geometry
- Relatively fast process of inspection (comprehensive information)
- Suitable for measurements of deformable and fragile parts
- Suitable for inspection of assemblies
- Measurement conducted by comparison of 3D model with CAD model

Disadvantages:
- Large number of influence parameters
- Lack of measurement uncertainty
- Lack of measurement traceability
- Lack of standard for system calibration

MEASURED CHARACTERISTICS

DIMENSIONAL CHARACTERISTICS

MEASUREMENT UNCERTAINTY – JCGM 100:201X [3]

\[ u(x) = \left( \frac{s_i}{n} \right)^{1/2} \cdot \frac{\xi_i}{n} \]

\[ s_i = \frac{1}{\sqrt{n-1}} \sum_{i=1}^{n} (x_i - \bar{x})^2 \]

\[ \xi_i = \text{average of a series of } n \text{ indication values } x_{i,1}, \ldots, x_{i,n} \]

\[ U_{exp} = \text{expanded uncertainty} \]

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Measured values, mm</th>
<th>( U_{exp}, \mu m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length, l</td>
<td>90,066</td>
<td>2,17</td>
</tr>
<tr>
<td>Outer diameter, D</td>
<td>30,016</td>
<td>1,99</td>
</tr>
<tr>
<td>Distance between holes, d</td>
<td>64,972</td>
<td>2,10</td>
</tr>
</tbody>
</table>

Measurement results TCMM

REFERENCES

[3] Joint Committee for Guides in Metrology, Evaluation of measurement data – Guide to uncertainty in measurement, JCGM 100 201X CD