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Inverse problems of measurement
with application on specification of surface profile

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Introduction:
A contradiction of the specification of free-form surface is pointed out. The inverse problem of measurement (IPM) is defined based on the representational measurement theory. By using the concept of IPM, a desired property of specification limit is derived and a correction for solving the contradiction is proposed.

Specimen and measurement of surface profile
The upper and lower specification limits (LSL and ULSL) of a free-form surface profile defined in ISO 1101 are two curves enclosing circles of certain diameter r, the center of which is located on the nominal surface profile (see figure 2a). For an actual surface profile l, if all the points on l are within the tolerance zone, i.e., LSL < l < ULSL, l is within the spec.

The canonical method of measuring surface profile is contact measurement by moving a stylus along the surface to be measured to obtain the locus of the central point of the stylus tip.

A Contraction of the Specification of Free-form Surface

The contradiction
Due to the extensive property of closing filter, the estimated profile is always above the actual profile (see figure 1). Hence when an actual surface profile coincides with the ULSL (l is within spec.), the measurement result (without errors) would, however, be out of spec., which contradicts with the real situation.

A correction of the tolerance zone of surface profile

A proposed solution
- Correcting the curve of LSL from l1 to l2 = C1(l1) (see figure 2b), where C1 is the closing filter with the structure element S.

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