

# Hierarchical Model for Rough Surface Contact Postprint

**Authors:** Yan Duo, Li Leize, Liang Xuanming, Xing Yuming

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## Abstract

The roughness of real machined material surfaces often spans multiple scales. This study establishes a novel hierarchical contact model for rough surfaces. For the larger-scale portion, short-wavelength roughness is truncated and filtered, and then the corresponding approximate contact area and local pressure distribution are calculated using methods from continuum mechanics; for the smaller-scale portion, this study employs fractal theory, utilizing a two-dimensional Cantor set to describe the stacked short-wavelength asperities, and then refines and corrects the approximate contact area obtained at the larger scale to calculate the final contact area. To validate the established model, the overall contact response obtained was compared with finite element method calculation results. The results demonstrate that the model can adequately predict the elastic contact response of rough surfaces, and significantly reduces the computational scale of contact mechanics modeling for multiscale rough surfaces. This holds significant importance for further research on contact and friction between cross-scale rough surfaces.

## Full Text

### Preamble

This work addresses fundamental challenges in machine learning through a novel theoretical framework. The mathematical foundation begins with the core formulation presented in  $MATH_{0001}$ , which establishes the primary optimization objective. Complementary expressions  $MATH_{0002}$  and  $MATH_{0003}$  define the constraint manifold and regularization terms, respectively. The complete problem statement is synthesized in  $MATH_{0004}$ .

These equations specify the transformation operators, parameter spaces, and convergence criteria that govern system dynamics. Subsequent analysis yields  $MATH_{0005}$ , characterizing the stability properties, while  $MATH_{0006}$

and MATH\_{0007} derive the error bounds and computational complexity guarantees.

The methodological approach integrates insights from prior research, with key theoretical precedents established in MATH\_{0008}. Empirical validation frameworks follow protocols detailed in MATH\_{0009} and MATH\_{0010}, ensuring comprehensive evaluation across diverse operational scenarios. Implementation guidelines are standardized according to MATH\_{0011}. Notation conventions are summarized in MATH\_{0012}, providing a reference for all symbols and operators employed throughout this work.

*Note: Figure translations are in progress. See original paper for figures.*

*Source: ChinaXiv — Machine translation. Verify with original.*