An Intelligent Surface Denoiser: A DnCNN-based Approach for freeform structured surface

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Abstract

Surface characterization as a crucial metrological operation is defined to quantify the surface texture with feature extraction and pattern analysis using a set of parameters to evaluate functionalities. Denoising/Filtration is a multi-purposes metrological operation which usually used after F-operator to remove the small-scale components from the surface. This kind of signals usually are outliers or high-frequency noise in optical measurement resulted from instrument internal, all of which have effects on accuracy and precision of surface feature extraction. Traditional filtration techniques such as Gaussian/Spline filters perform well on the stochastic surfaces, while they involve manually chosen parameters and suffer from edge distortion. To date, deep learning as a powerful technique in image processing which is rarely used in metrology field. This paper proposed an noval Denoising Convolutional Neural Network (DnCNN)-based approach on the freeform structured surface denoising with few-shot measured surface samples. The experimental results with parameter analysis show that DnCNN model performs well on removing unknown and mixed levels of noise and has well structure-preserved property. The pre-training process is efficient with low cost, and once the network has been trained it can filter different types of freeform structured surfaces within average 0.2s without manual operation. The main advantage is our model is an automatic denoising system for processing massive inputs efficiently. For future development, it can support for smart metrological system construction for online manufacturing monitoring and data analytical system integration.

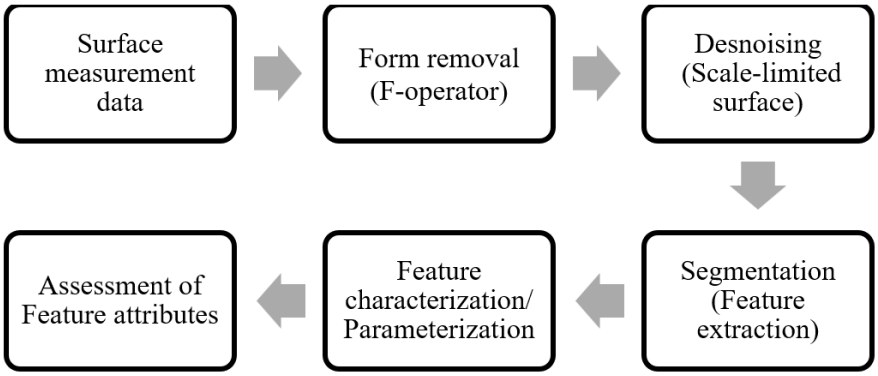

Fig. 1. A general surface characterization scheme for complex freeform structured surface

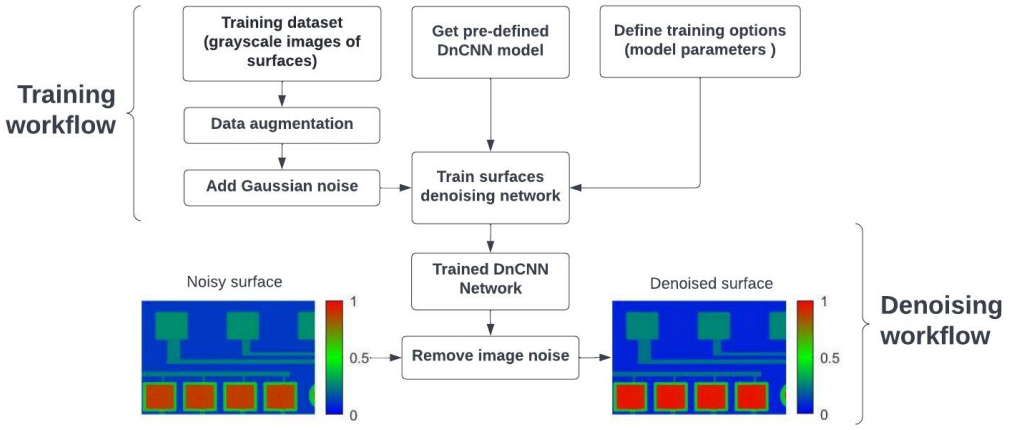

Fig. 2. Framework of DnCNN-based surface denoising model

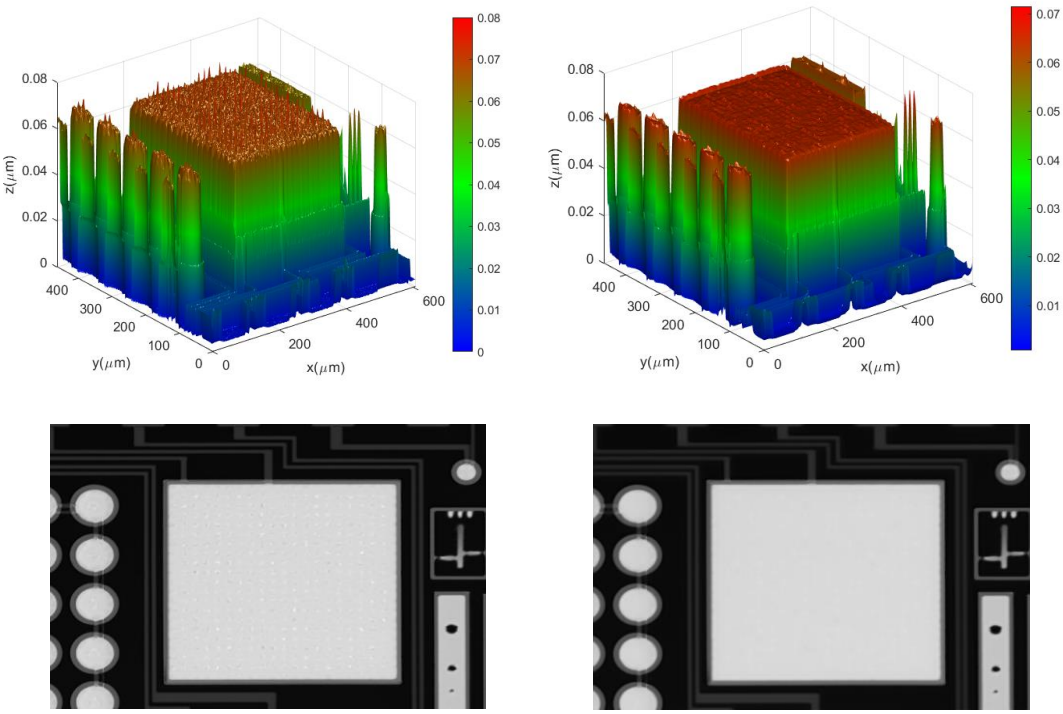

Fig. 3. MEMS surface denoising using DnCNN-based approach

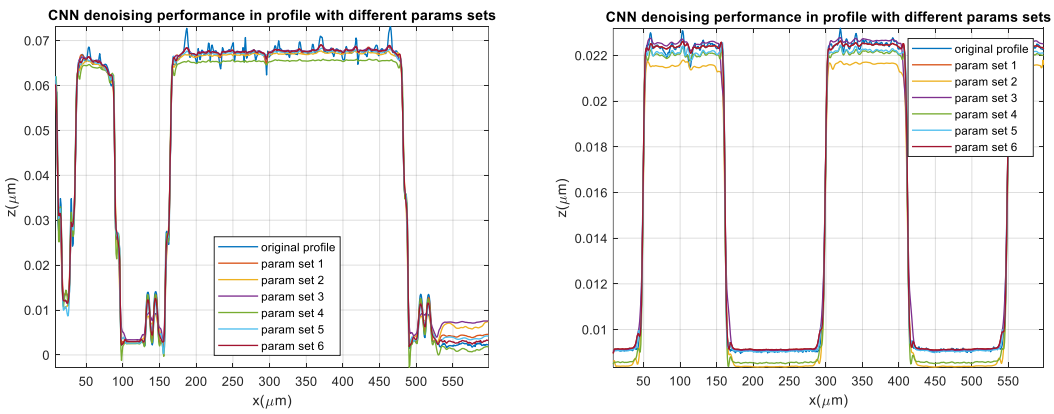

Fig. 4. DnCNN-based denoising with parametric analysis