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Suting Chen [a,b,*], Rui Feng [a], Chuang Zhang[b] and Yanyan Zhang[b]

[a] Jiangsu Key Laboratory of Meteorological Observation and Information Processing, Nanjing University of Information Science & Technology, Nanjing 210044, China. 1010304559@qq.com(R.F.),

[b] CICAEET, School of Electronic & Information Engineering, Nanjing University of Information Science & Technology, Nanjing 210044, China. zhch_76@nuist.edu.cn (C.Z.); 002243@nuist.edu.cn (Y.Z.)

* Correspondence: sutingchen@nuist.edu.cn; Tel.: +13913864015

Abstract: To improve the accuracy and efficiency of the existing roughness measurement methods, we propose a new surface roughness measurement technique based on multi-parameter modelling learning. First, multi-feature descriptor is constructed through speckle feature, grey feature and Tamura texture feature. Then, an identification reasoning method based on ACC-random forest was proposed to determine the work-piece classification. Finally, to realize surface roughness measurement efficiently, a multi-parameter learning model is established. Through establishment and optimization of multi-parameter surface roughness modeling, the value of surface roughness can be measured accurately. Thus, not only the class of work-piece be classified, also the value of surface roughness can be measured. Our proposed method breaks through the limitations of existing methods, which are based on several roughness measurement models for different classes of work-pieces. The experimental results indicate that our proposed method significantly outperform the state-of-the-art methods in terms of classification accuracy and measurement error rate.

Keywords: feature extraction; random forest; mutual information; roughness learning

1. Introduction

Surface roughness is an important characteristic parameter that reflects the rough surface performance, and it is a measure of the surface quality of a work-piece. In the machining industry, surface roughness can affect the performance and quality of the product, which is mainly reflected in its impact on the product wear, resistance, and fatigue resistance[1]. Therefore, it is significant to evaluate the surface roughness accurately.

At present, surface roughness measurement methods can be divided into two types, contact measuring methods and non-contact measuring methods[2-4]. The most common method of contact measurement is the stylus method, which can not only calculate the value but also record the outline. However, it is not suitable for work-piece running under high temperatures, which runs slowly with low accuracy and work-piece losses. Compared with this approach, the non-contact measuring method features low loss, high temperature resistance and high efficiency. Research based on optical measurements and computer visionhas been widely used in non-contact measuring methods, which mainly include astigmatism, optical interference, light scattering and speckle measurements[5-8] . A previous study proposed a method for an optimized project of a Multi-Layer Perceptron network architecture applied for the prediction of Average Surface Roughness, which lead to significant reduction of roughness prediction errors in machining operations[9]. Liu et al. proposed a new roughness detection method based on image quality algorithm, which solved the problems of the current roughness detection methods, such as the limited range of measuring workpieces and the incomplete consideration of indicators. The algorithm improves the accuracy of non-contact online measurement to some extent, but the scope of applicability still needs to be