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Computer vision measurement and optimization of surface roughness using soft computing approaches

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Abstract

This paper proposes an efficient methodology for predicting surface roughness using different soft computing approaches. The soft computing approaches are artificial neural network, adaptive neuro-fuzzy inference system and genetic algorithm. The proposed surface roughness prediction procedure has the following stages as feature extraction from the materials, classifications using random forests, adaptive neuro-fuzzy inference system (ANFIS). In this paper, the statistical features are extracted from material images as skewness, kurtosis, mean, variance, contrast, and energy.The surface roughness accuracy value varied between ANFIS and random forest classification in every measurement sequence. This limitation can be overcome by the genetic algorithm to optimize the best results. The optimization technique can produce more accurate surface roughness results for more than 98% and reduce the error rate up to 0.5%.

Keywords

Surface roughness, soft computing, feature extraction, statistical features

Introduction

The impact of the surface quality mainly depends on the cutting parameters like speed rate, proper depth of cut and feed rate. Stylus probe method has been mostly preferred in the machining industries. Especially, this method was only possible for random work sampling in a mass-production system. But inspections in all the components are not possible in manual stylus probe instruments. Vision measurement technique is able to take the measurement in all the machining components. Many automobile industries require materials that have high quality in production. This will be done using surface roughness prediction process, which measures the surface roughness of the materials. In conventional methodologies, the surface roughness prediction was made manually, and it is not suitable for the high number of production units. The limitation of these works was that the conventional manual surface prediction process consumed more time. The error rates of these methods are high and not tolerable for many industries. Hence, there is a need for computer interference-based prediction methodologies, to overcome the limitation in conventional methodologies. The error rate will be reduced during surface prediction process of materials using this computer interface procedure.

This paper selected Aluminum 6063 as workpiece materials for the Computer Numerical Control (CNC) machining process. Al6063 is mainly used to form a complex shape with a good surface finish. The workpiece is machined in CNC with different speed, depth of cut and feed rate, then machined surface roughness is measured by stylus probe equipment, which acts as the reference value for producing the accuracy of vision measurement (Radha et al., 2019). The present computer methods capture the surface of the materials by images using high-resolution cameras. These captured images are processed for surface prediction of the materials. The computer methods for surface prediction using feed-forward back propagation neural network classification algorithms. This method gives low performance for surface roughness prediction for low-resolution images. Another limitation of this method is that the error rate was high due to the requirement of a high number of surface images (Lee and Tarng, 2001). For improving the performance of the surface roughness prediction using image processing techniques, the computer system requires some additional supporting parameters as the speed of the cutting process with its feed rate and depth of the cutting procedure. These additional parameters will improve the performance of the surface roughness prediction process using image processing techniques with the aid of computational approaches. The production industries want to improve their quality with minimum cost. So, they were developing the

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