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Optimization and Prediction of Surface Roughness in Turning Operations: A Review of Modern Techniques

Khushi S Dikkar, Amol Gawai, Vishal J Dhore, Junaid M Shaikh
Department of Mechanical Engineering
Guru Gobind Singh Polytechnic, Nashik

Abstract: *Surface roughness is a critical quality metric in metal cutting, particularly in the manufacturing industry, where high surface quality is essential. Optimizing machining parameters, such as cutting speed, feed rate, and tool materials, is crucial for achieving the desired surface roughness. However, this optimization process is challenging due to constraints related to time, cost, and skill levels. Recent advancements in surface roughness prediction techniques, including the Taguchi method, Grey Relational Analysis, and Artificial Neural Networks, have simplified the selection of cutting parameters, reduced costs, and ensured superior surface quality. This study reviews these methods and their applications in various machining processes. The Taguchi method employs orthogonal arrays to minimize the number of experiments while effectively identifying critical parameters. Grey Relational Analysis optimizes multiple response characteristics simultaneously, such as surface roughness, material removal rate, and tool wear. Artificial Neural Networks excel at modeling nonlinear relationships and learning from data, demonstrating superior performance in predicting surface roughness compared to other methods. This review highlights the significance of modern statistical and computational models in achieving efficient and high-quality machining processes, ultimately benefiting industries that require precise and reliable manufacturing techniques.*

Keywords: Artificial Neural Networks, Taguchi Method, Manufacturing, Speed, Feed rate

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