Comparative Evaluation of Chatter Detection Indicators under Simulated Machining Conditions

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Résumé : Early detection of chatter would potentially enable reducing surface degradation, tool wear, and machine tool degradation. While numerous time- and frequency-domain indicators exist, their relative sensitivity and robustness are rarely assessed under a unified framework. This work presents a systematic benchmark of chatter detection indicators using controlled time-domain simulations of machining dynamics. The study compares representative approaches based on vibration energy trends, phase space geometry, statistical signal descriptors, and other time-domain features, including a novel energy based indicator. All methods are tested within identical simulation conditions and signal processing settings. The evaluation focuses on three aspects: the earliest detectable sign of instability, robustness to measurement noise, and consistency across varying cutting parameters. The resulting performance map provides insight into how different indicators respond to chatter onset and under what conditions they remain reliable. The study aims to clarify the trade-offs among existing methods and to guide the selection of effective, real-time or offline chatter detection strategies for stable and productive machining operations.

Mots clés : Chatter detection, Early detection, Time-domain simulation, Indicator benchmarking, Signal processing, Machining stability,