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Chatter Prediction of Curved Thin-walled Parts Considering Variation of Dynamic Characteristics Based on Acoustic Signals Acquisition

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Abstract : High-speed milling of thin-walled parts with complex curvilinear profiles often encounters machining instability, commonly referred to as chatter. This phenomenon arises due to the dynamic interaction between the cutting tool and the part, exacerbated by the part's low rigidity and varying dynamic characteristics along the tool path. This research presents a dynamic model specifically developed to predict machining stability for such curved thin-walled components. The model employs the semi-discretization method, segmenting the tool trajectory into small, straight elements to locally approximate the behavior of an inclined plane. Dynamic characteristics for each segment are extracted through experimental modal analysis and incorporated into the simulation model to generate global stability lobe diagrams. Validation of the model is conducted through cutting tests where acoustic intensity is measured to detect instabilities. The experimental data align closely with the predicted stability limits, confirming the model's accuracy and effectiveness. This work provides a comprehensive approach to enhancing machining stability predictions, thereby improving the efficiency and quality of high-speed milling operations for thin-walled parts.

Keywords : chatter, curved thin-walled part, semi-discretization method, stability lobe diagrams
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