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Nonlinear Dynamics of High-Speed Milling

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In case of highly interrupted machining, the ratio of time spent cutting to not cutting is considered as a small parameter, and the classical regenerative vibration model breaks down to a simplified discrete mathematical model. The linear analysis of this discrete model leads to the recognition of the doubling of instability lobes in the stability charts of machining parameters. This kind of lobe doubling is related to the appearance of period doubling bifurcations occurring primarily in low-immersion high-speed milling along with the classical self-excited vibrations (or secondary Hopf bifurcations). The present work investigates the nonlinear vibrations in case of period doubling and compares this to the well-known subcritical nature of the Hopf bifurcations in turning processes. Our experimental results draw the attention to the limitations on the highly interrupted cutting condition. The analysis of the general milling model requires the use of the stability chart of the delayed Mathieu equation.

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