
New Perspective on the Stability and Optimization of Variable Pitch Milling Process

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Abstract: From the perspective of stability, variable-pitch milling process offers a mathematically very challenging task particularly due to the complex nature of the ensuing regenerative chatter dynamics. It can be reduced to a problem of stability assessment of a linear time-invariant systems (LTI) which contains more than one independent delays. This mathematically notorious problem can be solved by a recent paradigm, which is called the Cluster Treatment of Characteristic Roots (CTCR). The paper suggests a process optimization procedure based on the CTCR for a particular milling operation with variable pitch cutters. The objective function entails two compromising components: to maximize the metal removal rate while creating the best chatter rejection ability. The end result is a new process planning tool to determine both the cutter geometry and the operating conditions, which are: (i) the pitch angle distribution on the milling cutter (i.e., the geometry of the variable pitch cutter), and (ii) the optimum cutting conditions (i.e., the axial depth of cut and the spindle speeds). The paper also contains an example case study.

Keywords: High speed machining, Optimization, Stability, Regenerative Chatter, Delayed Differential Equation (DDE), Cluster Treatment of Characteristic Roots (CTCR), Variable-pitch milling process.

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