

# CHATTER DETECTION AND PREVENTION IN HIGH-SPEED MILLING

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## ABSTRACT

In this work, two separate mathematical models, a traditional and new model, are presented for an end-milling process. The traditional model assumes circular tool motion, while the new model accounts for trochoidal tool motion resulting from the feed of the workpiece past the rotating tool. Simulated bifurcation diagrams are generated using each model and compared to experimental results. An extended Kalman filter (EKF) algorithm is created for estimating the states and modal parameters of the milling process given the tool deflections in the  $x$  and  $y$ -directions and rotational angle. Once parameter estimates are calculated, stability analysis is performed to generate the stability bound of the system as a function of the spindle speed and depth of cut. A control system is designed for a simulated milling process that uses updated EKF parameter estimates to track the stability bounds of the system through time. Through knowledge of these stability bounds, the spindle speed and/or feed rate are varied to avoid instability (i.e. avoid the onset of chatter vibrations). This control system is unique in its ability to adapt to changing system dynamics. A chatter detection method is also given based on the root-mean-square (RMS) value of the once-per-tool deflection data. This method cannot avoid chatter vibrations from forming; however, it can detect and quantify the severity of chatter vibrations.