Period-two and quasi-periodic vibrations of high-speed milling

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Abstract

In this paper two numerical techniques are proposed to study periodic and quasi-periodic motions of the high-speed milling process. In high-speed milling two kinds of stability loss is possible, which lead to period-two or classical chatter vibrations. The first part of the paper is focusing on the period doubling stability loss, whereby period-two vibrations arise. These vibrations are found by numerical continuation techniques along one of the process parameters, while other parameters are kept constant. The stability of period-two motions is characterized by following the bifurcation curves in the two technological parameters of the chip width and spindle speed. It is found that stable period two orbits coexist with stable stationary cutting in large regions of the stability chart making the process sensitive to perturbations. Also, chatter vibrations are continued as quasi-periodic orbits, which correspond to a subcritical secondary Hopf bifurcation, using a different numerical method in the second part of the paper. In order to underpin the theoretical findings, experimental data are compared to the numerical results.