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MODELLING OF FRICTIONAL CHATTER IN METAL CUTTING

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Abstract: A new frictional model of cutting process is developed in order to simplify modelling and gain a further insight into the mechanics of frictional chatter. It is based on the well known Rayleigh oscillator generating self-excited oscillations and has been applied to the shaping/planning operation. The new approach which takes into account also the forces acting on the tool flank is compared with the one developed by Wiercigroch [1]. The results, obtained here are alike to a certain degree but some of them show some different trends. Nonlinear dynamic behaviour is examined using bifurcation diagrams where cutting velocity and specific cutting force coefficient are chosen as the bifurcation parameters. The effect of the variation of the stiffness of the tool in the directions parallel and perpendicular to the workpiece has been investigated. Some practical conclusions relevant to metal cutting dynamics have also been drawn from this study.

Keywords: cutting process, dynamics, chatter, dry friction

1. Introduction

Cutting process is one of the most popular manufacturing methods, however, it naturally generates unwanted vibration of negative effects. Specifically, they can reduce the volumetric efficiency, increase the tool wear, and decrease the geometric accuracy and surface finish. Therefore, understanding the origin of these vibrations and developing methods to control them has strong fundamental and industrial interest. A thorough review of the current state of the art in dynamics of cutting and grinding processes, new challenges in modelling and avoiding machine tool vibrations are presented in [2]. One of the most important steps in the process of avoiding chatter is the development of robust mathematical models, which can accurately capture the complex phenomena occurring during the metal cutting especially the one which can unveil the mechanisms behind chatter.