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MODELLING OF THE 3D MACHINING GEOMETRIC DEFECTS ACCOUNTING FOR WORKPIECE VIBRATORY BEHAVIOUR

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Abstract
In this paper, we present a three-dimensional manufacturing tolerancement model. Several researchers have interested to modelling the machining geometric defects. The most researchers are limited to kinematic and static study. Only some works are evoked the dynamic effects, especially the influence of the chatter phenomenon on the roughness of the machined surface. In this context, the paper presents a contribution for modelling and quantification of the machining geometric defects where the machining dynamic effects are considered. A developed method is established based on Homogeneous Transformation Method in subject to determine the kinematical deviations caused by part locating and relocating. The dynamic displacements due to clamping and machining forces are defined using Finite Element Method. The numerical results are then compared to published experimental results.
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Key Words: Machining, Defects, Tolerancing, Dynamic

1. INTRODUCTION

The fixturing and resultant quality study have two principal topics: 1) the analysis of fixture errors under different conditions, such as the rigid body assumption, the deformable workpiece, or the dynamic errors; 2) the design and optimization of fixtures.

In fixture analysis, Shawki and Abdel-Aal [1] presents an experiment study of the influence of fixture rigidity and wear condition on dimensional accuracy. Basing on the worst-case assumption and rigid-body errors, Salisbury and Peters [2] study the impact of workpiece surface error on the workpiece location and orientation. Chaari R. et al. [3] studies the influence of the fixture errors on the respect of the orientation geometric specifications. De Meter [4] presented a linear model for predicting the effect of locator and clamp placement on workpiece displacement. Hockenberger and De Meter [5] studied the impact of fixture design parameters, such as the fixture layout, locator contact region geometry, and clamping intensity, on the workpiece displacement. The finite element method is used by Menassa and DeVries [6] to optimize the fixture locator positions by minimizing the workpiece deflection.

However, the fixture-workpiece system is modelled in most works by a quasi-static model; the dynamic behaviour is not considered. For example, DeMeter et al. [7] considered a static deformation for both clamping and machining. They have developed a linear programming (LP) model to compute the minimum required clamp pre-loads to prevent workpiece slip at the fixture–workpiece contacts during machining. Liu and Melkote [8] modelled the change of the workpiece gravity during machining. Kaya and Ozturk [9] applied an FE-based element death technique to simulate the chip removal process for fixture layout verification. However, both papers treat the fixture-workpiece system as quasi-static.

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