

Proof of need for knowledge on cutting location for smart deflection

Yiğit Özcın^{1,2} Shashwat Kushwaha^{1,2} Jun Qian^{1,2} Dominiek Reynaerts^{1,2}

¹Department of Mechanical Engineering, KU Leuven, Celestijnenlaan 300, Leuven 3001, Belgium

²Member Flanders Make, Belgium

yigit.oezcan@kuleuven.be

Abstract

Reducing lead time without compromising quality is one of the many challenges of any industry. In CNC Milling, after the chip formation is done, geometrical inspection takes one of the biggest efforts. The need for re-work or malfunction during the machining process negatively affects the lead time. Real-time monitoring of the process has a potential to reach the desired productivity. Despite CNC machines being stiff and having high accuracy and precision, few of the main factors affecting the process are undesired tool deflection and vibration, collision, and tool wear during the operation. To better monitor and understand the process, smart tool holders started to enter the machining market. They allow the machinist to monitor the process in real-time and hopefully take early action to improve productivity.

Many studies in the literature show promising results for vibration and tool wear with instrumented tool holders. However, academic studies and industrial applications are scarce on the knowledge of cutting forces for different load conditions. Especially for the knowledge of tool bending, it is necessary to obtain the load distribution. Therefore, in this study, different case scenarios - from micro milling to high-speed machining - are modeled, and the effect of load distribution on tooltip position is shown as an important parameter to estimate workpiece quality. Solution methods like 6 DOF sensor smart tool holder and real-time simulation-based methods are proposed. Tests are done to prove that it is not possible to estimate part geometry estimation for widely different material removal scenarios without knowing where the cutting force is exerted on the tool during the operation.

Keywords: Digital-Twin, Machine tool, smart tool holder, milling