Voxel-based Machining Simulation for Fast Process Validation

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Extended Abstract

Machining simulation is essential to modern Computer Numerical Control (CNC) machining operations. It is used to validate whether the machining commands to be executed by a CNC machine tool are generated without errors and able to produce the desired part geometry correctly. Erroneous machining commands produce defective parts, or worse, damage the machine tools due to collision, leading to a major loss of productivity and profits. This presentation outlines a voxel-based geometric modeling method developed by our research group for the creation of a novel machining simulation software tool for fast and accurate machining process validation. The simulation tool covers milling operations with up to five-axis tool motions. Machining simulation is not new and is available commercially. However, it remains a challenge to simulate complex machining cases with high computational speed and acceptable geometric accuracy. Industry constantly pushes for maximizing the production efficiency. To meet the industry demand, fast machining simulation is needed in order to create error-free machining tool paths in a timely manner and to incorporate machining simulation functions on next-generation smart machine tools. The advanced geometric modeling method developed by our research group is based on an enhanced multi-level voxel modeling format to represent the machined workpiece geometry. An associated workpiece update process is used to compute the machined workpiece geometry from its initial blank and a given set of NC tool path commands. Costly machine crashes and repeated physical machining test runs can, thus, be avoided with reliable and fast machining simulation.