Study of the Parallel Precision Positioning Platform in Five-axis Machine Tools Design

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ABSTRACT

Many manufacturers have demands for high precision and complicated 3D geometry in recent years. The machined pieces must meet the requirement of a machine tool that completes all or part of the work pieceswith minimal number of clamping operations. For this, multi-axial structure has become the tendency of precision machining. The rotary axis in a common 5-axis machine tool is driven by a single motor that holds the platform for the axial rotation. However, with different weights of work pieces and the motor loaded, the rotating speed should be in reverse proportion to the weight. As a result, the axis-to-axis synchronization is poor, resulting in dramatic decrease in machining precision. Therefore, a 2PRP planar parallel platform is designed by connecting the two PRP connectors and moving table with a round bar. Themotor drives ball screws and propels the PRP connectors. The two parallel ball screws acquire both effects onmovement or rotation by generating different displacements of these two connectors. Thus the simulation of the rotating table on a 5-axis machine tool is achieved. A planar parallel platform is designed to required specifications. Detailed design of structure is performed. Calculations are conducted to select suitable crossed roller bearings, ball screws, linear guideways and other key components to meet precision requirements. For the selection of machining process, suppliers are sought out to satisfy the demands for costs and delivery deadlines. Parts and components to be machined are scrutinized for tolerance based on design drawings. After measurement, parts and components are placedin warehouse by categories. Standard assembly procedures and machine checklists are established to facilitate the assembly based on standard procedures and ensure the errors accumulated from allowable tolerance within control. The laser interferometer is used for positioning compensationand ball-bar test for roundness in order to meet the requirement of synchronic interpolation error. The planar parallel platform is used mostly for the positioning in semiconductor manufacturing process rather than in precision machining with machine tools. The special way proposed in this study is to apply the planar parallel platform in machine tools to establish the position vs. orientation relationship regarding the coordinate systems of machining piece and cutter. This type of machine does not have a post-processor, and therefore a dedicated post-processor is designed based on the screw theory. Finally D-H modified notation is introduced for coordinate conversion program. CC path is converted to CL path to produce NC Code of machining. NC Code is imported into the control for machining and the precision of finished products is measured to make sure that the requirements of dimension in the design are met.

Keywords : Parallel Platform、Five-axis Machine Tool、D-H modified notation

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