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ABSTRACT

Design and performance evaluation of hybrid parallel link machine tools

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Machine tools with high speed and high acceleration have been sought and expected for a long time. Technology development in this area realizes that the high acceleration maybe achieved by substituting serial link mechanisms by parallel link mechanism. Parallel link mechanisms have been used in many types of machine tools. However, many related problems are still required to be solved for the practical applications of this type machine tool. The main related problems are seriously restricting the application of the machine tools. This dissertation presents a novel machine tool, called the TRR-XY hybrid parallel link machine tool which provides the advantages of both serial link mechanism and parallel link mechanism. Here, the hybrid parallel link machine tool means that the α, β and Z motion degree of freedoms of this machine tool are achieved by a parallel link mechanism and the x and y translation motion degree of freedoms are achieved by a serial link mechanism. Its theoretical models of inverse kinematics and dynamics are established; angular workspace and singularities are analyzed; inverse dynamic analysis with driving force is also discussed. A new theory for optimizing its dimensions is proposed. Two error models are developed in this research: manufacturing error model and controller parameters error model. A prototype machine tool is designed and developed to perform the experiments for verifying the correctness of the theory. This study demonstrates some results about hybrid machine tool that have not been reported before. All the aforementioned models will contribute to develop a new type hybrid

parallel machine tool by providing helpful advice on such aspects as the optimization of the workspace, the minimum of the driving force, the improvement of machining accuracy, and the development of a parallel machine tool with high speed, high acceleration and high accuracy.