World Academy of Science, Engineering and Technology
International Journal of Industrial and Systems Engineering
Vol:10, No:09, 2016

Milling Simulations with a 3-DOF Flexible Planar Robot

Authors : Hoai Nam Huynh, Edouard Rivière-Lorphèvre, Olivier Verlinden

Abstract : Manufacturing technologies are becoming continuously more diversified over the years. The increasing use of robots for various applications such as assembling, painting, welding has also affected the field of machining. Machining robots can deal with larger workspaces than conventional machine-tools at a lower cost and thus represent a very promising alternative for machining applications. Furthermore, their inherent structure ensures them a great flexibility of motion to reach any location on the workpiece with the desired orientation. Nevertheless, machining robots suffer from a lack of stiffness at their joints restricting their use to applications involving low cutting forces especially finishing operations. Vibratory instabilities may also happen while machining and deteriorate the precision leading to scrap parts. Some researchers are therefore concerned with the identification of optimal parameters in robotic machining. This paper continues the development of a virtual robotic machining simulator in order to find optimized cutting parameters in terms of depth of cut or feed per tooth for example. The simulation environment combines an in-house milling routine (DyStaMill) achieving the computation of cutting forces and material removal with an in-house multibody library (EasyDyn) which is used to build a dynamic model of a 3-DOF planar robot with flexible links. The position of the robot end-effector submitted to milling forces is controlled through an inverse kinematics scheme while controlling the position of its joints separately. Each joint is actuated through a servomotor for which the transfer function has been computed in order to tune the corresponding controller. The output results feature the evolution of the cutting forces when the robot structure is deformable or not and the tracking errors of the end-effector. Illustrations of the resulting machined surfaces are also presented. The consideration of the links flexibility has highlighted an increase of the cutting forces magnitude. This proof of concept will aim to enrich the database of results in robotic machining for potential improvements in production.

Keywords : control, milling, multibody, robotic, simulation
Conference Title : ICIPSE 2016 : International Conference on Industrial and Production Systems Engineering
Conference Location : Rome, Italy
Conference Dates : September 15-16, 2016