

Accurate machining using robots and a robust based control law

Context of the work:

Manufacturing processes such as machining and welding are widely applied in industry production, for instance machining of composites materials or the Friction Stir Welding (FSW). These two applications have an innovative character; the first is due to application of composite materials, and the second because of its new development. Composite materials are used extensively for their high specific properties of strength and stiffness; however, these materials are difficult to machine due to non-homogeneous, anisotropic and reinforced by very abrasive components. The FSW is a solid state welding technology that can be used for many joining applications.

Precedent works in the same area at the LCFC

The project COROUSSO supported by the French National Agency for Research (ANR) is currently underway in the laboratory with another academia and two industrial partners. This project has so far demonstrated the feasibility of machining by robot.

Description of the subject:

The technical and economic performances of some manufacturing processes can be greatly improved by using a robot polyarticulated or a robotic system [5] as holder of the production tooling. However, using robot to do these two processes is a challenge: the natural rigidities of industrial robots are not sufficient to perform the tasks in the minimum requirements of the processes. Actually, those processes are carried out by some special developed machines which are very expensive. In the sector of aeronautic industry these two processes are strongly applied. New technologies are highly required to reduce the investment and to improve the quality of the products. Due to a strong external force during operations, the deformations of the robot can not be neglected [1] therefore, the real angular positions and velocities of links are different from those measured by the motor sensors. Moreover, to make an accurate machining or welding, the forces exerted on the material should be measured: unfortunately, most of the industrial robots have only motor side measurement, thus a new approach to estimate link side states as well as the efforts applied by the robot on external process is required.

Disturbance observer technique is widely used in mechanical servo systems and observers are often used for the state estimations. In order to realise these operations in an very accurate way, this thesis proposes to study a new observer based control, which can estimate not only the unmeasured states but also the external force [2] [3] and which guarantees a good precision. In this thesis, it is then proposed to use the controller of robot and to add an external perturbation in order to reduce the trajectory errors of robot. This method has the advantage of being quickly integrated in the robot controller. An analysis of stability of the whole control will be done to provide safety conditions of such an observer based robust control [4].

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[3] Kravaris, C., Sotiropoulos, V., Georgiou, C., Kazantzis, N., Xiao, M. Q., and Krener, A. J., 2007. “Nonlinear observer design for states and disturbance estimation”. Systems & Control Letters, 56(11-12), pp. 730–735.

[4] Park, S.-K., and Lee, S.-H., 2007. “Disturbance observer based robust control for industrial robots with flexible joints”. In International Conference on Control, Automation and Systems 2007, ICCAS '07, pp. 584 – 589.

[5] Siciliano B., L. Sciacivico, L. Villani and G. Oriolo. Robotics Modelling, Planning and Control, Springer ed. 2008.

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Application:

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