Résumé

Objectif: optimiser le choix des paramètres de coupe à l’usinage robotisé

Modélisation d’un bras robotisé et couplage au procédé d’usinage

Simulation de l’usinage robotisé sur base d’un modèle numérique

Validation du modèle dynamique par des essais expérimentaux

Mise en place d’outils visant la recommandations des paramètres de coupe suivant le compromis “stabilité-productivité-précision”

Contexte

Attractive cost: cost reduction of about 30 to 50 % in comparison with a CNC machine tool having the same workspace

Machining of large workpiece with complex shapes and difficult access

Increase of productivity for current manuel operations such as composite trimming and chamfering

On the other hand, robot stiffness is low: < 1 N/μm (CNC machine tool stiffness > 50 N/μm)

Machining errors are mainly caused by the backlash and friction losses at joints

Hence, vibration of the structure, instability and loss of accuracy (chatter phenomenon) [1]

Simulation environment

EasyDyn

EasyDyn: multibody framework [2]

Simulation of a multibody system such as an industrial robot

Construction and resolution of the equations of motion by application of the d’Alembert principle:

\[
[M]{\ddot{q}} + [C]{\dot{q}} + [K]{q} = {F}
\]

DyStaMill

DyStaMill: milling routine [3]

Macroscopic model of milling

Simulation of milling operations:
- prediction of the cutting forces
- update of the workpiece geometry

Coupling

Coupling of EasyDyn and DyStaMill [4]

Simulation of the milling performed by a complex mechanical system

Experiment setup and milling tests

Experimental setup

Milling tests on aluminium plates

Resulting workpiece

Aluminium 6062 T6

Cutting forces

Surfacing operations, depth of cut ranging from 0.1 mm to 1.6 mm

Overall flatness: 0.238 mm

Roughness: Rₚ=0.4-0.8, Rₐ=6 μm

Cutting coefficients

Model fitting: 18700 RPM at 1.6 mm

Identification by inverse analysis

References


