Zoltán ZOLLER

Vacuum Gripping Method for Handling of Polyurethane Foam Parts With Robots

PhD Theses

1st thesis. Defining and systematizing parameters influencing robotized handling of soft polyurethane foam parts.

I defined parameters which have effects on demoulding of soft polyurethane foam parts. I worked out a moulded foam part description system based on aspects of robotic handling of soft polyurethane foams. I proved, that the moulded foam part description system can be properly applied for defining problematic areas of demoulding and for developing planning directives in the DFFD (Design for Foam Demoulding) system and can be well used for foam part description in the expert system for supporting robot grippers' selection.

2nd thesis. Define air flow losses in soft polyurethane foams.

Analysing formulas for description of flow in porous mediums I applied the formula

$$\frac{\Delta p}{\delta} = av + bv^2$$

for soft polyurethane foams for defining the relation of pressure gradient and velocity based on theoretical considerations. I proved adequacy of this formula by measurements in the full velocity range used for vacuum gripping while applying different deformation states.

3rd thesis. Theoretical analysis of vacuum gripping of soft polyurethane foam parts.

I applied and adapted formulas which describe flow in porous parts for describing air flow in soft polyurethane parts. I developed a procedure to solve the equations to determine air flow for suction heads' application. I used the procedure to design robot grippers for demoulding. I determined the relations between dimensionless items, defined by dimension analyses using important factors in aspects of vacuum gripping, by numerical experiments.

4th thesis. Define planning directives to develop vacuum robot grippers for soft polyurethane foam parts.

Based on studies described in 3rd thesis I defined planning directives to develop vacuum robot grippers, applicable in practice. I proved the efficient industrial applicability of vacuum gripping method by designing and building a vacuum robot gripper and testing it on complex foam parts under industrial circumstances.

5th thesis. Integration of results in design support tools.

I developed two design support tools applying the collected experiences systematically and in practice:

- I determined grasping methods which are applicable for soft polyurethane foams, and their applicability conditions. I developed a rule-based expert system to support robot gripper selection and adaptation.
- I defined planning directives for supporting foam parts' demoulding, and to secure them systematically I proposed introducing a new DFx procedure called 'Design for Foam Demoulding' method.