CRC 805 B2 – funding period 3

CRC 805 B2 – Production families at constant quality – funding period 3

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Abstract

The research work of the sub-project aimed at controlling uncertainty in forming processes and machines by using different control approaches. Forming processes and process chains are characterised by inherent uncertainty, the causes of which can be traced back to fluctuations in semi-finished product properties, unknown disturbance variables and inaccurate machine variables, among other things. For this reason, the sub-project dealt with the integration of control loops in (multi-stage) forming processes and machines and the associated overcoming of control engineering challenges such as non-linearities, singularities and elasticities.

Project description

The basis for working on the sub-project was the results of the previous funding periods, which were marked by countering uncertainty in forming processes by increasing flexibility and integrating control loops. This was pursued through the development of the 3D servo press, which can perform movements of the tool tip with three degrees of freedom. This makes it possible to manufacture a wide range of product variants, enabling manufacturers to respond more flexibly to fluctuating demand. The increase in the number of degrees of freedom and thus the overall complexity is also accompanied by control engineering challenges, which on the one hand relate to the position and force controls of the press, and on the other hand address the component-specific control of properties. This requires both kinematic and elastic models that describe the gear behaviour of the forming machines used with high precision, as well as intelligent control approaches that enable component-specific property detection and derivation of desired manipulated variables.

Results

Particularly outstanding results of the sub-project relate to the model-based control of the 3D servo press (see Figure 1). It could be demonstrated that approaches from robotics enable a control of the three-dimensional ram pose, whereby position trajectories can be traversed with high precision. In contrast to applications from robotics, high forming forces act on presses, which lead to significant positions deviations. For this purpose, reduced elasticity models were developed, which make non-linear elasticities in the press gear calculable in real time and can thus be used in control laws. Furthermore, it could be shown by means of a multi-stage blanking-bending process that information from force signals of the blanking stage is valuable for the control of bending angles in the subsequent bending operation and can be used for the adjustment of bending angles. In this way, the springback behaviour of the components can already be predicted before the bending operation and subsequently compensated for.

[1] 160t version of the 3D Servo Press with schematic representation of the gearbox

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