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Machine learning-based optimal control for Y-shape tube hydroforming processes

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Manufacturing of complicated components encountered industrially associated with the control of the process are similar to those relating to optimization. In fact, the control of a hydroforming process requires a precise determination and adjustment of the operating parameters so that the product obtained satisfies precise criteria of shape and/or mechanical properties and at the lowest possible cost. In the automotive industry, the experimental trial and error process is replaced by the numerical procedure, so the production time and costs can be decreased drastically. As the result, the engineering guidelines and finite element software would be used in the optimal control for tube hydroforming processes. We present a methodology of optimal control for Y-shape tube hydroforming processes by using the machine learning technique. The main study is to use the coupling of the optimization method and finite element simulation at each time step to optimize the load paths that consist of internal pressure and the axial feeds. An optimization strategy is based on the Gaussian processes combined with dimensionality reduction method to build the approximation of optimization problem of the tube thickness versus process parameters during processing. By this way, the optimal command curves are constructed to obtain a better quality component. The result obtained showed an efficiency in improving the quality of the final form of a tube. These results achieved from numerical control can help the designers in manufacturing a product formed. As a result, the proposed approach has an ability to replace the traditional methods and to use in tube hydroforming processes.

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