Computer aided design of rotary forming technology with laser beam material heating

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1. Introduction

The rotary forming process is a plastic forming operation used mainly when shaping thin--walled, axisymmetric products (high plasticity and low strength materials). The design concept for rotary forming with material reheating during forming was developed at the Fraunhofer Institute [1]. A laser beam heats a small part of the surface (in front of the forming roller), and thanks to the coordinated movement of the crushing roller, it is possible to form the material on the rotating pattern.

The selection of process parameters for the forming of new products or the modification of an existing process involves a lot of expensive and time-consuming experimental research to develop new technological guidelines. In the design of these processes, numerical simulations are exceptionally helpful, allowing the virtual design of new processes and the selection of process parameters [2]. Numerical simulations of rotary forming processes have not yet been widely used in operational process control due to the time limitations of these simulations, which can take up to tens of hours.

2. Research methodology

The purpose of this study was to develop a new design approach using advanced numerical modeling of rotary forming processes with laser beam heating (GPU-assisted calculations) and the capabilities of virtual reality (VR) systems. To speed up computation times, implemented in the developed VR system, work was undertaken using artificial intelligence methods to develop a metamodel.

To acquire learning data for the metamodel, the developed numerical model was used [2]. The metamodel was developed using artificial neural networks. Figure 1 shows the process of acquiring the learning set. Computer simulations were carried out for a pipe made of 316 L stainless steel with a wall thickness of 2 mm. The rotational speed, laser power and temperatures were taken as input parameters for the simulation. The heating time was taken as the output parameter. 102 simulations were carried out, one of which took about 4–5 days.

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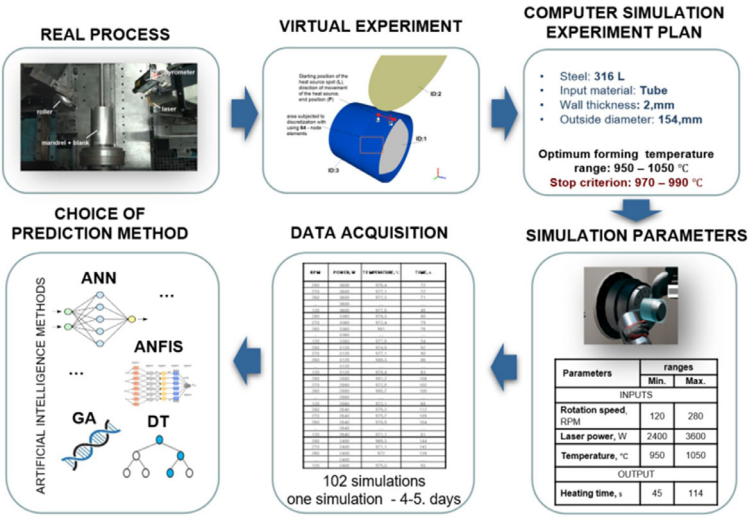

Figure 1. Research methodology.

3. Summary

The developed metamodel allows to acquire information about the required heating time for the set input parameters in real time. The developed methodology was verified for 316L stainless steel and can be adopted to design new metamodels for other materials. The metamodel will be a component of the designed and developed interactive interface, based on VR technology. The designed system can be a useful tool to support the design and realization of industrial processes.

References

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