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Accelerated Thermal Simulation for 3D Interactive Optimization of CNC Sheet Metal Laser Cutting

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Abstract

In the context of CNC-based (Computer Numeric Control) sheet metal laser cutting, the problem of heat transfer simulation is relevant for the optimization of CNC programs. Current physically-based simulation tools use numeric or analytic algorithms which provide accurate but slow solutions due to the underlying mathematical description of the model. This manuscript presents: (1) an analytic solution to the laser heating problem of rectangular plates for curved laser trajectories and convective cooling, (2) a GPU implementation of the analytic solution for fast simulation of the

problem, and (3) an integration within an interactive environment for the simulation of sheet metal CNC laser cutting. This analytic approach sacrifices the material removal effect of the laser cut in favor of an approximated real-time temperature map on the sheet metal. The articulation of thermal, geometric and graphic feedback in virtual manufacturing environments enables interactive redefinition of the CNC programs for better product quality, lower safety risks, material waste and energy usage among others. The error with respect to FEA in temperature prediction descends as low as 3.5 %.

Topics: Sheet metal, Simulation, Laser cutting, Optimization, Computer numerical control machine tools, Lasers, Temperature, Heat transfer, Cooling, Safety

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