Time-Optimal Trajectory Generation for Laser Drilling: Time-Optimal Trajectory Generation for 5-Axis On-the-Fly Laser Drilling of Jet Engine Combustion Chamber Panels

Ammar A. Alzaydi

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On-the-fly laser drilling provides a highly productive method for producing hole clusters (pre-defined groups of holes to be laser drilled) on free-form surfaced parts, such as gas turbine combustion chambers. Although the process is capable of achieving high throughputs, current machine tool controllers are not equipped with appropriate trajectory functions that can take full advantage of the achievable laser drilling speeds. While the problem of contour following has received previous attention in time-optimal trajectory generation literature, on-the-fly laser drilling presents different technological requirements, needing a different kind of trajectory optimization solution, which has not been studied prior to this book. Trajectories for individual hole clusters are optimized by minimizing the integral square of the 4th time derivative, and by adjusting the velocity and acceleration conditions at the hole locations to enable the maximum time compression (i.e., highest laser pulsing frequency). Axis constraints are also considered. Individually optimized clusters are stitched together using time-optimal segments with nonzero velocity boundary conditions.

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