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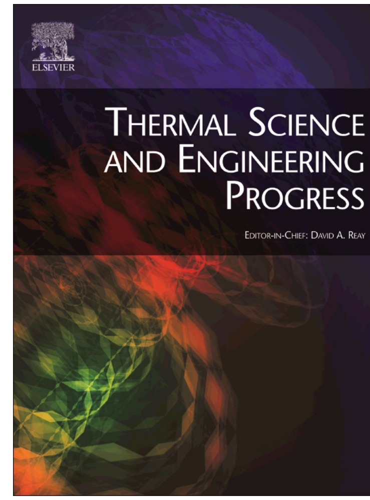

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Abstract

As an innovative and non-traditional manufacturing system the ice-clamping device fixes workpieces by freezing water under sub-zero temperatures. The ice structure encapsulates the piece nearly force-free by adhesive bonding, protecting the piece from deformation, which is especially crucial for thin-walled and micro parts. The generation of cooling power is actuated by thermoelectric coolers (TECs). The challenge arises by preventing the ice from thawing in the presence of external thermal disturbances. Thermal noise occurs through process heat caused by the machining operations like drilling, turning or milling. The paper shows that the usage of several TECs leads to an inhomogeneous temperature distribution on the clamping plate, which is analogous to not uniform clamping forces. Thus, the contribution of this paper is to guarantee a homogeneous temperature profile on the clamping plate, ensuring constant and homogeneous bonding and hence a secure grip during machining processes through a distributed control as well as a thermal disturbance attenuation. Therefore, a robust controller is proposed for the non-linear thermal system based on Lyapunov's approach. A model of an Ice-Clamping system being activated by two TECs is derived, in particular, taking the interaction between them both into account. Simulation and experimental results prove the robustness of the designed controller against parametric uncertainties and show good responses to external thermal disturbances.

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