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Robin optimal boundary control for cooling electronic circuits

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ABSTRACT

We consider the optimal cooling of an electronic circuit plate, which is subject to internal heating sources. The constitutive equations are obtained by modeling the circuit as a parabolic partial differential equation. The properties of the materials (specific heat, density and conductivity), are constant by part over the space domain. Robin boundary conditions (control variable) are used to model the convective electromechanical cooler system.

To simulate the transient period, the standard finite element method, and the backward Euler method are used for the spatial and temporal discretizations, respectively. This results in a large linear system (state equations) parameterized by the control variable where the unknown is the temperature of the circuit plate.

To design a controller, we define a constrained minimization problem where a linearized quadratic cost function is associated to the state and control variables, and the restrictions are given by the state equations. This constrained minimization problem yields a large nonlinear system of equations in the state, control and dual variables. This nonlinear equation is solved using an iterative method with relaxation for the control variable.

Comparisons between numerical results and experimental data found in the literature show that the temperature in the circuit can be controlled effectively with high precision.

Keywords: *Parabolic PDE, Robin Boundary Condition, Optimal Control*

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