Temperature-Dependent Modeling of Thermoelectric Elements
Enzo Evers¹, Rens Slenders¹, Rob van Gils², and Tom Oomen¹

¹ Eindhoven University of Technology, Department of Mechanical Engineering, Control Systems Technology group
PO Box 513, 5600MB Eindhoven, The Netherlands.
e-mail: e.evers@tue.nl

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Abstract for Poster
Active thermal control is key in achieving the required accuracy and throughput in many industrial applications (Evers, de Jager, & Oomen, 2018) e.g., in the medical industry, high-power lighting industry, and semiconductor industry. In these fields, thermoelectric modules (TEMs) have received increased attention over traditional water conditioning circuits because they have compact dimensions and no moving parts. However, the thermoelectric behavior of these modules is non-affine in their inputs and state, complicating their implementation.

In view of control, and to facilitate the implementation of both accurate linearization methods and observer based control, a high fidelity model of the TEM is required. In earlier research, often a limited operating temperature for the TEM is considered, allowing the model to be simplified by using temperature-independent parameters. Here, a significantly larger operating temperature range is considered, e.g., from 5 to 80 degrees celsius, necessitating the inclusion of temperature dependent parameters.

High fidelity modelling for thermoelectric elements for a wide temperature range is achieved by including temperature dependent parameters in the system model. An experimental approach (D. Mitrani, 2004) is used that exploits different timescales in the thermoelectric dynamics to uniquely determine the temperature dependent Seebeck coefficient $S_M$ and electrical resistance $R_M$ for different operating temperatures. The approach is applied in a dedicated experimental setup, shown in Figure 1, and yields results as shown in Figure 2 for the temperature dependency of both parameters.

Including the temperature dependent parameters in the system model facilitates the application of advanced control approaches over a wide range of temperatures. This yields improved performance for applications beyond typical steady-state operation.

Bibliografie