

## **Real-time optimization of intermediate temperature for a cascade heat pump via extreme seeking**

Wenyi Wang<sup>1</sup>   Yaoyu Li<sup>1</sup>

<sup>1</sup>Department of Mechanical Engineering, University of Texas at Dallas, Richardson, TX 75080, U.S.A. {Wenyi.Wang1, [yaoyu.li](mailto:yaoyu.li@utdallas.edu)}@utdallas.edu

### **Abstract**

Improving the energy efficiency of air-source heat pump (ASHP) has been a critical issue for heating operation in cold climates. The cascade heat pump system has been developed as a more advantageous solution over the single-stage heat pump. However, the increased complexity of cascade heat pump systems has presented great challenge for online optimization for the energy efficiency, as model based control/optimization methods incur costly modeling and calibration under different operation and equipment conditions. We propose to use the extremum seeking control as a model-free real-time optimization strategy for efficient operation of cascaded heat pump. The intermediate temperature setpoint is used as the manipulated input for minimizing the system efficiency while satisfying the heating load demand. A Modelica model of an R134a/410a cascade heat pump is developed, and control simulations are conducted for validating the system performance under different ambient conditions.