Master's Thesis Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

Design, Development, and Characterization of a Flow Control Device for Dynamic Cooling Liquid-Cooled Servers

By

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11:00 am, Friday, 30th April 2021

Microsoft Teams Link

Abstract

Since the early '60s, based on Moore's law, transistor density has been doubling every generation resulting in increased power density. Eventually, in the early '90s, we moved from constant voltage to constant electric field and corresponding constant power for a given area during technology changes. Dennard's model of voltage scaling and corresponding constant power ceased, ending improved performance gains in the early 2000s that again required techniques to mitigate increased power and corresponding temperature. The performance gain is being achieved by using multi-core processors, leading to non-uniform power distribution and localized high temperatures making cooling very challenging. Direct cold plate-based liquid cooling is one of the most efficient cooling technologies. The servers in traditional liquid-cooled data centers operate at constant flow rates irrespective of the IT load on each server which leading to redundant pumping power. Dynamic cooling based on a new low-cost Flow control device (FCD) is designed to control the coolant flow rates at the server level. The dynamic cooling will result in pumping power savings by controlling the flow rates based on server utilization. The proposed FCD design contains a V-cut ball valve connected to a micro servo motor. The valve position is varied to change the flow rate through the valve by servo motor actuation based on pre-decided rotational angles. FCD working was validated by varying flow rates and pressure drop across the device by varying the valve position using both CFD and experiments.