Researchers are working on tech so machines can thermally 'breathe'

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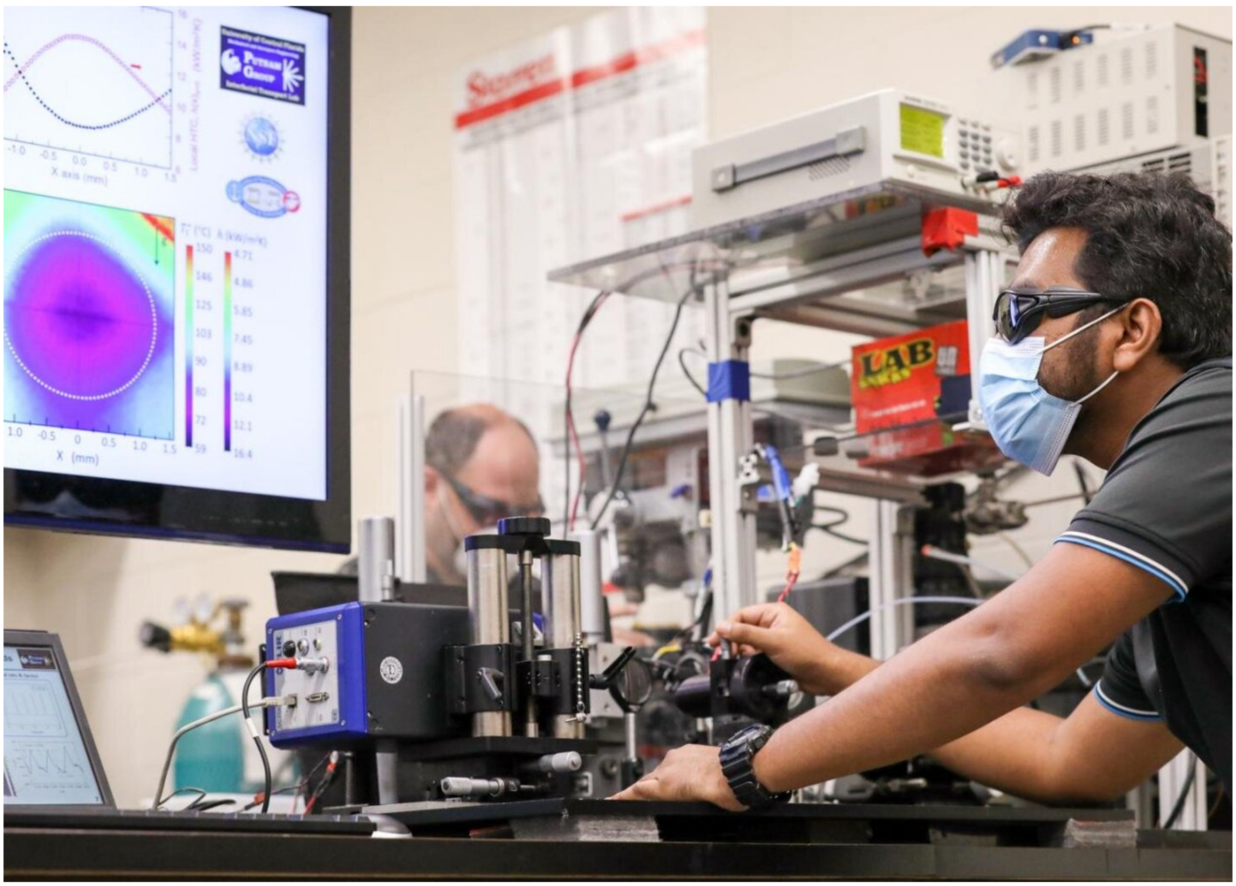

UCF mechanical and aerospace engineering researchers Khan Rabbi and Shawn Putnam are developing new ways to cool machines and electronics. Rabbi is a doctoral candidate in the department, and Putnam is an associate professor. Credit: Karen Norum, University of Central Florida Office of Research

In the era of electric cars, machine learning and ultra-efficient vehicles for space travel, computers and hardware are operating faster and more efficiently. But this increase in power comes with a trade-off: They get superhot.

To counter this, University of Central Florida researchers are developing a way for large machines to "breathe" in and out cooling blasts of water to keep their systems from overheating.

The findings are detailed in a recent study in the journal *Physical Review Fluids*.

The process is much like how humans and some animals breath in air to cool their bodies down, except in this case, the machines would be breathing in cool blasts of water, says Khan Rabbi, a doctoral candidate in UCF's Department of Mechanical and Aerospace Engineering and lead author of the study.

"Our technique used a pulsed water-jet to cool a hot titanium surface," Rabbi says. "The more water we pumped out of the spray jet nozzles, the greater the amount of heat that transferred between the solid titanium surface and the water droplets, thus cooling the titanium. Fundamentally, an idea of optimum jet-pulsation needs to be generated to ensure maximum heat transfer performance."

"It is essentially like exhaling the heat from the surface," he says.

The water is emitted from small water-jet nozzles, about 10 times the thickness of a human hair, that douse a hot surface of a large electronic system and the water is collected in a storage chamber, where it can be pumped out and circulated again to repeat the cooling process. The storage chamber in their study held about 10 ounces of water.

Using high-speed, infrared thermal imaging, the researchers were able to find the optimum amount of water for maximum cooling performance.

Rabbi says everyday applications for the system could include cooling large electronics, space vehicles, batteries in electric vehicles and gas turbines.

Shawn Putnam, an associate professor in UCF's Department of Mechanical and Aerospace Engineering and study co-author, says that this research is part of an effort to explore different techniques to efficiently cool hot devices and surfaces.

"Most likely, the most versatile and efficient cooling technology will take advantage of several different cooling mechanisms, where pulsed jet cooling is expected to be one of these key contributors," Putnam says.

The researcher says there are multiple ways to cool hot hardware, but water-jet cooling is a preferred method because it can be adjusted to different directions, has good heat-transfer ability, and uses minimum amounts of water or liquid coolant.

However, it has its drawbacks, namely either over or underwatering that results in floods or dry hotspots.The UCF method overcomes this problem by offering a system that is tunable to hardware needs so that the only water applied is the amount needed and in the right spot.

The technology is needed since once device temperatures surpass a threshold value, for example, 194 degrees Fahrenheit, the device's performance decreases, Rabbi says.

"For this reason, we need better cooling technologies in place to keep the device temperature well within the maximum temperature for optimum operation," he says. "We believe this study will provide engineers, scientists and researchers a unique understanding to develop future generation liquid cooling systems."

More information: Khan Md. Rabbi et al, Understanding pulsed jet impingement cooling by instantaneous heat flux matching at solid-liquid interfaces, *Physical Review Fluids* (2020). DOI: 10.1103/PhysRevFluids.5.094003

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