Cooling inspired by sweat

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Mario Trujillo creates incredibly detailed simulations of liquid flow to better understand liquid cooling.

In many of today's electronics, the price we pay for speed comes in the form of heat. As the number of processors on a computer chip increases, so does the amount of heat each chip generates—and there's a greater

chance a device will overheat and fail.

With funding from the U.S. Office of Naval Research, Assistant Professor of Mechanical Engineering Mario Trujillo is conducting computer simulations to optimize liquid cooling—a method that uses evaporation to remove heat—for applications such as radar and high-density electronics.

Liquid cooling is not new; however, recent advances in computational capability now allow researchers to study, in detail, how the method works.

Using algorithms derived from natural law, Trujillo is focusing on the interface of different phases of matter— such as the points where liquids mix with gases in a fuel-injected engine—to track each droplet. From the algorithms, powerful computer clusters can create visual simulations that can help create pictures of behavior under not just one set of conditions, but any point or time in an interaction.

As part of his research, Trujillo also is studying ways to improve the simulation methods and measure their accuracy. "What we want to know is, what are the errors, what are the current methods for dealing with them, and how do we improve on them?" Trujillo says.

His goal is to make those metrics relatively easy to implement—yet able to directly measure complex aspects of the computation that specifically target phase change. "The aim is to enable researchers to assess their code so that they can compute these processes with confidence," he says.

Down the road, both his simulation research and resulting benchmarks could give him and other researchers greater insight, for example, into fuel injection behavior or understanding of the process of cooling a nuclear reactor with boiling water.

And simulations also can help make research more efficient. "It is too expensive, both in time and money, to design and run experiments for every imaginable application," says Trujillo.

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