New Supercomputer Simulates Blood Flow

Researchers have successfully used a new supercomputer simulation of blood that moves around the entire human body. This simulated blood flow compares extremely well with real-world flow measurements. The findings were presented at the American Physical Society's meeting in Baltimore.

The computer, called Harvey, operates on a software that uses a 3D representation of every artery that is 1mm across or wider. The 3D framework is built up from full-body CT and MRI scans of a single patient. The accuracy of the simulated blood flow has passed a first key test when physicists compared the blood flow in the virtual aorta with that of real fluid in a 3D-printed replica. The flow patterns that were seen in the physical copy were deemed to be a good match for the simulation.

According to lead researcher Amanda Randles, from Duke University in Durham, North Carolina, the researchers have been able to get very close results both in the steady flow and the pulsatile.

"It's not a common practice," she said.. "But if we have it, then we can extract the arterial network. We get a surface mesh representing the vessel geometry, then we decide what's a fluid node and what's a wall node, and then model fluid flow through there."

The supercomputer is at the Lawrence Livermore National Laboratory in California. It has 1.6 million processors and can be considered to be among the top 10 supercomputers.

The aim of this effort to simulate blood flow is to test how different interventions in cardiovascular disease - such as stents or other surgical modifications - might affect the system more widely and to be able to change the mesh file to represent different treatment options.

Dr. Randles' team collaborated with the team of David Frakes, an engineer at Arizona State University, on a physical comparison. Both teams used 3D printing and created a plastic version of the scanned aorta. Then the fluid was pumped thorugh it and the flow was tracked.

"It's pretty straightforward to calculate analytical solutions for flow in a pipe, or flow in a curved tube. But to make sure we're really getting an accurate simulation in a complex geometry was much more difficult."

Source: Duke University
Image Credit: Randles Lab, Duke University

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