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Adaptive Flow Simulation of Turbulence in Subject-Specific Abdominal Aortic Aneurysm on Massively Parallel Computers ONKAR SAHNI, KENNETH JANSEN, MARK SHEPHARD, SCOREC, RPI, CHARLES TAYLOR, CBRL, STANFORD — Flow within the healthy human vascular system is typically laminar but diseased conditions can alter the geometry sufficiently to produce transitional/turbulent flows in regions focal (and immediately downstream) of the diseased section. The mean unsteadiness (pulsatile or respiratory cycle) further complicates the situation making traditional turbulence simulation techniques (e.g., Reynolds-averaged Navier-Stokes simulations (RANSS)) suspect. At the other extreme, direct numerical simulation (DNS) while fully appropriate can lead to large computational expense, particularly when the simulations must be done quickly since they are intended to affect the outcome of a medical treatment (e.g., virtual surgical planning). To produce simulations in a clinically relevant time frame requires; 1) adaptive meshing technique that closely matches the desired local mesh resolution in all three directions to the highly anisotropic physical length scales in the flow, 2) efficient solution algorithms, and 3) excellent scaling on massively parallel computers. In this presentation we will demonstrate results for a subject-specific simulation of an abdominal aortic aneurysm using stabilized finite element method on anisotropically adapted meshes consisting of $O(10^8)$ elements over $O(10^4)$ processors.

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