Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

A Novel Computational Framework for Pulsatile Wall-shear Stress in Image-based Computational Fluid Dynamics[1] H. YU, X. ZHANG, S. ABOOTORABI, H. YOKOTA, L. ZHU, Indiana University - Purdue University Indianapolis — Wall shear stress (WSS), a tangential force per unit area exerted on the inner wall of a vessel by blood flow, plays an important role in the prevention, pathogenesis, and treatment of cardiovascular diseases. Image-based computational fluid dynamics provides a unique tool to quantify the velocity vector field, from which WSS is conventionally calculated via finite difference method. The key is to determine the local normal direction of the wall in image-based flow domains. We present a novel computation method seamlessly integrating the quantifications of the normal vector $\boldsymbol{n}$ of the local wall via signed distance field and the en-route viscous stress tensor σ using volumetric lattice Boltzmann method. The WSS is calculated by (Einstein index notation). An application study is to quantify WSS of Womersley flow in ducts. The computational efficiency and accuracy are assessed via comparisons with analytical solutions. The effects of Reynolds number, Womersley number, and shape of cross-section on WSS are systematically explored.

[1]The research is supported by the NSF grant (1803845) and IUPUI University Fellowship. The Extreme Science and Engineering Discovery Environment (XSEDE), supported by the NSF grant (ACI-1053575), was used.

Huidan Yu
Indiana University - Purdue University Indianapolis

Date submitted: 02 Aug 2020 Electronic form version 1.4