MIR MD NASIM HOSSAIN

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SUMMARY

PhD candidate in Mechanical Engineering with 6+ years of combined academic and industry experience in microvascular hemodynamics, high-fidelity computational fluid dynamics (CFD), and multiphysics simulations. Specializes in 3D red blood cell (RBC) resolved simulations of complex microvascular geometries using an in house solver integrating finite volume, spectral, and finite element methods, with demonstrated ability to develop project specific modules that extend solver capabilities to meet targeted research objectives. Worked on a $500k NSF-funded project, resulting in high-impact peer reviewed journal publications, conference presentations at top-tier venues, and national media coverage.

EDUCATION

Ph.D. in Mechanical Engineering — January 2022 - May 2026 [Anticipated]
New Jersey Institute of Technology, Newark, NJ — CGPA: 4.00/4.00

B.Sc. in Aeronautical Engineering — January 2013 - February 2017
Military Institute of Science and Technology, Bangladesh — CGPA: 3.66/4.00

PUBLICATIONS

[J5] Mir Md Nasim Hossain, Nien-Wen Hu, Liam B Walters, Ali Kazempour, Julia Withrow, Walter L. Murfee, and Peter Balogh (2025). "*Estimation of 3D Wall Shear Stress in New Blood Vessel Sprouts Using High-Fidelity Simulations*". In Biophysical Journal (Vol. 125, Issue 2). Elsevier. Link

[J4] Nien-Wen Hu, Mir Md Nasim Hossain, Julia Withrow, Ryan Walker, Ali Kazempour, Nikolaos Tsoukias, Donald G Welsh, Walter L Murfee, Peter Balogh (2025). "*Identification of shear stress as a potential vasoconduction signal across microvascular networks*". In Microvascular Research (Vol 162 Page 104855). Elsevier. Link

[J3] Mir Md Nasim Hossain, Nien-Wen Hu, Ali Kazempour, Walter L. Murfee, and Peter Balogh (2024). "*Hemodynamic Characteristics of a Tortuous Microvessel Using High-Fidelity Red Blood Cell Resolved Simulations*". In Microcirculation (Vol. 31, Issue 7). Wiley. Link

[J2] Mir Md Nasim Hossain, Nien-Wen Hu, Maram Abdelhamid, Simerpreet Singh, Walter L Murfee, Peter Balogh (2023). "*Angiogenic Microvascular Wall Shear Stress Patterns Revealed Through Three-dimensional Red Blood Cell Resolved Modeling*". In Function (Vol. 4, Issue 6). Oxford University Press (OUP). Link

[J1] Nien-Wen Hu, B M. Lomel, Elijah W. Rice, Mir Md Nasim Hossain, M Sarntinoranont, Timothy W. Secomb, Walter L. Murfee, Peter Balogh (2023). "*Estimation of Shear Stress Heterogeneity Along Capillary Segments in Angiogenic Rat Mesenteric Microvascular Networks*". In Microcirculation (Vol. 30, Issue 8). Wiley. Link

RESEARCH PROJECTS

Red Blood Cell(RBC) Resolved Modeling of 3D Angiogenic Microvascular Networks

- Digitally reconstructed *in vivo* angiogenic microvascular networks in 3D using CAD and performed high-fidelity 3D RBC-resolved simulations with 1500+ deformable RBCs
- Revealed previously unknown *in vivo* characteristics, including unique 3D Wall Shear Stress (WSS) and wall shear stress gradients (WSSG), vessel-to-vessel heterogeneity, WSS hot and cold spots, and RBC effects at sub-endothelial (sub-EC) length scales
- Characterized time-dependent WSS fluctuations across vessel diameters on RBC timescales

Hemodynamics Characterization of Tortuous Microvessels

- Revealed hemodynamic characteristics of a real tortuous microvessel for physiological flow conditions
- Discovered increase in apparent viscosity and reduced Fahraeus effect due to tortuosity
- Identified dependency of hematocrits(Ht) and shear rates on WSS characteristics and Cell Free Layer (CFL)

Wall Shear Stress(WSS) Estimation of Angiogenic Sprouts

- Performed 3D RBC-resolved simulations on in vivo capillary sprouts to quantify time-dependent WSS
- Revealed previously unknown WSS temporal fluctuations along sprout length, caused by unsteady movements of RBCs in the host vessel
- Identified dependence of temporal WSS on sprout length, host vessel diameter, hematocrit, and flow strength

CONFERENCE TALKS

[C5] Mir Md Nasim Hossain, Nien-Wen Hu, Ali Kazempour, Walter Murfee, Peter Balogh "*Estimation of 3D Wall Shear Stress in New Blood Vessel Sprouts Using High-Fidelity Simulations*", 78th Annual Meeting of the APS/DFD, American Physical Society (2025).
[C4] Mir Md Nasim Hossain, Nien-Wen Hu, Ali Kazempour, Walter Murfee, Peter Balogh "*Hemodynamic Characteristics of New Blood Vessel Sprouts Using High-Fidelity Red Blood Cell Resolved Simulations*", American Physiology Summit (APS Summit 2025).
[C3] Mir Md Nasim Hossain, Nien-Wen Hu, Ali Kazempour, Walter Murfee, Peter Balogh "*Hemodynamic Characteristics of Tortuous Microvessels Using High-Fidelity Red Blood Cell Resolved Simulations*", American Physiology Summit (APS 2024).
[C2] Mir Md Nasim Hossain, Yuan Nan Young, and Peter Balogh "*Effects of Red Blood Cell Stiffness on Hemodynamics in a Model Microvessel*", 76th Annual Meeting of the APS/DFD, American Physical Society (2023).
[C1] Mir Md Nasim Hossain, Nien-Wen Hu, Walter Murfee, Peter Balogh "*Three-Dimensional Shear Stress Characteristics in Angiogenic Microvascular Networks Revealed Through Red Blood Cell-Resolved Modeling Based on Real Image Data*", American Physiology Summit (APS 2023).

EXPERIENCE

Graduate Research Assistant January 2022 - Present
New Jersey Institute of Technology, Newark, NJ
- Perform high-fidelity 3D RBC-resolved simulations in complex microvascular geometries using IBM-based in-house solver integrating finite-volume, spectral, and FEM methods
- Implement project-specific modules to extend solver functionality for research objectives
- Reconstruct 3D microvascular geometries in CAD (Creo) from in vivo imaging data
- Develop custom post-processing subroutines to extract metrics including wall shear stress, apparent viscosity, and cell-free layer thickness
- Identify unresolved research questions through literature review and design simulation studies leading to publications

Research Assistant June 2021 - December 2021
Missouri University of Science and Technology, Rolla, MO
- Fabricated lithium-ion coin cells and assembled small-scale battery packs to measure voltage–time profiles through controlled charge–discharge experiments
- Calibrated and optimized Pseudo Two-Dimensional (P2D) model parameters in COMSOL using experimental voltage data
- Used the validated model to predict battery voltage and state-of-charge behavior under untested operating conditions

Design Engineer (R&D) February 2017 - October 2018
ISON3D, Dhaka, Bangladesh
- Led mechanical and system-level design of an FDM 3D printer
- Redesigned the print bed and selected a cost-effective extruder, improving first-layer adhesion, reducing warping, and enabling up to 0.4 mm layer height.
- Designed and rendered the complete product in SolidWorks and KeyShot, upgrading the electronics enclosure for protection and implementing an improved three-point bed-leveling system.

TECHNICAL STRENGTHS

Core Expertise	CFD Solver Development, Multiphysics Modeling, Particulate and Multiphase Flow
Numerical Methods	Immersed Boundary Method (IBM), Finite Difference Method (FDM), Finite Volume Method (FVM), Finite Element Method (FEM)
Simulation Software	ANSYS, COMSOL Multiphysics, In-house Solvers
Programming	Fortran , Python, MATLAB, C/C++, G-Code, LabVIEW
High-Performance Computing	MPI, OpenMP, CUDA
CAD	SolidWorks, Creo
Manufacturing Methods	Additive Manufacturing, Lathe Machining, CNC Machining, Casting, Injection Molding, Forging, Electrospinning, Heat Treatment
Others	ParaView, KeyShot, MeshLab, LaTeX, Git, Linux, Windows, Mac

BOOK CHAPTER

[**B1**] Nien-Wen Hu, Arinola Lampejo, Ariana D. Suarez-Martinez, Nicholas Hodges, **Mir Md Nasim Hossain**, Peter Balogh, Bing Ren, Yong Huang, Jonathan J. Adorno, Shashwat S. Agarwal, Jacob C. Holter, Elton Y. Cao, Jonathan W. Song, Dorothy N. Beck, Shayn M. Peirce & Walter L. Murfee "*Biomimetic Models for Investigation of Microvascular Remodeling*". In Handbook of Microcirculation, pp. 763–785, Springer Nature Switzerland, 2025.

MEDIA ATTENTION

[**M3**] Research "*Hemodynamic Characteristics of New Blood Vessel Sprouts Using High-Fidelity Red Blood Cell Resolved Simulations*" Featured on NSF ACCESS news.
[**M2**] Journal Article "*Angiogenic Microvascular Wall Shear Stress Patterns Revealed Through Three-dimensional Red Blood Cell Resolved Modeling*" Featured on Medical Xpress.
[**M1**] Journal Article "*Angiogenic Microvascular Wall Shear Stress Patterns Revealed Through Three-dimensional Red Blood Cell Resolved Modeling*" Featured as the Cover Image of Function Journal.

FUNDING INFORMATION

Research projects supported by the following federal grants:
- National Science Foundation (NSF) grant CBET 2309559
- National Institutes of Health (NIH) grant R21HL159501
- NSF ACCESS Accelerate Award BIO230073