

# JAVAD ESHRAGHI, PH.D.

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## SUMMARY

Traveler | Photographer | Researcher | Engineer | Amateur Astronomer

- Interdisciplinary experimentalist and fluid dynamicist with skills and experience in mechanical engineering, biomedical engineering, and measurement & data science.
- Led collaborative projects, resulting in 20+ peer-reviewed publications, including 9 first-authored publications, 2 patents, & 3 IPs
- Expertise in methods and analysis of multiphase flows and interfacial phenomena in medical devices
- Highly skilled in signal/image processing, design of experiment, and flow visualization
- Self-motivated, problem-solver, and a collaborative scientist with excellent communication and project management skills
- Experienced in coaching and mentoring junior-level scientists and technologists in both technical and career development

## RESEARCH & WORK EXPERIENCE

### Purdue University

West Lafayette

Postdoctoral Research Associate

May 2022 to Present

- Conducted physical experiments that led to the determination of critical shear stress beyond which the protein aggregation occurs. The aggregates were characterized using SEC, DLS, MFI, and Mass spectrometry.
- Delineated the role of cavitation in therapeutic protein aggregation by performing physical experiments
- Investigated the morphology of subvisible particles formed under different types of stresses and their correlation using advanced image processing techniques and K-means clustering.
- Modified DoVeR method for reconstructing velocity fields from Color Doppler images in the vasculature.

### Purdue University

West Lafayette

Research Assistant

Sept 2016 to Apr 2022

- Developed a data assimilation-based approach to model cavitation dynamics using a PID controller
- Developed a framework consisting mainly of high-speed shadowgraphy, PIV measurements, and advanced image processing for analyzing the kinematic performance of autoinjector medical devices
- Developed best practices for spring-driven autoinjector medical devices design by analyzing the kinematic performance of different autoinjectors and an experimentally validated dynamic model
- Determined the severity of cavitation in autoinjector medical devices during drug administration with a non-invasive approach using high-speed visualization and data assimilation.
- Investigated the sloshing-induced air entrainment and stress field in autoinjector medical devices employing simultaneous PIV and shadowgraphy.
- Developed a thermal modulation-based approach to induce echogenicity in liquid perfluorocarbon-based nanodroplets. Thermal modulation improved the echogenicity of BSA-shelled TDFH nanodroplets by a mean fold of 15 on the B-mode and NLC modes. The nanodroplets were characterized with TEM, DLS, and an image-based probability estimation of displacement technique based on confocal microscopy images.
- Determined the critical threshold for the shape oscillation onset on the bubble surface in an acoustic field from an energy absorption perspective. Developed a frequency-based analysis framework using DWT and CWT to robustly define different oscillation regimes of an air bubble in a cavitation-induced acoustic field.
- Developed an analytical model and conducted physical experiments that revealed the cause of splash curtain closure in the water entry phenomenon.
- Investigated the dynamics of a liquid spray using PIV and PTV, providing Eulerian and Lagrangian descriptions of the droplet motions. Evaluated the degree of size/velocity correlation by conducting simultaneous measurements of droplet size and velocity.
- Investigated the dynamics of falling spheres and rising bubbles by characterizing the induced reverse jet and internal waves in a confined linearly stratified fluid using 3D-PTV and 3D-PIV.
- Compared the performance of high-speed plenoptic-stereoscopic PIV and tomographic-PIV for a turbulent & pulsatile pipe flow.
- Developed Kalman filter-based volumetric PTV by replacing Wiener filter-based track predictor with a Kalman filter-based prediction in the Shake-The-Box method.
- Developed a unique experimental system to conduct BOS-PIV-Interferometry simultaneously in a flowing soap film
- Responsible for managing the team, designing experiments, data acquisition, data analysis, and drafting the manuscripts

### University of Tehran

Tehran

Research Assistant

Sept 2012 to July 2016

- Led 2 primary projects focused on multiphase flow and energy-saving strategies using renewable/optimized energies in buildings
- Developed two-phase flow patterns maps for air-water and air-oil flowing in an upward/downward tube using machine learning
- Used numerical & experimental approaches to study bubble dynamics & investigate the effects of nanoparticles on bubble growth
- Designed a Zero Energy Building for a moderately warm climate using active and passive heating/cooling strategies, including Phase Change Materials
- Designed and implemented CCHP system for commercial & office buildings

## AREA OF EXPERTISE & TECHNICAL SKILLS

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- **Data Assimilation & System Identification:** PID controller, Kalman filter, Bayesian inference, Uncertainty quantification
- **Machine Learning:** Clustering, Automated machine learning (Toolkit: autoklearn), Deep Learning (Toolkit: TensorFlow, Pytorch)
- **Experiments in Fluid Mechanics:** Particle Image Velocimetry (PIV), Background Oriented Schlieren (BOS), Interferometry
- **Experimentation:** Design of experiments, Imaging, Measurement science, Signal & image processing
- **Biology:** Protein characterization (SEC, DLS, MFI, and Mass spectrometry)
- **Microscopy/Imaging:** Confocal microscopy, Ultrasound imaging
- **Medical Devices:** Auto-injectors, Pre-filled syringes
- **Programming Languages:** MATLAB, Python, and C++
- **Software:** LabVIEW, ImageJ, Microsoft Office, LaTeX, Adobe Illustrator, Adobe Lightroom, Adobe Photoshop

## EDUCATION

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- Ph.D., Mechanical Engineering, Purdue University, 2022
- MS, Mechanical Engineering, University of Tehran, 2015
- BS, Mechanical Engineering, University of Tehran, 2013

## AWARDS

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- 2016 - Graduate Scholarship, Purdue University
- 2016 - Graduate Scholarship, EPFL (École Polytechnique Fédérale de Lausanne)
- 2007 & 2008 - Outstanding Astronomer in the 7th and 8th Messier Marathon

## PROFESSIONAL SERVICES

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- Reviewer of International Journal of Multiphase Flow
- Reviewer of Energy and Buildings

## PUBLICATIONS

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### - Journal Papers

- **Javad Eshraghi**, J.-C. Veilleux, G.H. Shi, D.S. Collins, A.M. Ardekani, P.P. Vlachos, "Flow-induced aggregation of high concentration BSA protein", *Pharmaceutical Research* (2022) [Internal Review]
- **Javad Eshraghi**, S. Bhattacharya, L.K. Rajendran, P.P. Vlachos, "The role of absorbed energy on oscillation mode of an air bubble in a cavitation-induced acoustic field", *PNAS Nexus* (2022) [Submitted]
- **Javad Eshraghi**, Z. Dou, J.-C. Veilleux, G.H. Shi, D.S. Collins, A.M. Ardekani, P.P. Vlachos, "The air entrainment and hydrodynamic shear of the liquid slosh in syringes", *International Journal of Pharmaceutics* 627 (2022) 122210.
- **Javad Eshraghi**, J.-C. Veilleux, G.H. Shi, D.S. Collins, A.M. Ardekani, P.P. Vlachos, "Assessment of cavitation intensity in spring-driven autoinjectors", *Pharmaceutical Research* 39 (2022) 2247–2261.
- A. Vasiukhina, **Javad Eshraghi**, A. Ahmadzadegan, C. Goergen, P.P. Vlachos, L. Solorio, "Thermally-induced echogenicity for stable nanodroplet ultrasound contrast agents", *Nanomaterials* 11(9) (2021) 2225.
- **Javad Eshraghi**, L.K. Rajendran, M.A. Stremmer, W. Yang, P.P. Vlachos, "On flowing soap films as experimental models of 2D Navier-Stokes flows", *Experiments in Fluids* 62(8) (2021) 162.
- **Javad Eshraghi**, A.M. Ardekani, P.P. Vlachos, "Data assimilation for modeling cavitation bubble dynamics", *Experiments in Fluids* 62(5) (2021) 90.
- X. Zhong, **Javad Eshraghi**, P.P. Vlachos, S. Dabiri, A.M. Ardekani, "A model for a laser-induced cavitation bubble", *International Journal of Multiphase Flow* 132 (2020) 103433.
- D.W. Carter, R. Hassaini, **Javad Eshraghi**, P.P. Vlachos, F. Coletti, "Multi-scale imaging of upward liquid spray in the far-field region", *International Journal of Multiphase Flow* 132 (2020) 103430.
- **Javad Eshraghi**, S. Jung, P.P. Vlachos, "To seal or not to seal: The closure dynamics of a splash curtain", *Physical Review Fluids* 5 (10) (2020) 104001.
- Z. Dou, **Javad Eshraghi**, T. Guo, J.-C. Veilleux, K.H. Duffy, G.H. Shi, D.S. Collins, A.M. Ardekani, P.P. Vlachos, "Performance characterization of spring actuated autoinjector devices for Emgality and Aimovig", *Current Medical Research and Opinion* 36 (8) (2020) 1343-1354.
- E. Kosari, **Javad Eshraghi**, W.H. Ahmed, P. Hanafizadeh, "Experimental investigation of bubble growth and detachment in stagnant liquid column using image-based analysis", *Energy Equipment and Systems* 7 (4) (2019) 353-375.
- J. Louf, B. Chang, **Javad Eshraghi**, A. Mituniewicz, P.P. Vlachos, S. Jung, "Cavity Ripple Dynamics after Pinch-Off", *Journal of Fluid Mechanics* 850 (2018) 611-623.
- H. Gharedaghi, A. Dousti, **Javad Eshraghi**, P. Hanafizadeh, M. Ashjaee, "A Novel Numerical Approach for Investigation of the Gas Bubble Characteristics in Stagnant Liquid Using Young-Laplace Equation", *Chemical Engineering Science* 173 (2017) 37–48.
- P. Hanafizadeh, **Javad Eshraghi**, Y. Nazari, K. Yousefpour, M.A. Akhavan Behabadi, "Light Oil-Gas Two-Phase Flow Pattern Identification in Different Pipe Orientations: An Experimental Approach", *Scientia Iranica* 24 (5) (2017) 2445-2456
- P. Hanafizadeh, **Javad Eshraghi**, P. Ahmadi, A. Sattari, "Evaluation and Sizing of a CCHP System for a Commercial and Office Buildings", *Journal of Building Engineering* 5 (2016) 67-78.
- P. Hanafizadeh, **Javad Eshraghi**, A. Taklifi, S. Ghanbarzadeh, "Experimental Identification of Flow Regimes in Gas-Liquid Two Phase Flow in a Vertical Pipe", *Meccanica* 51 (8) (2016) 1771-1782.
- P. Hanafizadeh, **Javad Eshraghi**, A. Amini, "Entropy Analysis of Buoyancy Driven Gas-Liquid Two Phase Flow: Analytical and Experimental Approaches", *European Journal of Mechanics - B/Fluids* 59 (2016) 169-176.

- P. Hanafizadeh, **Javad Eshraghi**, E. Kosari, W.H. Ahmed, "The Effect of Gas Properties on Bubble Formation, Growth and Detachment", *Particulate Science and Technology* 33 (6) (2015) 645-651.
  - **Javad Eshraghi**, N. Mirkhani, N. Narjabadifam, S. Sadoughi, M. Ashjaee, "Exploring the Reduction of Pollutant and greenhouse gas emissions by Utilizing Solar Zero Energy Buildings in Tehran", *Journal of Clean Energy Technology* 3 (1) (2015) 23-27.
  - **Javad Eshraghi**, N. Narjabadifam, N. Mirkhani, S. Sadoughi, M. Ashjaee, "A Comprehensive Feasibility Study of Applying Solar Energy to Design a Zero Energy Building for a Typical Home in Tehran", *Energy and Buildings* 72 (2014) 329-339.
- APS Gallery of Fluid Motion Entries
- **Javad Eshraghi**, S. Jung, P.P. Vlachos, "To Seal or Not To Seal", Voo45, APS/DFD Gallery of Fluid Motion 2018
  - **Javad Eshraghi**, M.A. Stremmer, P.P. Vlachos, "Wake of Cylinder Triangles", Voo97, APS/DFD Gallery of Fluid Motion 2017
- Patents
- **Javad Eshraghi**, "Characterization of flow-induced aggregation of therapeutic proteins—Impact of cavitation, high shear stress, and air-liquid interfaces on protein aggregation and particle formation", IP to be patented by Purdue University, Dec 2021, No. 2022-VLAC-69709 (50% share)
  - **Javad Eshraghi**, "A non-invasive method for characterization of liquid slosh in accelerating liquid column", Dec 2021, No. 2022-VLAC-69710 (50% share)
  - **Javad Eshraghi**, "An image-based non-invasive method for fluid stress field estimation", IP to be patented by Purdue University, Jan 2020, No. 2020-VLAC-68910 (33.33% share)
  - **Javad Eshraghi**, "Collapsible and portable solar cooker with ability to set the height & angle", July 2012, Iran Patent No.75841
  - **Javad Eshraghi**, "Intelligent external roller shading", October 2014, Iran Patent No. 315427
- Conference Presentations
- "Vascular velocity reconstruction using Color Doppler flow field velocity", 75th Annual Meeting of the APS DFD, Indianapolis, USA, Nov 2022
  - "Color Doppler Echocardiography Velocity Reconstruction using Data Fusion with 4D Flow MRI", 75th Annual Meeting of the APS DFD, Indianapolis, USA, Nov 2022
  - "Computational modeling of air bubble oscillations in a cavitation-induced acoustic field using multi-phase multicomponent model", 75th Annual Meeting of the APS DFD, Indianapolis, USA, Nov 2022
  - "Image-based measurements of diffusion coefficients from diffraction-limited nanoparticles", 75th Annual Meeting of the APS DFD, Indianapolis, USA, Nov 2022
  - "Shape oscillation dynamics of a single bubble in a cavitation-induced acoustic field", 74th Annual Meeting of the APS DFD, Phoenix, USA, Nov 2021
  - "Kalman filter-based volumetric PTV particle tracking", 74th Annual Meeting of the APS DFD, Phoenix, USA, Nov 2021
  - "Dynamics of a single bubble rising in confined stratified flow", 74th Annual Meeting of the APS DFD, Phoenix, USA, Nov 2021
  - "An experimental study of falling spheres in a confined density-stratified fluid", 74th Annual Meeting of the APS DFD, Phoenix, USA, Nov 2021
  - "A Kalman filtering approach to particle track filtering and track uncertainty quantification for 3D PTV measurement", 4th International Symposium on Particle Image Velocimetry (ISPIV), Chicago, USA, Aug 2021
  - "A model for a laser-induced cavitation bubble", 11th International Symposium on Cavitation, Daejeon, South Korea, May 2021
  - "A data assimilation method for analysis of cavitation bubble dynamics", 73rd Annual Meeting of the APS DFD, Chicago, USA, Nov 2020
  - "The role of contact angle on sloshing and air entrainment in a confined domain", 73rd Annual Meeting of the APS DFD, Chicago, USA, Nov 2020
  - "Performance of kHz-rate plenoptic-PIV versus tomo-PIV on a 10mm-scale pipe flow", 73rd Annual Meeting of the APS DFD, Chicago, USA, Nov 2020
  - "Analysis of Cavitation in Syringes", PDA Europe Parenteral Packaging, Basel, Switzerland, Feb 2020
  - "Soap Film Patterns Versus Flow Structures: Do they match?", 71st Annual Meeting of the APS DFD, Atlanta, USA, Nov 2018
  - "Numerical study of surface tension effects on bubble detachment in a submerged needle", 8th International Conference on Computational and Experimental Methods in Multiphase and Complex Flow, Valencia, Spain, Apr 2015
  - "Designing a Zero Energy Building for Tehran", International Conference for Enhanced Building Operations ICEBO, Manchester, England, Oct 2012
  - "Feasibility Study of Applying PCMs in Heating and Cooling System of Buildings", 2nd National Conference on Environmental Planning and Management EPM, Tehran, Iran, May 2012