

Santanu Chandra

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Research Area

Cardiovascular biofluid mechanics, vascular biomechanics, computational fluid dynamics, high performance computing, fluid-structure interaction analysis, experimental biofluids, particle image velocimetry, clinical image analysis, patient specific therapeutics

Professional Experience

2010-present **Post Doctoral Research Associate, Multi-Scale Cardiovascular Bioengineering Lab (MSCBL)**
Department of Aerospace and Mechanical Engineering, Bioengineering Program
University of Notre Dame, Notre Dame, IN
Advisor: Dr. Philippe Sucusky, Assistant Professor

2008 -2010 **Post Doctoral Research Associate, Vascular Biomechanics and Biofluids Lab (VBBL)**
Institute for Complex Engineered Systems (ICES)
Carnegie Mellon University, Pittsburgh, PA
Advisor: Dr. Ender Finol, Associate Research Professor

Education

2003 -2007 **PhD, Micro Electro Mechanical Systems Design**
Department of Mechanical Engineering
University of Akron, Akron, OH
Advisor: Dr. Celal Batur, Chairman and Professor

2001-2003 **MS, Design & Systems**
Department of Mechanical Engineering
University of Akron, Akron, OH
Advisor: Dr. Yueh-Jaw. Lin, Professor

1995 -1999 **B.Tech, Mechanical Engineering**
Kalyani Govt. Engineering College, University of Kalyani, WB, India

Accomplishments & Scholarships

- 13 peer reviewed paper (7 published, 6 submitted) and 19 national and international conference publications
- 'Best Tutor' award and scholarship from Dean's Office, University of Akron, 2005-2007 for contribution to Increasing Diversity in Engineering Academics (IDEAs) Program
- Research/Teaching Assistantship and full scholarship from University of Akron, towards PhD, 2003-2007
- Teaching Assistantship and full scholarship from University of Akron, towards MS, 2001-2003
- National Talent Search Scholarship, 1992, 1994, India

Research & Work Experience

Post-Doctoral Research Associate, University of Notre Dame, Notre Dame, IN

2010 - Present

Project Title: Experimental and computational studies of aortic valve leaflet to investigate the effect of hemodynamics on progression of Calcific Aortic Valve Disease (CAVD)

- Designed and developed 2D and 3D computational models of aortic heart valve anatomies to characterize the hemodynamic abnormalities of valve leaflet surface
- Performed complex fluid-structure interaction (FSI) analysis using ADINA 8.6 and ANSYS-CFX
- Designed and supervised the fabrication of aortic valve chamber for experimental verification of FSI results

- Supervised the development of a left heart simulator flow loop and particle image velocimetry setup for assessing hemodynamics through native porcine heart valves
- Managed lab and advised 2 graduate students in their daily activities

Accomplishments

- In 1 year, research resulted in 5 national conference (2 poster and 3 podium) and 1 first author paper
- Planned a research study and submitted a proposal for postdoctoral fellowship grant to American Heart Association(AHA)
- Actively assisted in proposal submission for federal grant (i.e. AHA early career and NIH-R01 programs)

Post-Doctoral Research Associate, Carnegie Mellon University, Pittsburgh, PA

2008 - 2010

Project Title: Bioengineering studies of abdominal aortic aneurysm (AAA) fluid and wall dynamics

- Executed a NIH funded research project for development of a patient specific modeling framework to characterize abdominal aortic aneurysm rupture potential
- Managed patient data and develop CT image based computational model through segmentation, modeling and FE meshing
- Developed and tested a novel protocol for extraction of patient specific flow data from MR Images
- Performed patient specific fluid structure interaction analysis using ADINA 8.6 for aortic wall stress assessment
- Managed high performance computing at Pittsburgh supercomputing center (PSC)
- Proposed a novel decoupling FSI strategy to save computational time
- Developed and tested a framework for reconstructing zero pressure model from CT image based pressurized vasculature
- Collaborated and organized follow-up meetings with surgeons and, radiologists at Allegheny General Hospital(AGH)
- Managed computer lab and advised 3 graduate students

Accomplishments

- 2 year research resulted in 8 national and international conferences (2 poster and 6 podium)
- Research resulted in 2 first author papers and 5 co-authored papers in collaboration with University of Zaragoza, Spain
- Initiated a research plan and developed collaboration with cardiologists at AGH to submit a proposal for NIH-K99 grant

FEA Analyst, American Engineering Group, Akron, OH

2007 - 2008

Project Title: Design optimization and reliability analysis of world's first retractable studded tire, a product of Qtire

- Developed computational model of Tire components and performed optimization and reliability analysis of world's first retractable studded Tire, a product of Qtire
- Supervised offshore team of engineers to perform inflation and footprint analysis, steady state rolling analysis, Tire/Stud/Road contact analysis using finite element modeling in ABAQUS
- Managed the product development project by interfacing with client, consultants in USA and offshore engineers in India

Accomplishments

- Completed the assigned projects and presented the results in an executive meeting to the CEO and Director of Design

Doctoral Candidate, University of Akron, OH

2003 - 2007

Dissertation Title: A numerical study for liquid bridge based microgripping and contact angle manipulation by electrowetting method

- Designed and analyzed a pick and place manipulation technique for assembly of micron sized objects
- The design idea was pursued from conception to feasibility analysis and testing
- Developed numerical models in MATLAB and solved differential equations to obtain the stable shape of liquid bridge between two solid surfaces. Characterized the interface shape change and capillary force exerted when contact angle is manipulated on the surface
- Performed computational fluid dynamics studies with CFD ACE+ to characterize the dynamic shape change of a liquid bridge between two surfaces

Accomplishments

- Research resulted in 1 peer reviewed paper and 2 national conference (1 poster and 1 podium)
- Successfully presented research and completed course requirements for PhD degree

- Assisted in other collaborative projects that resulted in 2 co-authored papers

Other Research Projects

- Studied the feasibility of using electromagnetic forces for motion generation in a micro actuator array with a team of four. Performed computational modeling and Stress analysis of the MEMS actuator using multiphysics software modules in ANSYS
- Developed the data acquisition module of a micro device designed for detecting the size and concentration of pollen particles by using Coulter Counter principles

Masters Candidate, University of Akron, Akron, OH

2001 – 2003

Thesis Title: An expert framework aide for determining optimal design metamodel

- Developed an expert framework aide using Matlab GUI for determining optimal design metamodels (i.e. Kriging and Response Surface Models). Designed 3D models in Pro/Engineer and performed geometry optimization

Accomplishments: Research was published as one conference paper

Submitted Proposals

- Submitted a proposal for 2 year Postdoctoral Fellowship to American Heart Association(Midwest affiliate)on July 22,2011, “Does Hypertensive fluid shear stress promote calcific aortic valve disease”, Mentor: Dr. Philippe Sucosky
- Submitted NIH K99/R00 proposal for pathway to independence award in June 2010: “Role of Nuclear Imaging in AAA rupture risk assessment”, Carnegie Mellon University (Pittsburgh, PA), Mentor: Dr. Ender Finol
- Submitted one SBIR proposal to US Military for development of a network of MEMS devices for damage analysis of Armored Vehicles in April 2008, American Engineering Group (Akron , OH)

Teaching Experience

Post-Doctoral Research Associate, University of Notre Dame , Notre Dame, IN, USA

2010 – Present

- Assisted in design and development of a graduate level course (Biofluid Mechanics - AME 60675). Participated in homework and final project evaluation
- Developed and instructed a workshop on application of Fluid Structure Interaction analysis in cardio biomechanics using ADINA for the same course. Advised students in their class project planning and execution.
- Lab Manager of Multi Scale Cardiovascular Laboratory(MSCBL) , managing 2 graduate students

Graduate Teaching Assistant, University of Akron, OH, USA

2001 – 2007

- Lab Instructor for Measurement Lab (Strain, Vibration and Flow measurement), ME Lab (Stress, Strain), CAD/CAM Lab (Design and Analysis using Pro/Engineer and Pro/Mechanica), ME Tools Lab (Design with AutoCAD 2000-2005, Simulation with MATLAB)
- Prepared lecture materials, lectured in classroom, prepared experiment setups and supervised lab experiments.
- Mentored student design projects involving design, analysis and optimization of mechanical structures using Pro/Engineer, Pro/Mechanica, and ANSYS

Tutor, University of Akron, OH, USA

2005– 2007

- Mentored multiple undergraduate students in physics, math and mechanical engineering subjects
- Volunteered in workshops to promote Engineering to high school students

Publications

Peer Reviewed Journals

1. **Chandra, S.**, Rajamannan, N., Sucosky, P., 2012,“ Computational assessment of bicuspid aortic valve wall-shear stress- implications for calcific aortic valve disease”, *Biomechanics and Modeling in Mechanobiology*(Impact Factor 3.162), accepted , Feb 20120 <http://www.ncbi.nlm.nih.gov/pubmed/22294208> (**most downloaded article in 90 days**)
2. Malvè, C. M., **Chandra, S.**, López-Villalobos, J. L., Finol, E. A., Ginel, A., Doblaré, M.,2012,“CFD analysis of the human airways under impedance-based boundary conditions: application to healthy, diseased and stented trachea”, *Computer Methods in Biomechanics and Biomedical Engineering* (Impact Factor 1.573), e-print available 10.1080/10255842.2011.615743

3. **Chandra, S.**, Raut, S., Jana, A., Biederman, R., Doyle, M., Muluk, S., and Finol, E., 2011, "Fluid Structure Interaction Modeling of Abdominal Aortic Aneurysms: the impact of patient specific inflow conditions and fluid/solid coupling", *Journal of Biomechanical Engineering*, submitted.
4. **Chandra, S.**, Rodriguez, J. F. and Finol, E.A, 2011, "Methodology for the derivation of unloaded vascular geometry with hyperelastic isotropic tissue properties" *Journal of Biomechanical Engineering*, submitted.
5. Malve, M., **Chandra, S.**, Garcia, A., Mena, A., Martinez, M.A., Finol, E., Doblare, M., 2012, "Impedance-based Outflow Boundary Conditions for Human Carotid Hemodynamics", *Computer Methods in Biomechanics and Biomedical Engineering*, submitted.
6. Malvè, M., Pérez del Palomar, A., **Chandra, S.**, López-Villalobos, J. L., Mena, A., Finol, E. A., Ginel, A., Doblare, M., 2011, "FSI Analysis of a Human Trachea Before and After Prosthesis Implantation", *Journal of Biomechanical Engineering*, Vol. 133, No. 7, pp. 071003 , doi:10.1115/1.4004315.
7. Malvè, M., Pérez del Palomar, A., **Chandra, S.**, López-Villalobos, J. L., Mena, A., Finol, E. A., Ginel, A., Doblare, M., 2011, "FSI Analysis of a Healthy and a Stenotic Human Trachea Under Impedance-Based Boundary Conditions", *Journal of Biomechanical Engineering*, Vol. 133, No. 2, pp. 021001 , doi:10.1115/1.4003130.
8. Raut, S., **Chandra, S.**, Shum, J., Washington, C.B., Muluk, S.C., Rodríguez, J. F. and Finol, E.A., 2011, "Biological, Geometric and Biomechanical Factors Influencing Abdominal Aortic Aneurysm Rupture Risk: a Comprehensive Review", *Special Issue Translational Application of in vivo Imaging and Mechanical Analysis of Atherosclerotic Plaque Vulnerability in the Journal Recent Patent on Medical Imaging*, in review
9. Scotti, C.M., Shu, F., Vandenbergh, S., Seong, J. S., Antaki, J.A., Lieber, B.B., **Chandra S.**, Finol, E.A., 2011, "Abdominal aortic aneurysm dynamics: A comparative analysis of PIV, CFD and FSI", *Biorheology*, submitted.
10. Malve, M., **Chandra, S.**, Garcia, A., Martinez, M.A., Finol, E.A., Ohayon, J., and Doblare, M., 2011, "Unsteady fluid solid interaction analysis of a bifurcation in a human healthy left coronary artery," *Communications in Numerical Methods in Engineering*, submitted.
11. **Chandra, S.**, Batur, C., 2010, "Contact Angle Manipulation for Microgripping", *Engineering Applications of Computational Fluid Mechanics*, Vol. 4, No. 2, pp. 181-195.
12. Ozlu, E., Zhe, J., **Chandra, S.**, Cheng, J., Wu, X., 2006, "Feasibility Study of a Smart Motion Generator Utilizing Electromagnetic Microactuator Arrays", *Smart Material & Structures*, 15, pp. 859-868.
13. Zhang, Z., Zhe, J., **Chandra, S.**, Hu, J., 2005, "An Electronic Pollen Detection Method Using Coulter Counter Principle", *Atmospheric Environment*, 39, 5446-5453.

Conferences & Proceedings

1. **Chandra, S.**, Raut, S., Jana, A., Biederman, R.W., Doyle, M., Muluk, S. C., Finol, E. , "MRI-based inflow boundary conditions for Patient Specific Fluid Structure Interaction modeling of abdominal aortic aneurysms", submitted to *Proceedings of the ASME 2012 Summer Bioengineering Conference*, Farjardo, Puerto Rico, USA, June 20-23, 2012
2. Raut, S.S. **Chandra, S.**, Shum, J., Liu, P., Di Martino, E.S., Doehring, T., Jana, A., Finol, E. A., "A Comprehensive Tool for Patient Specific AAA Biomechanics Assessment", submitted to *Proceedings of the ASME 2012 Summer Bioengineering Conference*, Farjardo, Puerto Rico, USA, June 20-23, 2012
3. **Chandra, S.**, Seaman, C., Sucosky, P., "Bicuspid aortic valve hemodynamics: a fluid-structure interaction study", **{Oral presentation}** *64th Annual Meeting of the APS Division of Fluid Dynamics*, Baltimore, MD, Nov 20-22, 2011.
4. **Chandra, S.**, Sun, L., Seaman, C., Rajamannan, N., Sucosky, P., " Effects of bicuspid aortic valve hemodynamics on valvular calcification: a computational and ex vivo study", **{Oral presentation}** *American Heart Association Scientific Sessions*, Orlando, FL, Nov 2011.
5. Pan, Y. , **Chandra, S.**, Sucosky, P., "Fluid-Structure Interaction model for the detection of blood damage-prone regions through a bileaflet mechanical heart valve in the mitral position", *Proceedings of ASME 2011 International Mechanical Engineering Congress & Exposition, IMECE2011*, Denver, Colorado, Nov 11-17, 2011.
6. **Chandra, S.**, Rodriguez J. F, and Finol, E., "Computational Algorithm for derivation of unstressed vascular geometry from CT Image based models", **{Oral presentation}**, *Biomedical Engineering Society Annual Fall Meeting (BMES 2011)* , Hartford, CT, Oct 12-15, 2011
7. Raut, S. S., Shum, J. , **Chandra, S.**, Jana, A., Liu, P., Lee, K., Di Martino, E. S., Doehring, T. C., and Finol, E. A., "AAVASC: A novel Integrated Approach for Image Based Modeling Toward Individualized AAA Rupture Risk Assessment", **{Oral presentation}**, *Biomedical Engineering Society Annual Fall Meeting (BMES 2011)*, Hartford, CT, Oct 12-15, 2011.
8. **Chandra, S.** , Rajamannan N.M., Sucosky P., " Prediction of the Degree of Hemodynamic Abnormality through a Calcifying Bicuspid Aortic Valve", **{Oral presentation}** *BMES Annual Meeting* , Hartford, Connecticut, Oct 2011

9. **Chandra, S.**, Seaman C., Rajamannan N.M., Sucosky P., "Computational comparison between normal and bicuspid aortic valve hemodynamics" **{Poster}** *Proceedings of the ASME 2011 Summer Bioengineering Conference*, Farmington, PA, June 22-25, 2011.
10. **Chandra, S.**, Seaman C., Rajamannan N.M., Sucosky P., "Computational assessment of Bicuspid Aortic Valve Hemodynamics : Implications for Calcific Bicuspid Aortic Valve Disease", **{Poster}**, *Arteriosclerosis, Thrombosis and Vascular Biology 2011 Scientific Sessions in collaboration with the Council on Peripheral Vascular Disease*, Chicago, IL, April 28-30, 2011.
11. Malvè, M., **Chandra, S.**, Garcia, A, Martinez, M.A., Finol, E., and Doblare, M., "FSI Analysis of a Human Carotid Bifurcation under Impedance-Based Boundary Conditions", **{Oral presentation}** *2nd International Conference on Mathematical and Computational Biomedical Engineering - CMBE2011*, Mar 30 - Apr 1, 2011, Washington D.C, USA.
12. Malvè, M., Pérez del Palomar, A., **Chandra, S.**, Lopez-Villalobos, J.L., Finol, E., Ginel, A., and Doblare, M." FSI analysis of a diseased human trachea before and after prosthesis implantation", **{Oral presentation}** *2nd International Conference on Mathematical and Computational Biomedical Engineering - CMBE2011*, Washington D.C, March 30 - April 1, 2011.
13. Malvè M, Pérez del Palomar A., Doblare M., **Chandra S.**, Finol E., "FSI Analysis of the Human Trachea under Impedance-based Boundary Conditions", **{Oral presentation}** *6th World Congress of Biomechanics*, Singapore, Aug 1 - 6, 2010.
14. Raut, S.S., **Chandra, S.**, Jana, A., Muluk, S., and Finol, E.A. "The effect of local infrarenal flow conditions on intra-aneurysmal flow dynamics," **{Poster}** *Proceedings of the 2009 Biomedical Engineering Society Annual Fall Meeting*, Pittsburgh, PA, Oct 7-10, 2009.
15. **Chandra, S.**, Jana, A., and Finol, E.A., "Individual anisotropic FSI modeling of aortic aneurysms: phase-contrast and dynamic MRI validation," **{Poster}** *Proceedings of the 2009 Biomedical Engineering Society Annual Fall Meeting*, Pittsburgh, PA, Oct 7-10, 2009.
16. **Chandra, S.**, Raut, S., Malve, M., Scotti, C.M., and Finol, E.A., "Phase contrast MRI derived boundary conditions for patient specific AAA fluid flow modeling," **{Oral presentation}** *Proceedings of the 2009 Summer Bioengineering Conference*, Lake Tahoe, CA, June 17-21, 2009.
17. **Chandra S.**, Batur C., "Liquid Bridge Based Micro gripper, **{Oral presentation}** *Proceedings of the ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE*, Las Vegas, NV, Sept 4-7, 2007.
18. **Chandra S.**, Batur C., "Manipulation of Capillary Force by Electrowetting for Micromanipulation" **{Poster}** *Nano Science Technology Institute (NSTI) Conference, MEMS Device Modeling*, Boston, MA, May 7-11, 2006.
19. **Chandra S.**, Lin Y.J., "An Expert Framework Aide for Determining Optimal Design Models", **{Oral presentation}** *Proceedings of IMECE'04, ASME International Mechanical Engineering Congress and Exposition*, Anaheim, CA, Nov 13-19, 2004

Presentations and Invited Talks

1. "Effect of Calcification on Aortic Valve Hemodynamics - A Fluid Structure Interaction Study, Bioengineering Seminar, University of Notre Dame , IN , Oct 10, 2011{ invited talk}
2. "Fluid Structure Interaction Analysis of Aortic Valve Hemodynamics", Flow PAC Seminar, University of Notre Dame , IN , April 8, 2011 { invited talk}
3. "Biomechanical Analysis of Patient Specific Abdominal Aortic Aneurysm ", University of Notre Dame, Notre Dame, IN, July 29, 2010. { invited Talk}
4. "Validation of abdominal aortic aneurysm dynamics: a comparative analysis of PIV, CFD, and FSI," *Proceedings of the 2009 Summer Bioengineering Conference*, abstract SBC2009-206606, Lake Tahoe, CA, June 17-21 {Oral presentation}.
5. "Microgripping - A Novel approach using liquid bridges and electrowetting", Carnegie Mellon University, Pittsburgh, PA, Aug 29, 2008. {invited talk}
6. "Microgripping - A Novel approach using liquid bridges and electrowetting", University of Maryland at College Park, Baltimore, MD, Aug 31, 2007. {invited talk}
7. "Microgripping - A Novel approach using liquid bridges and electrowetting", University of Cincinnati, Cincinnati, OH, Aug 9, 2007. {invited talk}

Professional Association and Service

➤ Membership

- American Heart Association (AHA) , Member , 2011 – Present
- American Physics Society (APS), member, 2011 - Present
- Bio Engineering Division Fluid Mechanics Committee Member , 2009 – Present
- Member of Biomedical Engineering Society , 2008-Present
- American Society of Mechanical Engineers (ASME) Member , 2003-Present
- IEEE Student Member 2007-2009

➤ **Journal & Conference Reviewer**

- Medical Engineering and Physics,2009-2012 (reviewed 4 Journal papers)
- Journal of Biomechanics , 2010 (reviewed 1 Journal paper)
- ASME Summer Bio Engineering Conference 2011 (Judge for MS student Competition)
- ASME Summer Bio Engineering Conference 2009,2010 (review of Conference paper)
- ASME Summer Bio Engineering Conference 2009 (Judge for PhD student Competition)

Workshops attended

- ‘Verification and validation in computational Science’, Workshop at University of Notre Dame , Notre Dame, IN, Oct 17-19,2011

Outreach & Volunteer Activities

- “2011 Northern Indiana Regional Science & Engineering Fair (NIRSEF)”,Lead a group of judges as Chair in the Engineering, Junior Division competition, Notre Dame, IN, March 5, 2011.
- “Outreach Project with Health works Kid's Museum”, advising two undergraduates in developing an interactive activity aimed at teaching children about cardiovascular risk factors, disease and treatments, Spring,2011.
- “Moving 4th Into Engineering 2009”, participated in ICES workshop for 4th grade students of Pittsburgh Public Schools, Carnegie Mellon University, Pittsburgh, PA, April 4, 2009.
- “Build a Bone”, participated in an activity representing ICES for National Engineers Week, Carnegie Science Museum, Pittsburgh, PA, July 13 and Feb 21, 2009.