Shankar Prasad Sastry

Contact Information

Postdoctoral Researcher
Scientific Computing and Imaging Institute
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Current Research Interests

Geometric Modeling, Mesh Generation, Numerical Analysis, Numerical Optimization

Future Research Interests

Computational Geometry, High Performance Scientific Computing, Finite Element Method

Education

The Pennsylvania State University, University Park, PA

Doctor of Philosophy, Computer Science and Engineering **August 2007 – August 2012**

- Advisor: Prof. Suzanne M. Shontz
- Dissertation Title: Dynamic Meshing Techniques for Quality Improvement, Untangling, and Warping

Indian Institute of Technology, Madras, Chennai, India

Bachelor of Technology, Mechanical Engineering **July2003 – July 2007**

- Minor: Theoretical Computer Science

Postdoctoral Research Experience

University of Utah, Salt Lake City, UT

Postdoctoral Researcher, Scientific Computing and Imaging Institute **September 2012 – present**

- Supervisors: Prof. Ross T. Whitaker and Prof. Robert M. Kirby

Honors and Awards

Academic Honors:

- Best Student Poster Award, 20th International Meshing Roundtable, Paris, France (2011)
- World Finalist, Association of Computing Machinery's (ACM) International Collegiate Programming Contest held at Tokyo, Japan (2007)
- Top 1% in Indian National Physics Olympiad (2003)

Doctoral Research

Log-Barrier Mesh Untangling and Quality Improvement Algorithm: Improvement of the quality of worst elements in a mesh that may be tangled through vertex movement dictated by a numerical optimization algorithm based on an interior point method.

Characterization of Mesh Quality Improvement Algorithms: Study of several mesh quality improvement algorithms in various meshing and time-constrained contexts and application-specific determination of mesh quality metrics.

Development of Mesh Vertex- and Element-Reordering Techniques for Improved Cache Utilization in Parallel Mesh Warping Algorithms: Improving cache utilization in a multi-core, shared-memory environment through mesh vertex- and element- reordering schemes in a parallel implementation of mesh warping algorithms. The Hilbert space-filling curves were used to reorder the vertices and elements

Development of Patient-Specific Mesh Generation Techniques for Inferior Vena Cava Blood Flow Simulations: Generation of high-quality patient-specific meshes for simulating blood flow in the inferior vena cava (IVC) with an implanted IVC filter. The algorithm involves the segmentation of patient computer tomography (CT) images and physics-based mesh warping techniques to obtain a surface mesh suitable for volume mesh generation. This techniques can be used for any application involving medical implants.

Postdoctoral Research

Unstructured Mesh Generation for Volumetric Data: An electrostatic particle distribution-based mesh generation technique that warps and cleaves a background mesh to generate a size-adaptive, boundary-conforming, multi-material volumetric mesh.

Advancing-Front Delaunay Mesh Generation: An off-center vertex insertion strategy based on the optimization of nondifferentiable functions to efficiently refine Delaunay meshes in an advancing-front manner.

Curvilinear Meshing Using Thin Plate Splines: Morphing of straight-sided meshes into curvilinear meshes using thin plate splines, which are radial basis function-based interpolation technique with a biharmonic kernel. Results from calculus of variations were used to explain why this technique performs better than other existing techniques.

Geometric Modeling and Surface Meshing of Geological Structures: Geometric representation of geological structures through a tree-based data structure and an implicit function representation of surfaces. Surface meshing of the model obtained.

Parallel Log-Barrier Mesh Untangling and Quality Improvement Algorithm: A parallel implementation of the log-barrier numerical optimization algorithm described above. It uses a greedy edge-coloring scheme to enable parallel data transfer.

Interpolation Error Bounds in High-Order Finite Elements: Determination of theoretical interpolation error bounds in high-order triangular finite elements through Taylor series expansion.

Workshops

Conducted a minisymposium on high-order mesh generation and adaptation at the International Conference on Spectral and High-Order Methods (ICOSAHOM) held at Salt Lake City, UT in 2014.

Publications (Journal)

1. **Shankar P. Sastry**, Emre U. Kultursay, Suzanne M. Shontz, and Mahmut T. Kandemir, "Mesh vertex- and element-reordering techniques for improved cache utilization in parallel mesh warping algorithms," invited submission to *Engineering with Computers*, vol. 30(4), pp. 535–547, 2014.
2. **Shankar P. Sastry**, Suzanne M. Shontz, and Stephen A. Vavasis, "A log-barrier method for mesh quality improvement and untangling," invited submission to *Engineering with Computers*, vol. 30(3), pp. 315–329, 2014.
3. **Shankar P. Sastry** and Suzanne M. Shontz, "A parallel log-barrier method for mesh quality improvement and untangling," invited submission to *Engineering with Computers*, vol. 30(4), pp. 503–515, 2014.
4. Kenneth I. Aycock, Robert L. Campbell, Keefe B. Manning, **Shankar P. Sastry**, Suzanne M. Shontz, Frank C. Lynch, and Brett A. Craven, "A computational method for predicting inferior vena cava filter performance on a patient-specific basis," *Journal of Biomechanical Engineering*, vol. 136(8), 2014.
5. Jibum Kim, **Shankar P. Sastry**, and Suzanne M. Shontz, "A numerical investigation on the interplay among geometry, meshes, and linear algebra in the finite element solution of elliptic PDEs," invited submission to *Engineering with Computers*, vol. 28, pp. 431–450, 2012.
6. **Shankar P. Sastry** and Suzanne M. Shontz, "Performance characterization of nonlinear optimization methods for mesh quality improvement," invited submission to *Engineering with Computers*, vol. 28(3), pp. 269–286, 2012.

Publications (Conference)

7. T. James Lewis, **Shankar P. Sastry**, Robert M. Kirby, Ross T. Whitaker, "A GPU-based MIS aggregation strategy: algorithms, comparisons and applications within AMG", in Proc. of the IEEE International Conference on High Performance Computing, accepted, 2015.
8. **Shankar P. Sastry**, Vidhi Zala, and Robert M. Kirby, "Thin-plate-spline curvilinear meshing on a calculus-of-variations framework," in Proc. of the 24th *International Meshing Roundtable*, pp. 135–147, 2015.
9. **Shankar P. Sastry**, "Maximizing the minimum angle with the insertion of Steiner vertices," in Proc of the 27th *Canadian Conference on Computational Geometry*, pp. 193–198, 2015.
10. Jonathan R. Bronson, **Shankar P. Sastry**, Joshua A. Levine, and Ross T. Whitaker, "Adaptive and unstructured mesh cleaving," in Proc. of the 23rd *International Meshing Roundtable*, pp. 266–278, 2014.
11. **Shankar P. Sastry** and Robert M. Kirby, "On interpolation errors over quadratic nodal triangular finite elements," in Proc. of the 22nd *International Meshing Roundtable*, pp. 349–366, 2013.
12. **Shankar P. Sastry**, Suzanne M. Shontz, Stephen A. Vavasis, "A log-barrier method for mesh quality improvement," Proc. of the 20th *International Meshing Roundtable*, pp. 329–346, 2011.

13. Jibum Kim, **Shankar P. Sastry**, and Suzanne M. Shontz, "Efficient solution of elliptic partial differential equations via effective combination of mesh quality metrics, preconditioners, and sparse linear solvers," in Proc. of the 19th *International Meshing Roundtable*, pp. 103–120, 2010.
14. **Shankar P. Sastry** and Suzanne M. Shontz, "A Comparison of Gradient- and Hessian-Based Optimization Methods for Tetrahedral Mesh Quality Improvement," Proc. of the 18th *International Meshing Roundtable*, pp. 631–648, 2009.

PUBLICATIONS (BOOK CHAPTER)

15. **Shankar P. Sastry**, Jibum Kim, Suzanne M. Shontz, Brent A. Craven, Frank C. Lynch, Keefe B. Manning, and Thap Panitanarak, "Patient-specific model generation and simulation for pre-operative surgical guidance for pulmonary embolism treatment," Invited submission to *Image-Based Modeling and Mesh Generation*, vol. 3, pp. 223–249, 2013.

PUBLICATIONS (UNDER PROGRESS)

1. **Shankar P. Sastry** and Robert M. Kirby, "Interpolation error bounds for curved, high-order finite elements and their implications to adaptive mesh refinement," **submitted** to the *Journal of Scientific Computing*, 2016.
2. **Shankar P. Sastry**, "Snow Globe: An advancing-front Delaunay mesh refinement algorithm," ***in preparation***, 2016.
3. **Shankar P. Sastry**, "Optimal insertion of multiple Steiner vertices for Delaunay refinement," ***in preparation***, 2016.
4. **Shankar P. Sastry**, Brig Bagley, and Ross T. Whitaker, "Implicit geometric modeling and visualization of geological structures," ***in preparation***, 2016.
5. Brig Bagley, **Shankar P. Sastry**, and Ross T. Whitaker, "Meshing of piecewise-smooth implicit surfaces," ***in preparation***, 2016.

OTHER RESEARCH EXPERIENCE

Argonne National Laboratory, Argonne, IL
Research Intern (Supervisor: Dr. Victor Zavala) **Summer 2010**
- Preconditioners for linear solvers used in optimizing cost of power generation in electrical grid networks.

Indian Institute of Science, Bangalore, India
Research Intern (Supervisor: Prof. Ravi S. Nanjundiah) **Summer 2005, Summer 2006**
- Functional Analysis: Analysis of the Indian rainfall data using empirical mode decomposition techniques.
- Support Vector Machines: Prediction of the Indian monsoon rainfall using machine learning techniques.

Indian Institute of Technology, Madras, Chennai
Senior Year Project (Advisor: Prof. Dhiman Chatterjee) **2006-07**
- Computational Fluid Dynamics: Simulation of fluid flow in a micro-pump using computational fluid dynamics techniques.

PROGRAMMING AND SOFTWARE PACKAGES

C, C++, MPI, OpenMP, MATLAB, Linux shell scripting, LaTeX 2_ε, Amira, Abaqus, CUBIT, Mesquite

REFERENCES

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