

hari sundar
curriculum vitæ

University of Utah
School of Computing

1

BIOGRAPHICAL DATA

1.1 education

Degree	Year	University	Field
Ph.D	2009	University of Pennsylvania	Bioengineering
B.Engg.	2000	University of Delhi	Control Systems

1.2 employment history

Title	Organization	When
Assistant Professor	University of Utah	Jul'14-present
Research Associate	University of Texas at Austin	Dec'11-Jun'14
Research Scientist	Siemens Corporate Research	Jan'08-Dec'11
Graduate Student	University of Pennsylvania	Jan'03-May-'09
Research Associate	Siemens Corporate Research	Jun'02-Dec'03
Graduate Student	Rutgers University	Sep'00-May'02

1.3 research focus

The central focus of my research is the development of computationally optimal parallel, high-performance algorithms, both discrete and continuous, that are efficient and scalable on state-of-the-art architectures. It is driven by applications in biosciences, geophysics, and computational relativity, such as cardiovascular mechanics, seismic wave propagation and the study of gravitational waves. My research has resulted in the development of state-of-the-art distributed algorithms for adaptive mesh refinement, geometric multigrid, fast Gauss transform and sorting.

The following are my current focus areas:

- Scalable PDE Solvers & Preconditioners
- Distributed Graph Algorithms, Graph Partitioning & Embedding
- Energy & Power Efficient Algorithms

2 | TEACHING

2.1 courses taught

Course Number	Course Name	Semester
CS 4150	Algorithms	Fall 2017
CS 6230	Parallel Algorithms & High Performance Computing	Spring 2017
CS 3960	Parallel Programming	Fall 2016
CS 6230	Parallel Algorithms & High Performance Computing	Spring 2016
CS 6965/5965	Big Data Computer Systems	Fall 2015
CS 6230	Parallel Algorithms & High Performance Computing	Spring 2015
CS 6965/5965	Big Data Computer Systems	Fall 2014

2.2 seminars

Seminar	Theme	Semester
Distributed Linear Algebra	Graph Algorithms	Fall 2017
Distributed Linear Algebra	Hierarchical Matrices	Fall 2016
Parallel Algorithms	SC Best Papers	Spring 2016
Distributed Linear Algebra	Matrix & Tensor Factorization	Fall 2015

2.3 individual student guidance

Students are from School of Computing, University of Utah unless otherwise noted.

2.3.1 Ph.D Students Supervised (as primary advisor)

1. Weerahannadige Milinda Shyamala Fernando (Fall 2015-present)
2. Seyed Majid Rasouli-Pichahi (Fall 2015-present)
3. Nishit Tirpankar (Summer 2016-present)

2.3.2 Ph.D Students Supervised (as co-advisor)

1. Vishal Sharma (with G. Gopalakrishnan), Graduated Jul 2016.

2.3.3 M.S. Students Supervised

1. Maxx Carlson (Fall 2017-present)
2. Christopher Mertin (Fall 2015-Spring 2017)
3. Bryant Baird (Fall 2016-Spring 2017)
4. Matthias Schneider, University of Erlangen-Nuremberg, Germany (2010) Thesis: **Model-based respiratory motion compensation for image-guided cardiac interventions**

2.4 ph.d dissertation committees

Students are from School of Computing, University of Utah unless otherwise noted.

1. Simone Atzeni, Graduated Aug 2017.
2. Wei-Fan Chiang, Graduated Aug 2016.
3. Mina Ghashami, Graduated May 2017.
4. John Holmen, Fall 2016-present
5. AshokBabu Jallepalli, Fall 2016-present
6. Mojgan Khaledi, Graduated June 2017.
7. Joe Noval, Fall 2017-present
8. Brad Peterson, Fall 2016-present
9. Elham Yazdani (School of Business) Fall 2015-present

3

RESEARCH

Web citation indexes:

- [Google Scholar](#)

3.1 theses

- Ph.D.: [Spatio-temporal deformation analysis of Cardiac MR Images](#) Completed: Jan 2009
Advisors: [George Biros](#), [Christos Davatzikos](#)

3.2 journal articles (refereed)

1. Milinda Fernando, Hari Sundar, Optimal Algorithms for Extreme Scale Adaptive Mesh Refinement, in review SIAM Journal on Scientific Computing.
2. Amir Gholami, Dhairya Malhotra, Hari Sundar, George Biros, [FFT, FMM, or Multigrid? A comparative study of state-of-the-art Poisson solvers in the unit cube](#), SIAM Journal on Scientific Computing 38(3), C280–C306. 2016
3. Hari Sundar, Georg Stadler, George Biros, [Comparison of multigrid algorithms for high-order continuous finite element discretizations](#), Numerical Linear Algebra with Applications 22 (4), 664-680. 2015
4. David Rivest-Henault, Hari Sundar, Mohamed Cheriet, [Nonrigid 2D/3D registration of coronary artery models with live fluoroscopy for guidance of cardiac interventions](#), IEEE Transactions on Medical Imaging 31 (8), 1557-1572. 2012
5. Parmeshwar Khurd, Leo Grady, Rafiou Oketokoun, Hari Sundar, Tejas Gajera, S Gibbs-Strauss, [Global error minimization in image mosaicing using graph connectivity and its applications in microscopy](#), Journal of pathology informatics 2 (2), 8. 2012
6. Hari Sundar, Harold Litt, Dinggang Shen, [Estimating myocardial motion by 4D image warping](#), Pattern Recognition 42 (11), 2514-2526. 2009
7. Hari Sundar, RS Sampath, George Biros, [Bottom-up construction and 2: 1 balance refinement of linear octrees in parallel](#), SIAM Journal on Scientific Computing 30 (5), 2675-2708. 2008
Over 100 Citations
8. Charles R Bridges, Kapil Gopal, David E Holt, Charles Yarnall, Steven Cole, Rochelle B Anderson, Xiaoqing Yin, Anthony Nelson, Benjamin W Kozyak, Zhonglin Wang, James Lesniewski, Leonard T Su, Danielle M Thesier, Hari Sundar, Hansell H Stedman, [Efficient myocyte gene delivery with complete cardiac surgical isolation in situ](#), The Journal of thoracic and cardiovascular surgery 130 (5), 1364.e1-e8. 2005

3.3 conference publications (refereed)

1. Hari Sundar, [Efficient Parallel Streaming Algorithms for large-scale Inverse Problems](#), 2017 IEEE High Performance Extreme Computing Conference (HPEC '17), 2017.

2. Isuru Fernando, Sanath Jayasena, Milinda Fernando, Hari Sundar, [A Scalable Hierarchical Semi-Separable Library for Heterogeneous Clusters](#), Parallel Processing (ICPP), 46th International Conference on, 513-522, 2017. Acceptance Rate: 28%.
3. Parmeshwar Khurd, Hari Sundar, [Parallel Algorithm for the Computation of Cycles in Relative Neighborhood Graphs](#), Parallel Processing (ICPP), 46th International Conference on, 191-200, 2017. Acceptance Rate: 28%.
4. Milinda Fernando, Dmitry Duplyakin, Hari Sundar, [Machine and Application Aware Partitioning for Adaptive Mesh Refinement Applications](#), Proceedings of the 26th International Symposium on High-Performance Parallel and Distributed Computing (HPDC'17), 2017. Acceptance Rate: 19%
5. Hari Sundar, Omar Ghattas, [A Nested Partitioning Algorithm for Adaptive Meshes on Heterogeneous Clusters](#), Proceedings of the 29th ACM on International Conference on Supercomputing (ICS15), 2015. Acceptance Rate: 25%
6. Jithin Jose, Sreeram Potluri, Hari Subramoni, Xiaoyi Lu, Khaled Hamidouche, Karl Schulz, Hari Sundar, Dhabaleswar K Panda, [Designing scalable out-of-core sorting with hybrid MPI+ PGAS programming models](#), Proceedings of the 8th International Conference on Partitioned Global Address Space Programming Models, 2014.
7. Hari Sundar, Dhairya Malhotra, Karl W Schulz, [Algorithms for high-throughput disk-to-disk sorting](#), Proceedings of the ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC13), 2013. Acceptance Rate: 20%
8. Hari Sundar, Dhairya Malhotra, George Biros, [HykSort: a new variant of hypercube quicksort on distributed memory architectures](#), Proceedings of the 27th international ACM conference on international conference on supercomputing (ICS13), 2013. Acceptance Rate: 21%
9. Hari Sundar, George Biros, Carsten Burstedde, Johann Rudi, Omar Ghattas, Georg Stadler, [Parallel geometric-algebraic multigrid on unstructured forests of octrees](#), Proceedings of the ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC12), 2012. Acceptance Rate: 22%
10. Rahul S Sampath, Hari Sundar, Shravan K Veerapaneni, [Parallel fast gauss transform](#), Proceedings of the ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC10), 2010. Best Paper Finalist. Acceptance Rate: 20%
11. Ying Zhu, Y. Tsin, Hari Sundar, Frank Sauer, [Image-based respiratory motion compensation for fluoroscopic coronary roadmapping](#), Medical Image Computing and Computer Assisted Intervention (MICCAI), 2010. Acceptance Rate: 32%
12. Matthias Schneider, Hari Sundar, Rui Liao, Joachim Hornegger, Chenyang Xu, [Model-based respiratory motion compensation for image-guided cardiac interventions](#), IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2010. Acceptance Rate: 22%
13. Matthias Schneider, Hari Sundar, [Automatic global vessel segmentation and catheter removal using local geometry information and vector field integration](#), IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI), 2010. Acceptance Rate: 15%
14. Hari Sundar, Christos Davatzikos, George Biros, [Biomechanically constrained 4D estimation of myocardial motion](#), Medical Image Computing and Computer-Assisted Intervention (MICCAI) 2009. Acceptance Rate: 27%
15. Hari Sundar, Ali Khamene, Liron Yatziv, Chenyang Xu, [Automatic image-based cardiac and respiratory cycle synchronization and gating of image sequences](#), Medical Image Computing and Computer-Assisted Intervention (MICCAI) 2009. Acceptance Rate: 27%
16. Rahul S Sampath, Santi S Adavani, Hari Sundar, Ilya Lashuk, George Biros, [Dendro: parallel algorithms for multigrid and AMR methods on 2: 1 balanced octrees](#), Proceedings of the ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC08), 2008. Acceptance Rate: 21%
17. Hari Sundar, Rahul S Sampath, Santi S Adavani, Christos Davatzikos, George Biros, [Low-constant parallel algorithms for finite element simulations using linear octrees](#), Proceedings of the ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC07), 2007. Best Student Paper Finalist. Acceptance Rate: 20%

18. Hari Sundar, Dinggang Shen, George Biros, Chenyang Xu, Christos Davatzikos, **Robust computation of mutual information using spatially adaptive meshes**, Medical Image Computing and Computer-Assisted Intervention (MICCAI) 2007. Acceptance Rate: 31%
19. Hari Sundar, Dinggang Shen, George Biros, Harold Litt, Christos Davatzikos, **Estimating myocardial fiber orientations by template warping**, IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI), 2006. Acceptance Rate: 35%
20. Dinggang Shen, Hari Sundar, Zhong Xue, Yong Fan, Harold Litt, **Consistent Estimation of Cardiac Motions by 4D Image Registration**, Medical Image Computing and Computer-Assisted Intervention (MICCAI) 2005. Acceptance Rate: 28%
21. Hari Sundar, Deborah Silver, Nikhil Gagvani, Sven Dickinson, **Skeleton based shape matching and retrieval**, IEEE Shape Modeling International, 2003. Over 500 Citations

3.4 other publications

2. Yang Gao, Hari Sundar, **Coronary arteries motion modeling on 2D x-ray images**, Proc. SPIE 8316, Medical Imaging 2012.
3. Vipin Gupta, Amit Kale, Hari Sundar, **A robust and accurate approach to automatic blood vessel detection and segmentation from angiography x-ray images using multistage random forests**, Proc. SPIE 8315, Medical Imaging 2012.
4. Rui Liao, Yunhao Tan, Hari Sundar, Marcus Pfister, Ali Kamen, **An efficient graph-based deformable 2D/3D registration algorithm with applications for abdominal aortic aneurysm interventions**, Medical Imaging and Augmented Reality, 2010.
5. Luc Duong, Rui Liao, Hari Sundar, Benoit Tailhades, Andreas Meyer, Chenyang Xu, **Curve-based 2D-3D registration of coronary vessels for image guided procedure**, Proc. SPIE 7261, Medical Imaging 2009.
6. Hari Sundar, Ali Khamene, Chenyang Xu, Frank Sauer, Christos Davatzikos, **A novel 2D-3D registration algorithm for aligning fluoro images with 3D pre-op CT/MR images**, Proc. SPIE 6141, Medical Imaging 2006.
7. Deborah Silver, Hari Sundar, Nikhil Gagvani, **Shape Based Culling for Volume Graphics**, Proc. 13th Eurographics Workshop on Rendering, 2002.

3.5 invited talks

1. Efficient Parallel Streaming Algorithms for large-scale Inverse Problems - September 13, 2017 - IEEE High Performance Extreme Computing Conference, Waltham, MA
2. Parallel Algorithms for the Computation of Cycles in Relative Neighborhood Graphs - August 16, 2017 - 46th International Conference on Parallel Processing, Bristol, UK
3. Challenges in Parallelizing Adaptive High-order Geometric Multigrid, 17th Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO Mar 2015.
4. Parallel hp-Multigrid for HDG, SIAM Conference on Computational Science and Engineering, Salt Lake City, UT Feb 2015.
5. A Nested Partitioning Scheme for Adaptive Meshes on Parallel Heterogeneous Clusters, SIAM Conference on Parallel Processing for Scientific Computing, Portland, OR Feb 2014.
6. Geometric Multigrid for high-order discretizations, 16th Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO Mar 2013.
7. Parallelization Strategies for High-order Discretized Hyperbolic PDEs, SIAM Conference on Computational Science and Engineering, Boston, MA Feb 2013.
8. Applications of projective registration for peripheral CTO, Interventional Radiology, University of Virginia Medical Center, Charlottesville, VA 2010.

9. Image-based guidance for the crossing of Chronic Total Occlusions, Thoraxcentrum, Erasmus Medical Center, Rotterdam, Netherlands Aug 2009.
10. A biomechanical model of the human heart incorporating myocardial fiber orientations, NSF ERC, Computer-Integrated Surgical Systems and Technology, Johns Hopkins University, Baltimore, MD Oct 2008.

3.6 patents

Full list, including pending applications can be [found here](#).

1. Medical imaging system, US 8422754 B2, Issued Apr 16, 2013.
2. Medical imaging system for segmenting blood vessel, US 8488852 B2, Issued Jul 16, 2013.
3. Method and system of affine registration of inter-operative two dimensional images and pre-operative three dimensional images, US 7450743 B2, Issued Nov 11, 2008
4. Hierarchical atlas-based segmentation, US 8861891 B2, Issued Oct 14, 2014.
5. Global error minimization in image mosaicking using graph laplacians and its applications in microscopy, US 8983230 B2, Issued Mar 17, 2015.
6. System and method for robust 2D-3D image registration, US 8457373 B2, Issued Jun 4, 2013.
7. Deformable 2D-3D registration of structure, US 8494243 B2, Issued Jul 23, 2013.
8. Coronary artery motion modeling, US 8849005 B2, Issued Sep 30, 2014.
9. Network cycle features in relative neighborhood graphs, US 9047660 B2, Issued Jun 2, 2015.
10. System and method for image-based respiratory motion compensation for fluoroscopic coronary roadmapping, US 8798347 B2, Issued Aug 5, 2014.
11. Non-rigid 2D/3D registration of coronary artery models with live fluoroscopy images, US 8948487 B2, Issued Feb 3, 2015.

3.7 grants

3.7.1 Approved & Funded

1. Sponsor: NSF
Role: co-PI
SHF: Medium: Hierarchical Tuning of Floating-point Computations
Award amount: \$1,200,000 (Utah)
Project Period: 8/1/2017-7/31/2020
2. Sponsor: NSF
Role: co-PI
EAGER: Application-driven Data Precision Selection Methods
Award amount: \$299,970
Project Period: 8/1/2016 - 07/31/2018
3. Sponsor: NSF
Role: PI
Scalable Multigrid Algorithms for solving elliptic PDEs on power-efficient Clusters
Grant# : 1464244
Award amount: \$175,000
Project Period: 8/1/2015 - 07/31/2017
4. Sponsor: DOE MMICCs
Role: Senior Investigator

DiaMonD: An Integrated Multifaceted Approach to Mathematics at the Interfaces of Data, Models, and Decisions

Award amount: \$5,425,000 (total for UT Austin)

Grant# : 11145687

Project Period: 1/1/2013 - 12/31/2017

5. Sponsor: NSF

Role: Senior Investigator

Algorithms and Architectures for Multiresolution Applications

Grant# : 1337393

Award amount: \$749,801

Project Period: 10/1/2013 - 09/30/2016

3.7.2 Pending

1. Sponsor: NSF

Role: PI

CAREER: Architecture and Network-aware Partitioning Algorithms for Improving Parallel Scalability

Award amount: \$551,730 (Utah)

2. Sponsor: NSF

Role: PI

SHF: Medium: Collaborative Research: Sustainable Exascale Debugging

Award amount: \$499,167 (Utah)

3.8 gifts

1. Gift of two **Jetson Tegra-K1** development boards from NVIDIA Corporation, worth \$400.

3.9 research honors & awards

- Best Poster Award, ACM/IEEE SuperComputing 2014.
- Best Paper finalist, ACM/IEEE SuperComputing 2010. Best paper in Math Library Parallelization.
- Best Student Paper finalist, ACM/IEEE SuperComputing 2007. Best paper in PDE Applications.
- Siemens-Penn Fellowship for Ph.D. studies

3.10 software development

The below codes build on MPI for distributed memory parallelism and are written in C/C++. Most implementations were started from a clean sheet of paper to ensure optimal parallel scalability of each component, and few external libraries are used. Currently, some codes are modified towards OpenMP and SIMD.

- **Dendro**: A C++ library for constructing and balancing octrees in parallel. It also generates hexahedral meshes from the octrees and extends PETSc's distributed array framework to support octree-based meshing. Basic routines for solving PDEs on such meshes using the finite element method are also provided. Currently major changes are underway to support efficient orderings using Hilbert Curves.
- **hombg** High-order finite-element package using hexahedral elements in Matlab. The code is a testbed for geometric multigrid approaches for high order discretizations. The current implementation supports setting up a combination of h and p hierarchy.

- The ALPS Toolkit, 2007-present (with C. Burstedde, T. Issac, G. Stadler, T. Tu and L.C. Wilcox): a collection of MPI based C libraries for large scale h-adaptive finite elements with applications in the geosciences.
- mangll, 2008-present (with T. Bui-Thanh, C. Burstedde, T. Issac, G. Stadler and L.C. Wilcox): a high order h-adaptive discretization library supporting discontinuous and continuous Galerkin finite elements. mangll includes solvers for high-order, discontinuous Galerkin wave propagation and a geometric multigrid solver, which have both shown close-to-optimal scalability to more than 220,000 cores.
- **hykSort**: Highly scalable distributed sorting and selection library. The package implements Bitonic-Sort, MergeSort, SampleSort and HykSort. The code is highly tuned and provides parallelism using MPI, OpenMP and SIMD vectorization.
- **pfgt**: Fast adaptive parallel algorithms to compute the sum of N Gaussians at M points using the fast Gauss Transform. We use parallel octrees and a new scheme for translating the plane-waves to efficiently handle non-uniform distributions.

4 | SERVICE

4.1 department, college and university service

- Track Director, Scientific Computing (Department)
- Poster Session Organizer, Grad Visit 2015, 2015 (Department)
- CES Steering Committee member (University)
- Member, Interdisciplinary Teaching Programs Committee (University)
- Member, Graduate Admissions Committee, 2015, 2016 (Department)
- Member, Faculty Hiring Committee, Architecture 2016 (Department)
- Member, Faculty Hiring Committee, Robotics 2015 (Department)

4.2 professional external service

- Editorial Board member for Journal of Computational Science (2014-present).
- Program Committee member for the following Conferences:
- ACM/IEEE Supercomputing (SC) 2016, 2017
- IEEE Cluster 2016, 2017
- ACM International Conference on Supercomputing (ICS) 2015
- IEEE International Parallel & Distributed Processing Symposium (IPDPS) 2015, 2017
- Reviewer for the following journals: IEEE Transactions on Medical Imaging, IEEE Transactions on Biomedical Engineering, IEEE Transactions on Image Processing, ACM Transactions on Mathematical Software, Medical Image Analysis, The Visual Computer, Signal, Image & Video Processing.
- Reviewer for the following Conferences: Supercomputing, ICCV, CVPR, IPDPS, MICCAI, ISBI.
- Member on the Stampede User Advisory Committee at the Texas Advanced Computing Center (TACC), 2013-.
- Member of XSEDE Resource Allocation Committee (XRAC) Aug 2017-

4.3 mentoring of faculty and students other than advisees

- Mentor for Utah Cluster Competition team, Supercomputing 2016, 2017.
- Mentor, Mentor-Protege program at Supercomputing 2015, Austin, TX
- Mentor, Student Mentorship program at SIAM Computational Science & Engineering 2015, Salt Lake City, UT.