RAKESH MULLICK

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OBJECTIVE

A technical lead position in medical imaging with an emphasis on applied research and software development in 3D image analysis and visualization.

EDUCATION

Ph.D., **EE**, Graphics, Visualization & Usability (GVU) Center,
Georgia Institute of Technology, *Jun '94.*

B.S., **EE**, University of Rochester, *May '88.*

PROFESSIONAL EXPERIENCE

Research Fellow, Diagnostic Radiology Department, Clinical Center, National Institutes of Health (**NIH**), Bldg. 10, Room 1C-660, MSC-1182, Bethesda, MD 20892. *Feb '99 - date.*

Designing and developing clinical volume data (MR,CT) analysis and visualization systems to support radiology research protocols. Research interests include volume rendering and image analysis.

Software Consultant, Johns Hopkins University (**JHU**),
Dept. of Cell Biology & Anatomy, 725 N. Wolfe St., Baltimore, MD 21205. *Aug '99-date.*

User training and customization of landmarking and visualization application for craniofacial research.

Senior Scientist, Centre for Information-enhanced Medicine (**CieMed**),
National Univ. of Singapore, The Alpha, Science Park. II, Singapore 117684. *Nov '94 - Jan '99.*

Lead the effort in designing and developing multi-dimensional volume visualization systems, medical simulation (minimal access & image-guided) architectures, and volume data interpretation support for projects within CieMed.

Graduate Research Assistant, GVU Center**,** School of Elect. and Comp. Engineering,
Georgia Tech., Atlanta, GA 30332. *Sep '88-Sep '94.*

Doctoral Thesis: "*Automatic Orientation Determination of 3D Objects from 3D Data"*

Co-investigator, Georgia Tech-Emory joint proposal for external funding: "*Knowledge-Based Image Interpretation*." Grant funded by NLM/NIH; $437,000; *'93-'97.*

Software Consultant, Pi4 Software, 208 Rumson Rd., Atlanta, GA 30305. *May '92-Sep '94.*

Ported and integrated clinical data interpretation software developed on Unix hardware to a Macintosh environment for *Siemens ICON* nuclear image acquisition and analysis system.

Summer Pre-Professional: I.B.M. Corp., Poughkeepsie, NY 12602, *Summer '87-'88.*
Engineering Design Systems, General Technology Division.

Involved in design and implementation of software in an IBM internal language for statistical and visual analysis of networks, as a part of an advanced logic simulator.

Undergraduate Assistant: Dept. of EE, Univ. of Rochester, NY 14627, *Sep '85-May '88.*
Diagnostic Ultrasound Research Laboratory

Engaged in projects involving signal & image processing aspects of bio-medical ultrasound data.

KEY ACHIEVEMENTS (See *http://www.artree.com/rakesh* for project details and animations)

Volume Visualization: Involved in the development of a memory-independent approach to volume render excessively large 3D datasets. Integrated this approach to create and volume render RGBα (α-Labeled) multi-GByte volume datasets derived from the Visible Human™ data. Developed methods to analyze and visualize orientation of 3D objects in 3D datasets for an NIH/NLM funded project at Georgia Tech. Active member in a team at Georgia Tech and Emory University developing a software-based *Emory Cardiac Toolbox*™ (*http://www.cequalqt.com*) to facilitate 4D unified multimodality visualization and quantification of cardiac anatomy and physiology. Developing the Confocal Volume Rendering concept for fast segmentation-free visualization of internal structures in 3D data.

Software Projects: Designed and coordinated the creation of a general purpose interactive environment to volume render and analyze 2D/3D data for the visualization projects at CieMed. Leading the effort in developing etdips™ (exploratory Two/Three Dimensional Image Processing System, demo version available on request) on the Windows 2000/NT/9x platform offering collaborative volume data analysis, volume and surface rendering capabilities with plug-in support for volume data analysis. Responsible for all visualization support (software design and development) for CieMed's daVinci project, a realistic interactive real-time simulator for interventional radiology. Lead inventor of DISHA™ (toolkit for automatic reorientation of cardiac SPECT data), ported onto custom GE software Genie™/CEqual™, in a project funded by *GE Medical Systems*.

Image Interpretation: Co-investigator and developer for an ongoing NLM/NIH funded project at Georgia Tech to develop a knowledge-based system [PERFEX™ (Pending FDA 510(k))] for diagnostic interpretation of cardio-vascular tomographic imagery. Developed an interactive system to extract and quantify 2D vasculature from fluoroscopic (X-Ray) imagery, for use in VRecon™ (*http://bitc.gatech.edu/VRecon/*) of Emory-Georgia Tech for reconstructing 3D vasculature.

Segmentation: Lead an effort, at CieMed, to segment and label the entire Visible Human™ (male and female) datasets to create a 3D resolution-independent full-body human anatomical atlas for research and educational purposes. Work features in Body Voyage™: A Three-Dimensional Tour of a Real Human Body, Warner Books; ISBN: 0446520098, 1997 and CD-ROM (*http://www.learntech.com/products/body_voyage/index.html*). Developed a semi-automatic approach for extracting and building hierarchical models for 3D vasculature from MR Angiographic data.

SKILLS

Languages:	C++, C, Win32 SDK, HTML, Java, MMX, Pascal, Fortran, and scripting languages.
Operating Systems:	Windows 2000/NT/9x, UNIX and variants, VAX/VMS, MacOS, MS-DOS, PalmOS, and VM/CMS.
Software Systems:	OpenGL, Visual-C++, VGL (Volume Graphics Library, Real-time Visualization, Mitsubishi), Purify, SGI-GL, X-Windows, Neuron Data NEXPERT, MATLAB, FrameMaker, DreamWeaver, UML, SPICE, MACSYMA, Mathematica, DISSPLA, GE Starcam™ 3000, Siemens ICON™, Macromedia Director (Lingo), Photoshop, MPW, Tcl/Tk, and IMSL.

MANUSCRIPT REVIEWS

Reviewer, IEEE Transactions on Medical Imaging, *'95*-date.
Reviewer, IEEE Signal Processing Letters, *'96*-date.

STUDENTS

Cao Qiong, Masters Candidate, Dept. of Anatomy, National University of Singapore (NUS), 1997.
Wang Fuxiong, Special Project, MBBS Candidate, National University of Singapore (NUS), 1997.
Chan Wai Herng, Bachelors Project, Centre for Biomedical Materials Appl. and Tech., (NUS), 1998.
Cassio Guan-Shi Lynm, Masters Thesis, Art as Applied to Medicine, Johns Hopkins (JHU), 2000.

JOURNAL ARTICLES

1. P. L. Choyke, P. Yim, H. Marcos, V. Ho, R. Mullick, and R. M. Summers, "Skeletonized Hepatic Magnetic Resonance Angiograms: A Multiobserver Comparison of Visualization Methods," Submitted to Radiology, Sept. 1999.
2. M. Brady, K. Jung, W. Lawton, R. Mullick, H.T. Nguyen, T. Poston, R. Raghavan, S. R. Ranjan, K.

Schulz, S. Venkataraman, R. Viswanathan, Y. Yu and G. Zhu, "*Interactive haptic modeling of tensegrities and network structures*," SIGGRAPH Sketches & Applications: Technical, ACM SIGGRAPH, Aug. 1999.

3. H. T. Nguyen, R. Mullick, V. Shalini, and S. Warusavithana, *SIGGRAPH Technical Slides*, ACM SIGGRAPH, July 1998.
4. H. T. Nguyen and R. Mullick, "*Partitioned Volume Rendering (ParVo): An Efficient Approach to Visualizing Large Datasets*," Submitted to the ACM Journal of Graphics Tools, Nov. '98.
5. N. F. Ezquerra and R. Mullick, "*Knowledge-Guided Segmentation of 3D Imagery*," CVGIP: Graphical Models and Image Processing, Academic Press, vol. 58, no. 6, pp. 510-23, Apr 1996.
6. N. F. Ezquerra and R. Mullick, "*An Approach to 3D Pose Determination*," ACM Transactions on Graphics, vol. 15, no. 2, pp. 99-120, 1996.
7. R. Mullick and N. F. Ezquerra, "*Automatic Determination of LV Orientation from SPECT Data*," IEEE Transactions on Medical Imaging, vol. 14, no. 1, pp. 88-99, 1995.
8. R. Mullick, N. F. Ezquerra, C. D. Cooke, R. D. Folks, and E. V. Garcia, "*Clinical Evaluation of Automated Technique to Reorient Left-Ventricular Myocardium in Cardiac SPECT*," Journal Nuclear Medicine (Supplement), vol. 35, no. 5 pp. 116P, Jun 1994.
9. N. F. Ezquerra, R. Mullick, E. V. Garcia, C. D. Cooke, and E. Kachouska, "*PERFEX: An Expert System for Interpreting 3D Myocardial Perfusion*," Expert Systems With Applications, Pergamon Press, vol. 6, pp. 459-68, 1993.
10. L. Klein, J. W. Peifer, R. Mullick, N. F. Ezquerra, E. Hyche, C. D. Cooke, S. B. King III, and E. V. Garcia, "*Three Dimensional Display of Phantom Coronary Arteries in Myocardial Perfusion Images*," Journal of the American College of Cardiology, vol. 15, no. 2A, pp. 261A, 1990. (abstract)
11. J. W. Peifer, N. F. Ezquerra, C. D. Cooke, R. Mullick, L. Klein, M. E. Hyche, and E. V. Garcia, "*Visualization of Multimodality Cardiac Imagery*," IEEE Transactions on Biomedical Engineering, vol. 37, no. 8, pp. 744-756, 1990.
12. Acknowledged as contributor in "*Comparison of Techniques for In-Vivo Attenuation Measurements*," by K. J. Parker, R. M. Lerner, and R. C. Waag, IEEE Transactions on Biomedical Engineering, vol. 35, no. 12, pp. 1064-8, 1988.

CONFERENCE PUBLICATIONS

1. H. Marcos, V. Ho, P. L Choyke, R. Mullick, and P. Yim, "Skeletonized Maximum Intensity Projections for Runoff Vessels: A Method of Displaying Magnetic Resonance Angiograms," Submitted to Intl. Society of Magnetic Resonance Imaging in Medicine (ISMRM), Nov 1999.
2. Y. Yamazaki, R. Mullick, A. F. Goldszal, J. Solomon, A. Dagher, and R. N. Bryan, "*Structure/Function Localization of the motor finger area using fMRI*," Submitted for presentation at ASNR, Atlanta, GA, 2000.
3. P. J. Yim and R. Mullick, "*Vesselize: A System for the Analysis and Visualization of Magnetic Resonance Angiography*," Accepted for presentation at SCAR, Philadelphia, PA, 2000.
4. P. J. Yim and R. Mullick, "*Measurement of Stenosis from Magnetic Resonance Angiography*," Presented at SPIE: Medical Imaging 2000, San Diego, CA, Feb. 2000.
5. R. Mullick and R. N. Bryan, "*Confocal Volume Rendering: Segmentation-free visualization of internal structures*," Presented at SPIE: Medical Imaging 2000, San Diego, CA, Feb. 2000.
6. R, Mullick, P. J. Yim, R. M. Summers, and P. L. Choyke, "*Vasculature Detection with applications in Diagnosis, Pre-treatment Planning, and Interventional Radiology Training*," NIH Research Festival, Oct. 1999.
7. R. Mullick, A. Premkumar, and S. Hill, "*3D Visualization of Ankle and Hind foot Tendons using MR Images*," NIH Research Festival, Oct. 1999.
8. R. Mullick, S. V. Warusavithana, V. Shalini, and P. Pang, "*Plug-Ins: A Software Model for Biomedical Imaging and Visualization Research*," Biomedical Imaging Symposium: Visualizing the Future of Biology and Medicine, National Institutes of Health (NIH), June 1999.
9. P. J. Yim, R. M. Summers, R. Mullick, and P. L. Choyke, "*Detection of the Small Vessels in Magnetic Resonance Angiograms by Grey-Scale Skeletonization*," Biomedical Imaging Symposium: Visualizing the

Future of Biology and Medicine, National Institutes of Health (NIH), June 1999.

10. S. V. Warusavithana, S. Venkataraman and R. Mullick, "*A PC based collaborative visualization system*," Proceedings of International Workshop on Volume Graphics-Volume II, pp. 391-407, Swansea, UK, Mar. 1999.
11. J. Anderson, T. Goradia, R. Raghavan, R. Mullick, N. Bryan, and A. Liu, "*Augmented and Virtual Reality Based Medical Simulators for Radiology and Surgery*," InfoRAD, ET-9440, RSNA, Nov. 1998.
12. R. Mullick, S. Venkataraman, S. Warusavithana, H.T. Nguyen, and R. Raghavan, "*eTDIPS: 2D/3D Image Processing System for Volume Rendering and Telemedicine*," Annual Meeting of the Society for Computer Applications in Radiology (SCAR), June 1998.
13. R. Raghavan, T. Poston, and R. Mullick, "*Biomedical Image computing, medical simulators and Image-Guided Therapies*," 9th International Conference on Biomedical Engineering, Singapore, Dec. 1997.
14. V. Shalini and R. Mullick, "*An Object-Oriented Paradigm for Interactive Multi-Dimensional Data Visualization*," Fifth International Conference on Advanced Computing, Chennai, INDIA, Tata-McGraw Hill Publishers, pp. 381-9, Dec. 1997.
15. R. Jose, R. Raghavan, Ng Hern, and R. Mullick, "*Work Bench Tools for Registering Patterns of the One Cerebral Sulci Atlas*," 3rd International Conference on Functional Mapping of the Human Brain, NeuroImage, vol. 5, no. 4, Part 2 of 4, May 1997.
16. J. Anderson, R. Raghavan, Y. P. Wang, R. Mullick, and C. K. Chui, "*da Vinci-A Vascular Catheterization Simulator*," Abstract, Annual Meeting of the Society of Cardio-Vascular Interventional Radiology (SCVIR), March 1997.
17. R. Mullick, H. T. Nguyen, Y. P. Wang, J. K. Raphel, and R. Raghavan, "*Overview of Visible Human ™ based applications at CIeMed*," Proceedings of the First Visible Human Project Conference, pp. 119-20, Bethesda, MD, Oct 1996.
18. C. K. Chui, H. T. Nguyen, Y. P. Wang, R. Mullick, and R. Raghavan, "*Potential Field of Vascular Anatomy for Real-time Computation of Catheter Navigation*," Proceedings of the First Visible Human Project Conference, pp. 113-4, Bethesda, MD, Oct 1996.
19. R. Mullick and H. T. Nguyen, "*Visualization and Labeling of the Visible Human ™ Dataset: Challenges & Resolves*," Proceedings of the 4th International Visualization in Biomedical Computing conference, Lecture Notes in Computer Science (1131) Springer-Verlag, pp. 75-80, 1996.
20. E. Garcia, C. D. Cooke, E. Krawczynska, J. Vansant, L. daBraal, R. Mullick, and N. Ezquerra, "*Expert System Interpretation of Tc-99m Sestamibi Myocardial Perfusion Tomograms: Enhancements and Validation*," Circ. 92(8): I-10, October 1995. Abstract #0048 at the American Heart Association's 68th scientific session, Anaheim, Nov. 1995.
21. R. Mullick and N. F. Ezquerra, "*Volume Segmentation of 3D Cardiac SPECT Imagery*," Accepted for presentation at 1994 Visualization in Biomedical Computing Conference, Oct 1994. (Poster)
22. R. Mullick and N. F. Ezquerra, "*Automatic Segmentation of 3D Cardiac SPECT Data*," Proc. of the 12th IEEE Southern Biomedical Engineering Conference, pp. 40-42, New Orleans, LA, Apr 1993.
23. R. Mullick and N. F. Ezquerra, "*3D Visualization of Pose Determination: Application to SPECT Imaging*," Proc. of the Second Conference on Visualization in Biomedical Computing, Chapel Hill, NC, SPIE vol. 1808, pp. 445-52, Oct 1992.
24. M. E. Hyche, N. F. Ezquerra, and R. Mullick, "*Spatio-temporal Detection of Arterial Structure using Active Contours*," Proc. of the Second Conference on Visualization in Biomedical Computing, Chapel Hill, NC, SPIE vol. 1808, pp. 52-62, Oct 1992.
25. N. F. Ezquerra and R. Mullick, "*Medical Informatics Research at Georgia Tech: An Overview*," Proc. of the 7th World Congress on Medical Informatics - MEDINFO-92 North-Holland, vol. 7, pp. 40, 1992.
26. R. Mullick, N. F. Ezquerra, E. V. Garcia, and C. D. Cooke, "*A Knowledge-Based System to Assist in the Diagnosis of Coronary Artery Disease*," Proc. of the Tenth Southern Biomedical Engineering Conference, pp. 107-9, Oct 1991.
27. R. Mullick and N. F. Ezquerra, "*Research in Medical Informatics at Georgia Tech: An Overview*," Proc. of the 1991 IEEE Region 10 International Conference on Energy, Computer, Communication, and Control Systems-TENCON'91, New Delhi, INDIA, vol. 2, pp. 63-70, Aug 1991.

28. E. V. Garcia, M. D. Herbst, C. D. Cooke, R. Mullick, R. Folks, and N. F. Ezquerra, "*An Expert System for Automatically Interpreting Three-Dimensional Myocardial Perfusion Imaging*," 2nd International Symposium on Computer Applications in Nuclear Medicine and Cardiac MR Imaging, program book, pp. 64, Rotterdam, 1991. (abstract)
29. J. W. Peifer, R. Mullick, N. F. Ezquerra, M. E. Hyche, E. V. Garcia, L. Klein, and C. D. Cooke, "*Coronary Vasculature Visualization from Limited Angiographic Views*," IEEE Proc. of the First Conference on Visualization in Biomedical Computing, Atlanta, GA, May 1990, pp. 195-200.
30. S. K. Mullick, S. Rastogi, and R. Mullick, "*Partial Realization, Berlekamp-Masey Algorithm and Image Coding*," in Systems and Signal Processing - Proc. of the 1988 Indo-US Workshop on Signals and Systems, Bangalore, INDIA, Edited by R. N. Madan, N. Viswanathan, and R. L. Kashyap. Oxford & IBH Publishing Co., New Delhi, pp. 515-25, 1991.

ACTIVITIES & HONORS

- Graduated with ***High Distinction***, Deans List every semester.
- ***Member***, Engineering Honor Society, Tau Beta Pi (τβπ).
- ***Member***, Honor Society, Phi Beta Kappa (φβκ).
- **Volunteer Teacher and Organize**r,
  - A Hindi language school for children of all ages, *'91-'94*, Balvihar (Atlanta Chapter).
  - A language school for children, *'99-date*, Balvihar (Washington, DC, Chinmaya Mission).
- **Volunteer (Web Architect and Admin)** www.washcas.org (Metropolitan **Wash**ington Area **C**omputer Assisted **S**urgery Interest Group).
- **First Prize**: MEDINFO-92 Poster Paper, co-authored with Dr. N. F. Ezquerra.
- **Best Poster Award**: IMRE, Progress in Materials R&D Conference *'97*, co-authored with Dr. Raju Viswanathan and Dr. Raghu Raghavan.
- **Invited Lecture:** "भावी चिकित्सा *(Modern Medicine): Mothercare to Motherboards*," TechKriti '98, I. I. T. Kanpur, INDIA, March 1998
- **Invited Lecture:** Comdex Asia '98, Singapore, September 1998.
- **Invited Lecture:** "*Information enhanced Imaging*," Grand Rounds, Department of Radiology, Northwestern University Medical School, Chicago, March 2000.
- **Other Interests:** hiking, traveling, cooking, and scriptural reading.
- **Affiliations**: CRY Foundation.

PUBLIC CITATION OF RESEARCH

- Atlanta Business Chronicle, *Oct. 9-15 '92*
- Imaging Technologies, SPIE Catalog of new and recent publications, *Spring '93.*
- Research Horizons, Georgia Tech. Research Quarterly, *Summer '92 -'93.*
- Alumni Magazine, Georgia Institute of Technology, *Fall '93.*
- Biomedical Technology Info. Source, Vol. 20, No. 21, Quest Publishing, Brea, CA, *'93.*
- LIFE Magazine, A Time-Life Publication, *Feb. '97.*
- Body Voyage (Book & CD-ROM) by Alexander Tsiaras, A Time-Warner Publication, *'97.*
- Strait Times, National Singapore Daily Newspaper, *Feb. 27, '97.*
- Dainik Jagran, National Hindi Language Daily Newspaper, INDIA, *Mar. 2, '98.*

PERSONAL DATA

Birth: Nov 26, 1966
Country of Citizenship: **USA**
Family: Seema Mullick (*wife*), Graphic & Multimedia Designer; Anavi Mullick (*daughter*).

REFERENCES

Dr. Raghu Raghavan, Vice President,
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