Shree K. Nayar

Department of Computer Science, Columbia University

500 West 120 Street, 450 Computer Science Building, New York, NY 10027
Office: (212) 939-7092, Fax: (212) 939-7172
nayar@cs.columbia.edu, http://www.cs.columbia.edu/~nayar

RESEARCH

Computational cameras and the physics of computer vision. Emphasis on the creation of cameras that provide new forms of visual information, the design of physics-based models for the interaction of light with materials, and the development of algorithms for the recognition of objects from images. Applications include digital photography, machine vision, scientific imaging, computer graphics, robotics, and human-computer interactions.

EDUCATION

Ph.D. Carnegie Mellon University, Pittsburgh, PA
Electrical and Computer Engineering, December 1990
Dissertation: *Shape Recovery Using Physical Models of Reflection and Interreflection*
Advisors: Professors Takeo Kanade and Katsushi Ikeuchi

M.S. North Carolina State University, Raleigh, NC
Electrical and Computer Engineering, April 1986

B.S. Birla Institute of Technology, Ranchi, India
Electrical Engineering, June 1984 with honors
Project: *Design and Implementation of a Microprocessor Controlled Robot*

EXPERIENCE

Snap Inc.,
Director, NYC Research Lab, Jan 2018 – present

Department of Computer Science, Columbia University
T. C. Chang Professor, July 2002 – present
Department Chair, July 2009 – June 2012
Professor, December 1996 – June 2002
Acting Chair, July 2000 – December 2000
Associate Professor, January 1995 – December 1996
Assistant Professor, January 1991 – December 1994

The Robotics Institute, Carnegie Mellon University
Research Assistant, July 1986 – December 1990

Hitachi, Ltd., Yokohama, Japan
Visiting Research Scientist, Summer 1989

Taylor Instruments Ltd., New Delhi, India
Research Engineer, July 1984 – November 1984

AWARDS & HONORS

Best Paper Award
ACM Symposium on User Interface Software and Technology (UIST),
Quebec City, Canada, 2017.

Best Paper Award
IEEE International Conference on Computational Photography,
Houston, TX, 2015.

Election to the National Academy of Inventors
Tampa, FL, 2014.

Appreciation Honor for Seminal Contributions to Digital Imaging
Sony Corporation, Tokyo, 2014.

Election to the American Academy of Arts and Sciences
Boston, MA, 2011.

Best Paper Award
IEEE International Conference on Computational Photography,
Boston, MA, 2010.

Carnegie Mellon Alumni Achievement Award
Pittsburgh, PA, 2009.

Election to National Academy of Engineering
Washington, DC, 2008**.**

Great Teacher Award
Society of Columbia Graduates
Columbia University, New York, 2006.

Best Paper Award
IEEE Computer Society
IEEE Computer Vision and Pattern Recognition Conference, Washington, DC, 2004.

University Lecture
Columbia University, New York, 2003.

T. **C. Chang Endowed Chair**
Columbia University, New York, 2003**.**

Best Paper Honorable Mention Award
IEEE Computer Society,

IEEE Computer Vision and Pattern Recognition Conference, Hilton Head, 2000.

Engineering Teaching Excellence Award
W. M. Keck Foundation, Los Angeles, 1995.

David Marr Prize
IEEE Computer Society, Outstanding Paper Award
Fifth International Conference on Computer Vision, Boston, 1995.

Siemens Outstanding Paper Award
IEEE Computer Society
IEEE Computer Vision and Pattern Recognition Conference, Seattle, 1994.

20th Pattern Recognition Award
Best Pattern Recognition Journal Paper Award
Pattern Recognition Society, Jerusalem, Israel, 1994.

Best Industry Related Paper Award
International Association of Pattern Recognition
International Conference on Pattern Recognition, Jerusalem, 1994.

NTT Distinguished Scientific Achievement Award
Information Science Research
NTT Basic Research Laboratory, Japan, 1994.

Fellow of the Packard Foundation
1992 Science and Engineering Award
David and Lucile Packard Foundation, Los Altos, 1992.

National Young Investigator Award
Information, Robotics and Intelligent Systems Program
National Science Foundation, Washington, D.C. 1991.

Research Initiation Award
Information, Robotics, and Intelligent Systems Program
National Science Foundation, Washington, D.C. 1991.

David Marr Prize
IEEE Computer Society, Outstanding Paper Award
Third International Conference on Computer Vision, Osaka, 1990.

Westinghouse Graduate Research Fellowship
Westinghouse Electric Corporation, Baltimore, MD, Jan. 1988 – Dec. 1990.

RECENT PRESS

[Shree Nayar Transformed Smartphone Technology, Now He's Looking to the Future](#)
Popular Photography Magazine, January 23, 2017

[You might not recognize the camera of the future](#)
CBS News, April 21, 2016

[A Self-Powered Camera](#)
2016 Invention Awards, Popular Science, April 19, 2016

[A Video Camera That Runs on Light](#)
Wall Street Journal, April 17, 2015

[This Photo Was Taken By A Camera That's Fully Powered By Light](#)
Popular Science, April 15, 2015

[A *flexible camera*: A radically different approach to imaging](#)
Science Daily, April 13, 2016

[This Camera Is Powered by Light](#)
Top 100 Stories of 2015, Discover Magazine, November 30, 2015

['*Eternal*' camera can take pictures forever](#)
BBC News, April 17, 2015

[Photography Without a Lens? Future of Images May Lie in Data](#)
New York Times, December 23, 2015

[STEAM Blends Science and the Arts in Public Education](#)
Wall Street Journal, December 2, 2013

[To Learn How Your Camera Works, Try Building One](#)
National Public Radio, November 1, 2013

[Bigshot DIY camera aims to teach kids tech basics](#)
BBC News, August 5, 2013

[Draw the Curtains: Gigapixel Cameras Create Highly Revealing Snapshots](#)
Scientific American, January 6, 2011

PATENTS

Systems, Methods, and Media for Modular Cameras,
Odamaki; Makoto, Nayar; Shree K.,
U.S. Patent 10,148, 908, The Trustees of Columbia University in the City of New York, December 2018.

Methods, Systems, and Media for High Dynamic Range Imaging,

Gupta; Mohit, Mitsunaga; Tomoo, Iso; Daisuke, Nayar; Shree K.,
U.S. Patent 10,148,893, Sony Corporation, Tokyo, December 2018.

Systems, Methods, and Media for Extracting Information and a Display Image from Two Captured Images,
Jo; Kensei, Gupta; Mohit, Nayar; Shree K.,
U.S. Patent 10,070,067, Sony Corporation, Tokyo, September 2018.

Circuits for Self-Powered Image Sensors,
Nayar; Shree K., Sims; Daniel, Fridberg; Mikhail,
U.S. Patent 10,027,914, The Trustees of Columbia University in the City of New York, July 2018.

Methods, Systems, and Media for Detecting Gaze Locking,
Smith; Brian Anthony, Yin; Qi, Nayar; Shree Kumar,
U.S. Patent 9,996,743, The Trustees of Columbia University in the City of New York, June 2018.

Systems, Methods, and Media for Reconstructing a Space-Time Volume from a Coded Image,
Hitomo; Yasunobu, Gu; Jinwei, Gupta; Mohit, Mitsunaga; Tomoo, Nayar; Shree K.,
U.S. Patent 9,979, 945, Sony Corporation, Tokyo, May 2018.

Systems, Methods and Media for Performing Shape Measurement,
Gupta; Mohit, Nayar; Shree K.,
U.S. Patent 9,857,168, Columbia University, January 2018.

Systems and Methods for Controlling Aliasing in Images Captured by an Array Camera for Use in Super Resolution Processing Using Pixel Apertures,
Nayar; Shree K., Venkataraman; Kartik, Pain; Bedabrata, Lelescu; Dan,
U.S. Patent 9,794,476, FotoNation Cayman Limited, October 2017.

Systems and Methods for Performing Machine Vision Using Diffuse Structured Light,
Nayar; Shree K.,
U.S. Patent 9,752,869, Columbia University, September 2017.

Methods and Systems for Coded Rolling Shutter,
Gu; Jinwei, Hitomi; Yasunobu, Mitsunaga; Tomoo, Nayar; Shree K.,
U.S. Patent 9,736,425, Sony Corporation and Columbia University, August 2017.

Methods, Systems, and Media for High Dynamic Range Imaging,
Gupta; Mohit, Mitsunaga; Tomoo, Iso; Daisuke, Nayar; Shree K.,
U.S. Patent 9,648,248, Sony Corporation, May 2017.

Camera Systems and Methods for Gigapixel Computational Imaging,
Cossairt; O., Miau; D., and Nayar; S.K.,
U.S. Patent 9,473,700, Columbia University, October 2016.

Systems, Methods, and Media for Recording an Image Using an Optical Diffuser,
Cossairt; O., Zhou; C., and Nayar; S.K.,
U.S. Patent 9,407,833, Columbia University, August 2016.

Systems, Methods, and Media for Capturing Scene Images and Depth Geometry and Generating a Compensation Image,
Zhang; L. and Nayar; S.K.,
U.S. Patent 9,122,946, Columbia University, September 2015.

Methods and Systems for Coded Rolling Shutter,
Gu; J.W., Hitomi; Y., Mitsunaga; T., and Nayar; S.K.,
U.S. Patent 9,100,514, Columbia University, August 2015.

Generalized Assorted Pixel Camera Systems and Methods,
Nayar; S.K., Yasuma; F., and Mitsunaga; T.,
U.S. Patent 8,934,034, Columbia University, January 2015.

Apparatus and Method for High Dynamic Range Imaging Using Spatially Varying Exposures,
Nayar; S.K. and Mitsunaga, T.,
U.S. Patent 8,934,029, Columbia University and Sony Corporation, January 2015.

Systems and Methods for Panoramic Imaging,
Krishnan; G.K. and Nayar; S.K.,
U.S. Patent 8,817,066, Columbia University, August 2014.

Systems and Methods for Panoramic Imaging,
Krishnan; G.K. and Nayar; S.K.,
U.S. Patent 8,767,037, Columbia University, July 2014.

Profilometer, Measuring Apparatus, and Observing Apparatus,
Ohnishi; Y., Kimachi; M., Suwa; M., Nayar; S.K., and Kyotanabe; K.,
U.S. Patent 8,717,578, Omron Corporation, May 2014.

Methods, Systems, and Media for Swapping Faces in Images,
Bitouk; D., Kumar; N., Belhumeur; P.N., and Nayar; S.K.,
U.S. Patent 8,712, 189, Columbia University, April 2014.

Adaptive Imaging Using Digital Light Processing,
Nayar; S.K. and Boult; T.,
U.S. Patent 8,675,119, Columbia University, March 2014.

Apparatus and Method for Inspecting Surface State,
Mori; Y., Mitsumoto; D., Ohnishi; Y., and Nayar; S.K.,
U.S. Patent 8,615,125, Omron Corporation, December 2013.

Method and Apparatus for Obtaining High Dynamic Range Images,
Nayar; S.K. and Mitsunaga; T.,
U.S. Patent 8,610,789, Columbia University and Sony Corporation, December 2013.

Methods, Systems, and Media for Automatically Classifying Face Images,
Kumar; N., Belhumeur; P.N., Nayar; S.K., and Berg; A.C.,
U.S. Patent 8,571,332, Columbia University, October 2013.

System and Methods for De-blurring Motion Blurred Images,
Ben-Ezra; M. and Nayar; S.K.,
U.S. Patent 8,547,441, Columbia University, October 2013.

Methods, Systems, and Media for Swapping Faces in Images,
 Nayar; S.K., Belhumeur; P.N., Bitouk; D. and Kumar; N.,
U.S. Patent 8,472,722, Columbia University, June 2013.

Shape Measuring Apparatus and Shape Measuring Method,
Sho; T., Sakai; T., Mitsumoto; D., Ohnishi; Y., Kojima; T., Mori; Y., and Nayar; S.K.,
U.S. Patent 8,334,985, Omron Corporation, December 2012.

Method of Multispectral Imaging and an Apparatus Thereof,
Park; J.-I., Lee; M.H., Grossberg; M.D., and Nayar; S.K.,
U.S. Patent 8,284,279, Columbia University, October 2012.

Lensless Imaging with Controllable Apertures,
Zomet; A. and Nayar; S.K.,
U.S. Patent 8,144,376, Columbia University, March 2012.

Systems and Methods for Displaying Three-Dimensional Images,
Nayar; S.K. and Nagarajan; V.,
U.S. Patent 8,087,784, Columbia University, January 2012.

Systems and Method for De-blurring Motion Blurred Images,
Ben-Ezra; M. and Nayar; S.K.,
U.S. Patent 8,009,197, Columbia University, August 2011.

System and Method for Sensing Geometric and Photometric Attributes of a Scene with Multiplexed Illumination and Solid States Optical Devices,
Raskar; R, Nii; H., Summet; J. W., Zhao; Y., Dietz; P. H., Westhues; J, Noland; M., Bruns; E., Nayar; S.K., and Branzoi; V.,
U.S. Patent 8,009,192, Mitsubishi Electric Research Laboratories, August 2011.

Apparatus and Method for High-dynamic Range Imaging Using Spatially Varying Exposures,
Nayar; S.K., and Mitsunaga; T.,
U.S. Patent 7,924,321, Columbia University and Sony Corporation, April 2011.

Systems and Methods for Displaying Three-Dimensional Images,
Nayar; S.K. and Nagarajan; V.A.,
U.S. Patent 7,891,815, Columbia University, February 2011.

Lensless Imaging with Controllable Apertures,
Zomet; A. and Nayar; S.K.,
U.S. Patent 7,830,561, Columbia University, November 2010.

Systems and Methods for Reducing Rain Effects in Images,
Garg; K. and Nayar; S.K.,

U.S. Patent 7,783,183, Columbia University, August 2010.

Rectified Catadioptric Stereo Sensors,
Gluckman; J.M. and Nayar; S.K.,
U.S. Patent 7,710,451, Columbia University, May 2010.

Systems and Methods for Displaying Three-Dimensional Images,
Nayar; S.K.,
U.S. Patent 7,703,924, Columbia University, April 2010.

Methods and Systems for Compensating an Image Projected onto a Surface Having Spatially Varying Photometric Properties,
Nayar; S.K., Grossberg; M.D., Peri; H. and Belhumeur; P.N.,
U.S. Patent 7,663,640, Columbia University, February 2010.

Systems and Methods for Reducing Rain Effects in Images,
Garg; K. and Nayar; S.K.,
U.S. Patent 7,660,517, Columbia University, February 2010.

Devices and Methods for Electronically Controlling Imaging,
Zomet; A. and Nayar; S.K.,
U.S. Patent 7,651,282, Columbia University, January 2010.

Systems and Methods for Deblurring Motion Blurred Images,
Ben-Ezra; M. and Nayar; S.K.,
U.S. Patent 7,619,656, Columbia University, November 2009.

Systems and Methods for Displaying Three-Dimensional Images,
Nayar; S.K. and Nagarajan; V.A.,
U.S. Patent 7,614,748, Columbia University, November 2009.

Method and Apparatus for Recording a Sequence of Images Using a Moving Optical Element,
Nayar; S.K. and Schechner; Y.Y.,
U.S. Patent 7,554,596, Columbia University, June 2009.

Imaging Method and System,
Nayar; S.K. and Boult; T.,
U.S. Patent 7,495,699, Columbia University, February 2009.

Method and Apparatus for Acquiring HDR Flash Images,
Raskar; R., Agrawal; A., Nayar; S.K., and Li; Y.,
U.S. Patent 7,454,136, Mitsubishi Research Laboratories Inc., November 2008.

Method and Apparatus for Image Mosaicing,
Schechner; Y.Y. and Nayar; S.K.,
U.S. Patent 7,440,637, Columbia University, October 2008.

Method for De-blurring Images of Moving Objects,
Ben-Ezra; M. and Nayar; S.K.,

U.S. Patent 7,440,634, Columbia University, October 2008.

Methods and Systems for Displaying Three-Dimensional Images,
Nayar; S.K. and Zomet; A.,
U.S. Patent 7,432,878, Columbia University, October 2008.

Catadioptric Single Camera Systems Having Radial Epipolar Geometry and Methods and Means Thereof,
Kuthirummal; S. and Nayar; S.K.,
U.S. Patent 7,420,750, Columbia University, September 2008.

Method for Estimating Camera Settings Adaptively,
Raskar; R., Agrawal; A., Nayar; S.K., and Li; Y.,
U.S. Patent 7,403,707, Mitsubishi Research Laboratories Inc., July 2008.

Method and Apparatus for Reducing Distortion in Images,
Swaminathan; R., Grossberg; M.D., and Nayar; S.K.,
U.S. Patent 7,245,761, Columbia University, July 2007.

System and Methods for Generating Spherical Mosaic Images,
Nayar; S.K. and Karmarkar; A.,
U.S. Patent 7,176,960, Columbia University, February 2007.

Method and System for Enhancing Data Quality,
Grossberg; M.D. and Nayar; S.K.,
U.S. Patent 7,151,801, Columbia University, December 2006.

Method and Apparatus for Enhancing Data Resolution,
Nayar; S.K. and Narasimhan; S.G.,
U.S. Patent 7,149,262, Columbia University, December 2006.

Systems and Methods for Modeling the Impact of a Medium on the Appearances of Encompassed Light Sources,
Nayar; S.K. and Narasimhan; S.G.,
U.S. Patent 7,106,327, Columbia University, September 2006.

Method and Apparatus for Obtaining High Dynamic Range Images,
Nayar; S.K. and Mitsunaga; T.,
U.S. Patent 7,084,905, Columbia University, August 2006.

Apparatus and Method for High Dynamic Range Imaging Using Spatially Varying Exposures,
Nayar; S.K. and Mitsunaga; T.,
U.S. Patent 6,864,916, Columbia University, March 2005.

Super Wide Angle Panoramic Imaging Apparatus,
Trubko; S., Peri; V., Nayar; S.K. and Korein; J.,
U.S. Patent 6,611,282, Remote Reality, August 2003.

Apparatus and Methods for Determining the Three-dimensional Shape of an Object Using Active Illumination and Relative Blurring in Two Images Due to Defocus,
Nayar; S.K., Noguchi; M., and Watanabe; M.,
U.S. Patent 6,229,913, Columbia University, May 2001.

Adjustable Imaging System with Wide Angle Capability,
Korein; J., Nayar; S.K., Yaseen; C., and Peri; V.,
U.S. Patent 6,226,035, Remote Reality, May 2001.

Combined Wide Angle and Narrow Angle Imaging Systems and Method for Surveillance and Monitoring,
Nayar; S.K., Swaminathan; R., and Gluckman; J.,
U.S. Patent 6,215,519, Columbia University, April 2001.

Omnidirectional Imaging Apparatus,
Nayar; S.K.,
U.S. Patent 6,118,474, Columbia University, September 2000.

Methods and Apparatus for Performing Digital Image and Video Segmentation and Compression Using 3-D Depth Information,
Eleftheriadis; A., Anastassiou; D., Chang; S.F., and Nayar; S.K.,
U.S. Patent 6,055,330, Columbia University, April 2000.

Robot System with Vision Apparatus and Transparent Grippers,
Nayar; S.K. and Nikolaev; A.,
U.S. Patent 5,802,201, Columbia University, September 1998.

Omnidirectional Imaging Apparatus,
Nayar; S.K.,
U.S. Patent 5,760,826, Columbia University, June 1998.

Method of Detecting Solid Shape of Object with Autofocusing and Image Detection at Each Focus Level,
Nakagawa; Y. and Nayar; S.K.
U.S. Patent 5,151,609, Hitachi, Ltd., September 1992.

Solder Joint Inspection System and Method,
Nayar; S.K., Sanderson; A.C., Weiss; L.E., and Simon; D.A.,
U.S. Patent 4,988,202, Westinghouse Electric Corp., January 1991.

Surface Shape and Reflectance Extraction System,
Nayar; S.K., Ikeuchi; K., and Kanade; T.,
U.S. Patent 4,912,336, Westinghouse Electric Corp., March 1990.

Robotic Vision System,
Nayar; S.K.,
U.S. Patent 4,893,183, Carnegie Mellon University, January 1990.

Fiber Optic Solder Joint Inspection System,

Sanderson; A.C., Weiss; L.E., and Nayar; S.K.,
U.S. Patent 4,876,455, Westinghouse Electric Corp. October 1989.

PUBLICATIONS

BOOKS

[1] *The Appearance of Skin: A Survey*, T. Igarashi, K. Nishino, and S.K. Nayar, Foundations and Trends in Computer Graphics and Vision, Vol. 3, No. 1, 1-95, 2007.

[2] *Early Visual Learning,* S. K. Nayar and T. Poggio, (editors), Oxford University Press, June 1996.

REVIEWED MAGAZINE ARTICLES

[3] "Visual Appearance of Matte Surfaces," S. K. Nayar and M. Oren, *Science*, 1153-1156, Vol. 267, No. 5201, February 1995.

JOURNAL PAPERS

[1] "What Are Optimal Coding Functions for Time-of-Flight Imaging?," M. Gupta, A. Velten, S.K. Nayar and E. Breitbach*, ACM Transactions on Graphics (ACM ToG), (also Proc. of ACM SIGGRAPH)*, Vol. 37, No. 2, pp. 13:1-13:18, 2018.

[2] "Cambits: A Reconfigurable Camera System," M. Odamaki and S.K. Nayar, *Communications of the ACM (CACM),* Vol. 60, No. 11, pp. 54-61, 2017.

[3] "DisCo: Display-Camera Communication Using Rolling Shutter Sensors," K.Jo, M. Gupta, and S.K. Nayar, *ACM Transactions on Graphics (ACM ToG)*, Vol. 35, No. 5, pp. 150:1-13, 2016.

[4] "Field Curvature Correction Using Focal Sweep," S. Matsunaga and S.K. Nayar, *IEEE Transactions on Computational Imaging*, Vol. 1, No. 4, 2015.

[5] "Phasor Imaging: A Generalization of Correlation-Based Time-of-Flight Imaging," M. Gupta, S.K. Nayar, M. Hullin, and J. Martin, *ACM Transactions on Graphics (ACM ToG)*, Vol. 34, No. 5, 2015.

[6] "Efficient Space-Time Sampling with Pixel-wise Coded Exposure for High Speed Imaging," D. Liu, J. Gu, Y. Hitomi, M. Gupta, T. Mitsunaga, and S.K. Nayar, IEEE *Transactions on Pattern Analysis and Machine Intelligence (PAMI),* Vol. 36, No. 2, 248-260, 2014.

[7] "Compressive Structured Light for Recovering Inhomogeneous Participating Media," J. Gu, S.K. Nayar, E. Grinspun, P. N. Belhumeur, R. Ramamoorthi, IEEE *Transactions on Pattern Analysis and Machine Intelligence (PAMI)*, Vol. 35, No. 3, 2013.

[8] "When Does Computational Imaging Improve Performance?," O. Cossairt, M. Gupta, and S.K. Nayar, IEEE *Transactions on Image Processing (TIP)*, Vol. 22, No. 2, 2013.

[9] "Computational Cameras: Convergence of Optics and Processing," C. Zhou and S.K. Nayar, IEEE *Transactions on Image Processing (TIP),* Vol. 20, No. 12, 3322-3340, December 2011.

[10] "A Scaling Law for Computational Imaging Using Spherical Objects," O. Cossairt, D. Miau, and S.K. Nayar, OSA *Journal of the Optical Society of America,* November 2011.

[11] "Describable Visual Attributes for Face Verification and Image Search," N. Kumar, A.C. Berg, P.N. Belhumeur, and S.K. Nayar, IEEE *Transactions on Pattern Analysis and Machine Intelligence (PAMI),* Vol. 33, No. 10, 1962-1977, October 2011.

[12] "Coded Aperture Pairs for Depth from Defocus and Defocus Deblurring," C. Zhou, S. Lin, and S.K. Nayar, IEEE *International Journal of Computer Vision (IJCV),* Vol. 93, No. 1, 53-72, May 2011.

[13] "Flexible Depth of Field Photography," S. Kuthirummal, H. Nagahara, C. Zhou, and S. K. Nayar, IEEE *Transactions on Pattern Analysis and Machine Intelligence (PAMI)*, Vol. 99, March 2010.

[14] "Generalized Assorted Pixel Camera: Postcapture Control of Resolution, Dynamic Range, and Spectrum," F. Yasuma, T. Mitsunaga, D. Iso, and S. K. Nayar, IEEE *Transactions on Image Processing (TIP)*, Vol. 19, No. 8, August 2010.

[15] "Diffusion Coded Photography for Extended Depth of Field," O. Cossairt, C. Zhou, and S. K. Nayar, ACM *Transactions on Graphics (Proceedings of SIGGRAPH*), July 2010.

[16] "Removing Image Artifacts Due to Dirty Camera Lenses and Thin Occluders," J.W. Gu, R. Ramamoorthi, P.N. Belhumeur, and S.K. Nayar, ACM *Transactions on Graphics (Proceedings of SIGGRAPH Asia),* December 2009.

[17] "An Empirical BSSRDF Model," C. Donner, J. Lawrence, T. Hachisuka, H. Wann Jensen, S. K. Nayar, and R. Ramamoorthi, ACM *Transactions on Graphics (Proceedings of SIGGRAPH),* New Orleans, August 2009.

[18] "Face Swapping: Automatically Replacing Faces in Photographs," D. Bitouk, N. Kumar, S. Dhillon, P.N. Belhumeur, and S. K. Nayar, ACM *Transactions on Graphics* (*Proceedings of SIGGRAPH*), August 2008.

[19] "Light Field Transfer: Global Illumination Between Real and Synthetic Objects," O. Cossairt, S. K. Nayar, and R. Ramamoorthi, ACM *Transactions on Graphics* (*Proceedings of SIGGRAPH*), August 2008.

[20] "Vision and Rain," K. Garg and S. K. Nayar, IEEE *International Journal of Computer Vision(IJCV),* Vol. 75, No. 1, 3-27, October 2007.

[21] "3D Display Using Passive Optical Scatterers," S. K. Nayar and V. Anand, IEEE *Computer Magazine*, Vol. 40, No. 7, 54-63, July 2007.

[22] "Active Refocusing of Images and Videos," F. Moreno, P. N. Belhumeur, and S. K. Nayar, ACM *Transactions on Graphics* (*Proceedings of SIGGRAPH)*, Vol. 26, No. 3, July 2007.

[23] "LumiNetra: High Speed Scene Point Capture and Video Enhancement Using Photosensing Markers and Multiplexed Illumination," R. Raskar, H. Nii, B. De Decker, Y. Hasimoto, J. Summet, D. Moore, Y. Zhao, J. Westhues, P. Dietz, M. Inami, S. K. Nayar, J. Barnwell, M. Noland, P. Bekaert, V. Branzoi, and E. Burns, ACM *Transactions on Graphics* (*Proceedings of SIGGRAPH)*, Vol. 26, No. 3, July 2007.

[24] "Time-Varying BRDFs," B. Sun, K. Sunkavelli, R. Ramamoorthi, P.N. Belhumeur, and S. K. Nayar, IEEE *Transactions on Visualization and Computer Graphics,* May-June 2007.

[25] "Optical Splitting Trees for High Precision Monocular Imaging," M. McGuire, W. Matusik, H. Pfister, B. Chen, J.F. Hughes, and S.K. Nayar, IEEE *Transactions on Computer Graphics and Applications,* March-April 2007.

[26] "Multiplexing for Optimal Lighting," Y. Y. Schechner, S.K. Nayar, and P.N. Belhumeur, IEEE *Transactions on Pattern Analysis and Machine Intelligence (PAMI),* Vol. 29, No. 8, 1339-1354, August 2007.

[27] "Corneal Imaging System: Environment from Eyes," K. Nishino and S.K. Nayar, IEEE *International Journal of Computer Vision (IJCV)*, (70) No. 1, 23-40, October 2006.

[28] "Computational Cameras: Redefining the Image," S.K. Nayar, IEEE *Computer Magazine, Special Issue on Computational Photography,* 62-70, August 2006.

[29] "Programmable Imaging: Towards a Flexible Camera," S.K. Nayar, V. Branzoi, and T.E. Boult, IEEE *International Journal of Computer Vision (IJCV)*, (70) No. 1, 7-22, October 2006.

[30] "Multiview Radial Catadioptric Imaging for Scene Capture," S. Kuthirummal and S.K. Nayar, ACM *Transactions on Graphics* (*Proceeding of SIGGRAPH*), August 2006.

[31] "Projection Defocus Analysis for Scene Capture and Image Display," L. Zhang and S.K. Nayar, ACM *Transactions on Graphics (Proceedings of SIGGRAPH)*, August 2006.

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GRADUATE STUDENTS

Michael Oren, Phd in 1996, currently with Black Box Group; **Sameer Nene**, Phd in 1997, currently with Microsoft, Redmond; **Dinkar Bhat**, Phd in 1998, currently with Invidi Technologies; **Simon Baker**, Phd in 1999, currently with Dilili Labs; **Kristin Dana**, Phd in 1999, currently at Rutgers, New Brunswick; **Joshua Gluckman**, Phd in 2000, currently consulting in greater Washington DC metro area; **Stathis Hadjidemetriou**, Phd 2002, currently at Cyprus Institute of Technology; **Rahul Swaminathan**, Phd 2003, currently with Deloitte Consulting (Berlin); **Srinivasa Narasimhan**, Phd 2003, currently at CMU; **Kshitiz Garg**, Phd 2007, currently with Adobe Sensei; **Sujit Kuthirummal**, Phd 2009, currently with WayMo; **Bo Sun,** Phd 2008 (co-advisor with Ravi Ramamoorthi), currently with Virtu Financial; **Neeraj Kumar**, Phd 2011, currently with Dropbox; **Jinwei Gu,** PhD 2010, currently with SenseTime; **Oliver Cossairt**, Phd 2011, currently at Northwestern University**; Changyin Zhou**, Phd 2012, currently with Visbit, Inc.; **Brian A. Smith**, Phd 2018, currently with Snap Research, will join Columbia University Computer Science faculty in Fall 2019; **Parita Pooj**, Phd candidate; **Ruilin "Henry" Xu**, Phd candidate.

Sayan Mukherjee, MS in 1996, currently at Duke University; **Venkat Peri**, MS in 1997, currently with Peri Ventures; **Harish Peri**, MS in 2000, currently with Lifion (ADP); **Amruta Karmakar**, MS in 2000, currently with Turbonomics; **Sonya Allin**, MS in 2000, currently at University of Toronto; **Naveed Hasan**, MS in 2001, currently with Hasan Media (NYC); **Maryam Kamvar,** MS in 2004, currently with Google (Boston); **Vlad Branzoi,** MS in 2004, currently with Misty Robotics; **Vijay Anand Nagarajan**, MS in 2006, currently with Imageloom (Chennai); **Gurunandan Krishnan**, MS in 2007, currently with Snap, Inc.; **Neesha Subramaniam**, MS in 2007, currently with Google; **Qi Yin**, MS in 2013, currently with Megvii (PRC); **Daniel Miau,** MS in 2014, currently with Citymapper (London, UK); **Olivia Winn**, MS in 2015, current Phd student at Columbia University DSI; **Avinash Nair,** MS in 2016, currently with Cruise Automation.

RESEARCH SCIENTISTS

Hiroshi Murase, 1992-1993, currently at Nagoya University; **Minori M. Noguchi**, 1993-1994, currently with Hitachi, Yokohama; **Masahiro Watanabe**, 1994-1995, currently with Hitachi, Yokohama; **Daiki Matsumoto**, 1997-1998, currently with Fujitsu, Kawasaki; **Tomoo Mitsunaga**, 1997-1999, currently with Sony, Tokyo; **Toshifumi Honda**, 1999-2000, currently with Hitachi, Yokohama; **Yoav Schechner**, 2000–2002, currently at the Technion, Haifa; **Michael Grossberg**, 1999–2004, currently at CUNY; **Yukio Sato**, 2001-2002, currently at NIT (Japan); **Koki Fujita,** 2002-2003, currently at Kyushu Univ. (Japan); **Moshe Ben-Ezra**, 2002–2004, computer vision consultant; **Naoyuki Ichimura**, 2002–2004, currently with AIST (Japan); **Ko Nishino**, 2002–2005, currently at Drexel; **Sylvia Pont**, 2003, currently at Delft University; **Takanori Igarashi,** 2003-2004, currently with Kao Corporation, Tokyo; **Kensaku Fujii,** 2003-2004, currently with NTT Corporation, Tokyo; **Assaf Zomet,** 2003-2005, currently with Google; **Yoshikuni Nomura,** 2005-2007, currently with Sony, Tokyo; **Li Zhang**, 2005–2007, currently with Google; **Francesc Moreno-Noguer**, 2005–2007, currently at Institut de Robòtica i Informàtica Industrial (CSIC-UPC), Barcelona; **Dmitri Bitouk**, 2006-2008, currently with Intel; **Jong-il Park,** 2005–2007, currently at Hanyang University, Seoul; **Fumihito Yasuma**, 2007-2009, currently with Sony, Tokyo; **Hajime Nagahara**, 2007-2008, currently at Kyushu University; **Alexander C. Berg**, 2008-2010, currently at UNC Chapel Hill; **Tatsuo Fujiwara,** 2009-2010, currently with Sony, Tokyo; **Toshihiro Kobayashi**, 2009-2011, currently with Canon, Japan; **Yasunobu Hitomi**, 2009-2011, currently with Sony, Tokyo; **Masato Toda,** 2011-2012, currently with NEC, Tokyo**; Bahadir Gunturk,** 2011, currently at Louisiana State University; **Gurunandan Krishnan**, 2011-2014, currently with Snap, Inc.; **Mohit Gupta,** 2011-2015, currently at University of Wisconsin-Madison; **Daisuke Iso,** 2011-2013,

currently with Sony, Tokyo; **Jingyi Yu**, 2011-2012, currently at University of Delaware; **Norimichi Tsumura**, 2012-2013, currently at Chiba University; **Tomokazu Takahashi**, 2012-2013, currently at Gifu Shotoku Gakuen Univ. (Japan); **Kensei Jo**, 2013-2015, currently with Sony, Tokyo; **Eric Kee,** 2013-2014, currently with UBER; **Shigehiko Matsunaga,** 2013-2014, currently with Sony, Tokyo; **Makoto Odamaki,** 2014-2016, currently with Ricoh, Japan; **Ryunosuke Yokoya**, 2014-2015, currently with Sony, Tokyo; **Hajime Nagahara**, 2016-2017; currently at Osaka University, Japan**.**

JOURNAL AND CONFERENCE ACTIVITIES

Program Committee, *IEEE International Conference on Computational Photography* (*ICCP'10*), Boston, March 2010; Co-Chair, *IEEE International Conference on Computational Photography* (*ICCP'09*), San Francisco, April 2009; Program Committee, ICCV, Rio de Janiero, October 2007; Area Chair, CVPR, Minneapolis, June 2007; Program Committee, SIGGRAPH, Boston, August 2006; Program Committee, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'06)*, New York, June 2006; Program Committee, *International Conference on Computer Vision (ICCV'05)*, Beijing, China, October 2005. Program Committee, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'05)*, San Diego, June 2005. Program Committee, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'04)*, Washington DC, June 2004. Editorial Board, *International Journal of Computer Vision*, December 2000 - present. Associate Editor, *IEEE Transactions on Pattern Analysis and Machine Intelligence,* August, 1994 - December 1997. Associate Editor, *Pattern Recognition Journal*, January 1995 - present. Area Chair, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'03)*, Madison Wisconsin, June 2003. Program Committee, *International Conference on Computer Vision (ICCV'03)*, Nice, France, October 2003. Area Chair, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'02)*, Madison, 2002. Program Committee, *OmniVision Workshop, European Conference on Computer Vision*, Copenhagen, 2002. Program Committee, *IEEE Face and Gesture Conference (FG'2002),* Maryland, 2002. Area Chair, *International Conference on Computer Vision (ICCV'01),* Vancouver, 2001. Area Chair, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'01)*, Kauai, 2001. Area Chair, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'00),* Hilton Head, 2000. Program Committee Member, *International Symposium on Robotics Research (ISRR'99),* Utah, 1999. Program Committee Member, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'99),* Fort Collins, 1999. Program Committee Member, *Seventh International Conference on Computer Vision (ICCV'99)*, Greece, September 1999. Co-Chairman, *Indian Conference on Computer Vision, Graphics and Image Processing*, New Delhi, December 1998. Program Committee Member, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'98),* Santa Barbara, June 1998. Program Committee Member, *Sixth International Conference on Computer Vision (ICCV'98),* Bombay, January 1998. Program Committee Member, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'97)*, Puerto Rico, June 1997. Program Committee Member, *Computer Vision Conference (ICPR'96)*, International Association of Pattern Recognition, Vienna, August 1996. Program Committee Member, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'96),* San Francisco, California, June 1996. Program Committee Member, *International Workshop on Shape Representation (ECCV'96)*, Cambridge, U.K. April, 1996. Program Committee Member, *International Conference on Intelligent Robots and Systems (IROS'95)*, Pittsburgh, August, 1995. Program Committee Member, *Fifth International Conference on Computer Vision (ICCV'95)*, Boston, June 1995. Program Committee Member, *Workshop on Physics Based Modeling in Vision (ICCV'95)*, Boston, June 1995. Program Committee Member, *Computer Vision Conference (ICPR'94)*, International Association of Pattern Recognition, Jerusalem, October 1994. Program Committee Member, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'93)*, Manhattan, New York, June

1993. Physics Based Vision Tutorial, *IEEE Computer Vision and Pattern Recognition Conference (CVPR'93),* Manhattan, New York, June 1993.

JOURNAL REVIEWING

Communications of the Association for Computing Machinery (ACM); IEEE Transactions on Pattern Analysis and Machine Intelligence; International Journal of Computer Vision, Kluwer Publications; IEEE Transactions on Robotics and Automation; Journal of Optical Society of America; Computer Vision, Graphics, and Image Processing, Academic Press; Machine Vision and Applications, Springer Verlag; IEEE Transactions on Control Systems; IEEE Transactions on Image Processing; American J. of Automatic Control.

SELECTED INVITED TALKS

Invited Talk, Kyoto University and Inamori Foundation Joint Symposium, Tokyo, Japan, June 2019*; Invited Talk;* 275th Anniversary Meeting, American Philosophical Society, Philadelphia, PA, November 2018; *Invited Talk,* Jan Koenderink Symposium, Rutgers University, New Brunswick, NJ, May 2018; *Invited Talk;* Marconi Symposium, New Jersey, October 2017; *Inaugural Distinguished Lecture,* Snap, Inc., Venice, CA, July 2017; *1st Winter School in Computer Science and Engineering on Computer Science;* Hebrew University (IIAS), Jerusalem, January 2017; *Keynote Speech,* Getty Images Retreat, San Diego, CA, May 2016; *Plenary Talk,* ICIP, Quebec City, PQ, September 2015. *Plenary Talk,* Optical Society of America Conference on Imaging and Applied Optics, Arlington, VA, June 2015. *Keynote Talk,* CONTEXT 2015, Carnegie Mellon University, Pittsburgh, PA, April 2015. *Invited Talk,* GRASP Laboratory Seminar, University of Pennsylvania, April 2015. *Invited Talk,* Okawa Foundation Symposium, Tokyo, March 2015. *Keynote Talk,* Symposium on Computational Imaging and Computer Vision, KAUST, Saudi Arabia, March 2015. *Panel Speaker,* International Workshop on Computer Vision, Alghero (Sardinia), Italy, May 2014. *Invited Talk,* KLA-Tencor Engineering Conference, Monterey, CA, April 2014. *Distinguished Lecture,* College of William and Mary, Williamsburg, VA, December 2013. *Distinguished Lecture,* Google India, Bangalore, March 2013. *Plenary Speaker,* Faculty Summit, ACM and Microsoft Research, New Delhi, February, 2013. *Invited Speaker,* ICCP 2012, April 2012. *Distinguished Lecture,* Rice University, Houston, February 2012. *Invited Speaker,* University of Texas at Austin, February 2012. *Invited Speaker,* Stanford EE Computer Systems Colloquium, December 2011. *Distinguished Lecture,* UC Santa Barbara Computer Science Department, February 2011. *Invited Talk,* MIT EECS Faculty Reception and Dinner, January 2011. *Invited Talk,* Yahoo! Tech Pulse, Santa Clara, CA, October 2010. *Plenary Speaker,* ICPR 2010, Istanbul, August 2010. *Master Class Presentation*, Columbia Engineering, April 2010. *Invited Talk, International Conference on Computational Photography*, Boston, March 2010*. Invited Talk, Entertaining Science*, Cornelia Street Cafe, New York, February 2010. Invited Talk, Workshop on Fundamental Advances in Computer Vision, Kyoto, September 2009. Distinguished Lecture, Robotics Institute, Carnegie Mellon University, October 2009. *Keynote Speaker, IC3: International Conference on Contemporary Computing,* Noida, India, August 2009; *Plenary Speaker, IEEE International Conference on Robotics and Automation,* Kobe, Japan, May 2009; *Distinguished Lecture,* University of Toronto Department of Computer Science, January, 2009; *Keynote Speaker,* SPIE Conference on Electronic Imaging, San Jose, CA, January 2009; *Distinguished Lecture,* State University of New York at Buffalo, November 2008; *After-Dinner Speaker, CRA Conference,* Snowbird, Utah, July 2008*; MIT CSAIL Dertouzos Lecture,* Cambridge, Massachusetts, April 2007*. Keynote Speaker, Indo-Israeli Workshop on Computer Vision,* Hyderabad, India, February 2008*. International Symposium on Robotics Research*, Hiroshima, Japan, November 2008. *Keynote Speaker, Robotics Science and Systems Conference,* Atlanta, Georgia, June 2008*. Plenary Speaker,*

IAPR Machine Vision and Applications Conference, Tokyo, Japan, May 2007. *Invited Speaker, Takeo Kanade 60th Celebration*, Pittsburgh*,* Pennsylvania, March 2007. *Invited Speaker, Computer Science and Telecommunication Board, National Academy of Engineering,* Washington, DC*,* October 2006. *Keynote Speaker, Eurographics Symposium on Rendering,* Cyprus, Greece, June 2006. *Keynote Speaker, IEEE International Workshop on Projector-Camera Systems,* New York City, New York, June 2006. *Invited Speaker, IEEE Computer Society Workshop on Mathematical Methods in Biomedical Image Analysis,* New York City, New York, June 2006. *Magill Lecture, Fu Foundation School of Engineering and Applied Science,* Columbia University, New York, June 2004. *Invited Speaker, International Symposium on Robotics Research,* Siena, Italy, October 2003. *University Lecture,* Columbia University, New York, February 2003. *Keynote Speaker, Tenth Color Imaging Conference,* Scottsdale, Arizona, November 2002. *Azriel Rosenfeld Lecture,* University of Maryland, College Park, Maryland, February 2002. *Keynote Speaker, Pacific Graphics/CAD,* Kunming, China, August 2001. *Plenary Speaker, International Conference on Image Processing,* Thessaloniki, Greece, October 2001. *Plenary Speaker, 7th Int. Symposium on Intelligent Robotic Systems,* Portugal, July 1999. *Plenary Speaker, British Conference on Machine Vision*, London, United Kingdom, September, 1998. *Computer Science Broad Area Colloquium*, Stanford University, California, November 2001. *MIT Seminar on Modern Optics*, Cambridge, Massachusetts, May, 1998.   First Image Based Rendering Workshop, Stanford University, California, March, 1998. *International Symposium on Robotics Research*, Japan, November, 1997. *International Symposium on Robotics Research*, Munich, Germany, October, 1995. *US-Czech Symposium on Computer Vision*, Prague, Czech Republic, September, 1995. *Annual Meeting of the Optical Society of America*, Dallas, Texas, October 1994. *SPIE Annual Meeting*, San Diego, California, July 1994. *Annual Meeting of the Packard Fellows*, Monterey, California, September 1993. *Workshop on Future Vision 2002,* Princeton, New Jersey, November 1992. *SPIE Intelligent Robotics Workshop*, Boston, Massachusetts, November 1992. *Allerton Control Conference*, Urbana-Champaign, Illinois, October 1992. *Symposium on Physics Based Vision*, Urbana-Champaign, Illinois, June 1992. *NASA Workshop on Space Robotics,* Troy, New York, November, 1991. *NSF Invitational Workshop*, Maui, Hawaii, June 1991.