

Connelly Barnes

Senior Research Scientist, Adobe Research

CONTACT INFORMATION

801 N 34th St
Seattle WA, 98103

cbarnes AT adobe.com
Webpage: www.connellybarnes.com

RESEARCH INTERESTS

My career has focused on computer science research with numerous Adobe and academic collaborators, and particularly on algorithms used by photographers. Currently, I work mainly on computer graphics and vision topics, such as image and video processing, texture, deep learning for image tasks, and domain specific languages especially for shaders.

EDUCATION

Princeton University

Ph.D. Computer Science, May 2011 (also M.A. Computer Science, 2009)

Thesis: PatchMatch: A Fast Randomized Matching Algorithm with Application to Image and Video

Dissertation Advisor: Adam Finkelstein

My Ph.D. research was technology transferred as a headline feature of Photoshop CS5. This feature received a Technical Award in 2010 from PC Magazine alongside new products such as the iPad [47]. I received a Gordon Wu Prize for Excellence in research from Princeton University for this work. Our research has been viewed by 8 million viewers on YouTube [49] [50].

Oregon State University

Honors B.S. Mathematics, June 2006 (*summa cum laude*, GPA 4.0/4.0)

Honors B.S. Computational Physics, June 2006 (*summa cum laude*, GPA 4.0/4.0)

EXPERIENCE

Adobe Research, Senior Research Scientist, Seattle WA 98103

2018-present.

University of Virginia, Assistant Professor, Charlottesville, VA

2013-2017.

Advised Masters students Shanshan He, Paul Nguyen. Advised visiting graduate student Liming Lou. Advised graduate students Ning Yu, Yuting Yang, Fuwen Tan.

Postdoctoral Research Scientist, Adobe Research, Cambridge, MA

August 2011 to August 2013.

Co-advised three research interns from ETH Zurich and MIT. Collaborated with Professor Frédo Durand at MIT. Co-advised also a Ph.D. student at MIT as well as on projects with Ph.D. and Masters students at Princeton.

Research Intern, Microsoft Research, Redmond, WA

Summer 2010. Advised by Hugues Hoppe.

Research Intern, Adobe Advanced Technology Lab, Seattle, WA

Summer 2008, spring and summer 2009. Advised by Eli Shechtman and Dan B Goldman.

Undergraduate Educational Software Development, Oregon State University

Summers, 2002-2006.

Supervised by Professor Milo Koretsky. Developed chemical engineering education software ThermoSolver and VirtualCVD. These remain in use for education at Oregon State University, and have been used at other universities such as Berkeley and University of Oregon.

TEACHING

At the University of Virginia:

Computer Science 6501 - 3D Reconstruction and Understanding (Fall 2017)
 Computer Science 4501 - Introduction to Computer Vision (Spring 2017)
 Computer Science 6501 - Deep Learning for Computer Graphics (Fall 2016)
 Computer Science 4810 - Introduction to Computer Graphics (Spring 2016)
 Computer Science 6501 - Large-scale Data-driven Graphics and Vision (Fall 2015)
 Computer Science 4810 - Introduction to Computer Graphics (Spring 2015)
 Computer Science 6501 - Computational Photography (Fall 2014)
 Computer Science 6501 - 2D/3D Shape Manipulation, 3D Printing (Spring 2014)
 Computer Science 6501 - Computational Photography (Fall 2013)

REFEREED
 COMPUTER
 GRAPHICS AND
 VISION
 PUBLICATIONS

- [1] **GeoFill: Reference-Based Image Inpainting of Scenes with Complex Geometry** Yunhan Zhao, Connelly Barnes, Yuqian Zhou, Eli Shechtman, Sohrab Amirghodsi, Charless Fowlkes. *WACV 2023*.
- [2] **Inpainting at Modern Camera Resolution by Guided PatchMatch with Auto-Curation** Lingzhi Zhang, Connelly Barnes, Sohrab Amirghodsi, Kevin Wampler, Eli Shechtman, Zhe Lin, Jianbo Shi. *ECCV 2022*.
- [3] **Image Inpainting with Cascaded Modulation GAN and Object-Aware Training** Haitian Zheng, Zhe Lin, Jingwan Lu, Scott Cohen, Eli Shechtman, Connelly Barnes, Jianming Zhang, Ning Xu, Sohrab Amirghodsi, Jiebo Luo. *ECCV 2022*.
- [4] **Perceptual Artifacts Localization for Inpainting.** Lingzhi Zhang, Yuqian Zhou, Connelly Barnes, Sohrab Amirghodsi, Eli Shechtman, Zhe Lin, Jianbo Shi *ECCV 2022, oral presentation*.
- [5] **Deep 360° Optical Flow Estimation by Multi-Projection Fusion.** Yiheng Li, Connelly Barnes, Kun Huang, Fang-Lue Zhang. *ECCV 2022*.
- [6] **A δ : Autodiff for Discontinuous Programs - Applied to Shaders.** Yuting Yang, Connelly Barnes, Andrew Adams, Adam Finkelstein. *SIGGRAPH 2022*.
- [7] **Learning from Shader Program Traces.** Yuting Yang, Connelly Barnes, Adam Finkelstein. *Eurographics 2022. Best full paper award*.
- [8] **Searching for Fast Demosaicking Algorithms.** Karima Ma, Michael Gharbi, Andrew Adams, Shoaib Kamil, Tzu-Mao Li, Connelly Barnes, Jonathan Ragan-Kelley. *ACM Transactions on Graphics (presented at SIGGRAPH 2022)*.
- [9] **Modulated Periodic Activations for Generalizable Local Functional Representations.** Ishit Mehta, Michaël Gharbi, Connelly Barnes, Eli Shechtman, Ravi Ramamoorthi, Manmohan Chandraker. *ICCV 2021*.
- [10] **TransFill: Reference-guided Image Inpainting by Merging Multiple Color and Spatial Transformations.** Yuqian Zhou, Connelly Barnes, Eli Shechtman, Sohrab Amirghodsi. *CVPR 2021*.
- [11] **Coherent Video Generation for Multiple Hand-held Cameras with Dynamic Foreground.** Fang-Lue Zhang, Connelly Barnes, Hao-Tian Zhang, Junhong Zhao, Gabriel Salas. *Computational Visual Media (CVM) 2020*.

- [12] **Unselfie: Translating Selfies to Neutral-pose Portraits in the Wild.** Liqian Ma, Zhe Lin, Connelly Barnes, Alexei A. Efros, Jingwan Lu. *ECCV 2020*.
- [13] **Image Morphing With Perceptual Constraints and STN Alignment.** Noa Fish, Richard Zhang, Lilach Perry, Daniel Cohen-Or, Eli Shechtman, Connelly Barnes. *Eurographics 2020*.
- [14] **Learning to Generate Textures on 3D Meshes.** Amit Raj, Cusuh Ham, Connelly Barnes, Vladimir Kim, Jingwan Lu, James Hays. *CVPR Workshops: 3D WiDGET 2019. Best paper award*.
- [15] **Foreground-aware Image Inpainting.** Wei Xiong, Jiahui Yu, Zhe Lin, Jimei Yang, Xin Lu, Connelly Barnes, Jiebo Luo. *CVPR 2019*.
- [16] **On the Continuity of Rotation Representations in Neural Networks.** Yi Zhou, Connelly Barnes, Jingwan Lu, Jimei Yang, Hao Li. *CVPR 2019*.
- [17] **Texture Mixer: A Network for Controllable Synthesis and Interpolation of Texture.** Ning Yu, Connelly Barnes, Eli Shechtman, Sohrab Amirghodsi, Michal Lukáč. *CVPR 2019*.
- [18] **Approximate Program Smoothing Using Mean-Variance Statistics, with Application to Procedural Shader Bandlimiting.** Yuting Yang, Connelly Barnes. *Eurographics 2018*.
- [19] **Where and Who? Automatic Semantic-Aware Person Composition.** Fuwen Tan, Crispin Bernier, Benjamin Cohen, Vicente Ordonez, Connelly Barnes. *IEEE Winter Conference on Applications of Computer Vision (WACV) 2018*.
- [20] **Automatic Image Defect Diagnosis.** Ning Yu, Xiaohui Shen, Zhe Lin, Radomír Měch, Connelly Barnes. *IEEE Winter Conference on Applications of Computer Vision (WACV) 2018*.
- [21] **Halide: A Language and Compiler for Optimizing Parallelism, Locality, and Re-computation in Image Processing Pipelines** Jonathan Ragan-Kelley, Andrew Adams, Dillon Sharlet, Connelly Barnes, Sylvain Paris, Marc Levoy, Saman Amarasinghe, Frédo Durand. *Communications of the ACM 2018: Research Highlights*.
- [22] **A Survey of the State-of-the-art in Patch-based Synthesis.** Connelly Barnes, Fang-Lue Zhang. *Computational Visual Media 2017*.
- [23] **VizGen: Accelerating Visual Computing Prototypes in Dynamic Languages** Yuting Yang, Samantha Prestwood, Connelly Barnes. *ACM SIGGRAPH Asia 2016*.
- [24] **Image Perforation: Automatically Accelerating Image Pipelines by Intelligently Skipping Samples.** Connelly Barnes, Paul Nguyen, Jason Lawrence. *ACM Transactions on Graphics 2016*.
- [25] **PatchTable: Efficient Patch Queries for Large Datasets and Applications.** Connelly Barnes, Fang-Lue Zhang, Liming Lou, Xian Wu, Shi-Min Hu. *ACM Transactions on Graphics (Proc. SIGGRAPH 2015)*.
- [26] **Synthesis of Complex Image Appearance from Limited Exemplars.** Olga Diamanti, Connelly Barnes, Sylvain Paris, Eli Shechtman, Olga Sorkine-Hornung. *ACM Transactions on*

Graphics 2015.

- [27] **RealPigment: Paint Compositing by Example.** Jingwan Lu, Stephen DiVerdi, Willa Chen, Connelly Barnes, Adam Finkelstein. *NPAR 2014: Symposium on Non-Photorealistic Animation and Rendering*, Proceedings in ACM.
- [28] **Stylized Keyframe Animation of Fluid Simulations.** Mark Browning, Connelly Barnes, Samantha Ritter, Adam Finkelstein. *NPAR 2014: Symposium on Non-Photorealistic Animation and Rendering*, Proceedings in ACM.
- [29] **Style Transfer for Headshot Portraits.** YiChang Shih, Sylvain Paris, Connelly Barnes, Frédo Durand, William Freeman. *ACM Transactions on Graphics (Proc. SIGGRAPH Asia 2014)* vol. 33(4).
- [30] **DecoBrush: Drawing Structured Decorative Patterns by Example.** Jingwan Lu, Connelly Barnes, Connie Wan, Adam Finkelstein, Paul Asente, Radomir Mech. *ACM Transactions on Graphics (Proc. SIGGRAPH 2014)* vol. 33(4).
- [31] **Camouflaging an Object from Many Viewpoints.** Andrew Owens, Connelly Barnes, Alex Flint, Hanumant Singh, Bill Freeman. *CVPR 2014 (oral presentation)*.
- [32] **Patch-based High Dynamic Range Video.** Nima Khademi Kalantari, Eli Shechtman, Connelly Barnes, Soheil Darabi, Dan B Goldman, Pradeep Sen. *ACM Transactions on Graphics (Proc. SIGGRAPH Asia 2013)* vol. 32(5).
- [33] **RealBrush: An Example-based Painting System.** Jingwan Lu, Connelly Barnes, Stephen DiVerdi, Adam Finkelstein. *ACM Transactions on Graphics (Proc. SIGGRAPH 2013)* vol. 32(4).
- [34] **Halide: A Language and Compiler for Optimizing Parallelism, Locality, and Re-computation in Image Processing Pipelines.** Jonathan Ragan-Kelley, Connelly Barnes, Andrew Adams, Sylvain Paris, Frédo Durand, and Saman Amarasinghe. *ACM PLDI 2013*.
- [35] **Image Melding: Combining Inconsistent Images using Patch-based Synthesis.** Soheil Darabi, Eli Shechtman, Connelly Barnes, Dan B Goldman, and Pradeep Sen. *ACM Transactions on Graphics (Proc. SIGGRAPH 2012)* vol. 31(4).
- [36] **The PatchMatch Randomized Matching Algorithm for Image Manipulation.** Connelly Barnes, Dan B Goldman, Eli Shechtman, and Adam Finkelstein. *Communications of the ACM*, 54, 11 (Nov. 2011). Invited paper.
- [37] **The Generalized PatchMatch Correspondence Algorithm.** Connelly Barnes, Eli Shechtman, Dan B Goldman, and Adam Finkelstein. *European Conference on Computer Vision, Springer (Sept. 2010)*.
- [38] **Video Tapestries with Continuous Temporal Zoom.** Connelly Barnes, Dan B Goldman, Eli Shechtman, and Adam Finkelstein. *ACM Transactions on Graphics (Proc. SIGGRAPH 2010)* vol. 29(3).
- [39] **PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing.** Connelly Barnes, Eli Shechtman, Adam Finkelstein, and Dan B Goldman. *ACM Transactions on Graphics (Proc. SIGGRAPH 2009)* vol. 28(3).

- [40] **Video Puppetry: A Performative Interface for Cutout Animation.** Connelly Barnes, David E. Jacobs, Jason Sanders, Dan B Goldman, Szymon Rusinkiewicz, Adam Finkelstein, Maneesh Agrawala. *ACM Transactions on Graphics (Proc. SIGGRAPH Asia 2008)* vol. 27(5).
- [41] **Digital Bas-Relief From 3D Scenes.** Tim Weyrich, Jia Deng, Connelly Barnes, Szymon Rusinkiewicz, and Adam Finkelstein. *ACM Transactions on Graphics (Proc. SIGGRAPH 2007)* vol. 26(3).
- PUBLICATIONS IN EDUCATION
- [42] **Enhancement of Student Learning in Experimental Design Using a Virtual Laboratory.** Milo Koretsky, Danielle Amatore, Connelly Barnes, and Sho Kimura. *IEEE Transactions on Education 2008.*
- [43] **Experiential Learning of Design of Experiments Using a Virtual CVD Reactor.** Milo Koretsky, Sho Kimura, Connelly Barnes, Danielle Amatore, and Derek Meyers-Graham. *American Society for Engineering Education Conference 2006.* Award for best paper in chemical engineering.
- [44] **The Virtual CVD Learning Platform.** Milo Koretsky, Danielle Amatore, Connelly Barnes, and Sho Kimura. *Frontiers in Education Conference 2006.*
- [45] **ThermoSolver: An Integrated Educational Thermodynamics Software Program.** Undergraduate thesis. University Honors College, Oregon State University Library 2006.

PATENTS

14 US patents granted. Some international patents as well, not listed here.

- US Patent 11,321,847, "Foreground-aware image inpainting." Z Lin, W Xiong, C Barnes, J Yang, X Lu.
- US Patent 11,270,415, "Image inpainting with geometric and photometric transformations." C Barnes, S Amirghodsi, E Shechtman.
- US Patent 11,080,833, "Image manipulation using deep learning techniques in a patch matching operation." C Barnes, U Singhal, E Shechtman, M Gharbi.
- US Patent 11,024,060, "Generating neutral-pose transformations of self-portrait images." MA Liqian, J Lu, Z Lin, C Barnes, AA Efros.
- US Patent 10,964,084, "Generating realistic animations for digital animation characters utilizing a generative adversarial network and a hip motion prediction network." J Lu, Y Zhou, C Barnes, J Yang.
- US Patent 10,878,575, "Foreground-aware image inpainting." Z Lin, W Xiong, C Barnes, J Yang, X Lu.
- US Patent 10,818,043, "Texture interpolation using neural networks." C Barnes, S Amirghodsi, M Lukac, E Shechtman, N Yu.
- US Patent 10,762,680, "Generating deterministic digital image matching patches utilizing a parallel wavefront search approach and hashed random number." S Amirghodsi, C Barnes, EL Palmer.
- US Patent 8,861,869, "Determining correspondence between image regions." E Shechtman, DR Goldman, C Barnes, A Finkelstein.
- US Patent 8,811,749, "Determining correspondence between image regions." C Barnes, D Goldman, E Shechtman.
- US Patent 8,625,927, "Image Processing Using Image Web."
- US Patent 8,571,328, "Determining correspondence between image regions." E Shechtman, D Goldman, C Barnes, A Finkelstein.
- US Patent 8,407,575, "Video Content Summary."
- US Patent 8,285,055, "Determining correspondence between image regions."

REVIEWING

Technical papers committees: CGDIP (2017), Eurographics short papers (2013), Eurographics Symposium on Rendering (2013, 2014, 2017), ICCP (2013), Pacific Graphics (2017), SIGGRAPH (2015, 2016, 2019, 2020), SIGGRAPH Asia (2018, 2021).

TALKS

- Invited talk for Peking University with Yuting Yang on her first author SIGGRAPH paper *A δ* . (2022).
- In 2016, invited talks at University of Hong Kong, Chinese University of Hong Kong, Hong Kong University of Science and Technology, and the Shandong University summer school at Qingdao campus.
- PatchTable: Efficient Patch Queries for Large Datasets and Applications; and a translating compiler for visual computing in dynamic languages. University of Southern California, California, USA (November 2015).
- Patch-based methods, including PatchTable, which permits efficient patch queries for large datasets. Shandong University, Department of Computer Science, Jinan, China (August 2015); Tsinghua University, Department of Computer Science, Beijing, China (August 2015).
- Patch-based methods: PatchMatch and PatchTable. INRIA Nancy-Grand Est, Nancy, France (June 2015).
- Computer graphics: a bridge between real and virtual worlds. Talk for high school students. Math Science Innovation Center, Richmond, VA, USA. (March 2015).
- Data-driven methods for image manipulation. Hampden-Sydney College (2014).
- Guest lectures: Patch-based synthesis and Halide autotuning at University of Virginia, NVidia, Harvard (2013).
- Patch-based synthesis lecture at Brown University (2012), U.W. and MIT (2011).

BOOK CHAPTERS

Created plots, appendices, and educational software ThermoSolver accompanying textbook *Engineering and Chemical Thermodynamics* by Professor Milo Koretsky.

Co-authored a chapter for *A First Course in Scientific Computing* by Professor Rubin H. Landau.

AWARDS

- Gordon Wu Prize for Excellence in scholarship and research (2010)
- National Merit scholarship (2003-2006)
- Intel American Electronics Association scholarship (2003-2006)
- Rensselaer Polytechnic medal and scholarship (2002)
- Edward H. Stockwell award and scholarship for mathematics (2006)
- Drucilla-Shepard-Smith scholastic award (awarded annually, 2004-2006)

PRESS COVERAGE

- [46] **Wired** and **Gizmodo** covered a research project I collaborated on camouflage, and it has 170,000 views on **YouTube**.
- [47] **PC Magazine** gave Photoshop content-aware fill a Technical Award in 2010.
- [48] **PatchMatch: The Algorithm Behind Adobe's CS5 Content Aware Fill in Photoshop**. Princeton University, 2010.
- [49] **Adobe Photoshop CS5: Content-Aware Fill Sneak Peek**, YouTube (4.9 million views).
- [50] **Adobe Photoshop CS6 - Content-Aware Fill, Move, Patch**, YouTube (3.2 million views). This is the technical video published with our paper in ACM SIGGRAPH.

CITIZENSHIP

United States

REFERENCES

Adam Finkelstein
Professor, Princeton University

Sylvain Paris
Fellow, Adobe Research