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Tobi Delbruck



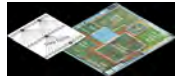
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I studied physics and applied math as an undergraduate in San Diego and then Computation in Neural Systems as a graduate student at Caltech. After projects with Christof Koch and David van Essen, I settled on building neuromorphic vision sensors with Carver Mead for my PhD work. After my graduate work, I went to Silicon Valley to work as a consultant on electronic imaging, first with Synaptics, and then with Arithmos, National Semiconductor and Foveon. I joined INI in 1998, together with Dr. Shih-Chii Liu. Aside from a major detour to work on the luminous tactile floor of INI's "Ada" contribution to the 2003 Swiss national exhibition, I have been working on developing neuromorphic vision sensors for real-world applications in machine vision. Together with my doctoral student Patrick Lichtsteiner, we achieved a breakthrough with the first highly functional Dynamic Vision Sensor event-based silicon retina in 2006. Since then, the Sensors group has been evolving this technology and exploring its manifold applications in event-driven vision. Our most recent breakthrough is our flagship sensor called DAVIS. In my spare time, I also really enjoy reading and like to play tennis and basketball. I like riding my bike to work and sometimes I practice some card magic and I even rejoined the Magic Castle in Hollywood recently. For holidays we often travel back to our home in Pasadena where I grew up as a faculty child.

Main-Projects



Available Positions/Projects



Neuromorphic Processor Project [Paid Position]

We have a number of available PhD and postdoc positions available now for the Neuromorphic Processor Project (NPP). [more](#)

Spin-Off Companies

[IniLabs](#)

[Insightness](#)

[iniVation AG](#)

Teaching

INI-404, 227-1033-00 [Neuromorphic Engineering I](#)

INI-405, 227-1032-00 [Neuromorphic Engineering II](#)

227-1042-00 [Electronics for Physicists II \(Digital\)](#)

INI-434, 227-1049-00 Block: Insights Into Neuroinformatics

INI-502, 227-1039-00 [Basics of instrumentation, measurement and analysis](#)

Publications

2017

Anumula, J., Neil, D., Xiaoya Li, X., Delbruck, T., and Liu, S-C. **Live Demonstration: Event-Driven Real-Time Spoken Digit Recognition System**, *IEEE Int. Symposium on Circuits and Systems (ISCAS)*, 2017

Moeys, D., Li, C., Martel, J., Bamford, S., Longinotti, L., Motsnyi, V., Bello, D., Delbruck, T. **Color Temporal Contrast Sensitivity in Dynamic Vision Sensors**, *IEEE Int. Symposium on Circuit and Systems (ISCAS)*, 2017 [pdf](#)

Yang, M-H., Liu, S-C., and Delbruck, T. **Analysis of Encoding Degradation in Spiking Sensors Due to Spike Delay Variation**, *IEEE Transactions on Circuits and Systems I: Regular Papers*, 64:(1) 145-155, 2017

2016

Bodo Rueckauer, Tobi Delbruck [Evaluation of Event-Based Algorithms for Optical Flow with Ground-Truth from Inertial Measurement Sensor](#), *Frontiers in Neuroscience*, 10:(176) 1-17, 2016 [OpticalFlowBenchmarking](#)

Ceolini, E., Neil, D., Delbruck, T., and Liu, S-C. [Temporal Sequence Recognition in a Self-Organizing Recurrent Network](#), *IEEE Second International Conference on Event-Based Control, Communication and Signal Processing (EBCCSP)*, 2016

- Christian Brändli, Jonas Strubel, Susanne Keller, Davide Scaramuzza, Tobi Delbruck [ELiSeD - An Event-Based Line Segment Detector](#), *Event-Based Control, Communication and Signal Processing (EBCCSP 2016)*, 2:, 2016
- Hu Y., Liu H., Pfeiffer M., and Delbruck T. [DVS Benchmark Datasets for Object Tracking, Action Recognition and Object Recognition](#), *Frontiers in Neuromorphic Engineering*, 10:(405), 2016
- Lee JH, Delbruck T., and Pfeiffer M. [Training deep spiking neural networks using backpropagation](#), *Frontiers in Neuromorphic Engineering*, 10:(508), 2016
- Liu, H., Moeys, D., Neil, D., Liu, S., Delbruck, T. [Combined frame- and event-based detection and tracking](#), *IEEE Int. Symposium on Circuits and Systems (ISCAS)*, 2016 [pdf](#)
- Moeys, D., Corradi F., Kerr, E., Vance, P., Das, G., Neil, D., Kerr, D., Delbrück, T. [Steering a Predator Robot using a Mixed Frame/Event-Driven Convolutional Neural Network](#), *IEEE Second International Conference on Event-Based Control, Communication and Signal Processing (EBCCSP)*, 2016 [pdf](#)
- Moeys, D., Delbruck, T., Rios-Navarro, A., Linares-Barranco, A. [Live Demonstration: Retinal Ganglion Cell Software and FPGA Implementation for Object Detection and Tracking](#), *IEEE Int. Symposium on Circuits and Systems (ISCAS)*, 2016 [pdf](#)
- Moeys, D., Delbruck, T., Rios-Navarro, A., Linares-Barranco, A. [Retinal Ganglion Cell Software and FPGA Implementation for Object Detection and Tracking](#), *IEEE Int. Symposium on Circuits and Systems (ISCAS)*, 2016 [pdf](#)
- Yang, M-H., Chien, C-H., Delbruck, T. , and Liu, S-C. [A 0.5V 55 uW 64X2-channel binaural silicon cochlea for event-driven stereo-audio sensing](#), *2016 IEEE International Solid-State Circuits Conference (ISSCC)* 388-389, 2016

2015

- Li, C. and Brandli, C. and Berner, R. and Liu, H. and Yang, M. and Liu, S.-C. and Delbruck, T. **Design of an RGBW Color VGA Rolling and Global Shutter Dynamic and Active-Pixel Vision Sensor**, *IEEE International Symposium on Circuits and Systems (ISCAS)* 718 - 721 , 2015
- Liu, H. and Brandli, C. and Li, C. and Liu, S.-C. and Delbruck, T. **Design of a Spatiotemporal Correlation Filter for Event-based Sensors**, *IEEE International Symposium on Circuits and Systems (ISCAS)* 722 - 725 , 2015 [pdf](#)
- Liu, S-C. and Yang, M-H. and Steiner, A. and Moeckel, R. and Delbruck, T. **1kHz 2D visual motion sensor using 20x20 silicon retina optical sensor and DSP microcontroller**, *IEEE Transactions on Biomedical Circuits and Systems*, 9: (2) 207 - 216 , 2015
- Moeys, D. and Delbruck, T. and Liu, S-C. **Current-mode automated quality control cochlear resonator for bird identity tagging**, *IEEE Int. Symposium on Circuits and Systems (ISCAS)* 1734 - 1737 , 2015 [pdf](#)
- Yang, M-H and Liu, S-C and Delbruck, T. [A Dynamic Vision Sensor with 1% Temporal Contrast Sensitivity and In-Pixel Asynchronous Delta Modulator for Event Encoding](#), *IEEE Journal of Solid-State Circuits*, 50:(9), 2015

[Event-Based Neuromorphic Systems](#), Shih-Chii Liu, Tobi Delbruck, Giacomo Indiveri, Adrian Whatley, Rodney Douglas (Eds.), Wiley, 2015

2014

Braendli, C. and Berner, R. and Yang, M-H and Liu, S-C. and Delbruck, T. [A 240x180 130dB 3us latency global shutter spatiotemporal vision sensor](#), *IEEE Journal of Solid-State Circuits (JSSC)*, 49:(10) 2333-2341, 2014

Braendli, C. and Berner, R. and Yang, M-H. and Liu, S-C. and Villeneuve, V. and Delbruck, T. **Live demonstration: The "DAVIS" Dynamic and Active-Pixel Vision Sensor**, *2014 IEEE International Symposium on Circuits and Systems* 440, 2014

Brandli, C. and Mantel, T. and Hutter, M. and Hopflinger, M. and Berner, R. and Siegwart, R. and Delbruck, T. [Adaptive Pulsed Laser Line Extraction for Terrain Reconstruction using a Dynamic Vision Sensor](#), *Frontiers in Neuroscience - Neuromorphic Engineering*, 2014

Brandli, Christian and Muller, Lorenz and Delbruck, Tobi [Real-Time, High-Speed Video Decompression Using a Frame- and Event-Based DAVIS Sensor](#), *Circuits and Systems (ISCAS), 2014 IEEE International Symposium on*, 2014

Lang, M. and Delbruck, T. [Robotic Goalie with 3ms Reaction Time at 4% CPU Load Using Event-Based Dynamic Sensor](#), *Frontiers in Neuromorphic Engineering*, 2014

Lee, J-H and Delbruck, T. and Pfeiffer, M. and Park, P.K.J. and Shin, C-W and Ryu, H. and Kang, B.C. **Real-Time Gesture Interface Based on Event-Driven Processing from Stereo Silicon Retinas**, *IEEE Transactions on Neural Networks and Learning Systems* 1-14, 2014

Steiner, A. and Moeckel, R. and Thurer, R. and Floreano, D. and Delbruck, T. and Liu, S-C. **1kHz 2D silicon retina motion sensor platform**, *2014 IEEE International Symposium on Circuits and Systems* 41-44, 2014

Yang, M-H and Liu, S-C and Delbruck, T. [Subthreshold DC-Gain enhancement by exploiting small size effects of MOSFETs](#), *Electronics Letters*, 50:(11) 835-837, 2014

Yang, M-H. and Liu, S-C. and Delbruck, T. **Comparison of spike encoding schemes in asynchronous vision sensors: Modeling and design**, *2014 IEEE International Symposium on Circuits and Systems* 2632 - 2635, 2014

2013

Berner, R. and Brandli, C. and Yang, M. and Liu, S.-C. and Delbruck, T. [A 240x180 120dB 10mW 12us-latency sparse output vision sensor for mobile applications](#), *Symposium on VLSI Circuits*, 2013

Berner, Raphael and Brandli, Christian and Yang, Minhao and Liu, Shih-Chii and Delbruck, Tobi **A 240x180 120dB 10mW 12us-latency Sparse Output Vision Sensor for Mobile Applications**, *IISW 2013*, 2013

Censi, Andrea and Strubel, Jonas and Brandli, Christian and Delbruck, Tobi and Scaramuzza, Davide [Low-latency localization by Active LED Markers](#)

[tracking using a Dynamic Vision Sensor](#), *RSJ IEEE/RSJ International Conference on Intelligent Robots and Systems IROS*, 2013

Liu, S-C. and Schaik, A. van and Minch, B. and Delbruck, T. [Asynchronous binaural spatial audition sensor with 2x64x4 channel output](#), *IEEE Transactions on Biomedical Circuits and Systems*, 2013

O'Connor, P. and Neil, D. and Liu, S-C. and Delbruck, T. and Pfeiffer, M. [Real-Time Classification and Sensor Fusion with a Spiking Deep Belief Network](#), *Frontiers in Neuromorphic Engineering*, 7:(178), 2013

Park, P. and Ryu, H. and Lee, J. H. and Shin, C. W. and Lee, K. B. and Woo, J. Y. and Kim, J-S. and Kang, B. C. and Liu, S-C. and Delbruck, T. **Fast neuromorphic sound localization for binaural hearing aids**, *IEEE Engineering in Medicine and Biology Society*, 2013

2012

Katz, M. and Nikolic, K. and Delbruck, T. **Live demonstration: Behavioural Emulation of Event-Based Vision Sensors**, *IEEE Intl. Symp. on Circuits and Systems (ISCAS 2012)* 741-745, 2012

Lee, J. and Delbruck, T. and Park, P.K.J. and Pfeiffer, M. and Shin, C.W. and Ryu, H. and Kang, B.C. **Live demonstration: Gesture-Based remote control using stereo pair of dynamic vision sensors**, *IEEE Intl. Symp. on Circuits and Systems (ISCAS 2012)* 736-740, 2012

Li, C-H. and Delbruck, T. and Liu, S-C. **Real-time speaker identification using the AEREAR2 event-based silicon cochlea**, *2012 IEEE International Symposium on Circuits and Systems* 1159– 1162, 2012

Sejnowski, T. and Delbruck, T. **The Language of the Brain**, *Scientific American* (Oct.) 54-59, 2012

Yang, M. H. and Liu, S-C. and Li, C-H. and Delbruck, T. [Addressable current reference array with 170dB dynamic range](#), *2012 IEEE International Symposium on Circuits and Systems* 3110-3113, 2012

T. Delbruck and S-C. Liu **Spiking silicon retinas and cochleas for vision and audition**, *Frontiers in Sensing - From Biology to Engineering* 88-99, 2012

2011

Abshire, P. and Bermak, A. and Berner, R. and Cauwenberghs, G. and Chen, S. and Christen, JB and Constandinou, T. and Culurciello, E. and Dandin, M. and Datta, T. and Delbruck, T. and Dudek, P. and Eftekhari, A. and Etienne-Cummings, R. and Indiveri, G. and Law M.K. and Linares-Barranco, B. and Tapson, J. and Tang, W. and Zhai, Y. [Confession session: Learning from others mistakes](#), *Circuits and Systems (ISCAS), 2011 IEEE International Symposium on* 1149-1162, 2011

Berner, R. and Delbruck, T. [Event-Based Pixel Sensitive to Changes of Color and Brightness](#), *Circuits and Systems I: Regular Papers, IEEE Transactions on*, 58:(7) 1581-1590, 2011

Drazen, D. and Lichtsteiner, P. and Häfliger, P. and Delbruck, T. and Jensen, A. [Toward real-time particle tracking using an event-based dynamic vision sensor](#), *Experiments in Fluids* 1465-1469, 2011

Indiveri, G. and Linares-Barranco, B. and Hamilton, T.J. and Van Schaik, A. and Etienne-Cummings, R. and Delbruck, T. and Liu, S.C. and Dudek, P. and Häfliger, P. and Renaud, S. and Schemmel, S. and Cauwenberghs, G. and Arthur, J. and Hynna, K. and Folowosele, F. and Saighi, S. and Serrano-Gottarredona, T. and Wijekoon, J. and Wang, Y., and Boahen, K. [Neuromorphic silicon neuron circuits](#), *Frontiers in neuroscience*, 5:(73), 2011

2010

Berner, R. and Delbruck, T. **Event-based color change pixel in standard CMOS**, *Circuits and Systems (ISCAS), Proceedings of 2010 IEEE International Symposium on* 349-352, 2010

Delbruck, T. and Berner, R. and Lichtsteiner, P. and Dualibe, C. **32-bit Configurable bias current generator with sub-off-current capability**, *Circuits and Systems (ISCAS), Proceedings of 2010 IEEE International Symposium on* 1647-1650, 2010

Delbruck, T. and Koch, T. and Berner, R. and Hermansky, H. **Fully integrated 500uW speech detection wake-up circuit**, *Circuits and Systems (ISCAS), Proceedings of 2010 IEEE International Symposium on* 2015-2018, 2010

Liu, S. C. and Delbruck, T. **Neuromorphic sensory systems**, *Current Opinion in Neurobiology*, 20:(3) 288-295, 2010

Liu, S. C. and van Schaik, A. and Minch, B. A. and Delbruck, T. **Event-based 64-channel binaural silicon cochlea with Q enhancement mechanisms**, *Proceedings of 2010 IEEE International Symposium on Circuits and Systems (ISCAS) : Paris, France, 30 May - 2 June 2010* 2027-2030, 2010

2009

Boerlin, M. and Delbruck, T. and Eng, K. [Getting to Know Your Neighbors: Unsupervised Learning of Topography from Real-World, Event-Based Input](#), *Neural Computation*, 21:(1) 216-238, 2009 [pdf](#)

Conradt, J. and Berner, R. and Cook, M. and Delbruck, T. **An Embedded AER Dynamic Vision Sensor for Low-Latency Pole Balancing**, *IEEE Workshop on Embedded Computer Vision (ECV09), Kyoto, Japan, 2009* [pdf](#)

Conradt, J. and Cook, M. and Berner, R. and Lichtsteiner, P. and Douglas, R. J. and Delbruck, T. **A Pencil Balancing Robot using a Pair of AER Dynamic Vision Sensors**, *International Conference on Circuits and Systems (ISCAS)* 781-785, 2009 [pdf](#)

Linares-Barranco, A. and Gomez-Rodriguez, F. and Jimenez, G. and Delbruck, T. and Berner, R. and Liu, S.-C. **Implementation of a time-warping AER mapper**, *Proceedings of IEEE International Symposium on Circuits and Systems* 2886-2889, 2009 [pdf](#)

Nageswaran, Jayram Moorkanikara and Wang, Yingxue and Delbrueck, Tobi and Dutt, Nikil **Computing spike-based convolutions on GPUs**, *IEEE International Symposium on Circuits and Systems 2009 (ISCAS 2009)* 1917-1920, 2009 [pdf](#)

Serrano-Gotarredona, R. and Oster, M. and Lichtsteiner, P. and Linares-Barranco, A. and Paz-Vicente, R. and Gomez-Rodriguez, F. and Camuñas-Mesa, L. and Berner, R. and Rivas, M. and Delbruck, T. and Liu, S.-C. and Douglas, R. J. and Hafliger, P. and Moreno, G. and Civit, A. and Serrano-Gotarredona, T. and Acosta-Jimenez, A. and Linares-Barranco, B. **CAVIAR: a 45k neuron, 5M synapse, 12G connects/s AER hardware sensory-processing-learning-actuating system for high-speed visual object recognition and tracking**, *IEEE Transactions on Neural Networks*, 20:(9) 1417-1438, 2009

2008

Berner, R and Lichtsteiner, P. and Delbruck, T. [Self-timed vertacolor dichromatic vision sensor for low power pattern detection](#), *IEEE International Symposium on Circuits and Systems (ISCAS 2008)* 1032-1035, 2008 [pdf](#)

Conradt, J and Lichtsteiner, P and Berner, R and Delbruck, T and Douglas, RJ and Cook, M [A Pencil Balancing Robot Using Only Spike-based Visual Input.](#), *Neural Information Processing Systems*, 2008 [pdf](#)

Delbruck, T. [Frame-free dynamic digital vision](#), *Invited paper in International Symposium on Secure-Life Electronics*, 1:(1) 21-26, 2008 [pdf](#)

Delbruck, T and Schrag, M and Boerlin, M and Eng, K **Real-time Topology Learning**, *NIPS 2008 (Demonstration Track)*, 2008

Fu, Z. and Culurciello, E. and Lichtsteiner, P. and Delbruck, T. **Fall detection using an address-event temporal contrast vision sensor**, *IEEE International Symposium on Circuits and Systems (ISCAS 2008)* 424-427, 2008

Fu, Z. and Delbruck, T. and Lichtsteiner, P. and Culurciello, E. **An address-event fall detector for assisted living applications**, *IEEE Transactions on Biomedical Circuits and Systems*, 2:(2) 88-96, 2008 [pdf](#)

Lichtsteiner, P. and Posch, C. and Delbruck, T. [A 128x128 120dB 15us Latency Asynchronous Temporal Contrast Vision Sensor](#), *IEEE Journal of Solid State Circuits*, 43:(2) 566-576, 2008 [pdf](#)

Indiveri, G. and Liu, S.-C. and Delbruck, T. and Douglas, R. **Neuromorphic systems**, *The New Encyclopedia of Neuroscience* 521-528, 2008

2007

Berner, R. and Delbruck, T. [A 5 Meps \\$100 USB2.0 Address-Event Monitor-Sequencer Interface](#), *IEEE International Symposium on Circuits and Systems (ISCAS 2007)* 2451-2454, 2007 [pdf](#)

Chicca, E. and Whatley, A. M. and Lichtsteiner, P. and Dante, V. and Delbruck, T. and Del Giudice, P. and Douglas, R. J. and Indiveri, G. **A multi-chip pulse-based neuromorphic infrastructure and its application to a model of**

orientation selectivity, *IEEE Transactions on Circuits and Systems I, Regular Papers*, 54:(5) 981-993, 2007 [pdf](#)

Delbruck, T. and Lichtsteiner, P. **[Fast sensory motor control based on event-based hybrid neuromorphic-procedural system](#)**, *IEEE International Symposium on Circuits and Systems (ISCAS 2007)* 845-848, 2007 [pdf](#)

Delbrück, T. and Whatley, A. M. and Douglas, R. and Eng, K. and Hepp, K. and Verschure, P. F. M. J. **[A tactile luminous floor for an interactive autonomous space](#)**, *Robotics and Autonomous Systems*, 55:(6) 433-443, 2007 [pdf](#)

Fasnacht, D. and Delbruck, T. **Dichromatic spectral measurement circuit in vanilla CMOS**, *IEEE International Symposium on Circuits and Systems (ISCAS 2007)* 3091-3094, 2007 [pdf](#)

Linares-Barranco, A. and Gomez-Rodriguez, F. and Jimenez, A. and Delbruck, T. and Lichtsteiner, P. **Using FPGA for visuo-motor control with a silicon retina and a humanoid robot**, *IEEE International Symposium on Circuits and Systems (ISCAS 2007)* 119-1195, 2007 [pdf](#)

Oster, M. and Lichtsteiner, P. and Delbruck, T. and Liu, S-C. **A spike-based saccadic recognition system**, *2007 IEEE International Symposium on Circuits and Systems (ISCAS 2007)* 3083-3086, 2007 [pdf](#)

2006

Chicca, E. and Lichtsteiner, P. and Delbruck, T. and Indiveri, G. and Douglas, R. J. **Modeling Orientation Selectivity Using a Neuromorphic Multi-Chip System**, *Proceedings of IEEE International Symposium on Circuits and Systems* 1235-1239, 2006 [pdf](#)

Delbruck, T. and Lichtsteiner, P. **[Fully programmable bias current generator with 24 bit resolution per bias](#)**, *2006 IEEE International Symposium on Circuits and Systems (ISCAS 2006)*, 2006 [pdf](#)

Eng, K. and Mintz, M. and Delbruck, T. and Douglas, R. J. and Whatley, A. M. and Manzolli, J. and Verschure, P. F. M. J. **An Investigation of Collective Human Behavior in Large-scale, Mixed Reality Spaces**, *Presence: Teleoperators and Virtual Environments*, 15:(4) 403-418, 2006 [pdf](#)

Lichtsteiner, P. and Delbruck, T. and Posch, C. **[A 100dB dynamic range high-speed dual-line optical transient sensor with asynchronous readout](#)**, *2006 IEEE International Symposium on Circuits and Systems (ISCAS 2006)*, 2006

Lichtsteiner, P. and Posch, C. and Delbruck, T. **[A 128x128 120dB 30mW Asynchronous Vision Sensor that Responds to Relative Intensity Change](#)**, *ISSCC Digest of Technical Papers 2006* 508-509, 2006 [pdf](#)

Nufer, Stephan K. and Buehlmann, Mathias and Delbruck, Tobi and Joller, Josef **[A mixture of experts for learning lighting control](#)**, *Proceedings from the Workshop on Artificial Intelligence Techniques for Ambient Intelligence (AITAmI'06)*, 2006 [pdf](#)

2005

- Delbruck, T. and Fenkart, A. and Zwicker, R. [Using personal computers for enhanced presence detection in building automation](#), *HCI International, 11th International Conference on Human-Computer Interaction*, 2005
- Delbruck, T. and van Schaik, A. [Bias current generators with wide dynamic range](#), *Analog Integrated Circuits and Signal Processing*, 43:(3) 247-268, 2005 [pdf](#)
- Grover, D. and Delbruck, T. and King, M. **An eye tracking system using multiple near-infrared channels with special application to efficient eye-based communication**, *Thirteenth European Conference on Eye Movements ECEM13* 36-39, 2005
- Lichtsteiner, P. and Delbruck, T. [64x64 Event-Driven Logarithmic Temporal Derivative Silicon Retina](#), *2005 IEEE Workshop on Charge-Coupled Devices and Advanced Image Sensors* 157-160, 2005
- Lichtsteiner, P. and Delbruck, T. **A 64x64 AER Logarithmic temporal derivative silicon retina**, *Research in Microelectronics and Electronics, 2005 PhD (PRIME 2005)*, 2: 202-205, 2005 [pdf](#)
- Serrano-Gotarredona, R. and Oster, M. and Lichtsteiner, P. and Linares-Barranco, A. and Paz-Vincent, R. and Gómez-Rodríguez, F. and Kolle Riis, H. and Delbrück, T. and Liu, S. C. and Zahnd, S. and Whatley, A. M. and Douglas, R. and Häfliger, P. and Jimenez-Moreno, G. and Civit, A. and Serrano-Gotarredona, T. and Acosta-Jiménez, A. and Linares-Barranco, B. **AER Building Blocks for Multi-Layer Multi-Chip Neuromorphic Vision Systems**, *Advances in Neural Information Processing Systems (NIPS)*, 18: 1217-1224, 2005 [pdf](#)

2004

- Delbruck, T. and Liu, S-C. [A silicon visual system as a model animal](#), *Vision Research*, 44:(17) 2083-2089, 2004 [pdf](#)
- Delbruck, T. and Oberhof, D. **Self biased low power adaptive photoreceptor**, *2004 IEEE International Symposium on Circuits and Systems IV*-844-847, 2004
- Delbruck, T. and Oberhoff, D. **Self biasing low power adaptive photoreceptor**, *2004 IEEE International Symposium on Circuits and Systems (ISCAS 2004)* IV-844-847, 2004 [pdf](#)
- Delbruck, T. and van Schaik, A. **Bias current generators with wide dynamic range**, *2004 IEEE International Symposium on Circuits and Systems (ISCAS 2004)* I-337-340, 2004 [pdf](#)
- Lichtsteiner, P. and Kramer, J. and Delbruck, T. **Improved on/off temporally differentiating address-event imager**, *ICECS 2004. Proceedings of the 2004 11th IEEE International Conference on Electronics, Circuits and Systems* 211-214, 2004 [pdf](#)

2003

- Delbruck, T. and Eng, K. and Baebler, A. and Bernardet, U. and Blanchard, M. and Briska, A. and Costa, M. and Douglas, R. and Hepp, K. and Klein, D. and Manzolli, J. and Mintz, M. and Roth, F. and Rutishauser, U. and Wassermann, K. and Wittmann, A. and Whatley, A. M. and Wyss, R. and Verschure, P. F. M. J. **Ada: a playful interactive space**, *Human-Computer Interaction --- INTERACT'03 : IFIP TC13 International Conference on Human-Computer Interaction, 1st-5th September 2003, Zürich, Switzerland*. 989-992, 2003 [pdf](#)
- Eng, K. and Baebler, A. and Bernardet, U. and Blanchard, M. and Costa, M. and Delbruck, T. and Douglas, R. J. and Hepp, K. and Klein, D. and Manzolli, J. and Mintz, M. and Roth, F. and Rutishauser, U. and Wassermann, K. and Whatley, A. M. and Wittmann, A. and Wyss, R. and Verschure, P. F. M. J. **Ada - Intelligent Space: An artificial creature for the Swiss Expo.02**, *Proceedings of the 2003 IEEE International Conference on Robotics and Automation (ICRA 2003)*, 3: 41544159, 2003
- Eng, K. and Klein, D. and Baebler, A. and Bernardet, U. and Blanchard, M. and Costa, M. and Delbruck, T. and Douglas, R. J. and Hepp, K. and Manzolli, J. and Mintz, M. and Roth, F. and Rutishauser, U. and Wassermann, K. and Whatley, A. M. and Wittmann, A. and Wyss, R. and Verschure, P. F. M. J. **Design for a brain revisited: The neuromorphic design and functionality of the interactive space Ada**, *Reviews in the Neurosciences*, 14:(1-2) 145-180, 2003 [pdf](#)
- Zahnd, S and Lichtsteiner, P and Delbruck, T **Integrated vision sensor for detecting boundary crossings**, *International Symposium on Circuits and Systems (ISCAS)*, 11: 376, 2003

2002

- Eng, K. and Bähler, A. and Bernardet, U. and Blanchard, M. and Briska, A. and Conradt, J. and Costa, M. and Delbrück, T. and Douglas, R. J. and Hepp, K. and Klein, D. and Manzolli, J. and Mintz, M. and Netter, T. and Roth, F. and Rutishauser, U. and Wassermann, K. and Whatley, A. M. and Wittmann, A. and Wyss, R. and Verschure, P. F. M. J. **Ada: Constructing a Synthetic Organism**, *Proceedings of the 2002 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2002)*, EPFL, Lausanne, Switzerland, 2: 1808-1813, 2002 [pdf](#)
- Liu, S-C. and Kramer, J. and Indiveri, G. and Delbruck, T. and Douglas, R. **Orientation-selective aVLSI spiking neurons**, *Advances in Neural Information Processing Systems*, 14:, 2002 [pdf](#)
- Zahnd, S and Lichtsteiner, P and Delbrück, T **Integrated vision sensor that detects objects crossing its boundaries**, *ISCAS2003*, 2002 [pdf](#)
- Liu, S-C. and Kramer, J. and Indiveri, G. and Delbruck, T. and Douglas, R. **Analog VLSI: Circuits and Principles**, MIT Press, 2002

2001

- Delbruck, T and Liu, S-C. and Chicca, E and Ricci, GM and Bovet, S **A Retina/V1 simple cell chip for physiology experiment design or classroom**

demonstration, *IEEE CCD and AIS meeting, June 7-9, 2001, Lake Tahoe, California*, 2001 [pdf](#)

Eng, K. and Baebler, A. and Bernardet, U. and Blanchard, M. and Briska, A. and Costa, M. and Delbruck, T. and Douglas, R. and Hepp, K. and Klein, D. and Manzolli, J. and Mintz, M. and Netter, T. and Roth, F. and Wassermann, K. and Whatley, A. and Wittmann, A. and Verschure, P. **Ada - Buildings as Organisms**, *Game, Set and Match (Proceedings)*, Faculty of Architecture, TU Delft, 2001

Liu, S-C. and Kramer, J. and Indiveri, G. and Delbruck, T. and Burg, T. and Douglas, R. **Orientation-selective aVLSI spiking neurons**, *Neural Networks*, 14:(6/7) 629-643, 2001

2000

Delbruck, T. **Silicon retina for autofocus**, *ISCAS 2000, Geneva, Switzerland, May 27-31, 2000* IV-393-396, 2000 [pdf](#)

1997

Delbrück, T. and Mascarenhas, M. and Chi, M. and Bergemont, A. and Mead, C. **Pulsed bipolar CMOS imager**, *IEEE CCD and AIS Meeting, Brugge, Belgium, June 5-7, 1997*, 1997

1994

Delbrück, T. and Mead, C.A. **Analog VLSI adaptive logarithmic wide-dynamic-range photoreceptor**, *Proceedings of the International Circuits and Systems Meeting*, 1994

1993

Delbrück, T. **Silicon Retina with Correlation-Based, Velocity-Tuned Pixels**, *IEEE Transactions on Neural Networks*, 4: 529-541, 1993

Sarpeshkar, R. and Delbrück, T. and Mead, C. **White noise in MOS transistors and resistors**, *IEEE Circuits and Devices* 23-29, 1993

1991

Benson, R.G. and Delbrück, T. **Direction Selective Silicon Retina that uses Null Inhibition**, *Advances in Neural Information Processing Systems* 4 756-763, 1991

Delbrück, T. **"Bump" circuits for computing similarity and dissimilarity of analog voltages**, *Proc. IJCNN* I-475-479, 1991

Delbrück, T. and Mead, C.A. **Time-derivative adaptive silicon photoreceptor array**, *Infrared Sensors: Detectors, Electronics, and Signal Processing*, 1541: 92-99, 1991

Mead, C.A. and Delbrück, T. **Scanners for Visualizing Activity of Analog VLSI Circuitry**, *Analog Integrated Circuits and Signal Processing*, 1: 93-106, 1991

1989

Mahowald, M. and Delbrück, T. **Cooperative stereo matching using static and dynamic image features**, *Analog VLSI Implementation of Neural Systems* 213-238, 1989