

## Eugenio Culurciello, PhD

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### HIGHLIGHTS

- Recipient: Presidential Early Career Award for Scientists and Engineers (PECASE)
- Distinguished Lecturer: IEEE, Circuit and System Society
- Keynote address at the at System-On-A-Chip conference 2017 and 2011
- Our deep learning research is featured on on the [MIT Technology Review](#), on [BBC](#), [FierceWireless](#) (Jan. 2014), and on [Business Insider](#), [Journal and Courier](#), on [18WFLI TV](#), [Phys org](#), [the Engineer](#), [Imperial Valley News](#), [Purdue News](#), [Phone Arena](#), [Hoosier AG Today](#), [CN beta](#), (April 2014)
- Ultra-disciplinary: very wide research interests and publications in electrical engineering, neuroscience, psychology, physiology, computer science, machine learning, computer science, statistics, applied mathematics, to name a few.
- Established and managing a laboratory facility for the design and testing of microchips, boards and complete hardware / software systems, recruited and managing a group of 10+ people: 3 graduate students, 3 post-doctorate associates, 2 full-time staff programmers, 2 other students
- Managing more than 9 research projects in different multi-disciplinary fields
- Funding awarded: >14 M\$ in years 2004-today
- Designed 5 generations of deep learning hardware: NeuFlow, nn-X, overX, SnowFlake, Inference Engine (2006 -2018)
- Designed > 32 integrated circuits with published results (2001-2013)
- Expert in VLSI analog and mixed-signal microchip design, digital and mixed systems on a chip, biomedical instrumentation, algorithms on chip, product development
- Transition to commercial products: 2 integrated circuits in production with patents, 2 patents on machine learning processors
- Founder: FWDNXT Inc. <http://fwdnxt.com/> Raised > 2.5 M\$ in 1.5 years
- Head of machine intelligence Movidius (an Intel company) Machine Intelligence, June 2016 - January 2017
- Founder of TeraDeep Inc. Won several award: GigaOm Structure Data Startup of the year 2014, EE Times Startups to Watch.

### RESEARCH INTERESTS

- Deep Learning, Neural Networks, Machine Learning
- Artificial intelligence for devices, computers, cloud computers, robots
- Learning in unstructured environments, unsupervised and reinforcement learning
- Synthetic vision systems and algorithms for super-human vision in hardware
- Natural language processing, machine language translation, text understanding

## EDUCATION

- **PhD, The Johns Hopkins University**, Baltimore, MD  
Electrical and Computer Engineering, September 2004  
Thesis: "Silicon on Sapphire CMOS Circuits and Devices for Sensor Interfaces"
- **M.S., The Johns Hopkins University**, Baltimore MD  
Electrical and Computer Engineering, May 1999
- **M.S., University of Trieste**, Italy  
Electrical Engineering, July 18 1997

## PROFESSIONAL EXPERIENCE

- **FWDNXT Inc.**, founder, CTO and president, January 2017 - today
- **Teradeep Inc**, founder, CEO, CTO: December 2013 - April 2016
- Purdue University, West Lafayette, IN  
**Associate Professor** with tenure (August 2011-present)
- Yale University, New Haven, CT  
**Associate Professor** (July 2009 – July 2011)  
**Assistant Professor** (July 2004 – July 2009)  
**Director** of the 'e-Lab' VLSI design laboratory at Yale University
- The Johns Hopkins University, Baltimore, MD (January 1998 – July 2004)  
**Research Assistant**, Sensory Communication & Microsystems Laboratory, Electrical and Computer Engineering, Academic advisor: Andreas G. Andreou
- Professionals College ENAIP, Udine, Italy (November 1997 – January 1998)  
**Instructor** – Short Courses for practical training
- Johns Hopkins University, Baltimore, MD (January 1997 – June 1997)  
University of Trieste, Trieste, Italy  
**Research Assistant** in Evaluation of variable resolution displays with visual search  
Academic advisors: Ernst Niebur, Accardo Agostino

## PUBLICATION LIST

see website: <http://e-lab.github.io/html/publications.html>

## CAPABILITIES

- Machine Learning: neural networks and deep learning, supervised and unsupervised learning, clustering learning,
- Computer vision: object recognition, categorization, tracking, learning
- Computer architecture: custom processors for machine learning
- Programming: Lua, Python C, C++, Java, Matlab, Mathematics, Xilinx FPGA tools
- Machine learning frameworks: Torch7, PyTorch, Tensorflow and more
- Chip design: Cadence, Synopsys, VHDL, Verilog, Spice, Tanner L-Edit
- Circuit simulation: Spice, Spectre, Hspice, EKV modeling
- Computer administration: Linux, Windows, Mac OS
- Document editing: LaTeX, Word, Illustrator, Photoshop, 3D CAD (Sketchup)

## TEACHING EXPERIENCE

1. BME595 Deep Learning, 500-level, Fall 2015-2018
2. BME495 Deep Learning for medical imaging, 400-level, Spring 2016-2019
3. BME 528/ECE 528 – Measurement & Stimulation of the Nervous System, Purdue University Spring 2015
4. BME 495 Computational Neuroscience and Learning, Purdue University Spring 2014
5. BME595, Artificial and Robotic Vision, Purdue University Spring 2013
6. BME 301, Bioelectricity, Purdue University Fall 2012, 2013
7. BME 595, Neuromorphic systems and synthetic vision, Purdue University Spring 2012
8. BME ECE 695, Analog Integrated Circuits and vision systems, Purdue Fall 2011
9. EENG201, Introduction to Computer Engineering, Yale 2009
10. ENAS993, Silicon on Sapphire devices, circuits and systems, Yale 2008,09
11. EENG 427 ENAS 627, Advanced Integrated Circuits, Yale 2005,07
12. EENG 348, Digital Systems, Yale University 2005,06,07,09
13. EENG 428 ENAS 628, Sensors and Biosensors, Yale University 2006
14. 520.495, Microfabrication Lab, Johns Hopkins University 1998
15. 520.498, Senior Design Project Laboratory, Johns Hopkins University 2003
16. Computer architecture short course, ENAIP, Italy, 1997

## PROFESSIONAL ACTIVITIES

1. Embedded Vision Alliance Research Advisory Board, [www.embedded-vision.com](http://www.embedded-vision.com), November 2015 - present
2. Conference program committee
  - Organizing committee ISCAS 2017: sponsorship chair. Involved in ICLR 2013, first conference with open-review system
  - IEEE BioCAS: tutorials chair 2007, 2008, demonstration chair: 2011
  - IEEE ISCAS Special Sessions Organizer, organized special sessions in 2008, 2009, 2010.
  - IEEE ISCAS 2011 Demonstration Session Chair
3. IEEE Circuits and Systems Society, Committee member:
  - Sensory Systems Technical Committee
  - Biomedical Circuits and Systems Technical Committee
  - Neural Networks Technical Committee
4. Neuromorphic Engineering workshop at Telluride, CO, 2001, 2004, 2006, 2009, 2013. Led a project on retinal implant prototype, image sensor network, synthetic vision systems
5. SOS Peregrine USC COOP workshop, University of Southern California, 2001
6. IEEE Senior Member, Member since 1993
7. Associate Editor for IEEE Transaction on Biomedical Circuit and Systems (BioCAS)
8. Associate Editor for PloS ONE Synthetic Vision Systems.
9. Reviewer for: IEEE Transaction on Electron Devices, IEEE Solid State Circuits Journal, IEEE Transaction on Circuits and Systems I and II, IEEE Transactions on Biomedical Circuits and Systems, IEEE Sensors, IEEE Transactions on VLSI Systems, Elsevier Optics Communications, PloS ONE, International Symposium On Circuits and systems (ISCAS), IEEE Transactions on Neural Networks, Kluwer Analog Integrated Circuits and

Signal Processing, IEEE region 4 Electro-information Technology Conference, IET Electronics Letters

10. Reviewer for National Science Foundation: Dr. Khosla Jan. 2005, Dr. Rao Jan. 2006, Dr. Midkiff Dec. 2006. Invited to NSF biomedical panel Fall 2012, Spring 2013.
11. Reviewer for the Natural Sciences and Engineering Research Council of Canada (NSERC) in 2008, 2009.
12. Reviewer for the Qatar National Research Fund (QNRF) and the National Priorities Research Program (NPRP) in 2009 - 2013.
13. Reviewer for the proposals of the Research Grants Council (RGC) of Hong Kong, in 2009.

## HONORS

1. Keynote address, SoC conference 2017, <http://www.socconference.com/keynotes.htm>
2. Invited Talk EVW at CVPR <http://cvisioncentral.com/promotion/evw2014> June 28th 2014, Host: Sek Chai, SRI
3. Invited to the Microsoft Research Faculty Summit 2013, July 2013, Redmond WA.
4. SoC Conference, keynote talk, Nov 2nd 2011, title: Vision for robots, vehicles and consumer electronics: how close are we?
5. **Distinguished Lecturer of the IEEE**, Circuit and System Society 2011-2012
6. **Presidential Early Career Award for Scientists and Engineers (PECASE) 2009**, nominated by ONR program manager Thomas McKenna and Matthew Swiergosz. The Presidential Early Career Award for Scientists and Engineers (PECASE) is the highest honor bestowed by the United States government on outstanding scientists and engineers in the early stages of their independent research careers.
7. Our work on synthetic vision system has been featured on large number of media outlets, including MSNBC, the New York Times, the Economist (Fall 2010)
8. Yale Associate Faculty Fellowship, calendar year 2010
9. Best Paper Award, IEEE Circuit and System Society, for the IEEE ISCAS 2008 paper "Fall detection using an address-event temporal contrast vision sensor"
10. Invited to the National Academies, NAFKI Complex Systems Conference, with full travel grant, November 13-15<sup>th</sup> 2008
11. Yale Junior Faculty Fellowship, calendar year 2008
12. Best poster award: "Integrated Patch-Clamp Amplifier", Farah Laiwalla, Zhengming Fu, Kate Klemic, Fred Sigworth, Eugenio Culurciello, 14<sup>th</sup> Annual CMOC Symposium, Yale University, March 17<sup>th</sup> 2005

## UNIVERSITY SERVICES

1. Data science initiative, Purdue College of Engineering panels, Spring 2018
2. Purdue University robotics group coordinator 2012 – 2013
3. Purdue University open access publication forum 2013 - 2014
4. Undergraduate Curriculum committee, Biomedical Engineering, Purdue, AY 2012-15
5. Graduate Curriculum committee, Biomedical Engineering, Purdue, AY 2011-12
6. University Council Committee on the School of Engineering & Applied Science 2010
7. School of Engineering, Vic Tyler Distinguished Lectureship committee 2009
8. Electrical Engineering curriculum steering committee, 2004 - 2007
9. Electrical Engineering web-page coordinator, 2006, 2008

10. Space committee for Computer Engineering Faculty, 2006 - 2007
11. Pierson College freshmen advisor, 2005 – 2008

## **COMMUNITY WORK**

Eugenio is an active philanthropist in community service via interest group memberships and capital donations for the improvement of our social nets and infrastructures. Eugenio regularly serves as public motivational speaker for young scientists, engineers, and entrepreneur. He is also interested in advancing and helping young kids and students in coding and programming, offering 1-to-1 and group tutoring to talented and motivated individuals.

Other professional community engagements are listed here:

1. Dr. Culurciello participated in the Connecticut Pre-Engineering Program, which provides outreach to under-represented students. This acclaimed program includes almost all of the schools in the New Haven Public School system and was the first national program to win a Presidential Award in Science, Mathematics, and Engineering Mentoring. Dr. Culurciello is involved in the Mentor Program, assisting as mentors for students in grades K- 12, and working with elementary school teachers and their classes.
2. Community seminar: “What Makes Your Gameboy Work: How Electronics are Evolving”, at Yale University Science Saturdays: a special lecture series designed for families that brings the excitement of research and the passion of scientists to school-age children in New Haven, October 10<sup>th</sup> 2009.

## **COLLABORATIONS IN INDUSTRY AND ACADEMIA**

E. Culurciello is committed to working on applied research on machine learning with commercial companies. In the recent years he interacted with: Micron, AMD, Amazon, Google, Facebook, Qualcomm, Samsung, Apple, Intel, Movidius, Nervana Sys, Continental, Valeo, John Deere, Synopsys, Cadence, to name a few.

E. Culurciello co-founded FWDNXT Inc. in 2017, on the commercialization of deep neural network hardware and software solutions. <http://fwdnxt.com/>. Started a collaboration with Micron Inc. on the development of neural network accelerators, 12 employee on payroll, strategic partnership with Micron Inc., 10+ customers, sales of FPGA and SoC IPs.

E. Culurciello co-founded company Teradeep Inc. <http://www.teradeep.com/>, in the area of artificial vision systems, security, home-automation, internet-of-things, robotics, cloud services. Hired 10 people and won a GigaOm Structure Data award as one of most-promising startups to launch in 2014. TeraDeep was invited to the Re.Work Deep Learning Summit. TeraDeep is one of 60 Hot Startups to Watch! TeraDeep is on the list of "EE Times Silicon 60: Hot Startups to Watch.

Dr. Culurciello maintains relationship with multiple DoD departments: ONR, DOE, Navy, Army, Air Force, DARPA, PNNL, etc. Also with contractors: Northrup Grumman, Mitre, InQTel, Irvine Sensors, Trident, to name a few.

In his early career, Dr. Culurciello demonstrated leadership in the field of electrical engineering by establishing several collaborations nationally and internationally in highly interdisciplinary areas bridging electronics, neuroscience and biology. During his first two years at Yale, he collaborated with Fred Sigworth on patch-clamp circuit developments, and with Vincent Pieribone in optical brain-machine interfaces. Dr. Culurciello and Dr. Botond Roska (Basel, Switzerland), and planned the development of novel instrumentation for the study of the retina. Dr. Culurciello also helped to establish a bridge between the two ONR areas with this collaboration. He has also connected with prof. Gunhee Han (S. Korea) and prof. Jun Ohta, (Nara NAIST, Japan), who are both extremely interested in the work on optical neural interfaces and low-noise image sensors.

He has started a collaboration with Ernst Niebur (Johns Hopkins University) for the development of synthetic attentive vision system. He also works in close contact with Shih-Chii Liu and Tobi Delbruck (Zurich ETH INI, Switzerland) on vision system of interest to ONR. He has also participated to the Neuromorphic Engineering workshop at Telluride, CO in July 2009 (and also in 2001, 2004, 2006). During this meeting, he led a project on retinal implant prototype, image sensor network, synthetic vision systems.

He currently works heavily with machine-learning leaders as Yann LeCun (NYU), Andrew Ng (Stanford) Jeffrey Hinton (Google, University of Toronto)

Dr. Culurciello has also been involved in many projects with industry partners.

He has collaborated for many years with an Australian micro-chip fabrication company: Silanna. Silanna is the world leader in silicon-on-sapphire technology, a field where Dr. Culurciello is the largest world expert and has written a book on. Silanna and Dr. Culurciello developed several integrated circuits in collaboration and are currently marketing an isolation-amplifier that was developed during this fruitful collaboration. Dr. Culurciello plans to further this collaboration during the Future Fellowship in Australia.

Dr. Culurciello collaborated with Warner Instruments, CT, a leading company in electrophysiology recording systems, biomedical instrumentation, and planar lipid bilayer technology. They co-developed instruments for the development of high-throughput patch-clamp amplifiers and obtained two large commercialization grant from the US National Institute of Health for a total of more than 800,000\$.

In the optical neural recording project, Dr. Culurciello collaborated with Red-Shirt Imaging to develop low-noise sensors and manufacture penny-sized sensors for recording neural activity in vivo. These sensors are currently being manufactured in large volumes for commercial production.

Dr. Culurciello is also collaborated with Google on the development of embedded vision system for use in servers. This device is used to parse videos and convert them to text.

## **INVITED TALKS AND SEMINARS**

1. October 1st 2018 Purdue MCCA colloquium speaker, host: Anne Sereno
2. May 1-3 2018, Invited talk at the Embedded Vision Summit, Embedded Vision Alliance
3. Feb 21st 2018: seminar on hardware for deep learning, Oregon Health Science University, discussion on CryoEM
4. Feb 22nd 2018: seminar on hardware for deep learning, Pacific Northwest National Lab, discussion on Proton decay
5. Jan 11th 2018: NAVAIR, seminar on hardware for deep learning, Point Mugu, discussion on AI for defense



6. September 7th 2017, Software Stir at Anvil, Purdue
7. Two invited talks at the Embedded Vision Summit, May 1-3 2017, Embedded Vision Alliance
8. Artificial Intelligence, past, present, future, April 14th 2016, Computational Science and Engineering, Applied Mathematics, Purdue
9. Artificial Intelligence, past, present, future, January 30th 2016, Purdue Mathematical and Computational Cognitive Science, host: Gregory Francis
10. 5th June 2016 special session in Design Automation Conference (June 5-9, 2016) on the topic of Low-Power Image Recognition (invited)
11. Deep Learning in practice, April 7th 2016, Futurewei Technologies, Inc, annual Strategy and Technology Workshop (STW) (invited)
12. Deep Learning in practice, Purdue University CS Machine Learning and Applications Seminar, September 30th 2015
13. Boston University NeuroHAM - <http://neuroham.bu.edu>, June 10th 2015 (invited)
14. JHU APL, November 5th 2014, Host: Roos Matthew, Title: Enabling gadgets to perceive the world
15. Purdue University, Dawn or Doom Summit, Thursday September 18, 2014, Title: Visual Intelligence and the Terminator
16. University of Udine, July 10th 2014, Host: Andrea Fusiello [andrea.fusiello@uniud.it](mailto:andrea.fusiello@uniud.it), Title: Modeling the human visual system in hardware
17. Invited Talk EVW at CVPR <http://cvisioncentral.com/promotion/evw2014/> June 28th 2014, Host: Sek Chai, SRI
18. University of California at Riverside, Feb 21st 2014, host: Najjar Walid [najjar@cs.ucr.edu](mailto:najjar@cs.ucr.edu), Title: Modeling the human visual system in hardware
19. Qualcomm, San Diego CA, February 7th 2014, host: Anthony Lewis, Title: Enabling computers to perceive the world
20. Swinburne University Melbourne, May 28th 2013, Title: Optogenetic tools, models and hardware to reverse engineer the human visual system, host: David Liley, Swinburne
21. Monash University, Melbourne, May 25th 2013, Title: Optogenetic tools, models and hardware to reverse engineer the human visual system, host: Jamie Evans
22. University of Melbourne, May 22nd 2013, Title: Modeling the human visual system in hardware, host: Steven Prawer
23. UIC talk/seminar, April 5th 2013, Title: Modeling the human visual system in hardware
24. Qualcomm, San Diego CA, April 2nd 2013, Title: Modeling the human visual system in hardware, host: Anthony Lewis
25. Google, Mountain View CA, April 1st 2013 Title: Modeling the human visual system in hardware, host: Rahul Sukthankar [sukthankar@google.com](mailto:sukthankar@google.com)
26. Purdue Biomedical Sciences Seminar, March 18th Title: "Synthetic human vision: eyes for machines", host: James F. Leary
27. Google NYC, January 17th 2013, Title: Image and video understanding: speeding-up computation through hardware acceleration host: Jonathan Ross [hash@google.com](mailto:hash@google.com)
28. Purdue University, December 14th 2012, Mathematical/Computational Cognitive Science area in the department of Psychological Sciences at Purdue, host: Sebastien Helie
29. Johns Hopkins University Symposium on Visual attention, Title: Finding and learning proto-objects in a synthetic vision system, September 27th 2012. Host: Ernst Niebur
30. Purdue April 2012 Computer Vision/Graphic seminar, Modeling the human visual system in hardware, host: Daniel Aliaga [aliaga@purdue.edu](mailto:aliaga@purdue.edu)
31. University of Southern California, March 30th talk, Bio-inspired hardware vision systems for robotics, host: Hossein Hashemi <[hosseinh@usc.edu](mailto:hosseinh@usc.edu)>, Zahra Safarian

32. Arizona State University, March 28-29, 2012, Title: Bio-inspired hardware vision systems for robotics, host: Bertan Bakkaloglu <Bertan.Bakkaloglu@asu.edu>
33. Drexel University, March 20, 2012, Modeling the human visual system in hardware, Host: Mark Hempstead <mhempstead@coe.drexel.edu>
34. Purdue Center Implantable Device symposium feb 24th 2012, "Biomedical instrumentation for optogenetic cortical recordings and high-throughput patch-clamp", host: Pedro Irazoqui
35. Purdue BME seminar Feb 15th 2012: "Scaling up neuroscience: optogenetic neural recording", host: Nam Kong
36. Machine Learning Purdue seminar, Feb 14th 2012: "Machine learning for synthetic vision systems", host: S V N Vishwanathan
37. SoC Conference, keynote talk, Nov 2nd 2011, title: Vision for robots, vehicles and consumer electronics: how close are we?
38. Purdue AVL laboratories seminar, "The Eye of the Terminator: Modeling the human visual system in hardware", host: Avi Kak
39. Samsung, Korea, April 27th 2011, "An hardware accelerated vision system for general-purpose vision algorithms", host: Wunki Jung
40. Yonsei, Korea, April 22nd 2011, "An accelerated vision processor for general-purpose vision algorithms" host: prof. Gunhee Han
41. University of Illinois at Chicago, April 8th 2011 "The Eye of the Terminator: Modeling the human visual system in hardware", host: Dr. Mitra Dutta
42. NYU/Poly February 15th, 16th 2011 Modeling the human visual system in hardware"
43. host: Farshad Khorrami
44. Yale Institute for Nanoscience and Quantum Engineering, January 28th 2011, Synthetic eyes, vision, and tools to reverse engineer the brain from the e-Lab team @ Yale, host Paul Fleury
45. IEEE Yale chapter: "How the magic 5 from Yale vanquished Intel and nVidia: The story of NeuFlow: the first Eye of the Terminator", Tuesday, September 28th 2010, host: Hur Koser
46. Purdue University, August 19<sup>th</sup> 2010, "Biomedical instrumentation for optical brain imaging and high-throughput patch-clamp", host Dr. Wodicka
47. Swartz Seminar, Yale Neuroscience May 14<sup>th</sup> 2010, "The eye of the Terminator: modeling the visual system in hardware", host: Xiao-Jing Wang
48. New York University NYU – May 12<sup>th</sup> 2010, "The eye of the Terminator: modeling the visual system in hardware", host: Yann LeCun
49. Northeastern University March 30<sup>th</sup> 2010, "Novel biomedical instrumentation for optical brain imaging and high-throughput patch-clamp", host. Dana Brooks"
50. University of New Haven, March 3<sup>rd</sup> 2010 "Integrated biomedical instrumentation: miniature patch-clamp and brain imaging devices", host: Prof. Ismail Orabi.
51. University of Washington at St Louis, Feb 19<sup>th</sup> 2010, "Biomedical instruments for patch-clamp recordings and voltage-sensitive dye imaging", host: Viktor Gruev.
52. Yale Science Saturdays, October 10<sup>th</sup> 2009, "What Makes Your Gameboy Work: How Electronics are Evolving", host: Ainissa Ramirez
53. Yale - Aging Research Seminar: "Synthetic vision system for assisted living" 9/2/2009, host: Lisa Barry.
54. Telluride Neuromorphic Engineering Workshop, July 3<sup>rd</sup> 2009: "Optical Neural Recording: in-vivo fast functional brain imaging with fluorescent dyes".
55. Yale Biomedical Engineering Seminar, April 16<sup>th</sup> 2009: "Novel instrumentation for optical brain imaging and high-throughput patch-clamp", host: Erin Lavik.



56. DARPA NeoVision 2, "Efficient feedforward categorization of objects and human postures with address-event image sensors", April 8<sup>th</sup> 2009.
57. Samsung Research, Korea, "Event-based image sensors for synthetic vision", December 5<sup>th</sup> 2008, host: Seog-Heon Ham.
58. Yonsei University, Seoul S. Korea, December 5<sup>th</sup> 2008, host: prof. Gunhee Han.
59. KAIST (Korean Advanced Institute of Science and Technology), Daejeon S. Korea, December 9<sup>th</sup> 2008, host: prof. Hoi-Jun Yoo.
60. National Academies, NAFKI Complex Systems Conference, invited with full travel grant, November 13-15<sup>th</sup> 2008.
61. Columbia University, "Silicon-on-sapphire: mixed-signal circuits and micro-systems design and opportunities", October 31<sup>st</sup> 2008. Host: prof. Yannis Tsividis.
62. IEEE International SOI conference, "Mixed Signal Microsystems in Emerging SOI ", invited talk, October 6-9 2008. Host: Mario Pelella, AMD.
63. DARPA DSRC Electronic Stem Cell, "Efficient feedforward categorization of objects and human postures with address-event image sensors", June 5<sup>th</sup> 2008, host: Paul Hasler.
64. University of Washington, "Integrated potentiostat for patch-clamp instrumentation", invited to weekly Electrical Engineering seminar series, Friday May 23<sup>rd</sup> 2008, Host: prof. Mani Soma.
65. Texas A&M University, "A Silicon on Sapphire Instrument for ion channels patch-clamp research", Thursday, February 28, 2008, invited seminar for the Department of Electrical and Computer Engineering. Host: prof. Edgar Sanchez-Sinencio.
66. Cornell University, "An integrated patch-clamp potentiostat", March 14<sup>th</sup> 2008, invited to the Department of Electrical and Computer Engineering, seminar Analog Devices VLSI Series. Host: prof. Alyssa Apsel.
67. University of Milan, Politecnico of Milan, Italy, "Current-mode biosensors for cell physiology", December 17<sup>th</sup> 2007, invited to a Seminar lecture. Host: prof. Marco Sampietro.
68. University of Trento, Italy, "Address-Event image sensors for sensor networks", July 16<sup>th</sup> 2007, invited to a Seminar lecture. Host: prof. Massimo Gottardi.
69. Tufts University, "An integrated patch-clamp amplifier in silicon on sapphire CMOS", April 10<sup>th</sup> 2007, invited to weekly Seminar lecture. Host: prof. Sameer Sonkusale.
70. Yale university, "Address-event image sensors: a future view of the world", invited to the Applied Mathematics Seminar, Tues. Sept. 12<sup>th</sup> 2006. Host: prof. Ronald Coifman.
71. Princeton University, "An Integrated Patch-Clamp Amplifier and the Battle of Bulk-Silicon vs. Silicon on Insulator CMOS", Invited colloquium speaker at the weekly colloquium series, March 13<sup>th</sup> 2006. Host: prof. Sigurd Wagner.
72. University of Arizona, "Address-event image sensors and networks", Invited colloquium speaker at the weekly colloquium series, March 3<sup>rd</sup> 2006. Host: prof. Andreas Spanias.
73. University of Connecticut, "Silicon on Sapphire Systems and Devices", Invited colloquium speaker at the ITE weekly colloquium series, April 22<sup>nd</sup> 2005. Host: prof. Faquir Jain.
74. Yale University, "Silicon on Sapphire Technology: Systems and Devices", invited to the Center for Systems Science Seminar Series. April 1<sup>st</sup> 2005, Host: prof Kumpati Narendra.
75. University of Udine, Italy, invited lecture: "Silicon on Sapphire Technology Systems and Devices, December 22<sup>nd</sup> 2004. Host: prof. Luca Selmi.

## GRANTS AND AWARDS

Current awards:

1. Purdue seed funding: "Autonomous exploration and localization of targets for aerial drones" to the iGSDI's RFP on "AI+" with David Cappelleri, ME Purdue, April 2018
2. FWDNXT Inc. (Purdue incubator) raised 1.5 M\$ for 1st year, August 2017
3. SRC: *C-BRIC: Center for Brain-inspired Computing Enabling Autonomous Intelligence*, submitted in response to the Joint University Microelectronics Program (JUMP) Research Announcement, Period: 9/2017 – 9/2022, Funding: 22 M\$ total, 1,2 M\$ to E. Culurciello's group,
4. ONR, Software and hardware for deep learning of video sequences, Office of Naval Research N00014-15-1-2791, Performance Period: 11/01/2015-10/31/2019, funding: \$800,000
5. ONR, Efficient hardware-acceleration for sparse-matrix computation, Office of Naval Research N00014-17-1-2225, funding: \$170,350, Performance Period: 01/01/2017 to 02/28/2019

#### **Past awards:**

1. Teradeep Inc. (Purdue incubator) raised 1.5 M\$ from Xilinx Inc. December 2015
2. NIH (PI Vincent Pieribone, Co-PI: E. Culurciello), "High-Speed, wide field fluorescent imaging of cortex in freely moving animals", Total Purdue Amount: \$1,168,196, Total period: August 2012- August 2016.
3. ONR PECASE (PI: Eugenio Culurciello) Title: A Trillion Operations-Per-Second Vision System for DoD Applications, Total Award Amount: \$1,000,000, Total Period: 02/01/11 – 01/31/15
4. ONR MURI (PI: Ernst Niebur, lead Johns Hopkins Univ.) Title: Figure-Ground Processing, Saliency and Guided Attention for Analysis of Large Natural Scenes, Total Award Amount: \$4,500,000, Amount award: \$463,407, Total Period: 06/01/09 – 05/31/14
5. ONR, Development of a Scalable Hyperbaric (0-500 psig) Multichannel Instrumentation (Plana Patch Clamp) for High-throughput, Single-cell Analysis of the Pharmacological Modulation of Macroscopic Ionic, Project Period: 09/12/11-09/11/15, Total Sponsor Award: \$480,000,
6. Google Research Awards program, "Hardware-accelerated scene-understanding vision system", Total Award Amount: 57,500, Period: Sept 2012-Aug 2013.
7. NSF IDBR: High-Throughput Instrumentation for Lipid Bilayers and Patch-clamp, , Sponsor Award No.: 1154498-DBI, Total Award Amount: \$660,000, Total Period: 08/15/2011 to 06/30/2014,
8. NIH (PI Vincent Pieribone, Co-PI: E. Culurciello), Title: High-Speed, wide field fluorescent imaging of cortex in freely moving animals, Total Award Amount: \$140,000, Total Period: 9/1/2011 – 8/31/2012
9. NSF ECS-0622133 (PI: E. Culurciello), Title: A Lightweight Event-Based Synthetic Vision System for Assisted-Living and Machine Vision Applications, Total Award Amount: \$330,000, Total Period: 07/01/09 - 06/30/12
10. DARPA NeoVision 2, HRL Lab, LLC (Co-PI: E. Culurciello), Award Amount: \$299,493, Total Period: 10/01/09 – 12/31/13
11. NIH (PI Vincent Pieribone, Co-PI: E. Culurciello), Title: High-Speed, Wide Field Fluorescent Imaging of Cortex in Freely Moving Animals, Total Award Amount: \$1,131,473, Total Period: 07/01/09 – 06/30/11
12. NIH STTR Phase II (PI: F Sigworth, Co-PI: E. Culurciello), Title: Patch Clamp Amplifier on a Chip, Total Award Amount: \$449,999, Total Period: 04/01/09 – 03/31/11
13. ONR BAA 2008 (PI: E. Culurciello), Award No.: N000140810065, Title: Patch Clamp Amplifier on a Chip, Incremental funding: \$44,500, Total Period: 10/1508-10/14/11

14. ONR BAA 2008 (PI: E. Culurciello), Award No.: N000140811014, Title: A High-Speed, In-vivo Optical Neural Recording System, Amount of Award: \$381,697, Total Period: 10/15/08-10/14/11
15. ONR BAA 2007 (PI: E. Culurciello), Title: Integrated Microscale Biosensor for Cell Membrane and Patch-Clamp, Total Award Amount: \$439,471, Total Period: 10/15/07-10/14/10
16. NSF (PI: E. Culurciello, Co-PI: F. Sigworth), Title: IDBR: High-Performance Integrated Patch Clamp Amplifiers, Total Award Amount: \$547,974, Total Period: 07/01/07 – 06/30/10
17. NSF ECS-0622133 (PI: E. Culurciello, Co-PI: Savvides), Title: A Lightweight Event-Driven Network of Biomimetic Image Sensors, Total Award Amount: \$270,000, Total Period: 09/01/06 – 08/31/09
18. NIH STTR 1R41NS062408-01A1, "Patch Clamp Amplifiers on a Chip", (PI: Fred Sigworth, Co-PI: E. Culurciello), Total Award Amount: \$134,245, Total Period: 06/01/06 – 05/30/07
19. ARO STIR 53393-LS-II (PI: Vincent Pieribone, Co-PI: E. Culurciello), Title: Development of an Implantable Optical Neuroprosthetic: System Integration and Testing, Total Award Amount: \$50,000, Total Period: 09/01/07 – 05/31/08
20. ARO STIR 193 (PI: Vincent Pieribone, Co-PI: E. Culurciello), Title: Development of an Implantable Optical Sensor for Use in Neural Prosthetics, Total Award Amount: \$50,000, Total Period: 07/20/06 – 04/19/07
21. Peregrine Semiconductors (PI: E. Culurciello), \$10,000 grant for research on energy harvesting circuits, 2007

## **STUDENTS AND STAFF**

### **Post-doctorate and Research associates:**

1. Dr Evan JoonHyuk Park, Jan. 2013 – optical neural recording, – 1<sup>st</sup> job: startup embedded sport equipment
2. Dr. Phi-Hung Pham, Jan 2012 – neuromorphic vision microchips, – 1<sup>st</sup> job: LG Electronics, USA
3. Dr. Shoushun Chen post-doctorate associate, PhD Hong Kong University of Technology, Jan. 2008-Jun. 2009, – 1<sup>st</sup> job: assistant professor at Nanyang Technical University (NTU) Singapore.
4. Dr. Dongsoo Kim, PhD Yonsei University 2008, S. Korea, post-doctorate associate since Jan. 2008 -June 2010, 1<sup>st</sup> job: Aptina Inc.
5. Dr. Selcuk Talay, PhD Bogazici University, 2007, Turkey, post-doctorate associate since Aug. 2009
6. Dr. Andrew Kunil Choe, PhD Yonsei University 2007, S. Korea, post-doctorate associate from Nov. 2009 – September 2010, – 1<sup>st</sup> job: LG imaging sensors, Korea

### **Staff:**

1. Berin Martini, Software developer, full-time since, June 2008 – December 2015
2. Polina Askelrod, Software developer, full-time Sep. 2008 – June 2011
3. Farah Laiwalla, 2004-2005, moved to graduate studies at Brown University.
4. Jordan Bates, Software developer for neural networks, Fall 2011 – Spring 2013

### **Former PhD students:**

1. Alfredo Canziani, August 2017, thesis: "CORTEXNET: A ROBUST PREDICTIVE DEEP NEURAL NETWORK TRAINED ON VIDEOS", 1<sup>st</sup> job: NYU post-doctorate associate with Yann LeCun
2. Vinay Gokhale, May 2017, thesis: "SNOWFLAKE: A MODEL AGNOSTIC ACCELERATOR FOR DEEP CONVOLUTIONAL NEURAL NETWORKS", 1<sup>st</sup> job: Google TPU team
3. Aysegul Dundar, May 2016, thesis: "LEARNING FROM MINIMALLY LABELED DATA WITH ACCELERATED CONVOLUTIONAL NEURAL NETWORKS", 1<sup>st</sup> job: NVIDIA
4. Jonhoon Jin, May 2016, thesis: "FAST AND ROBUST CONVOLUTIONAL NEURAL NETWORKS OPTIMIZED FOR EMBEDDED PLATFORMS", 1<sup>st</sup> job: Lighthouse AI, <https://www.light.house/>
5. Giovanni Barbera, October 2015, thesis: "DESIGN OF AN EMBEDDED FLUORESCENCE IMAGING SYSTEM FOR IMPLANTABLE OPTICAL NEURAL RECORDING", 1<sup>st</sup> job: NIH/NIDA with Da-Ting Lin.
6. Brian Goldstein, May 2013, thesis: "Integrated-Circuit Low-Current Measurement Systems for Biomedical Sensing", 1<sup>st</sup> job: Ion Torrent Inc.
7. Evan JoonHyuk Park, May 2012, thesis: "Mobile Imaging Systems for Behaving Animals", 1<sup>st</sup> job: post-doctorate associate, Pierce Institute, Yale University.
8. Wei Tang, May 2012, "Asynchronous Sensor and Wireless Communication Circuits and Systems", 1<sup>st</sup> job assistant professor at the University of New Mexico
9. Pujitha Weerakoon, March 2009, thesis: "An Integrated Patch-Clamp Amplifier for Automated, High-Throughput, Whole-Cell Recording Systems", 1<sup>st</sup> job: post-doctorate associate in Fred Sigworth lab, Yale University.
10. ZhengMing Fu, December 2007, thesis: "Low Power and Intelligent Image Sensing", 1<sup>st</sup> job: Freescale Semiconductors.

#### **Current PhD students:**

1. Abhishek Chaurasia, PhD Candidate Purdue ECE
2. Aliasger Zaidy, PhD Candidate Purdue ECE
3. Andre Ming Chang, PhD Candidate Purdue ECE
4. Lukasz Burzawa, PhD Candidate Purdue ECE
5. Sheik Dawood, PhD Candidate Purdue ECE
6. Juan Andreas Carvajal, PhD Candidate Purdue ECE
7. Thomas Molnar, PhD Candidate Purdue ECE

#### **Visiting students:**

1. Vincenzo Lomonaco, University of Bologna, Fall 2017 - Spring 2018
2. Angelo Rottigni, Politecnico di Milano, Italy, Fall 2009
3. Jose Carrasco, University of Sevilla, Spain, Fall 2008
4. Paolo Manfrin, University of Trieste, Italy, Fall 2008
5. Evan Park, RPI University, Summer 2005
6. Dongsoo Kim, Yonsei University, S. Korea, Spring 2008

#### **Significant Undergraduate students:**

1. Logesh Ramadoss, Ruihang Dui, 2017-2018 -- machine learning
2. Henrique Rocha, Spring 2007, Fall 2007 – hyper-resolution on image sensors
3. Kofi Keteku, Summer 2007 and academic year 2007-08 – Fall detection sensor
4. Matthew Herpich, all academic year 2006-07 – Patch-clamp Bio-sensor
5. Simba Marrakesh, all academic year 2006-07 – Octopus image sensor

6. Ajay Kishore, Spring 2006 – image sensor light adaptation
7. Hazael Montanaro, Summer 2008, 2009 – patch clamp amplifier software interfaces
8. Jonathan McMillian, Summer 2009, year 2010 – embedded software for vision
9. Conrad Lee, Summer 2009 – Visual attention coding
10. Faye Zhao, Summer 2010 – synthetic vision system and convolutional neural networks
11. Ifigeneia Derekli, Summer 2010 – synthetic vision system and convolutional neural networks

## **PERSONAL INFORMATION**

**Spoken languages:** Fluent in Italian and English, basic Korean and Chinese

**Citizenship:** US, Italian citizenship, European Community

**Marital Status:** Married

**Hobbies:** Spending time with my wife Kyoungsoo and our son Geo, ice-skating, volleyball, home improvements, painting, cooking/baking, hacking computers and cell-phones, video-games, programming embedded devices.