Sensory Systems Technical Committee Activity Report

IEEE Circuits and Systems Society
Activities for May 2003 through March 2004
Chair: Orly Yadid-Pecht, Ben-Gurion University, Israel, oyp@ee.bgu.ac.il
Previous Chair: Ralph Etienne-Cummings, Johns Hopkins University, retienne@jhu.edu
Chair Elect: Andre van Schaik, University of Sydney, Australia, andre@ee.usyd.edu.au
Secretary: Shih-Chi Liu, Institut für Neuroinformatik, Switzerland, shih@ini.phys.ethz.ch

Summary of Activities

The Sensory Systems (SS) committee of the IEEE Circuits and Systems Society focuses on the theory, analysis, design, and practical implementation of sensors, actuators, micro-electro-mechanical systems and processing electronics, and their applications.

Committee members are renowned experts, who are both committed to, and active within, the field. The committee membership currently stands at 35 members, up from last year by 3 new members. At ISCAS 2003, Andre van Schaik and Shih-Chi Liu were elected as the Chair Elect and Secretary, respectively, for the SSTC. This is the first year of Orly Yadid-Pecht's Chairmanship.

We are finalizing the publication process for a Special Issue in the Kluwer's *Analog Integrated Circuits and Signal Processing Journal* which should appear next year. We are also completing a book on CMOS Imagers, submitted to the publisher (Kluwer) in February, to be published hopefully by May'04.

For ISCAS 2004, our TC has maintained a good number of submitted papers – 57. We are also offering a tutorial on CMOS Imager Sensors, and a Special Session on Bolometric sensors. A Best Paper prize for our TC has been established already, and we would like to enhance this by a monetary award and hopefully having a special issue on our best ISCAS papers in the TSensors or TCAS journals.

In conclusion, we have a few goals to work at.

The following details the CASS-related activity by the committee and its members.

1. **Participation in ISCAS track paper reviews:** For the ISCAS conference, we are contributing regular oral presentation sessions and additional poster sessions. These sessions cover the various topics in our TC, i.e. Acoustic Sensors, Image Sensors, MEMS, Networked Sensors, Neuromorphic Circuits, Vision Systems, Sensor Circuits, Sensory Systems, Sensor Models, Chemical Sensors, Olfactory sensors and Others. We are also providing a half day tutorial titled *CMOS Imagers: From Phototransduction to Image Processing*. We are also offering a special session on *Bolometric Arrays.* We plan to have a total of 40 (30 oral presentations) papers in our track.

2. **Best Paper Award:**   Continuing the established procedure for the best paper prize for our TC, for 2003, we have selected the top six scoring papers from all the submission in our Track and resubmitted them to the TC membership for ranking. A certificate has been presented to the authors at the TC meeting in Bangkok. We aim to enhance this activity and have the best papers published in a special issue of TSensors or TCAS.

3. **Journal Special Issues**: We are in the printing stage of a Special Issue of Kluwer's *Analog Integrated Circuits and Signal Processing Journal* on Smart Sensors. Most of the papers were presented in our two Special Sessions at ISCAS 2002 and have been extended for journal publication. The special issue is currently set to be published in June'04.

4. **Out Reach:** Members of our TC serve on program committees of various conferences such as SPIE, NIPS, ISSCC, BIS and many others. A book on CMOS imagers is in the works which we believe will attract significant attention from members in the field.

5. **Technical Committee Membership:** We have recruited a group of TC members that cover all the thrusts of our TC. The committee has members from academia, national labs and industry. We have also attempted to diversify the membership to include senior and junior scientists, as well as women and minorities. In addition,

our members serve on the editorial boards of various Journals, such as IEEE TVLSI, TSensors, TCAS and AICSP journal.

Current list of members:
Majid Ahmadi, University of Windsor, ahmadi@uwindsor.ca
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Bernabe Linares, IMSE , Spain, bernabe@imse.cnm.es
Tobi Delbruck, Institut für Neuroinformatik, Switzerland

6. **Future Plans**: In the coming your, it is our goal to increase the ISCAS contributions in the SSTC track. We have been actively encouraging researchers, starting with the TC members, in the field to send their work to the conference. We will continue to offer tutorials or short courses in our track at the 2004 ISCAS. We hope to continue the best paper award and potentially provide a monetary award in addition to the certificates. We also plan to establish a relationship with either *IEEE TCAS-I & II* or *IEEE TSensors* to have the best papers in the Track appear as full papers in the Journals.

7. **Technology Leadership:**
Orly Yadid-Pecht   - Elected to the Board of Governors, *IEEE CAS Society, 2003*
                                   - Appointed Chair of the Technical Committee on Sensors, *IEEE ISCAS, 2004*
Ralph Etienne-Cummings - Associate Director for Education and Outreach, ERC on CISST, *JHU*, 2004 – Present
                                   - Appointed Associate Director for Education and Outreach, *ERC on CISST at Johns Hopkins University, 2004*
                                   - Elected to the Board of Governors, *IEEE CAS Society, 2003*
                                   - Appointed to the Program Committee on Emerging Technology, *NIPS Society, 2003*
                                   - Appointed Organizing Committee of the NSF Telluride Neuromorphic Engineering Workshop, *2003*
                                   - Appointed Past-Chair of the Technical Committee on Sensors, *IEEE ISCAS, 2003*
                                   - Elected Chair-Elect of the Technical Committee on Neural Networks, *IEEE ISCAS, 2003*

8. **Publications:**

Journal Publications:

1. O. Yadid-Pecht, A. Belenky, "In-Pixel Autoexposure CMOS APS", IEEE J. Solid State Circuits, Vol. 38, No. 8, pp. 1425-1428, August 2003.
2. I. Shcherback and O. Yadid-Pecht, "CMOS APS crosstalk characterization via unique Sub-micron Scanning System measurements", IEEE Trans. on Elec. Dev, Vol. 50, No. 9, pp.1994-1997, September 2003.
3. I. Shcherback, O. Yadid-Pecht, " CMOS APS Pixel Photoresponse Prediction for Scalable CMOS Technologies", IEEE Trans. on Elec. Dev, Vol. 51, No. 2, pp. 285-287, Feb 2004.
4. V. Gruev and R. Etienne-Cummings, "A Pipelined Temporal Difference Imager," *IEEE J. Solid-State Circuits*, Vol. 39, No. 3, pp. 538 – 543, March 2004.
5. R. Phillip, B. Reddy, Ralph Etienne-Cummings, "A Single Chip Stereo Vision System," *Analog Integrated Circuits and Signal Processing Journal*, Vol. 7, pp. 703-712, July 2003.
6. R. Etienne-Cummings, P. Pouliquen and M. A. Lewis, "A Vision Chip for Color Segmentation and Object Recognition," *EURASIP J. Applied Signal Processing,* Vol. 2003, No. 7, pp. 703-712, June 2003.
7. M. Graf, D. Barrettino, M. Zimmermann, A. Hierlemann, H. Baltes, S. Hahn, N. Bârsan and U. Weimar, "CMOS Monolithic Metal-Oxide Sensor System Compromising a Microhotplate and Associated Circuitry", *IEEE Sensors Journal*, Vol. 4, No. 1, pp. 9-16, 2004.
8. Teresa Serrano-Gotarredona and Bernab? Linares-Barranco, "Log-Domain Implementation of Complex Dynamics Reaction-Diffusion Neural Networks," IEEE Trans. on Neural Networks, vol. 14, No. 4, pp. 1337-1355, September 2003.
9. Bernab? Linares-Barranco, Teresa Serrano-Gotarredona , and Rafael Serrano-Gotarredona, "Compact Low-Power Calibration Mini-DACs for Neural Massive Arrays with Programmable Weights," IEEE Trans. on Neural Networks, vol. 14, No. 4, pp. 1207-1216, September 2003.
10. Bernab? Linares-Barranco, Teresa Serrano-Gotarredona , Rafael Serrano-Gotarredona, and Clara Serrano-Gotarredona, "Current-Mode Techniques for Sub-Pico Ampere Circuit Design," Int. Journal of Analog Integrated Circuits and Signal Processing, vol. 38, pp. 103-119, 2004.
11. Bernab Linares-Barranco and Teresa Serrano-Gotarredona , "On the Design and Characterization of Femtoampere Current-Mode Circuits," IEEE Journal of Solid-State Circuits, vol. 38, No. 8, pp. 1353-1363, August 2003.
12. T. Delbruck, S.C. Liu. (2004). A silicon visual system as a model animal (preprint) . accepted to Vision Research.
13. Eng, K, Klein, D, Baebler, A, Bernardet, U, Blanchard, M, Costa, M, Delbruck, T, Douglas, R J, Hepp, K, Manzolli, J, Mintz, M, Roth, F, Rutishauser, U, Wassermann, K, Whatley, A M, Wittmann, A, Wyss, R, and Verschure, P F M J (2003). Design for a brain revisited: the neuromorphic design and functionality of the interactive space Ada, Reviews in the Neurosciences, 14(1-2): 145-180.

Regular Refereed Conference Publications:

1. I. Shcherback, A. Belenky and O. Yadid-Pecht**, "**CMOS APS Pixel Photoresponse Prediction for Scalable CMOS Technologies", IEEE workshop on CCDs and advanced image sensors, Elmau, Germany, May 15-17, 2003.
2. I. Shcherback, T. Danov, B. Belotserkovsky, O. Yadid-Pecht, " Point by Point Thorough Photoresponse Analysis of CMOS APS by means of our Unique Sub-micron Scanning System", SPIE/IS&T Sym. on Electronic Imaging: Science and Technology, Santa-Clara CA, USA, Jan 20-24, 2004.
3. S. Hamami, L. Fleshel and O. Yadid-Pecht, "CMOS APS Imager employing 3.3V 12 bit 6.3 MS/s pipelined ADC", accepted to IEEE ISCAS, Vancouver, Canada, 2004.
4. A. Fish, V. Milrud and O.Yadid-Pecht, "High speed and high resolution current winner-take-all circuit in conjunction with adaptive thresholding", accepted to IEEE ISCAS, Vancouver, Canada, 2004.
5. E. Artyomov, O. Yadid-Pecht, "Adaptive Multiple Resolution CMOS Active Pixel Sensor", accepted to IEEE ISCAS, Vancouver, Canada, 2004.
6. F. Tenore, R. Etienne-Cummings and M. A. Lewis, "Entrainment of Silicon Central Pattern Generators for Legged Locomotory Control," *Proc. of Neural Information Processing Systems*, Vancouver, Canada, December 2003.
7. V. Gruev, T. Horiuchi and R. Etienne-Cummings, "Linear Current Mode Imager with Low Fix Pattern Noise" *accepted for publication at IEEE ISCAS'04*, December 2003.
9. S. Mehta and R. Etienne-Cummings, "Normal Optical Flow Measurement on a CMOS APS Imager" *accepted for publication at IEEE ISCAS'04*, December 2003.

10. M. Clapp and R. Etienne-Cummings, "Bearing Angle Estimation For Sonar Micro-Array Using Analog VLSI Spatiotemporal Processing" *accepted for publication at IEEE ISCAS'04*, December 2003.
11. E. Culurciello and R. Etienne-Cummings, "Second Generation of High Dynamic Range, Arbitrated Digital Imager" *accepted for publication at IEEE ISCAS'04*, December 2003.
12. R. Philipp and R. Etienne-Cummings, "Low Power Current Rectifiers for Large-Scale Current-Mode Signal Processing" *accepted for publication at IEEE ISCAS'04*, December 2003.
13. S. Mehta and R. Etienne-Cummings, "A 2D Normal Flow Chip," *IEEE ISCAS'03*, May 2003.
14. R. Philipp and R. Etienne-Cummings, "A Single Chip Stereo System," *IEEE ISCAS'03*, May 2003.
15. T. Horiuch and R. Etienne-Cummings, "A Time-Series Processor for Sonar Mapping and Novelty Detection," *IEEE ISCAS'03*, May 2003.
16. D. Barrettino, M. Graf, M. Zimmermann, C. Hagleitner, A. Hierlemann, and H. Baltes, "A Micro-Hotplate-Based Monolithic CMOS Gas Sensor Array", *Proc. IEEE International Symposium on Circuits and Systems (ISCAS)*, Bangkok, Thailand, pp. 852-855, May 25-28, 2003.
17. C. Hagleitner, D. Barrettino, A. Hierlemann, O. Brand, and H. Baltes, "Interface Circuitry for CMOS-Based Monolithic Gas Sensor Arrays", *Proc. IEEE International Symposium on Circuits and Systems (ISCAS)*, Bangkok, Thailand, pp. 542-545, May 25-28, 2003.
18. D. Barrettino, M. Graf, S. Taschini, M. Zimmermann, C. Hagleitner, A. Hierlemann, and H. Baltes, "Hotplate-Based Conductometric Monolithic CMOS Gas Sensor System", *IEEE Symposium on VLSI Circuits*, Kyoto, Japan, pp. 157-160, June 10-14, 2003.
19. M. Graf, D. Barrettino, P. Kaeser, J. Cerda, A. Hierlemann, and H. Baltes, "Smart Single-Chip CMOS Microhotplate Array for Metal-Oxide-Based Gas Sensors", *Proc. IEEE Transducers*, Boston, MA, USA, pp. 123-126, June 8-12, 2003.
20. D. Barrettino, W.H. Song, M. Graf, A. Hierlemann, and H. Baltes, "A Micro-Hotplate-Based Monolithic CMOS Thermal Analysis System", *Proc. IEEE European Solid-State Circuits Conference (ESSCIRC)*, Estoril, Portugal, pp. 329-332, September 16-18, 2003.
21. D. Barrettino, M. Graf, S. S. Taschini, C. Hagleitner, A. Hierlemann, and H. Baltes, "A Single-Chip CMOS Micro-Hotplate Array for Gas Detection and Material Characterization", *IEEE International Solid-State Circuits Conference (ISSCC)*, San Francisco, USA, February 14-19, 2004. (accepted for publication)
22. D. Barrettino, M. Graf, K.U. Kirstein, A. Hierlemann, and H. Baltes, "A Monolithic Fully-Differential CMOS Gas Sensor Microsystem for Microhotplate Temperatures up to 450°C", *Proc. IEEE International Symposium on Circuits and Systems (ISCAS)*, Vancouver, Canada, May 23-26, 2004. (accepted for publication)
23. T. Delbruck, D. Oberhof, Self biased low power adaptive photoreceptor, 2004 International Symposium on Circuits and Systems (ISCAS 2004), Vancouver, Canada, May 23-25 2004 (accepted).
24. T. Delbruck, A. van Schaik, Bias current generators with wide dynamic range, 2004 International Symposium on Circuits and Systems (ISCAS 2004), Vancouver, Canada, May 23-25 2004 (accepted).
25. T. Delbr?ck, K. Eng, A. B?bler, U. Bernardet, M. Blanchard, A. Briska, M. Costa, R. Douglas, K. Hepp, D. Klein, J. Manzolli, M. Mintz, F. Roth, U. Rutishauser, K. Wassermann, A. Wittmann, A.M. Whatley, R. Wyss and P.F.M.J. Verschure (2003) Ada: a playful interactive space, Interact 2003, Ninth IFIP TC13 International Conference on Human-Computer Interaction INTERACT'03, Sept 1-5, Zurich, Switzerland. pp 989-992.
26. Eng, K, Baebler, A, Bernardet, U, Blanchard, M, Costa, M, Delbruck, T, Douglas, R J, Hepp, K, Klein, D, Manzolli, J, Mintz, M, Roth, F, Rutishauser, U, Wassermann, K, Whatley, A M, Wittmann, A, Wyss, R, and Verschure, P F M J (2003). Ada - Intelligent Space: An artificial creature for the Swiss Expo.02, Proceedings of the 2003 IEEE International Conference on Robotics, Automation (ICRA 2003), May 2003 (In Press)
27. S. Zahnd, P. Lichtsteiner, T. Delbr?ck. (2003). Integrated vision sensor for detecting boundary crossings, 2003 International Symposium on Circuits and Systems, Bangkok, Thailand, vol II, pp. 376-379.
28. Bartolozzi, C. and Indiveri, G. A neuromorphic selective attention architecture with dynamic synapses and integrate-and-fire neurons , Proceedings of Brain Inspired Cognitive Systems, Aug, 2004, (In Press)
29. Ben Dayan Rubin, D. D. and Chicca, E. and Indiveri, G. Firing proprieties of an adaptive analog VLSI neuron , Proceedings of Bio-ADIT 2004 314--327, Springer, 2004
30. Chicca, E. and Indiveri, G. and Douglas, R. J. An event based VLSI network of integrate-and-fire neurons , Proceedings of IEEE International Symposium on Circuits and Systems, 2004, (In Press)
31. Indiveri, G. and Chicca, E. and Douglas, R. A VLSI reconfigurable network of integrate-and-fire neurons with spike-based learning synapses , Proceedings of 12th European Symposium on Artificial Neural Networks (ESANN04), 2004
32. Carota, L. and Indiveri, G. and Dante, V. A software-hardware selective attention system , Proceedings of the CNS2003 Conference 358--364, 2003

33. Chicca, E. and Indiveri, G. and Douglas, R. J. An adaptive silicon synapse , Proc. IEEE International Symposium on Circuits and Systems,, 1: I-84--I-84, May, 2003

34. Indiveri, G Neuromorphic bistable VLSI synapses with spike-timing-dependent plasticity , Advances in Neural Information Processing Systems, 15: 1091--1098, Dec, Becker, S. and Thrun, S. and Obermayer, K. (Eds.), MIT Press, 2003

35. Indiveri, G. A low-power adaptive integrate-and-fire neuron circuit. , Proc. IEEE International Symposium on Circuits and Systems, 4: IV-820--VI-823, May, IEEE, 2003

36. Indiveri, G. Neuromorphic selective attention systems , Proc. IEEE International Symposium on Circuits and Systems, 3: III-770--III-773, May, IEEE, 2003

Book:
1. O. Yadid-Pecht and R. Etienne-Cummings, *CMOS Imagers: from Phototransduction to Image Processing*, Kluwer Academic Publishers, May 2004

Book chapters:
1. Yadid-Pecht, O., Pain, B, Staller, C., Clark, C., and Fossum, E., *"CMOS active pixel sensor star tracker with regional electronic shutter"*, in CCD and CMOS Imagers, SPIE's Milestone Series of Selected Reprints, Moon Gi Kang, ed, pp. 54-62, 2003.
2. Yadid-Pecht, O., Ginosar, R., and Shacham-Diamand, Y., "A random access photodiode array for intelligent image capture", in CCD and CMOS Imagers, SPIE's Milestone Series of Selected Reprints, Moon Gi Kang, ed, pp. 403-406, 2003.
3. I. Shcherback and O. Yadid-Pecht, "CMOS APS MTF Modeling", in O. Yadid-Pecht and R. Etienne-Cummings, *CMOS Imagers: from Phototransduction to Image Processing*, Kluwer Academic Publishers, May 2004.
4. I. Shcherback and O. Yadid-Pecht, "Photoresponse Analysis and Pixel Shape Optimization for CMOS APS", in O. Yadid-Pecht and R. Etienne-Cummings, *CMOS Imagers: from Phototransduction to Image Processing*, Kluwer Academic Publishers, May 2004.
5. A. Fish and O. Yadid-Pecht, "Active Pixel Sensor Design – from pixels to systems", in O. Yadid-Pecht and R. Etienne-Cummings, *CMOS Imagers: from Phototransduction to Image Processing*, Kluwer Academic Publishers, May 2004.
6. R. Etienne-Cummings, M. Clapp and V. Gruev, "Focal-Plane Analog Image Processing," in O. Yadid-Pecht and R. Etienne-Cummings, *CMOS Imagers: from Phototransduction to Image Processing*, Kluwer Academic Publishers, Spring 2004

Invited Papers:
1. A. Fish, D. Akselrod and O. Yadid-Pecht, "An adaptive center of mass detection system employing a 2D dynamic element matching algorithm for object tracking", invited for ISCAS'03 special session on Navigation Sensors, Thailand, Bangkok, May 2003.
2. A. Belenky, A. Fish, S. Hamami, V. Milrud and O. Yadid-Pecht, "Widening the dynamic range of the readout integration circuit for uncooled micro-bolometer infrared sensors", invited for IEEE ISCAS'04 special session on Hybrid Systems, Vancouver, Canada, 2004.
3. F. Tenore, M. A. Lewis and R. Etienne-Cummings, "A Programmable Array of Silicon Neurons for the Control of Legged Locomotion," *accepted for publication at IEEE ISCAS'04*, December 2003.
4. M. Massie, J.P. Curzan, C. Baxter, P. McCarley and R. Etienne-Cummings, "Vision Chips for Robot Navigation," accepted for *IEEE ISCAS'03*, May 2003.

9. **Workshops/conferences:**

Orly Yadid-Pecht
-Technical Program committee member and Session Chairman: SPIE Elec. Imaging Conference, San-Jose, CA, 2004.
-Technical Program Committee member and Session Chairman: International Symposium on Circuits and Systems, 2003
- Technical Program Committee and Session chairman: IEEE Workshop on Advanced Image Sensors, Germany, 2003.
- Organizer: Tutorial, ISCAS 2003, May 2003; ISCAS 2004, May 2004
- General chair: IEEE ICECS 2004.

Ralph Etienne-Cummings
- Session Chairman: International Solid-State Circuits Conference, San Francisco, CA, 2004
- Session Chairman: International Symposium on Circuits and Systems, 2003

- Co-Chairman: Neural Information Processing Systems Workshop, December 2003
- Invited Participant: DARPA Workshop on Intelligent Arthropods, Arlington, VA, 2003
- Invited Speaker: NSF Telluride Workshop on Neuromorphic Engineering, CO, 2003
- Invited Speaker: LPS Seminar Series, University of Maryland, College Park, MD, 2003
- Invited Speaker: SRC Review, Seattle, WA, 2003
- Review Panel: NIH SBIR Panel, Washington, DC, Mar. 2004
- Review Panel: NSF ECS Panel, Arlington, VA, Jan., Oct. 2003
- Organizer: Tutorial, ISCAS 2003, May 2003; ISCAS 2004, May 2004
- Organizer: NSF Telluride Neuromorphic Engineering Workshop, Telluride, CO, 2003, 2004

Mona Zaghloul
- Organizer - Special Session on MEMS and their Applications at the MWSCAS 2003, Cairo Egypt.
- Organized the 2004 ISCAS-FORUM on Nanotechnology and Future technologies, and what the CAS community should do about it

S.C. Liu and T. Delbruck - Organized the Neural Information Processing Systems 2003 Demonstration Session.

10.   Professional activities:

Orly Yadid-Pecht
- Board of Governors: IEEE CAS Society, 2003.
- Deputy Editor in Chief: IEEE TCAS-I Journal
- Guest Editor: *Kluwer's AICSP Journal*, Special Issue on Smart Sensors, Spring 2004 (planned publication)

Ralph Etienne-Cummings
- Board of Governors: IEEE CAS Society
- Associate Editor: IEEE Sensors Journal
- Guest Editor: *Kluwer's AICSP Journal*, Special Issue on Smart Sensors, Spring 2004 (planned publication)

Mona Zaghloul (with Peter Wu) - Guest Editor for Special Issue of TVLSI on Nanoscale and GigaScale circuits and Systems.
- Attended IEEE Sensors Conference and reported to the CAS BOG community about the Sensors Council activities.

Bernabe Linares
- Guest Editor of the Special Issue on NN Hardware Implementations published in September 2003 at IEEE Trans. on Neural Networks with 35 outstanding full papers