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## RESEARCH INTERESTS

Computational and systems neuroscience, bio-robotics, machine learning, sensor-based machine olfaction and dynamical systems.

## EDUCATION

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|---------------|---|-----------|
| <b>Ph.D.</b>  | Computer Science, Texas A&M University,<br>Dissertation: Sensor-based machine olfaction with neuromorphic models of<br>the olfactory system.<br>Advisor: Dr. Ricardo Gutierrez-Osuna. | 2003-2005 |
| <b>M.S.</b>   | Computer Science, Texas A&M University,<br>Thesis: Enhancing inductive learning with example and feature selection.<br>Advisor: Dr. Thomas R. Iorger                                  | 2000-2003 |
| <b>B.Eng.</b> | Computer Engineering, University of Madras (India)  | 1996-2000 |

## WORK EXPERIENCE

### **Washington University in St. Louis, MO**

<i>Co-Director, Center for Cyborg and Biorobotics Research</i>	<i>to be launched Fall 2021</i>
<i>Professor, Biomedical Engineering Department</i>	<i>07/2020 –</i>
<i>Dennis and Barbara Kessler, Associate Professor, BME</i>	<i>09/2018 – 06/2020</i>
<i>Associate Professor (courtesy appointment), Electrical Engineering</i>	<i>07/2016 – 06/2020</i>
<i>Associate Professor (with tenure), Biomedical Engineering Department</i>	<i>07/2016 – 06/2020</i>
<i>Assistant Professor (courtesy appointment), Electrical Engineering</i>	<i>06/2013 – 06/2016</i>
<i>Assistant Professor, Biomedical Engineering Department</i>	<i>02/2010 – 06/2016</i>

### **National Research Council, Washington DC**

<i>Joint NIH-NIST Postdoctoral Fellow</i>	<i>02/2006 – 02/2010</i>
<i>Advisors: Dr. Mark Stopfer (NICHD-NIH)/ Dr. Steve Semancik (CSTL-NIST)</i>	

### **Texas A&M University, College Station, TX**

<i>Research Assistant, Department of Computer Science</i>	<i>05/2003 – 12/2005</i>
<i>Teaching Assistant, Engineering Technology Department</i>	<i>08/2001 – 04/2003</i>
<i>Research Assistant, Texas Transportation Institute</i>	<i>01/2001 – 07/2001</i>
<i>Research Assistant, Department of Computer Science</i>	<i>06/2000 – 12/2000</i>

## HONORS AND AWARDS

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|---|----------|
| 1. Office of Naval Research Distinguished Lecture Series Speaker                  | May 2017 |
| 2. IEEE Donald G. Fink award  | 2016     |
| 3. National Science Foundation's CAREER award                                     | Aug 2015 |
| 4. Wolfgang Gopel award, International Society for Olfaction and Chemical Sensing | May 2011 |
| 5. Outstanding poster presentation award (Math and Engineering), NIST Sigma XI    | May 2007 |

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|--|---------------|
| 6. NIH/NIST joint postdoctoral fellowship award, National Research Council | Oct 2005      |
| 7. International Education Study Grant, Texas A&M University.              | July 2005     |
| 8. IJCNN Travel Grant award, IEEE Computational Intelligence Society.      | June 2005     |
| 9. Bachelor of Engineering with Distinction, University of Madras.         | 08/96 – 05/00 |
| 10. Certificate of Academic Excellence, Hindustan College of Engineering.  | 08/96 – 05/00 |

## 1.1 PUBLICATIONS

### JOURNAL ARTICLES

- J1. R. Chandak, *B. Raman*<sup>†</sup>, “Neural manifolds for odor-driven innate and acquired appetitive preferences,” *bioRxiv* 2021.08.05.455310, August 2021. doi: <https://doi.org/10.1101/2021.08.05.455310>.
- J2. M. Traner<sup>\*</sup>, R. Chandak<sup>\*</sup>, *B. Raman*<sup>†</sup>, “Recent approaches to study the neural bases for complex insect behavior,” *Current Opinion in Insect Science*, accepted for publication, July 2021.
- J3. H. G. Derami, P. Gupta, K.-C. Weng, A. Seth, R. Gupta, J. R. Silva, *B. Raman*, and S. Singamaneni, “Reversible Photothermal Modulation of Electrical Activity of Excitable Cells using Polydopamine Nanoparticles,” *Advanced Materials*, 2008809, July 2021.
- J4. AA Abokifa, K Haddad, B Raman, J Fortner, P Biswas, “Room temperature gas sensing mechanism of SnO<sub>2</sub> towards chloroform: Comparing first principles calculations with sensing experiments,” *Applied Surface Science* 554, 149603, 2021.
- J5. S. Nizampatnam, L. Zhang, R. Chandak, N. Katta, *B. Raman*<sup>†</sup>, Invariant Odor Recognition with ON-OFF Neural Ensembles, *bioRxiv* 2020.11.07.372870; doi: <https://doi.org/10.1101/2020.11.07.372870>
- J6. H. Rong, L. Zhang, C. Greer, Y. Ben-Shahar, T.E. Holy, *B. Raman*<sup>†</sup>, Spatial and Temporal Organization of Odor-evoked Responses in a Fly Olfactory Circuit: Inputs, Outputs and Idiosyncrasies, *bioRxiv*, 2020.10.21.349688; doi: <https://doi.org/10.1101/2020.10.21.349688>
- J7. S. Mallik, S. Nizampatnam, A. Nandi, D. Saha, *B. Raman*, S.N. Ching, “Neural Circuit Dynamics for Sensory Detection,” *Journal of Neuroscience* 40 (17), 3408-3423, 2021.
- J8. D. Saha, D. Mehta, E. Altan, R. Chandak, M. Traner, R. Lo, P. Gupta, S. Singamaneni, S. Chakrabarty, *B. Raman*<sup>†</sup>, “Explosive sensing with insect-based biorobots,” *Biosensors and Bioelectronics: X*, vol. 6, 1 December 2020, 100050.
- J9. S. Tadeballi, S. Cao, D. Saha, K.K. Liu, A. Chen, S.H. Bae, *B. Raman*, S. Singamaneni, “Remote-controlled insect navigation using plasmonic nanotattoos,” *bioRxiv*, 2020.02.10.942540
- J10. Z Chen, *B. Raman*, A Stern, Structure-preserving numerical integrators for Hodgkin-Huxley-type systems, *SIAM Journal on Scientific Computing* 42 (1), B273-B298, 2020 (*arXiv preprint*, arXiv:1811.00173, 2018.)
- J11. H. Yilmaz, S. Bae, S. Cao, Z. Wang, *B. Raman*<sup>†</sup>, S. Singamaneni<sup>†</sup>, “Gold nanorod based plasmonic nose for analysis of chemical mixtures,” *ACS Applied Nano Materials*, 2(6): 3897-3905, 2019.
- J12. L. Zhang, A. Chen, D. Saha, C. Li, *B. Raman*<sup>†</sup>, “Sensory memory for repetition suppression and novelty enhancement in an olfactory circuit,” *bioRxiv*, 281071, 2018.
- J13. S. Nizampatnam, D. Saha, R. Chandak, *B. Raman*<sup>†</sup>, “Dynamic contrast enhancement and flexible odor codes,” *Nature Communications*, 9, article number: 3062, August 2018.
- J14. S. Haney, D. Saha, *B. Raman*, M. Bazhenov, “Differential effects of adaptation on odor discrimination,” *Journal of Neurophysiology*, 120, 2018.

- J15. K Haddad, A Abokifa, S Kavadiya, B Lee, S Banerjee, B Raman, “SnO<sub>2</sub> Nanostructured Thin Films for Room-Temperature Gas Sensing of Volatile Organic Compounds,” *ACS applied Materials & Interfaces*, 10 (35), 29972-29981
- J16. C. Schaber, N. Katta, L. B. Bollinger, M. Mwale, R. Mlotha-Mitole, I. Trehan, B. Raman, A. R. Odom John, “Breathprinting Reveals Malaria-Associated Biomarkers and Mosquito Attractants,” submitted to *Journal of Infectious Diseases*, Oct 2017.
- J17. Haoyang Rong, Prithwiraj Das, Adalee Lube, David Yang, Debajit Saha, Yehuda Ben-Shahar, and B. Raman<sup>†</sup>, “Early warning signals regarding environmental suitability in the Drosophila antenna,” *bioRxiv*, 146522, 2017.
- J18. D. Saha\*, W. Sun\*, C. Li\*, S. Nizampatnam, W. Padovano, Z. Chen, A. Chen, E. Altan, R. Lo, D. Barbour and B. Raman<sup>†</sup>, “Engaging and disengaging recurrent inhibition mediates sensing and unsensing of a sensory stimulus,” *Nature Communications*, 8:15413, 2017 (doi:10.1038/ncomms15413).
- J19. R. Raliya, D. Saha, T. S. Chadha, B. Raman and P. Biswas, “Non-invasive aerosol delivery and transport of gold nanoparticles to the brain,” *Scientific Reports*, vol. 7, no. 44718, March 2017.
- J20. N. Katta, K. Benkstein, D. Meier, S. Semancik, B. Raman<sup>†</sup>, “I/O transform of a chemical sensor,” *Sensors & Actuators B*, Vol. 232, pp. 357-368, 2016.
- J21. D. Saha and B. Raman<sup>†</sup>, “Relating neural activities in the early insect olfactory pathway with behavior: a perspective,” *Current Opinion in Insect Science*, Volume 12, December 2015, pp. 54-63. (Cover article)
- J22. D. Saha\*, C. Li\*, S. Peterson, W. Padovano, N. Katta and B. Raman<sup>†</sup>, “Behavioral correlates of synchronous vs. asynchronous odor evoked neural activities,” *Nature Communications*, 6: 6953, 2015 (doi:10.1038/ncomms7953).
- J23. T. York, S. B. Powell, S. Gao, L. Kahan, T. Charanya, D. Saha, N. W. Roberts, T. W. Cronin, J. Marshall, S. Achilefu, S. Lake, B. Raman, and V. Gruev, “Bio-Inspired Polarization Imaging Sensors: from Circuits and Optics to Signal Processing Algorithms and Biomedical Applications,” *Proceedings of the IEEE*, vol. 102, no. 10, pp. 1450-1469, 2014.
- J24. K. D. Benkstein, P. Rogers, C. Montgomery, C. Jin, B. Raman, S. Semancik, “Chemiresistive microsensor arrays in a simulated Martian atmosphere,” *Sensors & Actuators B*, Vol. 197, pp. 280-291, 2014.
- J25. D. Saha\*, K. Leong\*, C. Li\*, G. Siegel and B. Raman<sup>†</sup>, “A spatiotemporal coding mechanism for background invariant recognition of odors,” *Nature Neuroscience*, Vol. 16, pp. 1830-1839, 2013. (Cover article)
- J26. D. Saha, K. Leong, N. Katta and B. Raman<sup>†</sup>, “Multi-unit recording methods to characterize neural activity in the locust (*Schistocerca americana*) olfactory circuits,” *Journal of Visualized Experiments*, (71), e50139, doi:10.3791/50139, 2013.
- J27. B. Raman<sup>†</sup>, R. Shenoy, D. C. Meier, K. Benkstein, C. M. Mungle and S. Semancik, “Detecting and recognizing odors in untrained backgrounds,” *IEEE Sensors*, Special Issue on Machine Olfaction, Vol. 12, no. 11, pp. 3238 – 3247, 2012.
- J28. B. Raman<sup>†</sup>, M. Stopfer and S. Semancik, “Mimicking biological design and computing principles in artificial olfaction,” *ACS Chemical Neuroscience*, Vol. 2(9), pp. 487-499, September 2011 (Invited review article).
- J29. B. Raman<sup>†</sup>, J. Joseph\*, J. Tang, and M. Stopfer, “Temporally diverse firing patterns in olfactory receptor neurons underlie spatio-temporal neural codes for odors,” *Journal of Neuroscience*, Vol.

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- 30, no. 6, pp. 1994-2006, 2010 (Highlighted article; 32<sup>nd</sup> most downloaded paper in February, 2010).
- J30. K. Benkstein, *B. Raman* and S. Semancik, "Microsensors in Dynamic Backgrounds: Towards real-time breath monitoring with temperature programmed microsensors," *IEEE Sensors*, Special Issue on Sensors for Breath Analysis, Vol. 10, pp. 137-144, January 2010 (*Cover article*; 9<sup>th</sup> most downloaded paper in February, 2010).
- J31. I. Ito, M. Bazhenov, C. R. Ong, *B. Raman*, and M. Stopfer, "Frequency transitions in odor-evoked neural oscillations," *Neuron*, Vol. 64, pp. 692-706, December 2009.
- J32. D. Meier, *B. Raman*, and S. Semancik, "Detecting chemical hazards with temperature-programmed microsensors: overcoming analytical problems of increasing complexity by utilizing multi-dimensional databases," in *Annual Reviews Analytical Chemistry*, Vol. 2, pp. 463-484, July 2009 (*Invited Review*).
- J33. *B. Raman*\*, D. C. Meier\*, J. K. Evju and S. Semancik, "Designing and Optimizing Microsensor Arrays for Recognizing Chemical Hazards in Complex Environments," *Sensors & Actuators B*, Vol. 137(2), pp. 617-629, April 2009.
- J34. K. D. Benkstein, *B. Raman*, D. L. Lahr, J. E. Bonevich and S. Semancik, "Inducing analytical orthogonality in tungsten oxide-based microsensors using materials structure and dynamic temperature control," *Sensors & Actuators B*, Vol. 137, pp. 48-55, March 2009.
- J35. I. Ito, C. R. Ong, *B. Raman*, and M. Stopfer, "Olfactory learning and spike-timing dependent plasticity," *Communicative & Integrative Biology*, Vol. 1(2), pp. 170-171, December 2008 (*Article addendum*).
- J36. *B. Raman*\*, J. Hertz\*, K. Benkstein, and S. Semancik, "A bio-inspired methodology for artificial olfaction," *Analytical Chemistry*, Vol. 80, no. 22, pp. 8364-8471, November 2008 (*Highlighted article*).
- J37. I. Ito, C. R. Ong, *B. Raman*, and M. Stopfer, "Sparse odor representation and olfactory learning," *Nature Neuroscience*, Vol. 11, no.10, pp. 1177-1184, October 2008 (*Highlighted article*; *F1000 evaluation: 'Must read'*).
- J38. *B. Raman*, I. Ito, and M. Stopfer, "Bilateral olfaction: two is better than one for navigation," *Genome Biology*, Vol. 9, pp. 212, March 2008 (*News and Views*).
- J39. *B. Raman*, and M. Stopfer, "Olfactory computations: Non-linear processing separates smell," *Current Biology*, Vol. 18, no. 1, pp. R29-R32, January 2008 (*News and Views*).
- J40. D. C. Meier, J. K. Evju, Z. Boger, *B. Raman*, K. D. Benkstein, C. J. Martinez, C. B. Montgomery, and S. Semancik, "Potential for and challenges of detecting chemical hazards with temperature-programmed microsensors," *Sensors and Actuators B*, Vol. 121, no.1, pp. 282-294, January 2007.
- J41. *B. Raman*, T. Kotseroglou, L. Clark, M. Lebl and R. Gutierrez-Osuna, "Neuromorphic processing for optical microbead arrays: dimensionality reduction and contrast enhancement," *IEEE Sensors*, Vol 7, no. 4, pp. 506-514, April 2007 (*Cover article*).
- J42. *B. Raman*, T. Yamanaka, and R. Gutierrez-Osuna, "Contrast enhancement of gas sensor array - patterns with a neurodynamics model of the olfactory bulb," *Sensors & Actuators B*, Vol. 119, no. 2, pp. 547-555, December 2006.
- J43. *B. Raman*, P. Sun, A. Gutierrez-Galvez, and R. Gutierrez-Osuna, "Processing of chemical sensor array with a biologically-inspired model of olfactory coding," *IEEE Transactions of Neural Networks*, Vol. 17, no. 4, pp. 1015-1024, July 2006.

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\* Equal contributions

- J44. *B. Raman* and R. Gutierrez-Osuna, “Concentration normalization with a model of gain control in the olfactory bulb,” *Sensors and Actuators B*, Vol. 116, no. 1-2, pp. 36-42, July 2006.
- J45. A. Perera, T. Yamanaka, A. Gutierrez-Gálvez, *B. Raman*, and R. Gutierrez-Osuna, “A dimensionality-reduction technique inspired by receptor convergence in the olfactory system,” *Sensors and Actuators B*, Vol. 116, no. 1-2, pp. 17-22, July 2006.
- J46. *B. Raman* and Jody R. Naderi, “Computer based pedestrian landscape design using decision tree templates,” *Advanced Engineering Informatics*, Vol. 20, no. 1, pp. 23-30, January 2006.

### **PHD DISSERTATION & MASTER THESIS**

- Haoyang Rong, Neural Coding and Organization Principles in The Drosophila Olfactory System, PhD in Biomedical Engineering, December 2020.
- Srinath Nizampatnam, Neural Dynamics, Adaptive Computations, and Sensory Invariance in an Olfactory System, PhD in Electrical Engineering, November 2020.
- Nalin Katta, Robust Odorant Recognition in Biological and Artificial Olfaction, PhD in Biomedical Engineering, August 2017.
- Chao Li, Relating neural dynamics with olfactory coding and behavior, PhD in Biomedical Engineering, December 2015.
- Matthew O’Neill, Spontaneous Firing of Sensory Neurons Modulates the Gain in the Downstream Circuit of a Simple Olfactory System, MS in Biomedical Engineering, August 2015.
- Barani Raman, Sensor-based machine olfaction with neuromorphic models of the olfactory system, PhD in Computer Science, December 2015.
- Barani Raman, Enhancing inductive learning with feature and example selection, MS in Computer Science, May 2013.

### **BOOK CHAPTERS**

- B1. C. S. Thakur, *B. Raman* and S. Chakrabarty, “Sensing to Learn and Learning to Sense: Principles for designing neuromorphic sensors,” in *Handbook of Neural Engineering*, in press., 2021
- B2. K. D. Benkstein, *B. Raman*, D. L. Lahr, S. Semancik, “Evaluation of Metal Oxide Nanowire Materials with Temperature-Controlled Microsensor Substrates,” in *Metal Oxide Nanomaterials for Chemical Sensors*, eds. A. M. Carpenter, S. Mathur, A. Kolmakov, Springer, New York, pp. 439-464, 2012.
- B3. *B. Raman*, D. C. Meier, S. Semancik, “A statistical approach to material evaluation and selection for chemical sensor arrays,” in *Computational Methods for Sensor Material Selection*, eds. M. A. Ryan, A. V. Shevade, C. J. Taylor, M. L. Homer, M. Blanco, Springer, October 2009, pp. 221-244 (ISBN: 978-0-387-73714-0).
- B4. *B. Raman* and R. Gutierrez-Osuna, “Relating sensor response of odorants to their organoleptic properties by means of a biologically inspired model of receptor neuron convergence onto the olfactory bulb,” in *Biologically Inspired Signal Processing for Chemical Sensing*, eds. S. Marco and A. Gutierrez-Galvez, Springer-Verlag, April 2009, pp. 93-108 (ISBN: 978-3-642-00175-8).

## **CONFERENCE PROCEEDINGS (peer-reviewed)**

- C1. Darshit Mehta, Ege Altan, Rishabh Chandak, Baranidharan Raman, Shantanu Chakrabarty, Behaving Cyborg Locusts for Standoff Chemical Sensing, *IEEE International Symposium on Circuits and Systems*, 2017.
- C2. R Zhang, B Rao, H Rong, B Raman, LV Wang, In vivo photoacoustic neuronal imaging of odor-evoked calcium signals in the drosophila brain, *SPIE BIOS*, 2016.
- C3. T. York, V. Gruev, D. Saha, B. Raman, A 220× 128 120 mW 60 frames/s current mode polarization imager for in vivo optical neural recording, *IEEE International Symposium on Circuits and Systems*, pp. 1849-1852, 2014.
- C4. N. Katta, D. Saha, K. Leong, J. Wu, N. Gandra, W. Wang, P. Banerjee, S. Singameneni, P. Biswas, B. Raman, Analysis of Biological and Artificial Chemical Sensor Responses to Odor Mixtures, *IEEE Sensors Conference*, Baltimore, Nov 4-6, 2013.
- C5. K.D. Benkstein, P. H. Rogers, C. B. Montgomery, S. Semancik, C. Jin, B. Raman, Microsensor Analyses for trace targets over extended times in a simulated martian environment *IEEE Sensors conference*, Baltimore, USA, Nov 3-6, 2013
- C6. K. D. Benkstein, A. Vergara, C. B. Montgomery, S. Semancik, B. Raman, Methods for Optimizing and Extending the Performance of Chemiresistive Gas Microsensors *IEEE Sensors conference*, Baltimore, USA, Nov 3-6, 2013
- C7. K. D. Benkstein, P. H. Rogers, C. B. Montgomery, J. Jin, B. Raman and S. Semancik, Microsensors for Mars: trace analyte detection in a simulated Martian environment, *International Meeting on Chemical Sensors*, Nuremberg, Germany, May 20- 23, 2012
- C8. B. Raman, J. L. Hertz, K. Benkstein, and S. Semancik, “Odor Recognition vs. Classification in Artificial Olfaction,” *International Symposium on Olfaction and Electronic Nose*, New York, May 2-5, 2011. (Invited)
- C9. B. Raman, D. C. Meier, R. Shenoy, K. D. Benkstein, S. Semancik, “Advances toward practical detection of trace chemical hazards with solid-state microarray devices,” *International Symposium on Olfaction and Electronic Nose*, New York, May 2-5, 2011. (Invited)
- C10. B. Raman, R. Shenoy, K. D. Benkstein, D. C. Meier, S. Semancik, “A MEMS-based approach with temperature-dependent sensing responses for recognizing chemicals in untrained backgrounds,” *IEEE Sensors Conference*, Waikoloa, Hawaii, USA, Nov 1- 4, 2010.
- C11. B. Raman, and M. Stopfer, “Analysis of trial-by-trial variability in stimulus-evoked neural activity,” *IEEE Engineering in Medicine and Biological Society*, Buenos Aires, Argentina, Aug 31 – Sep 4, 2010. (Invited)
- C12. B. Raman, J.L. Hertz, K. D. Benkstein, D. C. Meier, C. S. Mungle, and S. Semancik, “Generating and Using Data of Higher Dimension for Gas-Phase Sensing,” in the *Proceedings of ElectroChemical Society Transactions*, Vol. 19, no. 6, pp. 255-260, San Francisco, CA, USA, May 24-29, 2009.
- C13. D. C. Meier, J. K. Ejuv, K.D. Benkenstein, B. Raman, Z. Boger, D. Lahr, C. B. Montgomery and S. Semancik, “Enabling MEMS Chemical Microsensor Arrays for Trace Analyte Detection,” in the *Proceedings of Transducer 07 and Eurosensors XXI conference*, Lyon, France, June 10-14, 2007.
- C14. B. Raman and R. Gutierrez-Osuna, “Odor mixture segmentation and background separation with a model of olfactory bulb-cortex interaction,” in the *Proceedings of the International Joint Conference on Neural Networks (IJCNN 2005)*, Montreal, Canada, July 31- Aug 4, 2005.

- C15. B. Raman and R. Gutierrez-Osuna, "Concentration normalization with a model of gain control in the olfactory bulb," in the *Proceedings of the 11th International Symposium on Olfaction and the Electronic Nose (ISOEN 2005)*, Barcelona, Spain, April 13-15, 2005.
- C16. A. Perera, T. Yamanaka, A. Gutierrez-Gálvez, B. Raman, and R. Gutierrez-Osuna, "A dimensionality-reduction technique inspired by receptor convergence in the olfactory system," in the *Proceedings of the 11th International Symposium on Olfaction and the Electronic Nose (ISOEN 2005)*, Barcelona, Spain, April 13-15, 2005.
- C17. B. Raman and R. Gutierrez-Osuna, "Chemosensory processing in a spiking model of the olfactory bulb: chemotopic convergence and center surround inhibition," in the *Proceedings of Advances in Neural Information Processing Systems 17 (NIPS 2004)*, Vancouver, BC, December 13-16, 2004.
- C18. R. Gutierrez-Osuna and B. Raman, "Cancellation of chemical backgrounds with generalized Fisher's linear discriminants," in the *Proceedings of the IEEE SENSORS Conference*, Vienna, October 24-27, 2004.
- C19. B. Raman, A. Gutierrez-Galvez, A. Perera-Lluna, R. Gutierrez-Osuna, "Sensor-based machine olfaction with a neurodynamics model of the olfactory bulb," in the *Proceedings of the IEEE International Conference on Intelligent Robots and Systems (IROS 04)*, Sendai, Japan, Vol. 1, pp.319-324, 2004.
- C20. B. Raman and J.R. Naderi, "Decision tree templates for interactive evidence-based design of site-specific use-specific pedestrian environments," *First International Conference on Design Cognition and Computing*, MIT, USA, July 2004.

## **ABSTRACTS**

- A1. R. Chandak, B. Raman, "Odor valence encoding in the antennal lobe and its behavioral correlates," *Society for Neuroscience meeting*, Chicago, October, 2019.
- A2. H. Rong, L. Zhang, C. Greer, S. Park, R. Deshpande, F. Brooks, T. Holy, M. Anastasio, B. Raman, "Characterization of odor-evoked response dynamics in three different neural populations in the fly olfactory system using light-sheet microscopy," *Society for Neuroscience meeting*, Chicago, October, 2019.
- A3. S. Nizampatnam, D. Saha, B. Raman, "Concentration-dependent switch in neural ensembles in the locust antennal lobe," *Society for Neuroscience meeting*, Chicago, October, 2019.
- A4. R. Chandak, B. Raman, "Distinct ensembles encode opposing odor valences in the antennal lobe," *Society for Neuroscience meeting*, San Diego, November 3 – 7, 2018.
- A5. L. Zhang, A.B. Chen, D. Saha, B. Raman, "Encoding the expectation of a sensory stimulus," *Society for Neuroscience meeting*, San Diego, November 3 – 7, 2018.
- A6. R. Chandak, B. Raman, "Decoding the Hedonic Value of a Sensory Stimulus," *BMES meeting*, Atlanta, October 17 – 20, 2018.
- A7. D. Mehta, L. Zhou, M. Traner, D. Saha, B. Raman, S. Chakrabartty, "Towards Long Term Self-Powered Neural Recording in Freely Behaving Organisms," *BMES meeting*, Atlanta, October 17 – 20, 2018.
- A8. D. Saha, D. Mehta, S. Chakrabartty, B. Raman, "Developing Freely-Moving, Insect-Based, Biorobots for Chemical Sensing in Natural Environments," *BMES meeting*, Atlanta, October 17 – 20, 2018.
- A9. L. Zhang, S. Nizampatnam, D. Saha, R. Chandak, B. Raman, "A Bayesian Boolean decoder for robust odor recognition," *Computational and Systems Neuroscience*, Mar 01 – 04, Denver, 2018.

- A10. L. Zhang, N. Katta, R. Chandak, B. Raman, “Compressed encoding of stimulus intensity in an olfactory circuit,” *Society for Neuroscience meeting*, Washington DC, November 11-15, 2017.
- A11. A. Chen, L Zhang B. Raman, “Encoding expected versus surprising olfactory stimuli,” *Society for Neuroscience meeting*, Washington DC, November 11-15, 2017.
- A12. S. Nizampatnam, D. Saha, R. Chandak, B. Raman, “Dynamic contrast enhancement and flexible odor codes,” *Society for Neuroscience meeting*, Washington DC, November 11-15, 2017.
- A13. S. Nizampatnam, D. Saha, B. Raman, “Evaluating various properties of odor-evoked neural responses,” *Society for Neuroscience meeting*, San Diego, CA, November 12-16, 2016.
- A14. S. Haney, D. Saha, B. Raman, M. Bazhenov, “Mechanisms and functions of the offset response in insect olfaction,” *Society for Neuroscience meeting*, San Diego, CA, November 12-16, 2016.
- A15. D. Saha, C. Li, W. Padovano, Z. Chen, B. Raman, “Switching between distinct neural ensembles mediates sensing and unsensing of a sensory stimulus,” *Society for Neuroscience meeting*, San Diego, CA, November 12-16, 2016.
- A16. H. Rong, P. Das, A. Lube, Y. Ben-Shahar, B. Raman, "Role of Sensory Neurons in Intensity Dependent Behavioral Switch in Drosophila", *Society for Neuroscience meeting*, Chicago, IL, October 17-21, 2015.
- A17. N. Katta, M. O'Neill, D. Saha, B. Raman, "Spontaneous Firing of Sensory Neurons Modulates the Gain in the Downstream Circuit of a Simple Olfactory System," *Society for Neuroscience meeting*, Chicago, IL, October 17-21, 2015.
- A18. D. Saha, C. Li, W. Padovano, B. Raman, “A functional role for off-transients in olfactory coding” *Society for Neuroscience Meeting*, Chicago, October 17-21, 2015.
- A19. S. Haney, D. Saha, B. Raman, M. Bazhenov, “Differential effects of adaptation on odor discrimination” *Society for Neuroscience Meeting*, Chicago, October 17-21, 2015.
- A20. D. Saha\*, C. Li\*, S. Peterson, W. Padovano, N. Katta and B. Raman<sup>†</sup>, “Behavioral correlates of synchronous vs. asynchronous odor evoked neural activities,” *Computational and Systems Neuroscience meeting*, Salt Lake City, Utah, March 2015.
- A21. D. Saha, C. Li, and B. Raman, “Computational Analysis of Ensemble Neural Data Recorded From An Insect Brain,” *SIAM Conference on Computational Science and Engineering*, Salt Lake City, Utah, March 2015.
- A22. D. Saha, C. Li, S. Peterson, W. Padovano, N. Katta, B. Raman, “Temporally coherent ensemble neural activity in an olfactory system elicits predictable behavioral response in an odor recognition task,” *Society for Neuroscience Meeting*, Washington DC, November 14-19, 2014.
- A23. S. Haney, D. Saha, B. Raman, M. Bazhenov, “A model of background invariant odor recognition,” *Society for Neuroscience Meeting*, Washington DC, November 14-19, 2014.
- A24. K. Leong, B. Raman, “A rich repertoire of odor-evoked sensory neuron responses in the insect antenna,” *Society for Neuroscience Meeting*, New Orleans, USA, Oct 13-17, 2012
- A25. D. Saha, G. Seigel, N. Katta and B. Raman, “Dynamic reformatting of neural activity in an olfactory circuit underlie background-independent recognition of odors,” *Society for Neuroscience Meeting*, New Orleans, USA, Oct 13-17, 2012
- A26. C. Li, D. Saha, K. Leong, C. Jin, B. Raman, “Trial-to-trial neural response variability in the antennal lobe predicts behavioral performance in an odor recognition task”, *Society for Neuroscience Meeting*, New Orleans, USA, Oct 13-17, 2012
- A27. K. D. Benkstein, P. H. Rogers, C. B. Montgomery, J. Jin, B. Raman and S. Semancik, “Microsensors for Mars: trace analyte detection in a simulated Martian environment,” *International Meeting on Chemical Sensors*, Nuremberg, Germany, May 20- 23, 2012



- A28. D. Saha, G. Seigel, N. Katta and B. Raman, “Background odor filtering in the locust olfactory system,” *Society for Neuroscience Meeting*, Washington DC, USA, Nov 12-16, 2011
- A29. D. Saha, N. Katta, G. Seigel and B. Raman, “A tensor-based method for analysis of multi-unit neural data,” *Society for Neuroscience Meeting*, Washington DC, USA, Nov 12-16, 2011
- A30. G. Shamsan and B. Raman, “Exploring the dimensions of the olfactory code,” *Biomedical Engineering Society Meeting*, Austin, USA, Oct 6-9, 2010. (*undergraduate student paper*)
- A31. B. Raman, J. L. Hertz, K. D. Benkstein, S. Semancik, “Probing the molecular features of chemical species with metal-oxide semiconductors,” *13<sup>th</sup> International Meeting on Chemical Sensors*, Perth, Australia, July 11-14, 2010.
- A32. K.D. Benkstein, B. Raman, C.J. Martinez, C.B. Montgomery, S. Semancik, “Assessing the value of chemical sensing materials in a microsensor array,” *13<sup>th</sup> International Meeting on Chemical Sensors*, Perth, Australia, July 11-14, 2010.
- A33. B. Raman, J. Joseph, J. Tang, and M. Stopfer, “Analysis of spatio-temporal odor codes in the locust olfactory system,” *Fifth Workshop on Statistical Analysis of Neural Data (SAND5)*, Pittsburg, USA, May 20-22, 2010.
- A34. B. Raman, K. D. Benkstein, and S. Semancik, “Towards real-time breath monitoring with MEMS-based microsensor arrays,” in *Breath Analysis Workshop*, Menlo Park, CA, USA, Nov 16-17, 2009.
- A35. K. D. Benkstein, R. Artzi-Gerlitz, C. J. Martinez, B. Raman, D. C. Meier and S. Semancik, “Integrating Nanomaterials with Nano/Micro Platforms to Achieve Enhanced Chemical Sensing Performance,” *European Materials Research Society (E-MRS) annual meeting*, Strasbourg, France June 8-12, 2009.
- A36. K.D. Benkstein, B. Raman, C.J. Martinez, C.B. Montgomery, S. Semancik, “Evaluating Nanomaterials Integrated with Microsensor Arrays for Breath Monitoring,” *Nanotech Conference & Expo*, Houston, Texas, USA, May 3-7, 2009.
- A37. B. Raman, J. Joseph, J. Tang, M. Stopfer, “Analysis of spatio-temporal odor codes in the locust olfactory system,” *Dimensionality reduction for multi-channel neural recordings Workshop, Computational and Systems Neuroscience (COSYNE’09)*, Salt Lake city, Utah, USA, Feb 26-Mar3, 2009.
- A38. I. Ito, R. Ong, B. Raman, and M. Stopfer, “Sparse odor representation of odor and associative learning,” *Computational and Systems Neuroscience (COSYNE’09)*, Salt Lake City, Utah, USA, Feb 26-Mar 3, 2009.
- A39. B. Raman, J. Joseph, J. Tang, M. Stopfer, “Temporally diverse firing patterns in olfactory receptor neurons underlie spatio-temporal neural codes for odors,” *Society for Neuroscience Meeting (SfN’08)*, Washington DC, Nov 15-19, 2008.
- A40. I. Ito, M. Bazhenov, R. Ong, B. Raman, M. Stopfer, “Mechanisms underlying frequency shifts in odor-evoked neural oscillations,” *Society for Neuroscience Meeting (SfN’08)*, Washington DC, Nov 15-19, 2008.
- A41. I. Ito, R. Ong, B. Raman, and M. Stopfer, “Sparse odor representation in the mushroom body and associative learning,” *International Symposium on Olfaction and Taste (ISOT’08)*, San Francisco, July 21-26, 2008.
- A42. B. Raman, D. C. Meier, J. K. Evju, S. Semancik, “Designing and Optimizing Microsensor Arrays for Recognition of Chemical Hazards in Complex Environments,” *12<sup>th</sup> International Meeting on Chemical Sensors*, Columbus Ohio, July 13-16, 2008.

- A43. C. S. Mungle, K. D. Benkstein, B. Raman, S. Semancik, "A statistical approach to event detection and materials selection for chemical sensor arrays," *12<sup>th</sup> International Meeting on Chemical Sensors*, Columbus Ohio, July 13-16, 2008.
- A44. D. C. Meier, B. Raman, and Steve Semancik, "The Life Cycle of a Metal Oxide Microsensor," *12<sup>th</sup> International Meeting on Chemical Sensors*, Columbus Ohio, July 13-16, 2008.
- A45. B. Raman, J. Joseph, J. Tang, M. Stopfer, "Olfactory receptor neuron response dynamics drives odor-elicited spatio-temporal patterning in the antennal lobe," *Society for Neuroscience Meeting (SfN'07)*, San Deigo, CA, Nov 3-7, 2007.
- A46. K. D. Benkstein, B. Raman, D. C. Meier, J. K. Evju, S. Semancik, "Advanced chemical microsensor arrays for trace analytes in complex gas mixtures," *Breath Analysis Summit 2007: Clinical Applications of Breath Testing, Scientific Meeting of the International Association for Breath Research (IABR)*, Cleveland, Ohio, USA, November 1-3, 2007.
- A47. D. C. Meier, J. K. Evju, K. D. Benkstein, B. Raman, Z. Boger and S. Semancik, "Methods for Enhancing the Analytical Capabilities of Chemical Microsensor Arrays," *212<sup>th</sup> Electrochemical Society Meeting (ECS'07)*, Washington DC, USA, October 7-12, 2007.
- A48. B. Raman, D. C. Meier, K. D. Benkstein, S. Semancik, "Tuning temperature-programmed microsensor arrays for real-time recognition of toxic industrial chemicals," *Nanoelectronic devices for defense and security conference (Nano-DDS' 06)*, Crystal City, VA, USA, June 2007.
- A49. I. Ito, R. Ong, B. Raman, and M. Stopfer, "Dynamic neural code and odor perception in an insect model," *Association of Chemical Senses 30<sup>th</sup> annual meeting*, Sarasota, USA, April 2007.
- A50. B. Raman, J. Joseph, J. Tang, M. Stopfer, "Olfactory receptor neuron response dynamics drives odor-elicited spatio-temporal patterning in the antennal lobe," *Computational and Systems Neuroscience Conference (COSYNE'07)*, Salt Lake City, Utah, Feb 22-27, 2007.
- A51. I. Ito, R. Ong, B. Raman, and M. Stopfer, "Time-evolving neural code and odor perception in an insect model," *Computational and Systems Neuroscience conference (COSYNE'07)*, Salt Lake City, Utah, Feb 22-27, 2007.
- A52. B. Raman, D. C. Meier, S. Semancik, "Towards real time recognition of toxic industrial chemicals with temperature programmed microsensors arrays," *European Union workshop on Bioinspired Signal Processing (BSP'07)*, Barcelona, Spain, Jan 24-27, 2007.
- A53. J. K. Evju, C. B. Montgomery, B. Raman, D.L. Lahr, D.C. Meier, Z. Boger, S. Semancik, "Improving Gas Microsensor Performance for Reliable Detection of Low Concentration Analytes," *On-Site Analysis and Homeland Security Annual Meeting*, Jan 28-31, 2007.
- A54. J. K. Evju, B. Raman, Z. Boger, D. C. Meier, K. D. Benkstein, C. B. Montgomery, S. Semancik, "Metal Oxide Gas Microsensors for Sensing & Recognition of Low Concentrations of Hazardous Chemicals," *American Vacuum Society 53<sup>rd</sup> International Symposium & Exhibition (AVS' 06)*, San Francisco, CA, Nov 12-17, 2006.
- A55. S. Semancik, D. C. Meier, J. K. Evju, Z. Boger, and B. Raman, "Detection of Chemical Hazards Using Temperature Programmed Solid State Microsensor Arrays," *9th International Conference Detection Technologies 2006 - New Developments in Identification of Microorganisms & Chemicals*, San Diego, CA, Nov 9-10, 2006.
- A56. I. Ito, C. R. Ong, B. Raman, and M. Stopfer, "Odor induced neural oscillations in the moth mushroom body originate in the antennal lobe," *Society for Neuroscience Abstracts (SfN'06)*, Atlanta, USA, October 2006.

- A57. B. Raman, T. Kotseroglou, M. Lebl, L. Clark, and R. Gutierrez-Osuna, "Pattern recognition for optical microbead arrays with a neuromorphic model of the olfactory bulb," *Association of Chemical Senses (AChems '06) 29<sup>th</sup> annual meeting*, Sarasota, USA, April 2006.
- A58. A. Gutierrez-Galvez, R. Gutierrez-Osuna, and B. Raman, "Pattern Recognition for chemical sensors with KIII model," *Intentional Dynamical Systems Symposium (IDS' 04)*, Memphis, USA, April 2004.

### **TECHNICAL REPORTS**

- R1. T. Yamanaka, A. Perera, B. Raman, A. Gutierrez-Galvez and R. Gutierrez-Osuna, "Learning sparse basis vectors in small-sample datasets through regularized non-negative matrix factorization," TAMU Technical Report CS-TR-2008-9-1, 2008.

### **PATENTS**

- P1. A. Odom, C. Schaber, I. Trehan, B. Raman, N. Katta, "Methods for diagnosing malaria," **US Patent App. 16/641,501**. 2021.

## **1.2 PRESENTATIONS**

### **INVITED TALKS**

1. Oct 2021 IEEE IROS Meeting
2. Sept 2021 Department of Biomedical Engineering, Washington University in St. Louis
3. April 2021 University of Illinois, Urbana-Champaign
4. Nov 2020 Entomology Virtual Annual Meeting
5. Oct 2020 NSF Neuronex Virtual Third Annual Investigators Meeting
6. Jun 2019 Indian Institute of Science, Bangalore, India
7. Mar 2019 Annual German Neuroscience Meeting, Gottingen, Germany
8. Feb 2019 COSYNE workshop, Lisbon, Portugal
9. Oct 2017 NACS Seminar, University of Maryland, MD
10. June 2017 ONR SAAET Program Review Meeting, Arlington VA
11. June 2017 Brain Dynamics Workshop, Washington University, MO
12. May 2017 ONR Distinguished Lecture Series
13. Apr 2017 St. Louis Zoo Lecture, MO
14. Sept 2016 Science of Tap, Kirkwood, MO
15. Oct 2015 Center for Theoretical Neuroscience, Columbia University, NY
16. Sept 2015 Department of Chemistry, Saint Louis University, MO
17. Mar 2015 SIAM Conference on Computational Science and Engineering, Salk Lake City, Utah
18. Dec 2014 Second International Congress on Digital Olfaction, Tokyo Institute of Technology, Tokyo, Japan
19. Sept 2013 First International Workshop on Odor Spaces, Hannover, Germany
20. May 2013 Hong Kong Polytechnic University-Washington University Joint Workshop on Frontiers in Biomedical Imaging, Biosensor and Biofeedback, Hong Kong, China
21. May 2013 Electrical and Systems Engineering Dept., Washington University, MO, USA
22. Dec 2012 Department of Anatomy and Neurobiology, Washington University, MO, USA
23. Oct 2012 West Kentucky University, Bowling Green, USA
24. Oct 2012 The Federation of Analytical Chemistry and Spectroscopy Societies Annual Meeting, Kansas City, MO, USA
25. Sep 2012 Inaugural Symposium of the Center for Biological and Systems Engineering,

- Washington University, St. Louis, USA
26. Aug 2012 Sciences Addressing Asymmetric Explosives Threat, Office of Naval Research, Arlington, Virginia, USA
  27. Feb 2012 Pacific Northwest National Labs, Richland, Washington, USA
  28. Nov 2011 Department of Materials Engineering, Purdue University, West Lafayette, USA
  29. Jul 2011 Organization of Computational Neurosciences Meeting, Stockholm, Sweden
  30. May 2011 International Symposium on Olfaction and Electronic Noses, New York, USA
  31. Oct 2010 Department Computer Science, Washington University, St. Louis, USA
  32. Sep 2010 IEEE Engineering in Medicine and Biological Society, Buenos Aires, Argentina
  33. Mar 2009 Department of Bioengineering, George Mason University, Virginia, USA
  34. Mar 2009 Dimensionality reduction for multi-channel neural recordings Workshop, Computational and Systems Neuroscience Meeting, Snow Bird, Utah, US
  35. Feb 2009 Department of Biomedical Engineering, Washington University, St. Louis, USA
  36. Feb 2009 Department of Biomedical Engineering, City College New York, New York
  37. Jul 2008 Organization of Computational Neurosciences Meeting, Portland, USA
  38. Jan 2007 European Union Workshop on Bioinspired Signal Processing, Barcelona, Spain
  39. May 2010 Fifth Workshop on Statistical Analysis of Neural Data (SAND5), Pittsburg, USA
  40. Nov 2009 Breath Analysis Workshop, Stanford Research Institute, Menlo Park, CA, USA
  41. Jul 2008 International Meeting on Chemical Sensors, Columbus, Ohio, USA
  42. Jun 2008 Nanoelectronic Devices for Defense and Security, Crystal City, VA
  43. Mar 2008 NICHD, NIH, Bethesda, MD, USA
  44. May 2007 NICHD Fellows Conference, Warrenton, VA, USA

### **1.3 RESEARCH GRANTS**

#### **CURRENT GRANTS**

- G1. Office of Naval Research** 05/01/2021 – 12/31/2024  
*Title: Benchmarking and enhancing the performance of insect-based chemical sensing biorobots in static and dynamic environments*  
*Role: PI (co-PIs: Shantanu Chakraborty, Electrical & Systems Engineering and Srikanth Singamaneni, MEMS; Total costs: \$800,000)*
- G2. Air Force Office of Scientific Research** 05/01/2019 – 04/30/2022  
*Title: Neuroplasmonics for selective and remote control of neural activity*  
*Role: co-PI (PI: Srikanth Singamaneni, MEMS; Total costs: \$678,000)*
- G3. National Science Foundation** 11/01/2020 – 10/31/2025  
*Title: BII-Implementation: Behavioral Plasticity Research Institute (BPRI): Transforming the Study of Phenotypic Plasticity through Biological Integration*  
*Role: Senior Investigator (PI: Fabrizio Gabbiani, Baylor College of Medicine, Total costs: \$12M)*
- G4. Office of Naval Research - DURIP** 07/01/2019 – 06/30/2022  
*Title: Robotic surgical and functional neural imaging systems for studying principles of sensory computation and behavior (Instrumentation Grant)*  
*Role: PI (co-PIs: Shantanu Chakraborty, Electrical & Systems Engineering and Srikanth Singamaneni, MEMS; Total costs: \$ \$271,620.00)*

- G5. Office of Naval Research** 01/01/2019 – 12/31/2021  
 Title: Real-time chemical sensing in complex environments with insect olfaction  
 Role: PI (co-PIs: Shantanu Chakraborty, Electrical & Systems Engineering and Srikanth Singamaneni, MEMS; Total costs: \$750,000)
- G6. National Science Foundation** 09/01/2017 – 08/31/2021  
 Title: CRCNS Research Proposal: Collaborative Research: Studying Competitive Neural Network Dynamics Elicited by Attractive and Aversive Stimuli and their Mixtures  
 Role co-PI (Other PIs: Shinung Ching (WUSTL) and Dirk Albrecht (WPI); Total costs: \$750,000)
- G7. National Science Foundation** 08/01/2017 – 07/31/2021  
 Title: NeuroNex Technology Hub: Advancing neuronal and genetic approaches to animal behavior research  
 Role co-PI (Other PIs: Yehuda Ben-Shahar (WUSTL), Ian Duncan (WUSTL) and Gene Robinson (UIUC); Total costs: \$2,642,385)
- G8. National Science Foundation CAREER** 09/01/2015–08/31/2021  
 Title: Neural dynamics, olfactory coding and behavior  
 Role: PI (Total costs: \$714,860)

#### COMPLETED GRANTS

- G9. Office of Naval Research** 05/01/2016 – 04/31/2019  
 Title: Hybrid chemical sensing with bio-electronic nose  
 Role: PI (coPIs: Shantanu Chakraborty, Electrical & Systems Engineering and Srikanth Singamaneni, MEMS; Total costs: \$750,000)
- G10. Office of Naval Research** 08/01/2016 – 07/31/2019  
 Title: Bio-optoelectronic Nose: A Novel Platform for Orthogonal Chemical Sensing  
 Role: Co-PI (PI: Srikanth Singamaneni, MEMS; Total costs: \$400,000)
- G11. Defense Advanced Research Projects Agency** 04/01/2019 – 10/01/2019  
 Title: WILD: CARROT (Wasp Inspired Logic Device: Connectome And RNAProfiles Represented On Transistors)  
 Role: co-PI (other PIs: Leaf labs, Ed Boyden (MIT), Giorgia Quadrato (USC))
- G12. National Institutes of Health Brain initiative R21** 09/01/2017 – 08/31/2019  
 Title: Self-powered sensing and data-logging for large-scale in-vivo monitoring of neural ensemble activity  
 Role co-I (PI: Shantanu Chakrabarty (WUSTL); Total costs: \$450,000)
- G13. McDonnell Center for Systems Neuroscience** 07/01/2015–06/30/2017  
 Title: Neuroplasmonics: Selective control of neural activity using plasmonic nanoheaters  
 Role: Co-PI (Total costs: \$84,800; PI: Srikanth Singamaneni)
- G14. Children Discovery Institute Interdisciplinary Research Initiative Grant** 02/1/2014–01/31/2017  
 Title: Towards noninvasive diagnosis of malaria infection through exhaled breath analysis  
 Role: joint PI (with Audrey Odom, Department of Pediatrics; Total costs: \$449,233)

- G15. **University Research Strategic Alliance** 08/01/2014–07/31/2015  
 Title: *Enabling artificial olfaction with AC admittance spectroscopy*  
 Role: joint-PI (joint with Parag Banerjee, Material Science and Mechanical Engineering Department; Total costs: \$25,000)
- G16. **McDonnell Center for Systems Neuroscience** 07/01/2013–06/30/2015  
 Title: *Monitoring ensemble neural activity with polarization-based imaging sensor*  
 Role: Co-PI (Total costs: \$84,800; PI: Viktor Gruev)
- G17. **Office of Naval Research Grant** 01/01/2012–08/31/2015  
 Title: *Neuromorphic chemical sensing using miniaturized microsensor arrays*  
 Role: PI (Total costs: \$732,084.00)
- G18. **Measurement Science and Engineering (MSE) Research Grants Programs, Department of Commerce Grant (NIST),** 01/01/2011-12/31/2012  
 Title: *Pattern recognition methods for non-invasive chemical monitoring in complex environments*  
 Role: PI (Total costs: \$90,000)
- G19. **McDonnell Center for Systems Neuroscience** 07/01/2010-06/30/2012  
 Title: *Neural Basis for Olfactory Invariance*  
 Role: PI (Total costs: \$84,800)
- G20. **National Research Council's joint NIH-NIST Postdoctoral Fellowship**  
 Title: *Neuromorphic chemical sensing using miniaturized microsensor arrays*  
 Role: PI (Total costs: \$256,092) 02/01/2006-01/31/2010

#### **1.4 MEDIA COVERAGE**

- **“Nanoparticles create heat from light to manipulate electrical activity in neurons,”** Beth Miller, WUSTL, July 2021.
- **“Locusts help uncover the mysteries of smell,”** Brandie Jefferson, WUSTL, Aug 2018. [Picked up by NSF news and Science Daily]
- **“Wash U engineers to look at how brain processes signals in different organism,”** Beth Miller, WUSTL Engineering News, Oct 2107.
- **“Engineers developing self-powered brain activity recorder,”** Erika Ebsworth-Goold, WUSTL Engineering news, Oct 2017.
- **“\$2.6 million to build genetic toolkit for studying animal behavior,”** Diane Lutz, WUSTL Source Magazine, Aug 2017. [Picked up by St. Louis Business Journal]
- **“A simple sniff,”** Erika Ebsworth-Goold, WUSTL Source Magazine, April 2017
- **“What a locust nose taught Wash U Engineers about monkeys’ ears,”** Beth Miller WUSTL Engineering News, May 2017 [Highlighted in NSF 360]
- **“Engineers to use cyborg insects as biorobotic sensing machines,”** Beth Miller, WUSTL Engineering News, July 2016 [picked up by BBC, Washington Post, Popular Science, KMOV, NPR, St. Louis Post, Telegraph and other prominent news outlets]
- **“Raman seeks to replicate sense of smell with NSF CAREER Award,”** Tony Fitzpatrick, WUSTL Engineering News, September 2015
- **“Locusts provide insight into brain response to stimuli, senses,”** Beth Miller, WUSTL Engineering News, April 2015.

- **“Swarming insect provides clues to how the brain processes smells,”** Beth Miller, WUSTL Engineering News, Nov 2013.
- **“Security Innovators,”** Beth Miller, WUSTL Engineering Momentum, Spring 2013.
- **“What’s that smell,”** Christine Piggee, Analytical Chemistry, Nov 4, 2008.
- **“Sniffing out a better Chemical Sensor,”** Mark Esser, NIST Tech beat, October 28, 2008.
- **“Pavlov’s moth: olfactory learning and spike timing-dependent plasticity,”** J. P. Meeks and T. E. Holy, Nature Neuroscience, Vol. 11, pp. 1126-1127, October 2008.
- **“Moths with a Nose for Learning,”** Mark Esser, NIST Tech beat, October 1, 2008.
- **“Neural nets find a niche,”** David Perear, Defense Systems Magazine, July 7, 2008.
- **“The Science of Scent,”** Susan E. Cotton, Texas A&M Engineering Research Magazine, 2006.
- **“Texas A&M researchers write software to help design optimal pedestrian environments,”** Judith White, A&M System Wide Research News, March 2006.

## **2.0 TEACHING**

- **Graduate course developed at Washington University**  
*Biological Neural Computation* (BME 572), Spring 2011, 2012, 2013, 2015, 2016, 2017, 2018, 2019, 2020, 2021
  - Sole instructor for this course
  - Developed the contents of the entire course  
(<http://labs.seas.wustl.edu/bme/raman/teaching.html>)*Special Topics in Engineering and Neuroscience: Engineering Methods for Understanding the Brain* (ESE 5591) Spring 2020, 2021
  - Co-taught with Dr. ShiNung Ching (ESE)
- **Undergraduate course taught at Washington University**  
*Quantitative Physiology* - Fall 2012, 2013 (course master), 2014, 2015 (course master), 2016, 2017 (course master), 2018, 2019 (course master)
  - Revamped the contents of two nerve modules, developed an experimental olfaction lab and a dynamical systems Simulink modeling lab
  - Co-taught this junior-level course with Kurt Thoroughman (2012 and 2013), Dennis Barbour (2012, 2014 - 2019), and Patricia Widder (2013-2018)
- **At Texas A&M University**  
*Local Area Networking* (ENTC 425; Lab instructor), Aug 01 – Apr 03.

## **GUEST LECTURES**

- Advanced Cognitive Computational and Systems Neuroscience (Fall 2012) – 4 lectures
- Introduction to Biomedical Engineering (Fall 2012, Fall 2013, Fall 2014, Fall 2015) – 1 lecture
- Introduction to Neuroethology (Spring 2012) – 1 lecture
- Quantitative Physiology (Fall 2010) – 5 lecture



### **3.0 SERVICE**

#### **3.1 SERVICE TO STUDENTS THROUGH RESEARCH MENTORING**

- **Postdoctoral Fellows and Research Associates**
  1. Quentin Coquerel (March 2020 – present)
  2. Debajit Saha (Feb 2011 – Aug 2019; starting faculty position at Michigan State University Fall 2019)
  3. Yilmaz, Huzeyfe (Jan 2017 – Aug 2018; co-advised with Srikanth Singamaneni; Next Position: ORISE Fellow at FDA)
  4. Prithwiraj Das (Jan 2012 – Aug 2014; Next position: Postdoctoral fellow, Ray Lab, UC Riverside)
  5. Jerry Jin (Nov 2011 – Sept 2012; Next position: Research Scientist, Actavis)
- **Graduate Students**
  1. Liza Bessanova (PhD, June 2021 – present)
  2. Mike Traner (PhD, May 2018 – present)
  3. Doris Ling (PhD, July 2017 – present)
  4. Rishabh Chandak (PhD, July 2017 – present)
  5. Lijun Zhang (PhD, Aug 2016 – present)
  6. Srinath Nizampatnam (PhD, Feb 2016 – Nov 2020; Next position: Scientist, Apple)
  7. Haoyang Rong (PhD, Sept 2013 – Dec 2020; Next position: Postdoc, UCSF)
  8. Nalin Katta (PhD, Aug 2011 – June 2017; Next position: Scientist, Merck)
  9. Chao Li (PhD, Aug 2011 – September 2015; Next position: Data Scientist, Bank Rate)
  10. Kevin Leong (MS, Aug 2011 – Dec 2012; Next position: Engineer, Lattice Engines)
- **Awards to mentored students and postdoctoral fellows**
  1. Mike Traner – Cognitive Computational Systems Neuroscience Pathway fellowship 2018
  2. Alex Chen – Ralph Quatrano Award for Outstanding Bachelors Thesis in Biology
  3. Doris Ling – Imaging sciences pathway fellowship 2017
  4. Srinath Nizampatnam – Finalist in the competition for the James L. O’Leary Prize for Excellence in Neuroscience Research 2017
  5. Haoyang Rong – Imaging sciences pathway fellowship 2015
  6. Debajit Saha – McDonnell Center for Cellular and Molecular Neurobiology Postdoctoral Fellowship 2015
  7. Nalin Katta – Center for Biological and Systems Engineering Scholarship 2015
  8. Chao Li – Center for Biological and Systems Engineering Scholarship 2014
  9. Pritwiraj Das- Honorable mention for poster presentation in the 10<sup>th</sup> Annual postdoctoral symposium at Washington University 2014
  10. Debaji Saha – Finalist in the competition for the James L. O’Leary Prize for Excellence in Neuroscience Research 2014
  11. Nalin Katta – NSF Bioelectronics Student Travel Award 2013
- **Graduate Student Dissertation Committees**
  1. Ahana Gangopadhyay (PhD, ESE, Fall 2021; PI: Shantanu Chakrabarty)
  2. Sruti Malik (PhD, Electrical & Systems Engg, Summer 2021; PI: ShiNung Ching)
  3. Jen-Chun Hsiang (PhD, DBBS, Fall 2018 – present; PI: Daniel Kerchensteiner)
  4. Adalee Lube (PhD, DBBS, Fall 2018 – present; PI: Bruce Carlson)
  5. Hamed Gholami Derami (PhD, Material Science, Fall 2020; PI: Srikanth Singamaneni)
  6. Elham Ghazizadeh Ahsaei (PhD, Electrical & Systems Engg, Fall 2020; PI: ShiNung Ching)
  7. Kenji Aono (PhD, CSE, Fall 2018; PI: Shantanu Chakrabarty)
  8. Chad Schaber (PhD, WUSM, Spring 2018; PI: Audrey Odom)

9. John Landes (PhD, Biomedical Engineering, Summer 2018; PI: Dan Moran)
10. Missael Garcia (PhD, CSE, Fall 2017; PI: Viktor Gruev)
11. Sirimuvva Tadepalli (PhD, Material Science, Fall 2017; PI: Srikanth Singamaneni)
12. Ravi Chacko (PhD, Biomedical Engineering, Fall 2017, PI: Eric Leuthardt)
13. Yang Lou (PhD, Biomedical Engineering, Fall 2017; PI: Mark Anastasio)
14. Li Xia (PhD, Biomedical Engineering, Fall 2017; PI: Michael Bruchas)
15. Wensheng Sun (PhD, Biomedical Engineering, Summer 2017; PI: Dennis Barbour)
16. David Song (PhD, Biomedical Engineering, Summer 2017; PI: Dennis Barbour)
17. Ruiye Ni (PhD, Biomedical Engineering, Summer 2017; PI: Dennis Barbour)
18. Nick Szrama (PhD, Medical Scientist in Training Program, Fall 2016; PI: Eric Leuthardt)
19. Piyush Karande (PhD, Biomedical Engineering, Fall 2016; PI: Dan Moran)
20. Christa Baker (PhD, Department of Biology, Spring 2015; PI: Bruce Carlson)
21. Adhira Sunkara (PhD, Biomedical Engineering, Fall 2014; PI: Dora Angelaki)
22. Gary Hammen (PhD, Anatomy and Neurobiology, Fall 2014; PI: Tim Holy)
23. Limei Tan (PhD, Mechanical Engg. & Material Science, Summer 2014; PI: Srikanth Singamaneni)
24. Elisha Marongelli (PhD, Biomedical Engineering, Fall 2013; PI: Kurt Thoroughman)
25. Mohit Sharma (PhD, Biomedical Engineering, Fall 2013; PI: Eric Leuthardt)
26. Nicholas Lyle (PhD, Computational Biology Program, DBBS, Spring 2013; PI: Rohit Pappu)
27. Raphael Njuguna (PhD, Computer Science, Spring 2013; PI: Viktor Gruev)
28. Jan Kubanek (PhD, Biomedical Engineering, Spring 2013; PI: Larry Snyder)
29. Hannah Arnson (PhD, Anatomy and Neurobiology, Spring 2013; PI: Tim Holy)
30. Illya Tolokh (PhD, Anatomy and Neurobiology, Fall 2012; PI: Tim Holy)
31. Dihui Lai (PhD, Physics, Spring 2012; PI: Ralf Wessel)
32. Matt Rycnega (PhD, Biomedical Engineering, Spring 2011; PI: Younan Xia)
33. Weiyang Li (PhD, Biomedical Engineering, Fall 2011; PI: Younan Xia)
34. Justin Brooks (PhD, Biomedical Engineering, Spring 2011; PI: Kurt Thoroughman)
35. Claire Cobley (PhD, Biomedical Engineering, Fall 2010; PI: Younan Xia)
36. Scott Burns (MS, Biomedical Engineering, Spring 2010; PI: Dennis Barbour)
37. Debajit Saha (PhD, Physics, Fall 2010; PI: Ralf Wessel)

- **Undergraduate Students**

1. Grayson Derossi (Fall 2020 – present)
2. Brittany Patrick (Fall 2021 – Spring 2021)
3. Elijah Korneffel (Summer 2019 – present)
4. Prajwal Keranahalli (Summer 2018 – Spring 2019)
5. Anxu Wang (Summer 2018)
6. Charlotte Merzbacher (Summer 2017; Amgen Scholar)
7. Ray Lo (Summer 2016 – Fall 2018)
8. Alex Chen (Summer 2016 – Spring 2018)
9. Daniel Lerner (Summer 2015)
10. William Padovano (Fall 2013 – Spring 2015)
11. Adele Lube (Summer 2013 – present)
12. Steve Peterson (Summer 2013 – Spring 2014)
13. David Yang (Summer 2011 – Summer 2013)
14. Alex Yang (Summer 2011)
15. Ghaidan Shamsan (Summer 2010)
16. Isabelle Heye (Summer 2010)
17. Vrinda Gaba (Summer 2010)
18. Leran Firer (Summer 2010)
19. Nikhil Shankar (at NIH, Summer'08)

20. Jeff Tang (at NIH, Summer'06)
21. Ella Wellman (at Texas A&M University, Summer 2005).

- **High-school Students**

1. J. J. Adler (Spring 2018 – present)
2. Minerva Pappu (Summer 2017)
3. Shaun Anastasio (Summer 2017)
4. Sarah Widder (Summer 2015)

- **Research Rotation Students**

1. Tom McGrath (Fall 2020)
2. Logan Collins (Fall 2020)
3. Pratyush Ramakrishna (Fall 2018)
4. Suyash Harlalaka (Fall 2017)
5. Eric Zhang (Fall 2017)
6. Drew Sinha (Summer 2015)
7. Ahana Gangopadhyay (Spring 2015)
8. Tyler Schlichenmeyer (Fall 2014)
9. Richard Hauser (Spring 2013)
10. Li Xia (Fall 2012)
11. Cody Greer (Fall 2012)
12. Li Xia (Fall 2012)
13. Haoyang Rong (Fall 2012)
14. Wensheng Sun (Spring 2012)
15. Riyue Ni (Summer 2011)
16. Mrinal Pahwa (Fall 2010)
17. John Landes (Fall 2010)
18. Piyush Karande (Summer 2010)

- **Lab Technician**

1. Yelzevetta Bessanova (Fall 2020 – present)
2. James Li – (Spring 2020 – present)
3. Greg Siegel (Summer 2010 – Summer 2011)

### **3.2 DEPARTMENT LEVEL COMMITTEE SERVICE**

- Chair of Adhoc Tenure Evaluation Committee for Jai Rudra 2021
- Research & Infrastructure committee 2014 – 2016
- BME Graduate seminar series coordinator 2015, 2016
- BME Faculty search committee 2016, 2017, 2018, 2019

### **3.3 UNIVERSITY LEVEL COMMITTEE SERVICE**

- Launching an interdisciplinary center – Center for Cyborg & BioRobotics Research (CCBR) along with Drs. Shantanu Chakrabartty, Srikanth Singamaneni, & Yehuda Ben-Shahar. The Center will official being operations in Fall 2019
- Instrumentation grant (DURIP) to set up a light-sheet functional imaging core facility in the school of engineering and applied sciences
- Tenure clock policy committee 2018
- DBBS graduate student admissions committee 2014 – 2017
- Computer Science Faculty Search Committee 2013
- MEMS Faculty search committee 2017

### **3.4 SERVICE TO SCIENTIFIC COMMUNITY**

#### **JOURNAL PEER REVIEW**

- Neuron, Nature communications, Cell, Elife, Journal of Neuroscience, Physical Review E, PLoS Genetics, PLoS One, Journal of Physical Chemistry, Neurocomputing, Sensors & Actuators (B), IEEE Sensors Journal, Proceedings of the Royal Society A, Journal of Bioinspiration & Biomimetics, Medical & Biological Engineering & Computing Journal, International Joint Conference on Neural Networks, International Symposium on Olfaction and Electronic Nose.
- Technical committee – World Congress on Computational Intelligence 2008
- Technical Program Committee member – International Symposium on Olfaction and Electronic Nose, 2015, 2017, 2019
- Editorial Board Member – Scientific Reports (NPG, 2016 – present)

#### **GRANT PEER REVIEW**

- NIH NINDS – Brain Initiative U19 panelist (2017, 2018, 2019)
- Air Force Office of Scientific Research
- Vienna Science and Technology Fund
- **NSF Panelist** - Robust Intelligence, Division of Information & Intelligent Systems
- **NSF Panelist** – Neural Cluster, Biology Directorate

#### **ACTIVE MEMBERSHIPS IN SCIENTIFIC SOCIETY**

- Member of the Society for Neuroscience
- Invited member of the task force on IEEE Computational Intelligence for Chemometrics and Chemical Sensing

### **3.5 OUTREACH ACTIVITIES**

- Talks in public forums
  - *St. Louis Zoo – ‘The Sweet Smell of Science.’*
  - *Science on Tap – ‘Understanding and Hijacking the Insect’s Sense of Smell.’*
- Summer 2014 – Participant of the Center of Biological and System’s Engineering outreach INSPIRE program (Integrating Numerical and Scientific Programming into Biological Research and Engineering) for rising high-school students. Organizer: Dr. Pappu, Washington University
- Fall 2010 – Fall 2018 (9 years) – Participated as an instructor in the “Moving and Shaking ... an Introduction to Engineering” program for middle school students. This program is organized by Dr. Sakiyama- Elbert and Dr. Ruth Okamoto at Washington University and supported by the Gifted Resource Council (GRC) of St. Louis.