

## Francesco Tenore

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### Education

Ph.D. in Electrical Engineering, February 2008  
Johns Hopkins University, Baltimore, MD, USA. Thesis title: "Biomorphic Circuits and Systems: Control of Robotic and Prosthetic Limbs"

M.S.E. in Computer Engineering, May 2002  
Johns Hopkins University, Baltimore, MD, USA

Italian Laurea in Electronics Engineering, October 2000,  
Università degli Studi di Trieste, Trieste, Italy

### Professional Experience

Johns Hopkins Applied Physics Laboratory Laurel, MD, USA  
Professional Staff 2008-present  
Team lead for Revolutionizing Prosthetics 2009 Phase II Neural Recording/Stimulating Devices.  
Responsible for:

- Determination of requirements for next-generation Utah electrode array and Utah slanted electrode array implantable neural interface (UEA/USEA-INI) recording and stimulating devices (UEA-R, UEA-S, USEA-R, USEA-S)
- Determination of requirements for next-generation implantable myoelectric sensors devices (IMES)
- Determination of requirements for electrocorticographic implantable neural interface recording device (ECoG-INI)
- Verification and traceability of each implantable device
- Design Basis Documents for all implantable devices.

Tommasi and Tommasi America, LLC. Baltimore, MD, USA  
Technical Consultant 2007-Present  
<http://www.tommasitommasi.com>.

- Assist with development of the company's core technology and a long-term strategy for it.

Iguana Robotics, Inc. Urbana, IL, USA  
Research Engineer Summer, 2004  
Investigation of phase relationships between limbs for different gait patterns to be implemented on chips. Experiments with biped robot with four actuated limbs (2 "hips", 2 "knees")

### Research Experience

Johns Hopkins University Laurel, MD, USA  
Applied Physics Laboratory  
Postdoctoral Fellow 2008-present  
*Stuart Harshbarger*.

- Non-invasive surface myoelectric signal decoding of individuated finger movements on transradial amputees and able-bodied subjects

- Real-time hardware characterization and implementation for decoding surface myoelectric signals

Johns Hopkins University Baltimore, MD, USA  
 Computational Sensorimotor Systems Laboratory  
 Research Assistant 2002-2008  
*Prof. Ralph Etienne-Cummings.*

- Control of locomotion using custom-designed neuromorphic silicon aVLSI chips.
- Implementation of networks used in lower-limb neuroprostheses.

Johns Hopkins University Baltimore, MD, USA  
 Biomedical Instrumentation Laboratory  
 Research Assistant March 2006 - present  
*Prof. N. Thakor and Prof. Ralph Etienne-Cummings. DARPA Revolutionary Prosthetics 2009.*

- Asynchronous decoding of cortical signals for real-time control of upper-limb prosthesis in monkey.
- Classification of individual finger movements in able bodied subjects.

Telluride Neuromorphic Engineering Workshop Telluride, CO, USA  
 Invited student Summer 2002, 2004  
 Workshop for Neuromorphic Engineering. Focus on Floating-gate and Locomotion workgroups.

## Teaching

Johns Hopkins University Baltimore, MD, USA  
 Teaching Assistant Fall 2001 - Fall 2002, Fall 2005  
 520.353: Control Systems, Dr. Nael Osman  
 520.216: Introduction to VLSI, Dr. Philippe Pouliquen  
 520.490: Analog and Digital VLSI Systems and Architecture, Prof. Gert Cauwenberghs  
 520.491: CAD Design of Digital VLSI, Prof. Ralph Etienne-Cummings

## Peer-Reviewed Publications

**F. Tenore**, A. Ramos, A. Fahmy, S. Acharya, R. Etienne-Cummings, N. V. Thakor. Decoding of individuated finger movements using surface Electromyography. *Accepted for publication on IEEE Transactions on Biomedical Engineering*, Aug. 2008.

**F. Tenore**, R. J. Vogelstein, L. Guevremont, R. Etienne-Cummings, and V. K. Mushawar. A Silicon Central Pattern Generator Controls Locomotion in vivo . *IEEE Transactions on Biomedical Circuits and Systems*, 2(3), pp. 212-222, 2008.

**F. Tenore**, R. Etienne-Cummings. Biomorphic circuits and systems: control of robotic and prosthetic limbs. *Special session: Ph.D. in a Nutshell - IEEE Biomedical Circuits and Systems Conference*, Nov. 2008.

**F. Tenore**, S. Acharya, V. Aggarwal, R. Etienne-Cummings, N. V. Thakor. Decoding Individuated Finger Movements Using Volume-Constrained Neuronal Ensembles in the M1 Hand Area. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 16(1), 15-23, 2008.

V. Aggarwal, S. Acharya, **F. Tenore**, H. C. Shin, R. Etienne-Cummings, N. V. Thakor. Asynchronous Decoding of Dexterous Finger Movements using M1 Neurons. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 16(1), 3-14, 2008.

- F. Tenore**, R. Armiger, R.J.Vogelstein, D. Wenstrand, K. Englehart, S. Harsbarger. An Embedded Controller for a 7-Degree of Freedom Prosthetic Arm. *Proc. IEEE Engineering in Medicine and Biology Conference*, Aug. 2008.
- R. Smith, **F. Tenore**, D. Huberdeau, R. Etienne-Cummings, N. Thakor. Continuous Decoding of Finger Position from Surface EMG Signals for the Control of Powered Prostheses *Proc. IEEE Engineering in Medicine and Biology Conference*, Aug. 2008.
- A. Russell, **F. Tenore**, G. Singhal, N. Thakor, R. Etienne-Cummings. Towards Control of Dexterous Hand Manipulations Using a Silicon Pattern Generator. *Proc. IEEE Engineering in Medicine and Biology Conference*, Aug. 2008.
- F. Folowosele, **F. Tenore**, A. Russell, G. Orchard, M. Vismer, J. Tapson, R. Etienne-Cummings. Implementing a Neuromorphic Cross Correlation Engine with Silicon Neurons. *Proc. IEEE International Symposium on Circuits and Systems*, May 2008.
- G. Orchard, A. Russell, K. Mazurek, **F. Tenore** and Ralph Etienne-Cummings. Configuring Silicon Neural Networks Using Genetic Algorithms. *Proc. IEEE International Symposium on Circuits and Systems*, May 2008.
- F. Tenore**, R. J. Vogelstein, R. Etienne-Cummings. Sensor-based Dynamic Control of the Central Pattern Generator for Locomotion. *Proc. IEEE International Symposium on Circuits and Systems*, May 2007.
- F. Tenore**, A. Ramos, A. Fahmy, S. Acharya, R. Etienne-Cummings, N. V. Thakor. Towards the Control of Individual Fingers of a Prosthetic Hand Using Surface EMG Signals. *Proc. IEEE Engineering in Medicine and Biology Conference*, Aug. 2007.
- F. Tenore**, R. J. Vogelstein, R. Etienne-Cummings, M. A. Lewis, N. V. Thakor, and A. H. Cohen. Dynamic Control of the Central Pattern Generator for Locomotion. *Biological Cybernetics* 95(6), 555-566, 2006.
- F. Tenore**, R. J. Vogelstein, R. Etienne-Cummings, M. A. Lewis, G. Cauwenberghs, and P. Hasler. A Floating Gate Programmable Array of Silicon Neurons. *Proc. IEEE International Symposium on Circuits and Systems*. May 2006
- F. Tenore**, R. J. Vogelstein, R. Etienne-Cummings, M. A. Lewis, G. Cauwenberghs, and P. Hasler. A spiking silicon Central Pattern Generator with floating gate synapses. *Proc. IEEE International Symposium on Circuits and Systems*, 2005.
- M. A. Lewis, **F. Tenore**, and R. Etienne-Cummings. CPG design using Inhibitory Networks. *Proc. IEEE International Conference on Robotics and Automation*, 2005.
- F. Tenore**, R. Etienne-Cummings, and M. A. Lewis. A Programmable Array of Silicon Neurons for the Control of Legged Locomotion. *IEEE Proc. of the International Symposium on Circuits and Systems*, 2004.
- F. Tenore**, R. Etienne-Cummings, and M. A. Lewis. Entrainment of Silicon Central Pattern Generators for Legged Locomotory Control. *Advances in Neural Information Processing Systems* 16. Cambridge, MA: MIT Press.
- R. J. Vogelstein, **F. Tenore**, R. Philipp, M. S. Adlerstein, D. H. Goldberg, and G. Cauwenberghs, 2003. Spike Timing-Dependent Plasticity in the Address Domain. In Becker, S, Thurn, S, and Obermayer, K. *Advances in Neural Information Processing Systems* 15. Cambridge, MA: MIT

Press.

### Manuscripts in Preparation

A. Ramos Murguialday, **F. Tenore**, A. Fahmy, R. Etienne-Cummings, and N. V. Thakor. Independent Component Analysis for optimal placement of ElectroMyoGraphic electrodes for controlling individual fingers of prosthetic hands. *IEEE Transactions on Biomedical Engineering*.

**F. Tenore**, A. Ramos Murguialday, R. Etienne-Cummings, and N. V. Thakor. Real-time decoding of individual finger movements using surface Electromyography.

### Presentations and Demonstrations

*An Embedded Controller for a 7-Degree of Freedom Prosthetic Arm*. IEEE Engineering in Medicine and Biology Conference. Vancouver, CA, Aug. 2008.

*Towards Control of Dexterous Hand Manipulations Using a Silicon Pattern Generator*. IEEE Engineering in Medicine and Biology Conference, Vancouver, CA. Aug. 2008.

*Using Real-time Finger Tracking to Detect User Errors*. North East BioEngineering Conference, Providence, RI, April 2008, **Honorable mention**.

*Sensor-based Dynamic Control of the Central Pattern Generator for Locomotion*. International Symposium on Circuits and Systems, New Orleans, LA, May 2007.

*A Floating Gate Programmable Array of Silicon Neurons*. International Symposium on Circuits and Systems, Kos, Greece, May 2006.

*Bipedal walking robot controlled by an array of silicon neurons*. Demo for the International Symposium on Circuits and Systems, Kos, Greece, May, 2006.

*Analog Central Pattern Generator Chip Control of a Biped Robot*. Demo for the Neural Information Processing Systems Conference, December 2005.

*A Programmable Array of Silicon Neurons for the Control of Legged Locomotion*. International Symposium on Circuits and Systems, Vancouver, BC, May, 2004

*Entrainment of Silicon Central Pattern Generators for Legged Locomotory Control*. Neural Information Processing Systems Conference, Vancouver, BC, December 2003.

### Journal Reviewing

IEEE Transactions on Biomedical Circuits and Systems (2007-Present)

IEEE Transactions on Circuits and Systems (I) (2006-Present)

IEEE Transactions on Neural Systems and Rehabilitation Engineering (2006-Present)

IEEE Transactions on Neural Networks (2005-Present)

### Awards and Memberships

Winner: Best work in “Ph.D. in a Nutshell”, Biomedical Circuits and Systems Conference, Baltimore, MD, Nov. 2008.

Neuroengineering Training Grant recipient, 2005-2006.

University of Trieste Fellowship, Trieste, Italy, 1997-1999.

Member, IEEE.

### **Computer Skills and Languages spoken**

Computer Skills and CAD tools: Cadence (Analog Artist, Virtuoso, divaDRC, divaLVS), Verilog, VHDL, Protel, Mentor Graphics (and most PCB CAD tools), Telelogic Doors, Matlab, Assembly, Visual C++, HTML, Pascal, Unix, Linux, L<sup>A</sup>T<sub>E</sub>X

Languages: **English** (native), **Italian** (native), advanced Spanish.

### **Other interests and hobbies**

Soccer, Swimming, Piano, Tennis, Biking, Hiking, Traveling, Eating (or, rather, Eating Well), Etymology of Words, Philosophy, History, Beating the S&P 500

### **Citizenship**

United States, Europe (Italy)

*Note: References can be sought from Profs. Ralph Etienne-Cummings (retienne@jhu.edu) and Nitish Thakor (nitish@jhu.edu) and Andreas Andreou (agagroup@olympus.ece.jhu.edu). Other references available upon request.*