## BIOGRAPHICAL SKETCH

| NAME<br>**Vasilis Z. Marmarelis** | POSITION TITLE<br>**Professor, Biomedical Engineering** |
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| eRA COMMONS USER NAME<br>**uscbmsr** | |

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | MM/YY | FIELD OF STUDY |
|---|---|---|---|
| **National Technical University of Athens** | **Diploma** | **1972** | **Electrical & Mechanical Engineering** |
| **California Institute of Technology** | **M.S.** | **1973** | **Information Science** |
| **California Institute of Technology** | **Ph.D.** | **1976** | **Engineering Science (Biosystems Analysis)** |

### A. Personal Statement

My primary research interest for 40 years has been the credible modeling of dynamic nonlinear physiological systems. Starting in 1978 with the publication of the seminal monograph on White-Noise Analysis of Physiological Systems (co-authored with my brother Panos and translated in Russian in 1981 and Chinese in 1990), I have compiled a long record of contributions to this subject. My recent monograph (2004) on the same subject presented comprehensively our progress over 30 years (1974-2004) and laid the foundation for subsequent innovative advancements, which we proudly present in this application. Most of this work has been supported by successive P41 awards to the Biomedical Simulations Resource (BMSR) at USC since 1985. The results of this long-record of cutting-edge, innovative research have influenced and inspired numerous investigators who have adopted some of the developed methodologies and, perhaps more importantly, some of the intellectual/scientific viewpoints advanced by our work. This record of success and innovation continues during the current funding cycle of the BMSR, directed towards the "capstone objective" of demonstrating the utility of the developed modeling methodologies for the advancement of medical science and clinical practice. The basic tenet of my work is that biomedical system modeling has critical importance both for scientific advancement and clinical innovation. Our modeling goals are pursued by analyzing sets of time-series data/measurements, typically collected under natural operating conditions, in a dynamic and nonlinear context. The obtained "nonparametric" data-based models are used to advance our scientific understanding of the subject system or to guide the collection of new types of time-series data that allow the development and testing of mechanism-based models. The latter ought to be amenable to meaningful interpretation in order to advance the state of the art and, most importantly, to enable innovative approaches to clinical diagnosis and treatment. It is the latter objective that currently drives much of our agenda, since our results to date on clinical applications corroborate the potential utility of our approach and portend a future of scientific discovery and valuable clinical impact.

### B. Positions and Honors

**Positions and Employment**

1976-1978 Lecturer and Research Fellow in Bioinformation Systems, California Institute of Technology
1978-1983 Assistant Professor of Biomedical & Electrical Engineering, University of Southern California
1983-1988 Associate Professor of Biomedical & Electrical Engineering, University of Southern California
1988- Professor of Biomedical & Electrical Engineering, University of Southern California

1990-1996 Chairman of Biomedical Engineering Department, University of Southern California
1985-2003 Founder & Director of the Biomedical Simulations Resource, University of Southern California
2003- Co-Director of Biomedical Simulations Resource, University of Southern California

**Other Experience and Professional Memberships**

1976- Member, IEEE Engineering in Medicine & Biology Society
1978- Member, Biomedical Engineering Society
1988 Editor of Special Issue of the Annals of Biomedical Engineering on Nonlinear Modeling
1990-1999 Associate Editor of the Annals of Biomedical Engineering
2011 Co-Editor of Special Issue of the IEEE Trans. on BME on Multi-scale System Modeling

Journal Reviewer for: Annals of Biomedical Engineering, IEEE Trans. on Biomedical Engineering, American Journal of Physiology, Journal of Applied Physiology, Mathematical Biosciences, Hearing Research, Brain Research, Biophysical Journal, Journal of Neurophysiology, Journal of Computational Neuroscience.
Grant Reviewer for: NIH Study Sections on Modeling & Analysis of Biomedical Systems, and on Multi-Scale System Modeling, NSF Bioengineering grant applications, Medical Research Council of Canada.
Professional Conferences: Member of Conference Program Committees and Chair/Organizer of Conference Sessions, Organizer of Workshops and Short-Courses on Biomedical System Modeling.

**Honors**

Fellow of the Institute of Electrical and Electronics Engineers
Fellow of the American Institute of Medical and Biological Engineers

**C. Selected publications**

***Books***

Marmarelis, P.Z., and V.Z. Marmarelis. *Analysis of Physiological Systems: The White-Noise Approach*. Plenum Press, New York, 1978. *Russian translation*: Mir Press, Moscow, 1981. *Chinese translation*: Academy of Sciences Press, Beijing, 1990.

Marmarelis, V.Z. (ed.) *Advanced Methods of Physiological System Modeling*. Volumes I, II and III, Plenum, NY, 1987, 1989 and 1994.

Marmarelis, V.Z. *Nonlinear Dynamic Modeling of Physiological Systems*. Wiley Interscience, NJ, 2004.

***Selected Journal Articles*** **(from a total of 208 peer-reviewed publications)**

Marmarelis, V.Z. Signal transformation & coding in neural systems. *IEEE Trans. Biomed. Eng.* **36**:15-24, 1989

Marmarelis, V.Z. Identification of nonlinear biological systems using Laguerre expansions of kernels. *Annals of Biomed. Eng.* **21**:573-589, 1993. .

Marmarelis, V.Z., and M.E. Orme. Modeling of neural systems by use of neuronal modes. *IEEE Trans. Biomed. Eng.* **40**:1149-1158, 1993.

Marmarelis, V.Z. Modeling methodology for nonlinear physiological systems. *Annals of Biomed. Eng.* **25**:239-251, 1997.

Marmarelis, V.Z. and T.W. Berger: General methodology for nonlinear modeling of neural systems with Poisson point-process inputs. *Mathematical Biosciences* **196**:1-13, 2005.

Zanos, T.P., S.H. Courellis, R.E. Hampson, S.A. Deadwyler, T.W. Berger and V.Z. Marmarelis. Nonlinear modeling of causal interrelationships in neuronal ensembles. *IEEE Transactions on Neural Systems & Rehabilitation Engineering* **16**(4):336-352, 2008.

Marmarelis, V.Z., T.P. Zanos, and T.W. Berger. Boolean modeling of neural systems with point-process inputs and outputs. Part I: Theory and simulations. Part II: Application to the rat hippocampus. *Annals of Biomed. Eng.* **37**: 1654-1682, 2009.

Berger T.W., D. Song, R. H. M. Chan and V. Z. Marmarelis. The neurobiological basis of cognition: Identification by multi-input, multi-output nonlinear dynamic modeling. *Proceedings of the IEEE* **98:** 356-374, 2010. PMCID:PMC2917774

Berger T.W., R.E. Hampson, D. Song, A. Goonawardena, V.Z. Marmarelis and S.A. Deadwyler. A cortical neural prosthesis for restoring and enhancing memory. *J Neural Eng.* **8**:1-12, 2011.

Berger T.W., D. Song, R. H.M. Chan, V.Z. Marmarelis, *Fellow*, R.E. Hampson, S.A. Deadwyler, J. LaCoss, J. Wills, J.J. Granacki. A hippocampal cognitive prosthesis: Multi-Input, Multi-Output nonlinear modeling and VLSI implementation. *IEEE Trans. Neural Systems & Rehab. Eng.* **20:**198-211, 2012.

Hampson R. E., Song, D., Chan, R. H. M., Sweatt, A. J., Fuqua, J., Gerhardt, G. A., Shin, D., Marmarelis, V. Z., Berger, T. W., & Deadwyler, S. A. A nonlinear model for hippocampal cognitive prosthesis: Memory facilitation by hippocampal ensemble stimulation. *IEEE Trans. Neural Systems & Rehab. Eng.* **20**:184-197, 2012.

Hampson R. E., Song D., Chan R. H. M., Sweatt, A. J., Riley, M. R., Goonawardena, A. V., Marmarelis, V. Z., Gerhardt, G. A., Berger, T. W., & Deadwyler, S. A. Closing the loop for memory prostheses: Detecting the role of hippocampal neural ensembles using nonlinear models. *IEEE Trans. Neural Syst & Rehab. Eng.* **20**:510-525, 2012.

Zanos S., T.P. Zanos, V. Z. Marmarelis, G. A. Ojemann, E.E. Fetz. Relationships between spike-free local field potentials and spike timing in human temporal cortex. *J Neurophysiol.* **107**:1808-1821, 2012.

Marmarelis V.Z., D.C. Shin and R. Zhang. Analysis of cerebral flow autoregulation using Principal Dynamic Modes: linear and nonlinear modeling. *Open Biomedical Eng. Journal* 6:42-55, 2012. PMID:PMC3377891

Marmarelis V.Z., D. C. Shin, D. Song, R. E. Hampson, S. A. Deadwyler and T. W. Berger. Design of optimal stimulation patterns for neuronal ensembles based on Volterra-type hierarchical modeling. *Journal of Neural Engineering* 9(6):066003, 2012. DOI:10.1088/1741-2560/9/6/066003. PMID: 23075519

Marmarelis V.Z., D. C. Shin, D. Song, R. E. Hampson, S. A. Deadwyler and T. W. Berger. Nonlinear modeling of dynamic interactions within neuronal ensembles using Principal Dynamic Modes. *Journal of Computational Neuroscience* 34(1):73-87, 2013. DOI 10.1007/s10827-012-0407-7. PMID: 23011343

Eikenberry S.E. and V.Z. Marmarelis. A nonlinear auto-regressive Volterra model of the Hodgkin-Huxley equations. *Journal of Computational Neuroscience* 34(1):163-173, 2013. DOI 10.1007/s10827-012-0412-x. PMID: 22878687

Marmarelis V.Z., D.C. Shin, M.E. Orme and R. Zhang. Closed-loop dynamic modeling of cerebral hemodynamics. *Annals of Biomedical Engineering* 41:1029-1048, 2013. DOI: 10.1007/s10439-012-0736-8.

Marmarelis V.Z., D.C. Shin, M.E. Orme and R. Zhang. Time-varying dynamic modeling of cerebral hemodynamics. *IEEE Trans. on Biomedical Engineering (in press).*

Marmarelis V.Z., D. C. Shin, Y. Zhang, A. Kautzky-Willer, G. Pacini and D.Z. D'Argenio. Analysis of intravenous glucose tolerance test data using parametric and nonparametric modeling. *Diabetes Science & Technology (in press).*

Marmarelis V.Z., D.C. Shin, M.E. Orme and R. Zhang. Model-based quantification of cerebral hemodynamics as a physiomarker for Alzheimer's disease. *Annals of Biomedical Engineering (in press).*

**D. Research Support**

**Ongoing Research Support**

P41 EB001978 D'Argenio/Marmarelis (Co-PIs) 9/1/2008 – 8/31/2013
NIBIB/NIH
*Biomedical Simulations Resource (BMSR)*
The BMSR is dedicated to the advancement of the state of the art in biomedical modeling and simulation through Technological Research/Development and Collaborative Research projects. It also seeks to disseminate this knowledge and related software through Service, Training and Dissemination activities aimed at the broader biomedical community.
*Role: Co-PI*

N66001-02-C-8057 Berger (PI) 9/24/2009 – 6/29/2013
Defense Advanced Research Projects Agency
*Restoration and Enhancement of Memory Function*
The goal of this project is to develop model-based neurostimulation techniques for the restoration and enhancement of memory related to hippocampal function during motor/navigation tasks.
*Role: Co-PI*

EEC-0310723 Humayan (PI)) 9/1/2003 - 8/31/2014
National Science Foundation
*Engineering Research Center for Biomimetic MicroElectronics Systems*
The goal of this project is to develop modeling methodologies that assist the effective and efficient design of "biomimetic" microelectronic systems that emulate the function of neural systems for the purpose of neural prostheses and neurostimulation devices.
*Role: Co-Investigator*

**Recently Completed Research Support**

P41 EB001978 D'Argenio/Marmarelis (Co-PIs) 9/1/2003 - 8/31/2008
NIBIB/NIH
*Biomedical Simulations Resource (BMSR)*
The BMSR is dedicated to the advancement of the state of the art in biomedical modeling and simulation through Technological Research/Development and Collaborative Research projects. It also seeks to disseminate this knowledge and related software through Service, Training and Dissemination activities aimed at the broader biomedical community.
*Role: Co-PI*

N66001-02-C-8057 (PI: Berger) 6/27/2002-02/25/2007
DARPA
*Brain-Implantable Biomimetic Electronics for Restoration and Augmentation of Cognitive Function*
The goal of this project was to develop model-based strategies for the design of brain-implantable prostheses for restoration and enhancement of cognitive function in behaving rodents.
*Role: Co-PI*