Toward Brain-Machine Interfaces for the Treatment of Neurological Injuries and Diseases: Predictive Multiscale Computational Electromagnetic Modeling for Bioelectric Activity and Neuroimplant Design

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Abstract

Although technical challenges are still daunting, the clinical utility of neuroprosthetics has increased dramatically over the past few years. This has been accomplished through the convergence of numerous disciplines, which have individually added fundamental understanding/capabilities to systems that interface with the human body to restore senses and movement, or treat prevalent diseases that have currently no foreseeable cure. Among these, predictive multiscale computational modeling methods have greatly aided in the design of neuroprosthetics by embracing the complexity of the nervous system, which span multiple spatial scales, temporal scales, and disciplines. In this talk, we will cover some of the recent advances in neuroprosthetics, with a focus on systems such as an artificial retina to restore vision to the blind and a hippocampus prosthetic system for memory restoration. The role of computational electromagnetics in the design of these systems will be covered. Further, multiscale computational electromagnetic methods employed to elucidate mechanisms of action behind newly proposed therapeutic treatments for incurable eye diseases and other degenerative conditions will be discussed.

Biography

Gianluca Lazzi, PhD MBA is a Provost Professor of Ophthalmology, Electrical Engineering, Clinical Entrepreneurship and Biomedical Engineering at the University of Southern California (USC) where he is also the holder of the Fred H. Cole Professorship and the Director of the newly established Institute for Technology and Medical Systems (ITEMS), a newly established joint initiative of the Keck School of Medicine and the Viterbi School of Engineering. He has authored or coauthored more than 250 international journal papers, conference presentations, and book chapters on implantable devices, neuroengineering, medical applications of electromagnetics, wireless telemetry, antenna design, computational modeling, dosimetry, and bioelectromagnetics.

Dr. Lazzi currently serves as the Chair of the Fellow Committee of the IEEE EMBS, a member of the Editorial Board of IEEE Access, and a Guest Editor of the Special Issue on "Wireless Real-time Health Monitoring Technology for Personalized Medicine," recently published in the *IEEE Transactions in Antennas and Propagation* (2019). He served as Editor-in-Chief of the *IEEE Antennas and Wireless Propagation Letters* from 2008 to 2013; Guest Editor for the Special Issue on "Biological Effects and Medical Applications of RF/Microwaves" of the *IEEE Transactions on Microwave Theory and Techniques* in 2004; Technical Program Chair of the *IEEE Antennas and Propagation International Symposium and URSI meetin*g in Charleston, SC, USA, in 2009; Member of the Editorial Board of the *Proceedings of the IEEE*; Chair of the

IEEE Sensors Council Fellow Committee; Chair of the Publications Committee of the IEEE AP Society and VP Publications of the IEEE Sensors Council; and Chair of the USNC-URSI Commission K. In 2014, he was the General Co-Chair of the *IEEE Microwave Symposium on RF and Wireless Technologies for Biomedical Applications*.

Dr. Lazzi is a Fellow of the IEEE, a Fellow of the American Institute for Medical and Biological Engineering (AIMBE), and a Fellow of the National Academy of Inventors (NAI). is the recipient of the 1996 Curtis Carl Johnson Memorial Award from the Bioelectromagnetics Society, the 1996 URSI Young Scientist Award, the 2001 Whitaker Foundation Biomedical Engineering Grant for Young Investigators, the 2001 National Science Foundation CAREER Award, the 2003 NCSU Outstanding Teacher Award, the 2003 NCSU Alumni Outstanding Teacher Award, the 2003 ALCOA Foundation Engineering Research Award, the 2006 H.A. Wheeler Award from the IEEE Antennas and Propagation Society for the best application paper published in the *IEEE Transactions in Antennas and Propagation* in 2005, the 2008 Best Paper Award at the IEEE GlobeCom Conference, the 2009 ALCOA Foundation Distinguished Engineering Research Award, the 2009 R&D 100 Award, and the 2009 Editors Choice Award from the R&D Magazine for the Artificial Retina Project. In 2015, he co-founded Teveri LLC, which is focused on the commercialization of liquid metal technology for textile, consumer electronics, and military applications.