"Technologies for Wireless Biosystems"

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Wireless technologies play two important roles in a wide variety of biosystems: 1) powering the biosystem either directly or indirectly by charging energy storage devices 2) communicating with the biosystem for command and control or data acquisition. Implantable microelectronic devices (IMD) is a rapidly growing category of biosystems, where the use of wireless technology is a necessity, particularly on the clinical side. In this tutorial I will address the key issues that need to be considered when utilizing wireless technologies for boisystem applications, with an emphasis on the IMDs. IMDs have been quite successful in neuroprosthetic devices, such as cochlear implants and deep brain stimulators. They are also being considered for brain-computer interfacing (BCI) to enable individuals with severe physical disabilities to control their environments, particularly by accessing computers. I will give numerous examples of how we are pushing the limits on developing key building blocks for state-of-the-art IMDs, particularly on the RF powering, power management, and bidirectional communication. At the GT-Bionics lab, we pursue implantable BCIs as advanced tools for neuroscience research on small freely behaving animal subjects. An example of these applications is a smart cage, which can wirelessly power, communicate with, and track IMDs implanted in or attached to small freely behaving animals. At the same time, we are exploring novel minimally invasive methods for individuals with severe paralysis to make the best use of their remaining abilities to control their environments. An example of such technologies is a wireless and wearable brain-tongue-computer interface (BTCI), also known as the Tongue Drive System (TDS), which enables individuals with quadriplegia to control their environments using their voluntary tongue motion.

Maysam Ghovanloo received the B.S. degree in electrical engineering from the University of Tehran, and the M.S. degree in biomedical engineering from the Amirkabir University of Technology, Tehran, Iran in 1997. He also received the M.S. and Ph.D. degrees in electrical engineering from the University of Michigan, Ann Arbor, in 2003 and 2004.

Dr. Ghovanloo developed the first modular Patient Care Monitoring System in Iran where he also founded Sabz-Negar Rayaneh Inc. to manufacture physiology and pharmacology research laboratory instruments. From 2004 to 2007 he was an assistant professor in the Department of ECE at the North Carolina State University, Raleigh, NC. Since 2007 he has been with the Georgia Tech School of Electrical and Computer Engineering, where he is an associate professor, the ON Semiconductor Junior Faculty Chair, and the founding director of the GT-Bionics Lab. He has authored or coauthored more than 100 peer-reviewed conference and journal publications on implantable microelectronic devices, integrated circuits and microsystems for neural interfacing, and modern assistive technologies.

Dr. Ghovanloo is an Associate Editor of the *IEEE Transactions on Biomedical Engineering* (2010-present) and *IEEE Transactions on Biomedical Circuits and Systems* (2011-present). He also served as an Associate Editor of *IEEE Transactions on Circuits and Systems*, *Part II* (2008-2011), as well as a Guest Editor for the *IEEE Journal of Solid-State Circuits* in 2011 and *IEEE Transactions on Neural Systems and Rehabilitation Engineering* in 2012. He has been serving on the Imagers, MEMS, Medical and Displays subcommittee of the *International Solid-State Circuits Conference* (ISSCC) since 2009. He has received the National Science Foundation CAREER Award, the Tommy Nobis Barrier Breaker Award for Innovation, and Distinguished Young Scholar Award from the Association of Professors and Scholars of Iranian Heritage.