

	Speaker	Chung-Yu (Peter) Wu
	Talk Title	Circuit and System Design in Implantable Closed-Loop Neuro-Prosthetic Systems for Epilepsy
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1. Tentative Abstract

Neuro-Prostheses and the related implantable electronics devices which treat intractable neurological disorders have become exciting research frontiers. In neuro-prosthetic devices, intelligent biomimetic circuits or subsystems are developed with heterogeneous integration of technologies to recover or enhance the neural functions. Many innovative circuits or subsystems have been explored to fit the strict requirement.

Epilepsy is defined as a tendency to have recurrent seizures. An epileptic seizure is caused by a sudden burst of excess electrical activity in the brain. 70 million people have epilepsy worldwide. It is possible to use electrical stimulation or neuro-modulation to suppress epileptic seizures through implantable stimulation systems. An implantable closed-loop neuro-prosthetic system for epilepsy is developed. It consists of an intraocular SOC (System-On-Chip) chip with sensors/stimulators, bio-signal processing, RF transceiver, and inductive power unit and extraocular part with RF transceiver and inductive coils. The system detects patient's ECoG and automatically generates electrical pulses to suppress epileptic seizures. The innovative circuits and subsystems will be presented and discussed. Finally, future research challenges and perspectives will be discussed.

2. Brief Biography

Dr. Chung-Yu (Peter) Wu (1998 IEEE Fellow) is Chair Professor of National Chiao Tung University (NCTU) and Program Director of Biomedical Electronics Translational Research Center (BETRC), NCTU, Taiwan. He served as Vice President for Conferences in 2004 -2005, and

was a Board of Governor (BoG) member in 2003 in IEEE Circuit and System (CAS) Society. He was General Chair of 1994 IEEE APCCAS Conference. Dr. Wu served as Guest Editors of November 2003 Nanoelectronics Special Issue for the Proceedings of the IEEE and Aug. 1997 Multimedia Special Issue for IEEE Trans on CSVT, Dr. Wu is the founding Chair of Technical Committee on Nanoelectronics and Giga-scale Systems. He served as Chair of Neural Technical Committee and Multimedia Technical Committee. In regional activities area, Dr. Wu served as CAS Taipei Chapter Chair and IEEE Taipei Section Chair. In 2007-2011, Dr. Wu served as president of National Chiao Tung University and Program Director of National Program on System-on-Chip. Currently, Dr. Wu served as the President of Taiwan Engineering Medicine & Biology Association (TWEMBA) promoting biomedical device and biomedical electronics research and development.

The major research interest of Dr. Wu is in the areas of nanoelectronic circuits and systems for implantable medical devices such as artificial retina, close-loop stimulator for epilepsy, etc., RF wireless communication circuits, and intelligent sensors.

Dr. Wu is a recipient of MOE National Chair Professorship, IEEE Third Millennium Medal, a Fellow of IEEE, and also a U.S. Fulbright Scholar. He is a member of Eta Kappa Nu and Phi Tau Phi Honorary Scholastic Societies.

3. List of Representative Publications

1. [SCI][EI] Yan-Jun Huang, **Chung-Yu Wu**, Wong, A.M.-K., and Bor-Shyh Lin, "Novel Active Comb-Shaped Dry Electrode for EEG Measurement in Hairy Site," *IEEE Transactions on Biomedical Engineering*, vol. 62, no. 1, pp. 256-263, Jan. 2015.
2. [SCI][EI] **Chung-Yu Wu**, Xin-Hong Qian, Ming-Seng Cheng, Yu-An Liang, and Wei-Ming Chen, "A 13.56-MHz 40-mW CMOS High-Efficiency Inductive Link Power Supply Utilizing On-Chip Delay-Compensated Voltage Doubler Rectifier and Multiple LDOs for Implantable Medical Devices," *IEEE Journal of Solid-State Circuits*, vol. 49, no. 11, pp. 2397-2407, Nov. 2014.
3. [SCI][EI] Jui-Wen Pan, Chiang Che-Wen, Kuan-Da Huang, and **Chung-Yu Wu**, "Demonstration of a broad band spectral head-mounted display with freeform mirrors," *Optics Express*, vol. 22, no. 11, pp. 12785-12798, Jun. 2014. <http://dx.doi.org/10.1364/OE.22.012785>
4. [SCI] Syu-Jyun Peng, Tomor Harnod, Jang-Zern Tsai, Chien-Chun Huang, Ming-Dou Ker, Jun-Chern Chiou, Herming Chiueh, **Chung-Yu Wu**, and Yue-Loong Hsin, "Through diffusion tensor magnetic resonance imaging to evaluate the original properties of neural pathways of patients with partial seizures and secondary generalization by individual anatomic reference atlas," *BioMed Research International*, vol. 2014, Article ID 419376, 8 pages, May. 2014. doi:10.1155/2014/419376
5. [SCI][EI] Wei-Ming Chen, Herming Chiueh, Tsan-Jieh Chen, Chia-Lun Ho, Chi Jeng, Ming-Dou Ker, Chun-Yu Lin, Ya-Chun Huang, Chia-Wei Chou, Tsun-Yuan Fan, Ming-Seng Cheng, Yue-Loong Hsin, Sheng-Fu Liang, Yu-Lin Wang, Fu-Zen Shaw, Yu-Hsing Huang, Chia-Hsiang Yang, and **Chung-Yu Wu**, "A fully integrated 8-channel closed-loop neural- prosthetic CMOS SoC for real-time epileptic seizure control," *IEEE Journal of Solid-State Circuits*, vol. 49, no. 1, pp. 232-247, Jan. 2014.

6. [SCI][EI] **Chung-Yu Wu**, Wei-Ming Chen, and Liang-Ting Kuo, "A CMOS power-efficient low-noise current-mode front-end amplifier for neural signal recording," *IEEE Transactions on Biomedical Circuits and Systems*, vol. 7, no. 2, pp. 107-114, Apr. 2013.
7. [SCI][EI] Tai-You Lu, Chi-Yao Yu, Wei-Zen Chen, and **Chung-Yu Wu**, "Wide tuning range 60 GHz VCO and 40 GHz DCO using single variable inductor," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 60, no. 2, pp. 257-267, Feb. 2013.
8. [SCI] Chuan-Chin Chiao, Ya-Ting Yang, Yu-Ting Huang, Po-Kang Lin, and **Chung-Yu Wu**, "Neural responses evoked by electrical stimulation in solar cell based subretinal prosthesis," *Journal of Neuroscience and Neuroengineering*, vol. 1, no. 9, pp. 42-47, Jun. 2012.
9. [SCI] Ya-Ting Yang, Po-Kang Lin, Chen Wan, Wen-Chia Yang, Li-Ju Lin, **Chung-Yu Wu**, and Chuan-Chin Chiao, "Responses of Rabbit retinal ganglion cells to subretinal electrical stimulation using a silicon-based microphotodiode array," *Investigative Ophthalmology & Visual Science*, vol. 52, no. 13 pp. 9353-9361, Dec. 2011.
10. [SCI][EI] Wen-Chia Yang, Li-Ju Lin, Herming Chiueh, and **Chung-Yu Wu**, "A CMOS bio-inspired 2-D motion direction sensor based on a direction computation method derived from the directionally selective ganglion cells in the retina," *IEEE Sensors Journal*, vol. 11, no. 12, pp. 3341-3351, Dec. 2011.
11. [SCI][EI] Hsuan-Yi Su, Robert Hu, and **Chung-Yu Wu**, "A 78~102-GHz front-end receiver in 90nm CMOS technology," *IEEE Microwave and Wireless Components Letters*, vol. 21, no. 9, pp. 489-491, Sept. 2011.
12. [SCI][EI] Zue-Der Huang and **Chung-Yu Wu**, "The design of a K-band 0.8-V 9.2-mW phase-locked loop," *IEICE Transactions on Electronics*, vol. E94-C, no. 8, pp. 1289-1294, Aug. 2011
13. [SCI][EI] Zue-Der Huang and **Chung-Yu Wu**, "The design of double-positive-feedback voltage-controlled oscillator," *IEEE Microwave and Wireless Components Letters*, vol.21, no. 7, pp. 386-388, Jul. 2011.
14. [SCI][EI] Su-Yung Tsai, Chi-Hsu Wang, and **Chung-Yu Wu**, "Stability analysis of autonomous ratio-memory cellular nonlinear networks for recognition," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 57, no. 8, pp. 2156-2167, Aug. 2010.
15. [SCI][EI] Po-Hung Chen, Min-Chiao Chen, Chun-Lin Ko, and **Chung-Yu Wu**, "An integrated CMOS front-end receiver with a frequency tripler for V-band applications," *IEICE Transactions on Electronics*, vol. E93-C , no. 6, pp. 877-883, Jun. 2010.
16. [SCI][EI] **Chung-Yu Wu**, Sheng-Hao Chen, and Yu Wu, "Design and analysis of a CMOS ratio-memory cellular nonlinear network (RMCNN) requiring no elapsed time," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 57, no. 6, pp. 1348- 1357, Jun. 2010.