	Speaker	Hsin Chen
	Talk Title	Development of a Miniaturised, Wireless Neuromodulator Based on Experiments with Parkinsonian Rats
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1. Tentative Abstract

Bio-electronic medicine has become a promising alternative for treating or rehabilitating neural diseases. However, the development of bio-electronic medicine relies greatly on understanding how the brain functions and identifying the biomarkers for distinguishing the states of a brain, at least between normal and pathological states. This kind of knowledge usually requires intensive research with animal disease models. To fulfill such research demand, so as to accelerate the development of bio-electronic medicine, a miniaturized microsystem suitable for recording and stimulating multiple brain regions of a freely-moving animal has been designed and tested. In addition, the microsystem allows the stimulation to be controlled in a closed-loop manner, i.e. the stimulation is triggered only upon the detection of particular disease-related signatures. This function is crucial especially for investigating novel treatments that improve therapeutic efficacy and minimise side effects. Based on experiments with Parkinsonian rats, the microsystem

had been proved able to wirelessly record pathological signals faithfully, as well as to suppress the occurrence of pathological rhythms by stimulating specific brain regions. Moreover, the algorithms for recognising pathological signals automatically are developed. The latest studies on the efficacy of treating the Parkinson's disease with closed-loop-controlled stimulation will be presented and discussed.. These technologies will facilitate long-term study on the therapeutic effects of novel bio-electronic medicines for various neural diseases.

2. Brief Biography

Dr. Hsin Chen received his PhD in Electronics from the Edinburgh University, UK in 2004. Afterwards, he joins the EE Dept. of the NTHU and is now appointed as a professor. Hsin has established the Neuro-Engineering Lab focusing on developing (1) novel neuro-electronic interfaces for neural prostheses and neural engineering; (2) neuromorphic algorithms and realising the algorithms as stochastic very-large-scale-integration (VLSI) microsystems; (3) bio-mimetic systems for advanced research in neuroscience. The latest research findings have been translated into two clinical applications: (1) the batteryless, implantable microsystem for investigating the mechanisms of the deep-brain stimulation; (2) the electronic nose for smelling out pneumonia infection. All these research results have been recognised by three National Innovation Awards, three MXIC Golden Silicon Awards, and Many Chip Design Awards. Moreover, to promote related research and international collaborations, Hsin has organised the International Workshop on Bio-inspired Systems and Prothetic Devices (BioPro) during 2009~2018. He received the Outstanding Young Researcher Award from the Taiwan Integrated Circuit Design (TICD) society in 2013, and Outstanding Young Researcher Grant during 2016~2019. He was invited as a visiting scholar in the Bordeaux Uni. in France in 2008, in the University d'Evry in France in 2011, and in

the Inst. of Neuroinformatics, University of Zurich in Switzerland in 2014. Finally, Hsin Chen is a member of the IEEE, the IEEE EMB, the IEEE CaS, and the TICD societies.

3. List of Representative Publications

1. J.B. Liaw, H.C. Wu, and **H. Chen*** "Biological Studies with Tin Oxide Materials", *Tin Oxide Materials--Synthesis, Properties, and Applications, In Press, 2019*

2. Y.C. Chen[†], H.C. Chang[†], **H. Chen***, "Two-Dimensional Multiply-Accumulator for Classification of Neural Signals" *IEEE Access,* Vol.6, p. 19714 - 19725*, 2018*

3. H.C. Wu, J.B. Lyau, M.H. Lin, Y.J. Chuang and **H. Chen***, "Multilayer Microfluidic Systems with Indium-tin-oxide Microelectrodes for Studying Biological Cells", Journal of Micromechanics and Microengineering, In Press, 2017

4. M.Y. Lin, W.Y. Hsu, Y.S. Yang, J.W. Huang, Y.L. Chung, and **H. Chen***, "Immobilized Rolling Circle Amplification on Extended-gate Field-effect Transistors with Integrated Readout Circuits for Early Detection of Tumor-related Protein in Physiological Buffers" *Analytical and Bioanalytical Chemistry*, *vol.408, p.4785-4797,* 2016 (IF = 3.436, Rank : 13/74,   ANALYTICAL CHEMISTRY, Cited no. 0)

5. J.H. Wang, C.T. Tang, **H. Chen***, "An Adaptable Continuous Restricted Boltzmann Machine in VLSI for Fusing the Sensory Data of an Electronic Nose" *IEEE Trans. Neural Netw. Learn. Syst., In Press,* 2016 (SCI, IF=4.291, R=1/102)

6. Y.P. Lin, C.Y. Yeh, P.Y. Huang, Z.Y. Wang, H.H. Cheng, Y.T. Li, C.F. Chuang, P.C. Huang, K.T. Tang, H.P. Ma, Y.C. Chang, S.R. Yeh, and **H. Chen*** "A Battery-less, Implantable Neuro-electronic Interface for Studying the Mechanisms of Deep Brain Stimulation in Rat Models" *IEEE Trans.*

Biomed. Circuits Syst., vol.10, no.1, p.98-112, 2016 (SCI, IF=2.482, R=34/249)

7. Y.D. Wu and **H. Chen*** "The Diffusion Network in Analog VLSI Exploiting Noise-induced Stochastic Dynamics to Regenerate Various Continuous Paths" *IEEE Trans. Circuits Syst. I, 62(6): 1617 – 1626*, 2015 (SCI, IF=2.403, R=39/249)

8. K.T. Tang*, **H. Chen**, and Y.P. Lin, "Closed-Loop Bidirectional Neuroprosthetic Systems" *Handbook of Biochips, Springer, pp. 1 – 15*, 2015

9. V. Vigneron* and **H. Chen**, "A multi-scale seriation algorithm for clustering sparse imbalanced data: application to spike sorting" *Pattern Analysis and Applications, Springer,* pp. 1 – 19, 2015 (SCI, IF=0.646, R=100/123)

10. V. Vigneron* and **H. Chen** "Sparse data analysis strategy for neural spike classification", *Computational Intelligence and Neuroscience, doi:10.1155/2014/757068, 2014*. (IF = 0.596, Rank: 54/57, MATHEMATICAL & COMPUTATIONAL BIOLOGY, Cited no. 0)

11. **H. Chen***, Y.C. Chang, S.R. Yeh, , C.C. Hsieh, K.T. Tang, P.H. Hsieh, Y.T. Liao, R. Perumel, J.F. Chuang, C.C. Chang, Y.C. Chen, S.H. Chen, S.E. Hsieh, Y.P. Chen, Y.T. Chen, T.H. Liu, Y.M. Chang, W.C. Lai, C.Y. Wu, Y.H. Chen, Y.C. Weng, "Development of a Multisite, Closed-loop Neuromodulator for the Theranosis of Neural Degenerative Diseases"

12. Ramesh Perumal, Vincent Vigneron, Chi-Fen Chuang, Yen-Chung Chang, Shih-Rung Yeh, **Hsin Chen***"An efficient algorithm for predicting pathological high-voltage spindles related to Parkinsonian resting tremor from local field potential recordings" *Int. Congress of Parkinson's Disease and Movement Disorders*, 2018

13. Remi Souriau, Vincent Vigneron, Jean Lerbet, and **Hsin Chen*** "Latent variables estimation of probit model with Gaussian Process classier: application for the detection of High-Voltage Spindles", *Int. conf. on Latent Variable Analysis and Signal Separation* (LVA/ICA), 2018 (EI)

14. Chiao-Teng, Chung, Chih-Cheng Lu and **<u>Hsin Chen</u>***, *"A Beta-band Energy Detecting Circuit for Deep Brain Stimulator"*, *IEEE Int. conf. on Consumer Electronics - Taiwan* (ICCE-TW). 2018 (EI)

15. Y.C. Chen, R. Perumal, C.H. Huang, and **<u>H. Chen</u>***, "A Hardware Based Simplified Discrete Wavelet Transform for Detecting High-Voltage Spindles in Neuron Signal" to 2017 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)