

## BIOGRAPHICAL SKETCH

### Name

**Tzyy-Ping Jung, Ph.D.**

### POSITION TITLE

Co-Director of Center for Advanced Neurological Engineering, Institute of Engineering in Medicine, University of California San Diego, La Jolla, CA

Associate Director of Swartz Center for Computational Neuroscience, Institute for Neural Computation, UCSD

Adjunct Professor, Dept of Bioengineering, UCSD

Professor, Dept of Computer Science, National Chiao-Tung University, Taiwan

### Education/Training

INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
National Chiao Tung University, Hsinchu, Taiwan	B.S.	1984	Electronic Engineering
Ohio State University, Columbus, OH	M.S.	1989	Electrical Engineering
Ohio State University, Columbus, OH	Ph.D.	1993	Electrical Engineering
National research Council, National Academy of Sciences	Post-doc	1996	Computational Neurobiology

### Professional Experience

8/86-7/87	Teaching Assistant	Dept. of Electronic Engineering, National Chiao-Tung University, Taiwan
9/88-4/93	Graduate Research Associate	Dept. of Electrical Engineering, The Ohio State University, Columbus, Ohio
9/93-9/96	Research Associate	National Research Council, National Academy of Sciences, USA
10/93-9/98	Research Associate	Computational Neurobiology Laboratory, The Salk Institute, San Diego, CA
10/98-6/02	Assistant Research Scientist	Institute for Neural Computation, University of California, San Diego, La Jolla, CA
1/01	Visiting Professor	Veteran Tri-service General Hospital, Taipei, Taiwan
4/05	Visiting Professor	Taipei Medical University Taipei, Taiwan
7/02-6/07	Associate Research Scientist	Institute for Neural Computation, University of California, San Diego, La Jolla, CA
1/02-	Associate Director	Swartz Center for Computational Neuroscience, University of California, San Diego, La Jolla, CA
7/07-	Research Scientist	Institute for Neural Computation, University of California, San Diego, La Jolla, CA
10/10-	Co-Director	Center for Advanced Neurological Engineering, University of California, San Diego, La Jolla, CA
7/09-	Adjunct Professor	Department of Computer Science National Chiao-Tung University, Hsinchu, Taiwan,
7/11-	Adjunct Professor	Department of Bioengineering University of California, San Diego, La Jolla, CA

## Short Bio

**Tzyy-Ping Jung** received the B.S. degree in electronics engineering from National Chiao Tung University (NCTU), Taiwan, in 1984, and the M.S. and Ph.D. degrees in electrical engineering from The Ohio State University in 1989 and 1993, respectively. During 1993-1996, he was a Research Associate of the National Research Council of the National Academy of Sciences working at the Computational Neurobiology Laboratory, The Salk Institute for Biological Studies, San Diego, CA. He is currently a full-ranked Research Scientist at the Institute for Neural Computation and Institute of Engineering in Medicine of University of California, San Diego (UCSD), an Adjunct Professor of Department of Bioengineering of UCSD, and an Adjunct Professor of Department of Computer Science of NCTU.

## INTERNATIONAL ACADEMIC REPUTATION

Prof. Jung has pioneered the research, development, applications and distribution of blind source separation or Independent Component Analysis (ICA) for biomedical signal analysis since 1995. His team first proposed to apply ICA to multi-channel electroencephalographic (EEG) and event-related potential (ERP) data to decompose the data into statistically independent components arising from functionally distinct brain or extra-brain networks. The new signal-processing technique opens a novel and revolutionary window into complex event-related brain data that leads to a more detailed understanding of the strengths and limitations of the human mind, plus possible applications to medicine and to cognitive testing and monitoring. ICA was a biomedical signal-processing algorithm that was not known in biomedical science and engineering before Prof. Jung's contributions. It is now a standard approach for biomedical time- and frequency-series analysis. It is worth noting that Dr. Jung not only brought ICA into the fields of biomedical science and engineering, but also continues to develop new signal-processing methods to explore new vistas of event-related brain dynamics measured by non-invasive neuroimaging techniques including EEG, ERPs, and MEG, in the past 20 years. Prof. Jung and his colleagues have also popularized and broadly disseminated the techniques and demonstrated numerous uses and applications of ICA (e.g. spectroscopic data, electrocardiogram or ECG, functional Magnetic Resonance Imaging (fMRI), sound separation, etc.). Jung's pioneering efforts in the use of ICA for fMRI analysis has also made huge impacts in both pure and applied science. According to Google scholar, 1,455 articles have cited their landmark work published in *Human Brain Mapping*. ICA has become widely adopted in the neuroimaging community due to their efforts.

Prof. Jung also made ICA a big impact in industry. He co-founded a private company, SoftMax, Inc. with Dr. Te-Won Lee and Stanley Kim in 1998. SoftMax developed noise-filtering tools for the communication industry and R&D in medical applications. SoftMax has seen great success as the exclusive noise-canceling technology (1Voice) to SK Telecom, and in several commercial products offered by Motorola, Samsung, LG Electronics and BlueAnt. 1Voice significantly enhances the audio quality of Bluetooth headsets. In 2007, Qualcomm acquired SoftMax and incorporated the noise-canceling technology into several generations of chipsets for smartphones.

Another significant contribution made by Prof. Jung is the development and dissemination of wearable biosignal sensing including dry bio-potential sensors, which are portable and wireless. The unavailability of EEG monitoring systems that do not require application of conductive gels to the scalp and are capable of high-definition recording, online signal processing, and artifact cancellation has long thwarted applications of EEG monitoring in other than well-controlled laboratory conditions. In the past few years, Profs. Jung and Lin have been working on wearable sensing systems with online real-time signal processing on smartphones or mobile devices. The wearable and wireless EEG technology will have big future impacts on clinical research and practice in neurology, psychiatry, gerontology, and rehabilitation medicine. The revolutionary design allows assessment of brain activities of participants actively performing ordinary tasks in natural body positions and situations in real-world environments.

Prof. Jung is one of most productive and well-cited researchers in the field of biomedical signal processing and neural engineering. In the past 20 years, He has published many articles in prestigious **scientific** journals such as *Science*; **engineering** journals such as *Proceedings of the IEEE*; and **clinical** journal such as

*European J. Nuclear Medicine and Molecular Imaging*. Prof. Jung's publications have been well cited. His ~120 published articles have over 12,000 citations; among them 22 have over 100 citations, according to scholar.google.com. On average, each publication was cited by over 90 articles. Prof. Jung's *h*-index is 41 according to scholar.google.com. To serve the research communities, Prof. Jung and colleagues have packaged, released and broadly disseminated the aforementioned signal-processing methods into two Matlab toolboxes, EEGLAB and FMRLAB, for free download via the World Wide Web. Over 110,000 individual/institute users have downloaded the EEGLAB toolbox since its introduction in 2002. FMRLAB facilitating the analysis of fMRI data has been downloaded by over 4,800 users. These tools have profound impacts in biomedical signal processing and neuroscience communities. Prof. Jung's expertise has been well respected by peers. He has served as a reviewer for over 35 journals including *IEEE TBME*, *IEEE TNSER*, *IEEE TBCAS*, *IEEE TNN*, *Science*, *PNAS*, *NeuroImage*, *J of Neuroscience*, etc., and for several international conferences, e.g. IEEE EMBC, IEEE IJCNN, IEEE ICASPP, and NIH/NSF proposals.

Prof. Jung is a recipient of SPIE Unsupervised ICA Learning Pioneer Award in 2008 and a recipient of Distinguished Alumni Award of National Chiao-Tung University in 2012.

#### ACADEMIC LEADERSHIP

Prof. Jung has been co-directing the Swartz Center for Computational Neuroscience (SCCN) and Center for Advanced Neurological Engineering of UCSD since 2002 and 2010, respectively. The Centers are truly interdisciplinary with over 50 staff and researchers and an annual budget of >US\$4M, one of the largest research centers at UCSD.

#### Selected Publications

(~12,000 total citations, h-index = 41 based on google scholar <http://scholar.google.com/citations?user=IWsSoAUAAAJ&hl=en>, 22 articles have over 100 citations)

- Makeig S. and Jung, T-P., Changes in alertness is principal component of variance in the EEG spectrum, *NeuroReport* 7,213-216, 1995.
- Jung, T.-P., A. Krishnamurthy and el. Deriving Gestural Scores from Articulator-Movement Records using Weighted Temporal Decomposition, *IEEE Trans. Speech, Audio Processing* 4(1), 2-18, 1996.
- Makeig S. and Jung, T-P., Tonic, phasic and transient EEG correlates of auditory awareness in drowsiness, *Cognitive Brain Research* 4, 15-25, 1996.
- Makeig, S., Bell, A.J., Jung, T-P, and Sejnowski, T.J., Independent component analysis of Electroencephalographic data, In: *Advances in Neural Information Processing Systems* 8:145-51, 1996.
- Makeig, S., Jung, T-P, and Sejnowski, T.J., Using feedforward neural networks to monitor alertness from changes in EEG correlation and Coherence, In: *Adv. in Neural Information Processing Systems* 8:931-7, 1996.
- Jung, T.-P., Makeig, S., Stensmo, M. and Sejnowski, T. J., Estimating alertness from the EEG power spectrum, *IEEE Transactions on Biomedical Engineering* 44(1), 60-69, 1997.
- Makeig, S., Jung, T.-P., Bell, A. J., Ghahremani, D., Sejnowski, T. J., Blind separation of auditory event-related brain responses into independent components, *Proc. of the Natl. Acad. of Sci.*, 94, 10979-84, 1997.
- Jung, T-P., Makeig, S., Bell, A. J., and Sejnowski, T. J., Independent component analysis of electroencephalographic and event-related potential data, In: P. Poon, J. Brugge, ed., *Auditory Processing and Neural Modeling*, Plenum Press, 160-88, 1998.
- Jung, T-P, Humphries, C., Lee, T-W, Makeig, S., McKeown, M.J., Iragui, V., and Sejnowski, T.J., Extended ICA removes artifacts from electroencephalographic recordings, In: *Advances in Neural Information Processing Systems* 10:894-900, 1998.
- McKeown, M.J., Makeig, S., Brown, G.G., Jung, T-P., Kindermann, S., Bell, A.J., and Sejnowski, T.J., Analysis of fMRI by blind separation into independent spatial components, *Human Brain Mapping*, 6(3):160-88, 1998.
- McKeown, M.J., Jung, T-P, Makeig, S., Brown, G., Kindermann, S., Lee, T-W, and Sejnowski, T.J., Spatially independent activity patterns in functional magnetic resonance imaging data during the Stroop color-naming task, *Proc. of Natl. Acad. of Sci.*, 95:803-810, 1998.
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- Makeig, S., Westerfield, M., Jung, T-P, Covington, J., Townsend, J., Sejnowski, T.J. and Courchesne, E. Independent Components of the Late Positive Response Complex in a Visual Spatial Attention Task, *J. Neuroscience*, 19(7), 2665-2680, 1999.
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- Jung, T-P, Humphries, C., Lee, T-W et al., Removing Electroencephalographic Artifacts by Blind Source Separation, *Psychophysiology*, 37, 163-178, 2000.
- Van Orden, K., Jung, T-P, and Makeig, S. Eye Activity Correlates of Fatigue, *Biological Psychology*, 52(3):221-40, 2000.
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- Jung T-P, Makeig S, McKeown M.J., Bell, A.J. , Lee T-W, and Sejnowski TJ, Imaging Brain Dynamics Using Independent Component Analysis , *Proceedings of the IEEE*, 89(7):1107-22, 2001.
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- Lin, Y-P, Wang, C-H, Jung, T-P, Wu, T-L, Jeng, S-K, Duann, J-R, and Chen, J-H. EEG-based Emotion Recognition in Music Listening, *IEEE Transactions on Biomedical Engineering*, 57(7): 1798-1806, 2010.
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### Patents

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- T-P. Jung and J-R. Duann, System and Method for Separating Cardiac Signals, US Patent # 7,941,205.
- T-P. Jung and J-R. Duann, Method and System for Cardiac Signal Decomposition, US Patent # 7,853,317.
- J-R. Duann and T-P. Jung, Device and method for detecting cardiac impairments, US Patent # 8,055,333.
- T-P. Jung, Y. Wang, Collaborative Electroencephalogram (EEG) for Brain Machine Interfacing (US provisional patent, No. 61/489,200), 2011
- T-P. Jung, Y. Wang, Y-T. Wang, A Cell-Phone Based Wireless and Mobile Brain-Machine Interface (US patent pending, SD2010-204-1PCT; 09062-8173.WO00), 2011
- J. P. Menon, T-P. Jung, Y-T. Wang, Y. Wang, Brain-Machine Interface for Communication with Mechanically Ventilated Patients (US provisional patent, No. 61/555,220), 2011.
- C. Kothe, T-P Jung, High-amplitude artifact removal with signal reconstruction provisional patent, 2013.

### External Professional Activities

#### Associate Editors:

- IEEE Transactions on Biomedical Circuits and Systems (2013-present).
- IEEE Transactions on Circuits and Systems, a special issue on topics from the 2012 IEEE Biomedical Circuits and Systems Conference (BioCAS 2012)
- Frontiers in Human Neurosciences, a special issue on Research Topic: Towards a New Cognitive Neuroscience: Modeling Natural Brain Dynamics (2013-2014).

#### Reviewers:

1. NSF/NIH Proposal Peer Review Panel
2. NASA/NIAC Peer Review Panel
3. Science
4. Brain Research
5. Brain Tomography
6. Cognitive Brain Research
7. Cerebral Cortex
8. Clinical Neurophysiology
9. Frontiers in Human Neurosciences
10. Frontiers in Neuroprosthetics
11. Human Brain Mapping
12. IEEE Transactions on Biomedical Engineering
13. IEEE Transactions on Neural Networks
14. IEEE Transactions on Signal Processing
15. IEEE Transactions on Circuits and Systems

16. IEEE Transactions on Neural Systems and Rehabilitation Engineering
17. IEEE Transactions on Systems, Man, and Cybernetics
18. IEEE Signal Processing Letters
19. IEEE Transactions on Human-Computer Systems
20. IEEE Transactions on Intelligent Transportation Systems
21. Iranian Journal of Electrical and Computer Engineering
22. Journal of Neuroscience
23. Journal of Neuroscience Method
24. Journal of Neurophysiology
25. Journal of Sound and Vibration
26. Journal of Machine Learning
27. Journal of Medical and Biological Engineering
28. Journal of Neural Engineering
29. Journal of Computational Neuroscience
30. Medical Engineering & Physics
31. Neural Computation
32. NeuroImage
33. NeuroReport
34. Neurocomputing
35. Neuropsychologia
36. Physics in Medicine and Biology
37. Physiological Measurement
38. Proc. of National Academy of Sciences (PNAS)
39. Psychophysiology
40. Sensors
41. TheScientificWorld

**Conference Technical Review Committee:**

- Neural Information Processing System (NIPS)
- Workshop in Neural Networks for Signal Processing (NNSP)
- International Workshop on Independent Component Analysis and Signal Separation (ICA 2001)
- IEEE Int'l Conference on Acoustic, Speech and Signal Processing (ICASSP 2001)
- IEEE Workshop on Nonlinear Signal and Image Processing
- The 2nd International Conference on Informatics in Control, Automation and Robotics (ICINCO 2005)
- The 27th Annual International Conference of the IEEE Engineering in Medicine and Biology Society
- The 12th International Conference on Neural Information Processing
- IEEE 2006 International Symposium on Circuits and Systems (ISCAS 2006)
- The 3rd International Conference on Informatics in Control, Automation and Robotics (ICINCO 2006)
- International Workshop on Independent Component Analysis and Signal Separation (ICA 2006)
- International Workshop on Independent Component Analysis and Signal Separation (ICA 2007)



- The 29th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2007)
- IEEE 2008 International Joint Conference on Neural Networks (IJCNN Technical Committee)
- IEEE 2008 International Conference on Fuzzy Systems (FUZZ-IEEE Technical Committee)
- IEEE 2008 Congress on Evolutionary Computation (CEC Technical Committee)
- The 2nd International Symposium on Bio- and Medical Informatics and Cybernetics: BMIC 2008.
- The 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2008)
- IEEE Int'l Conference on Acoustic, Speech and Signal Processing (ICASSP 2008)
- IEEE Int'l Conference on Acoustic, Speech and Signal Processing (ICASSP 2009)
- The 31st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2009)
- The 32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2010)
- IEEE Int'l Conference on Acoustic, Speech and Signal Processing (ICASSP 2010)
- Wireless Healthcare 2010
- The 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2011)
- IEEE Int'l Conference on Acoustic, Speech and Signal Processing (ICASSP 2011)
- The 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2012)
- IEEE Int'l Conference on Acoustic, Speech and Signal Processing (ICASSP 2012)
- IEEE Int'l Conference on Acoustic, Speech and Signal Processing (ICASSP 2013)
- The 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2013)
- The 6th International IEEE EMBS Conference on Neural Engineering (IEEE NER 2013)
- 2013 IEEE International Symposium on Circuits and Systems (ISCAS 2013)
- 2013 IEEE Symposium Series on Computational Intelligence (IEEE SSCI 2013)
- IEEE 2014 International Joint Conference on Neural Networks (IJCNN 2014)
- The 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2014)

#### **Conference/Workshop Organizing Committee:**

- The 3rd International Workshop of Independent Component Analysis and Blind Source Separation.
- Organizing Committee, The 1<sup>st</sup> EEGLAB Workshop, University of California San Diego, La Jolla, CA
- Organizing Committee, The 2<sup>nd</sup> EEGLAB Workshop, University of Porto, Portugal
- Organizing Committee, The 3<sup>rd</sup> EEGLAB Workshop, Singapore
- Organizing Committee, The 5<sup>th</sup> EEGLAB Workshop, University of California San Diego, La Jolla, CA
- Organizing Committee, The EEG/fMRI Boot Camp, National Chiao-Tung University, Hsinchu, Taiwan, June 26-18, 2012.
- International Chair, ISSNIP Biosignals and Biorobotics Conference 2010.
- Co-Chair of Technical Committee, 2012 IEEE Biomedical Circuits and Systems Conference (BioCAS), 2012.