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Independent Component Analyses, Compressive Sampling, Wavelets, Neural Net, Biosystems, and Nanoengineering XI

Harold H. Szu
Editor

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INTRODUCTION

HUMAN COMPONENTS SCIENCE (<http://www.ica-wavelet.org>)

The 2013 conference: "Independent Component Analyses, Compressive Sampling, Wavelets, Neural Net, Biosystems, and Nanoengineering, XI" was held from May 1st to May 3rd at the Baltimore Convention Center. Three days were divided into 6 tracks. We introduced human sciences as component tracks, and integrated them together as an interdisciplinary endeavor over the decades since SPIE Aerosense Symposium in Orlando. Thanks to the efforts of our Web Master, Professor Yufeng Zheng who committed his own financial resources and know-how to design and update the www.ica-wavelet.org website, our decades-old activity in the educational research and development forum are now recorded and available. Our conference proceedings are one of the most timely and sought-after review publications in the standing order of worldwide libraries. We strongly encourage our Pioneer Award recipients to author comprehensive reviews of their work for the worldwide interdisciplinary readership adding to the impact. Albert Einstein once said to a celebrated educator, physicist George Uhlenbeck that "science has nothing to do with the truth but with consistency;" but "a terrible thing to waste in science is a developing young mind." Our human component science rightly belongs in the *SPIE Defense, Security, and Sensing* (DSS) Symposium because in a broad sense, DSS is against the worst enemies of mankind.

We capture the human sciences in various components in the SPIE proceedings over the last decades. They included: (i) sensor-like ears & eyes in adaptive wavelets, (ii) brain-like unsupervised learning and independent component analysis; (iii) compressive sampling in spatiotemporal sparse processing, (iv) nano-engineering approach to measure the components; (v) biomedical wellness applications; and (v) system of systems biology. All and all we wish to learn from Mother Nature a system of systems that can interact in a nonlinear competitive and cooperative synergism called a dynamic programming. The design by iterative Kalman-like filter concept led naturally to wavelets by Kohonen Self Organization Feature Map in a higher dimensionality. The Artificial Neural Network Learning evolves towards unsupervised learning resembling some de-clutter *Independent/dependent Component Analysis (ICA)* functionality of our brains. *Compressive sampling* may emulate brain-like storage (at hippocampus associative memory); DNA genetic coding together with epic-genetic adaptation is relevant to the core application of nanotechnology implemented by *Nanoengineering*. *Human Biomedical wellness* requires the understanding of a system of biological sub-systems, which behaves like a real-world complex, nonlinear, robust dynamics.

In other words, we need to broaden our concepts and tools beyond college linear algebra, to understand one another. Together we can serve the

interdisciplinary community better. Thus, as conference facilitators we have incorporated the compressive sampling pioneer award in 2012. Every year we try to do our best, without financial resources but with our sincerity, to invite the best of the best to give us the lectures. How did we do the track continuously? We learned from the Nobel Laureates Foundation. Conference chairs became only the facilitator, not financier nor managers, we let "the former recipients with their scientific and personnel relationship to influence and secure the next recipient(s)" to deliver their review talks. Since SPIE has a 20 minutes hopping unit for audiences, we suggested 2 units per an invited talk and 1 unit panel for Q & A. The total length would satisfy the need to prepare material for a 60 minute class.

We are grateful to the previous year award recipients, and wish to thank all six of them again. 2011 recipients: John Benedetto (Univ. Maryland); Metin Sitti (CMU); Hiroshi Nakajima (Omron Inc.); Doug Lauffenburger (MIT); Soo-Young Li (KAIST); and Hyung-Min Park (Sogang U.). They headed each track and its selection processes for 2012 year's 6 awardees and a special leadership award was given to by John F. Tangney (Office of Naval Research). The 2012 recipients were: in Wavelets: Zuowei Shen (Nat. Univ. Singapore); in unsupervised learning ICA: Emmanuel Vincent (IRISA, France); in Compressive Sampling: Richard Baranuik (Rice Univ.); in Nano-Engineering: Yiping Zhao (Univ. Georgia); in Biomedical wellness: Lipo Wang (Nanyang Tech. Univ., Singapore); In Systems of Biology: Xiaowei Zhuang (Harvard Univ.).

The World-Class scientists invited to the Baltimore Convention Center this year, were selected by the aforementioned 2012-recipients serving as the track chairs: Shen, Vincent, Baranuik, Wang, Zhuang:

- (1) Wavelet: Hans G. Feichtinger, University of Vienna, Austria spoke about group theoretical methods and wavelet theory.
- (2) ICA Unsupervised Learning: Hiroshi Sawada, NTT Communication Science Lab, Japan, spoke and demonstrated on the spot multiple microphone and multiple speakers de-mixing speeches.
- (3) Compressive Sampling: Justin Romberg, GIT, Blind de-convolution using convex programming.
- (4) Nanoengineering: David Gracias, John Hopkins University spoke about 3D self assembly.
- (5) Biomedical Wellness: Weichuan Yu, Hong Kong Univ. of Science and Technology
- (6) Systems of Biology: Yoshiki Sasai, RIKEN, Kobe, Japan, spoke about embryonic stem cells self assembly model. Dr. Yoshiki Sasai (Nature, 472, 51-56, 07 April 2011) will receive his worldwide recognition, if his embryonic stem cell growth protocol of 6-layer optical cup of human eye in vitro were also be able to apply in vivo in Parkinson disease.

From nature, we learned that change is the norm, and adaptation means survival. We are on an evolutionary process to change the wavelet track to something bigger and better. The first conference in this wavelet series was inceptioned in 1994 by few colleagues in ONR called "*Wavelets applications*" as a part of *Aerosense annual symposium held by SPIE at Orlando during Easter week*. We followed the leadership of Applied Computational Mathematics Program (DARPA PM Helena Wiesniewski and PM Ira Skurnick) selected the first Wavelet Pioneer Recipient *Stephan Mallat, and Ingrid Daubechies*. Then, the recipients gradually evolve from wavelets mathematics towards adaptive wavelets are like human ears and eyes in an over-determined & non-orthogonal set. Then, several years later, the recipient *Dr. Swelden* promoted the Next Gen Wavelets for a natural generalization to a higher dimensionality graphic filter bank. Wavelet Pioneer Award has dealt with Multiple Resolution Analysis (MRA). We are thinking MRA could help the redundancy reduction, similar to the counting strategy after sorting data in wavelet transform used in Compressive Sensing. We realized the challenges of reducing the redundancy and revealing the sparseness are necessary for living in a curse digital society. We may call, instead of MRA, replacing two letters *M* of *multiple*, *R* of *resolution* to *M* for *Massive* and *D* for *data*, as well as *Analysis with Harmonic Analyses*. We have *Harmonic Analysis and Massive Data (HAMD)* that can attract federal R/D resources admitting modern operation research tools and math representations (Raphy Coifman's Nonlinear Dimensionality Reduction, Daubechies-Mallat Fourier-Wavelet transforms, and Benedetto and Feichtinger's Harmonic analyses, as well as Daugman's Gabor Billions Iris Analyses). If so agreed on *Harmonic Analysis and Massive Data (HAMD)*, we will recommend SPIE Conference Education Coordinator to support CS awards with a short course by *Justin Romberg* with a rapid medical imaging taken from 20 minutes to one minute, and *HAMD awards in turns* by *John Benedetto* about harmonic analysis and wavelets, and *Waichuan Yu* for low rank & sparse novelty, as well as *Anke Meyer-Baese* for data mining in Bionmics.

Harold H. Szu