New fractal and symbolic methods for nonlinear signal and image processing

**ABSTRACT:** It is unbelievable but in the 21st century some scientists still maintain they have demonstrated, using methods like linear forecasting or surrogate data tests of EEG time series, that the human brain is a linear system. The living organism is a complex nonlinear system showing complicated emergent properties. It is much more appropriate to use nonlinear methods for the analysis of signals generated by such a complex nonlinear system despite the fact that for limited time intervals linear methods like FFT seem to work fine. Biosignals in general, and human EEG in particular, are deterministic-chaotic signals. I will demonstrate the use of fractal and symbolic methods for the analysis of sleep-EEG and EEG under anesthesia, for revealing the influence of electromagnetic fields generated by cellular phones on EEG, as well as for analysis of HRV, posturographic signals, and in biofeedback. Classical neurofeedback is based on spectral characteristics of EEG-signal obtained by FFT; as we have suggested, neurofeedback may be based on non-spectral characteristics, like fractal dimension of the EEG signal. For a special purpose - treatment of stuttering persons - we have constructed a peripheral biofeedback based on capnographic signal i.e. on the concentration of carbon dioxide in the exhaled air. Fractal and symbolic methods can also be very useful for quantitative assessment and classification of images, based on analysis of experimental data such as microscopic images. I will show how our methods may be applied e.g. for choosing better implant materials or in histology to help distinguish between different types of cancer or in differentiating between mammographic images of benign masses and malignant tumors in screening medical examinations. Our methods draw from multiple disciplines and may find multidisciplinary applications. They may be used for bionic hybrid modeling of cardiopulmonary system that is developed in our Institute since they are computationally effective and may be applied in real-time. Hybrid models may be very helpful in medicine for noninvasive functional assessment.

**SPEAKER:** Wlodzimierz Klonowski, Ph.D., D.Sc. is the Head of Lab. of Biosignal Analysis Fundamentals at the Institute of Biocybernetics and Biomedical Engineering, Polish Academy of Sciences, Warsaw. Previously he has served as President and Computer Consultant with Canadian Consulting and Tutoring Services, Halifax, NS, Canada (1988-1998); Professor and Division Chairman, World Open University, Raleigh, NC, USA, and Halifax, NS, Canada (1986-1994); Visiting Professor, Brandeis University, Waltham, Ma, USA (1984-1986); Max Planck Fellow, MPI Biophysikalische Chemie, Goettingen, Germany (1982-1984); Professor, National University of Zaire, Kinshasa, Congo-Zaire (1980-1982). He has a Ph.D. from the Institute of Physics, Polish Academy of Sciences, Warsaw (1973) and D.Sc. (Dr hab.) from Humboldt University, Berlin, Germany (1990). He has been the leader of several scientific projects and is the author of numerous scientific papers on interdisciplinary problems concerning Nonlinear Dynamics and Networks Structure-Property Relationships.

Note: Engineers Australia members are eligible to claim CPD for attending this event.

With the kind support of the School of Electrical and Computer Engineering, RMIT

**Contact Information:**
John Fang, IEEE Engineering in Medicine and Biology Society-Victorian Chapter, Ph: 9925 2432, john.fang@rmit.edu.au
Robert Slaviero, IEEE Signal Processing Society-Victorian Chapter Chair, Ph: 9881 9900, r.slaviero@ieee.org