

Keynote

Biology Inspired Techniques for Soft Computing, Robot Control, and Perception in the Machine and Human-Machine Symbiotic Systems



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ABSTRACT

Understanding the internal working mechanisms of biological systems is a continuous source of inspiration for the development of more efficient computational, control, and perception technologies.

While studying the reliability of the data transmission mechanisms in biological nervous systems, John von Neumann advanced in 1956 the idea of representing analog variables by the statistical mean value of random-pulse streams. Based on this data representation model, a variety of stochastic computing and Neural Network (NN) architectures were reported during the last 60 years. On similar tracks, dither techniques have been developed to reduce the quantization noise in instrumentation, signal processing, and control systems. Developed the mid '60s fuzzy logic provides the formalism for modeling the approximate reasoning mechanisms specific to the human brain. Expanding on this concept, Zadeh pioneered the Fuzzy Logic Control (FLC) that allows describing complex control algorithm in human-like language terms.

The first part of this presentation will discuss the basics of two biology inspired data representation modalities: stochastic data representation and fuzzy linguistic variables. A number of soft-computing, robot control, and sensing & perception applications developed by author and his collaborators will illustrate these concepts.

The second part of the presentation will discuss a new generation of intelligent autonomous robotic sensor agents working together with symbiotic human-instrument systems, including humans as explicit sensors as well as human and animal behaviours as implicit contextual indicators, to provide multimodal sensing capability for complex environment monitoring and situation assessment. Human beings are valuable in this symbiotic partnership to the degree that their capabilities complement those of the computers, such as possessing an intelligence (still) superior to any computer and an ability to act on incomplete or ambiguous instructions and interact directly with other humans.

Biography

Emil M. Petriu (M'86-SM'88-F'01) is a Professor and University Research Chair in the School of Information Technology and Engineering at the University of Ottawa, Canada. His research interests include biology-inspired robot sensors and perception, interactive virtual environments, human-computer symbiosis, and soft computing systems. He is a Fellow of IEEE, Fellow of the Canadian Academy of Engineering, and Fellow of the Engineering Institute of Canada. He is a co-recipient of the IEEE's Donald G. Fink Prize Paper Award for 2003, and recipient of the 2003 IEEE Instrumentation and Measurement Society Award. He has published over 290 papers, co-authored 4 books and holds 2 patents.