Artificial Intelligence Techniques in Power Electronics and Motor Drives

Abstract:

Artificial intelligence (AI) techniques, such as expert system (ES), fuzzy logic (FL), artificial neural network (ANN), and genetic algorithm (GA) have recently brought a new and advancing frontier in power electronics and motor drives area, which is already a complex and interdisciplinary technology. The goal of AI is to plant human intelligence in a computer so that a computer can think intelligently like a human being. Computational intelligence has been debated over a long time. There is no denying the fact that AI techniques can solve complex problems which are difficult to solve by traditional methods. Currently, AI technology is advancing at a fast rate, and its applications in power electronics and motor drives are growing fast, as evident by large number of publications in IEEE journals. Recent advancement of powerful DSPs and FPGAs is making implementation of fuzzy and neural systems economical with improvement of performance, compact and more competitive. Evidently, the future impact of this technology on power electronics and motor drives is very significant. The frontier of AI is bringing a new challenge to the traditional engineers specialized in power electronics and motor drives.

The tutorial presentation will discuss comprehensively the principles of AI and its applications in power electronics and motor drives. In the beginning, the importance of AI will be reviewed, which will be followed by brief discussion on principles of different AI techniques. However, the presentation will mainly focus on fuzzy logic and neural network (main focus) applications in the control and estimation of power electronic systems, illustrating some application examples. Fuzzy logic example applications will include robust motor speed control, online efficiency optimization of ac drive, and optimal control of modern wind generation system. The ANN application examples will include space vector PWM wave synthesis for 2-level and multi-level converters, delayless filtering of inverter output waves, waveform generation for converters, model referencing adaptive control (MRAC) of ac drives, drift-free flux estimation of drives (approaching zero speed), and neuro-fuzzy control of drives. Time permitting, computer-aided design examples of fuzzy and neural systems will be discussed. Finally, in conclusion, the future prognosis of the technology will be reviewed.

Lead Instructor:

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Instructor Bios

Dr. Bose held the Endowed Chair in Power Electronics at the University of Tennessee for 15 years, where he was responsible for the power electronics program. Prior to this, he was a research engineer in GE Corporate R&D Center , Schenectady, NY for 11 years, and an Assoc. Prof. of EE in Rensselaer Polytechnic Onstitute, Troy, NY for 5 years. He has made pioneering research contributions in power electronics and motor drives, particularly in fuzzy logic and neural network applications. He authored/edited 7 books in power electronics, authored 230 publications (mostly IEEE), and holds 21 U.S. Patents. His book “Modern Power Electronics and AC Drives” is used as text in many universities around the world (Chapters 10, 11 and 12 deal with AI applications). He has presented tutorials, plenary and keynote addresses throughout the world. He published an invited paper “Neural Network Applications in Power Electronics and Motor Drives – An Introduction and Perspective”, IEEE Trans. IE, vol.54, pp. 14-33, Feb. 2007 which is highly cited in the literature. Currently, he is writing an invited IAS Magazine paper “Control Techniques for High Power Variable Speed Drives”, where a significant content will be

on AI applications. He is a winner of IEEE Newell Award (2005), IEEE Millennium Medal (2000), IEEE Lamme Medal (1996), IEEE- IAS Outstanding Ach. Award (1993), IEEE-IES Mittelmann Award (1994), IEEE Meritorious Ach. Award (1997), IEEE Region 3 Outstanding Ach. Award (1994), and several other awards. He is an IEEE Fellow in 1989 and Life Fellow in 1996. He represented IAS in the Neural Network Council, which later became Computational Intelligence Society.

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