# Guest Editorial

I would like to present this "Special Section on Neural Network Applications in Power Electronics and Motor Drives" to the professional community of the world. As I understand, there has been no such publication of such a vitally important "emerging technology" topic anywhere in the past. Power electronics and the motor drives area is already a complex and multidisciplinary technology which is going through dynamic evolution during the last three decades. Now, artificial intelligence (AI) techniques, particularly neural networks, have created a new and advancing frontier in this evolution. This is creating a challenge to traditional power electronics engineers. It can be predicted without any doubt that neural networks will have a significant impact on power electronics and motor drives in the future.

It is interesting to note that the history of neural network evolution is very old and fascinating. In fact, it predates the modern digital computers, and other AI techniques, such as expert systems, fuzzy logic, and genetic algorithms. The history essentially started with the pioneering work of McCulloch and Pitts in 1943 who were trying to model the nervous system of the human brain, which is the most complex computational machine in the world. McCulloch was a psychiatrist and neuroanatomist, whereas Pitts was a mathematician. The next major development in neural networks came in 1949 when Hebb proposed his synaptic learning mechanism of biological neurons in his book *The Organization of Behavior*. The book had immense influence among psychologists, but was practically ignored by the engineering community. In the 1950s, the dominant figure in neural network research was psychologist Frank Rosenblatt who invented Perceptron and its learning theory. In 1960, Widrow and Hoff proposed Adaline and Madaline, and trained them by the least-mean-square (LMS) algorithm. Unfortunately, the lack of expected performance of these networks, coupled with the glamour of the von Neumann digital computer in the late 1960s and 1970s, practically camouflaged the evolution of neural networks. Many researchers, except those in psychology and neurosciences, practically deserted the field almost for a decade. Of course, during the 1970s and early 1980s, attention was diverted for extensive research of expert system techniques and their applications. The modern era of neural networks with rejuvenated research practically started in 1982, when Hopfield, a chemistry and biology professor, presented his invention at the National Academy of Science, establishing much-needed credibility to the neural nertwork field and stimulating a new round of research in this area. In 1986, the modern backpropagation supervised training algorithm was reported by Rumelhart, Hinton, and Williams, which has been used extensively for training multilayer-percepton (MLP)-type networks. This type of feedforward network is most commonly used in recent years. It may be of interest to note that backpropagation theory was originally proposed by Paul Werbos in his doctoral thesis at Harvard University in 1974, but it went unnoticed by the scientific community for almost a decade. Since the beginning of the 1990s, neural networks have captivated the interest of a large segment of the scientific community. Often, it has been defined as the greatest technological invention since the transistor. It is amazing to see how the results of research from psychologists, psychiatrists, and neuroscientists can be of such importance to the engineering community.

Although the history of neural networks is old, their applications in power electronics and motor drives is only recent, and hardly exceeds more than the last 10–15 years. The first application, according to the author's knowledge, is the hysteresis-band PWM control by Harashima in 1989. Then, there were a number of applications in PWM control before it diverged to many other applications, such as adaptive motor speed control, single or multidimensional function generation, feedback signal estimation of vector drives, space-vector PWM, vector rotation and inverse rotation, estimation of distorted waves, waveform processing and delayless filtering, neuro-fuzzy DTC control, online fault diagnostics, and fault-tolerant control. Many of these applications are described in the introductory paper "Neural Network Applications in Power Electronics and Motor Drives—Introduction and Perspective" which is contributed by me.

In this Special Section, I received altogether 48 papers from which 23 papers were selected. The first paper is general and deals with methodology development, the next six papers deal with application in power systems, the next two are general drive applications, the next four are induction motor applications, the next four deal with synchronous motor applications, the next three relate to fault diagnosis of induction machines, and the last one relates to hardware implementation of neural networks.

I hope that the professional community will agree that the bulk of initial pioneering work on neural network applications in power electronic systems was done at the Power Electronics Research Laboratory, University of Tennessee. The main contributors in this area were Dr. M. Simoes of Colorado School of Mines, Dr. J. Pinto of the Federal University of Mato Grosso do Sul, Brazil, Dr. L. daSilva of the Federal University of Itajuba, Brazil, Dr. J. Zhao of Huazhong University of Science and Technology, China, Dr. C. Wang of the China University of Mining and Technology, Beijing, Dr. S. Mondal of AeroVirment, Inc., Mr. N. Patel of GM Advanced Tech-

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nology Vehicles, Dr. M.-H. Kim of Yeungnam College of Science and Technology, Korea, Dr. W.-S. Oh of Unan College, Korea, and Dr. X. Min Ma of Xi'an University of Science and Technology. Their undaunted enthusiasm for innovative research in this frontier technology is admirable, and in my opinion, they are the best researchers in the world. I would like to extend my thanks for the reviewers of these papers who contributed so much time from their busy schedule. Finally, my sincere thanks go to Dr. M. Kazmierkowski, the former Editor-in-Chief, for inviting me and giving me the opportunity for Guest Editing this Special Section. It was a pleasure to work with him.

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**Bimal K. Bose** (S'59–M'60–SM'78–F'89–LF'96) received the B.E. degree from Bengal Engineering College (currently Bengal Engineering and Science University), Calcutta, India, in 1956, the M.S. degree from the University of Wisconsin, Madison, in 1960, and Ph.D. degree from Calcutta University, West Bengal, India, in 1966.

He held the Condra Chair of Excellence (Endowed Chair) in Power Electronics at the University of Tennessee, Knoxville, since 1987, where he was responsible for teaching and the research program in power electronics and motor drives. Concurrently, he served as a Distinguished Scientist (1989–2000) and Chief Scientist (1987–1989) of EPRI-Power Electronics Applications Center, Knoxville, TN. Prior to this, he was a Research Engineer in the General Electric Corporate Research and Development Center (now GE Global Research Center), Schenectady, NY, for 11 years (1976–1987), an Associate Professor of Electrical Engineering, Rensselaer Polytechnic Institute, Troy, NY, for five years (1971–1976), and a faculty member at Bengal Engineering and Science University for 11 years (1960–1971). He has been a power electronics consultant in a large number of industries. He holds a Honorary Professorship at Shanghai University (1991), China University of Mining and Technology (1995), Xi'an Mining University (1998), Huazhong University of Science and Technology (2002), and Honorary Adviser of Beijing Power Electronics R&D Center (1990). He has authored more than 190 papers and holds 21 U.S. patents. He has authored/edited seven books in power electronics: *Power Electronics and Motor Drives – Advances and Trends* (Academic Press, 2006), *Modern Power Electronics and AC Drives* (Prentice-Hall, 2002), *Power Electronics and AC Drives* (Prentice-Hall, 1986), *Power Electronics and Variable Frequency Drives* (Wiley/IEEE Press, 1997), *Modern Power Electronics* (IEEE Press, 1992), *Microcomputer Control of Power Electronics and Drives* (Piscataway, NJ: IEEE Press, 1987), and *Adjustable Speed AC Drive Systems* (Piscataway, NJ: IEEE Press, 1981). He has given tutorials, keynote addresses and invited seminars extensively throughout the world, particularly in IEEE sponsored programs and conferences. He is specialized in power electronics and motor drives, specially including power converters, PWM techniques, microcomputer/DSP control, electric/hybrid vehicle drives, renewable energy systems, and artificial intelligence (expert system, fuzzy logic, and neural network) applications in power electronic systems.

Dr. Bose is a recipient of a number of awards, including IEEE Power Electronics Society Newell Award (2005), IEEE Meritorious Achievement Award in Continuing Education (1997), IEEE Lamme Gold Medal (1996), IEEE Industrial Electronics Society (IES) Eugene Mittelmann Award (for lifetime achievement) (1994), IEEE Region 3 Outstanding Engineer Award (1994), IEEE Industrial Applications Society (IAS) Outstanding Achievement Award (1993), Calcutta University Mouat Gold Medal (1970), GE Silver Patent Medal (1986), GE Publication Award (1985), and a number of IEEE prize paper awards. He also received the Distinguished Alumnus Award (2006) from Bengal Engineering and Science University. He has served the IEEE in various capacities, including Chairman of the IEEE Industrial Electronics Society (IES) Power Electronics Council, Associate Editor of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, IEEE IECON Power Electronics Chairman, Chairman of the IEEE Industry Applications Society (IAS) Industrial Power Converter Committee, IAS member of the Neural Network Council, Vice-Chair of the IEEE Medals Council, Member of IEEE Energy Policy Committee, Member of the IEEE Fellow Committee, Member of the Lamme Medals Committee, etc. He has been a Member of the Editorial Board of the PROCEEDINGS OF THE IEEE since 1995 and the *Journal of Intelligent and Fuzzy Systems* since 2001. He was the Guest Editor of the PROCEEDINGS OF THE IEEE (Special Issue on Power Electronics and Motion Control, August 1994). He has served as a Distinguished Lecturer of both the IAS and IES, and is now Vice-Chairman of the IAS Distinguished Lecturer Program.