

## Tutorial Title

**Artificial Intelligence Applications for Switched Reluctance Motors Drives**

## Instructor Team

Team Chair: Marcio Magri Kimpara, Oak Ridge National Laboratory

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## Abstract

Despite the many attractive advantages of Switched Reluctance Motors (SRM) for drive applications, for instance, electric vehicles, home appliances, and other industrial applications, issues related to vibration/noise and torque ripple production in this type of electric machine, remain a challenge. These issues are related to the constructive nature of the machine and its principle of operation. In addition to that, another drawback is the need for a rotor position sensor for the implementation of speed or position control. Artificial Intelligence (AI) can minimize, or even eliminate these drawbacks. The SRM motor drive involves many areas of knowledge, including power electronics, control systems, sensors, signal processing, and electromagnetics, among others. To solve major problems faced with SRM drives and especially, to mitigate their adverse characteristics, one may use control methods, parameter estimation, design optimization, diagnostics, prognostics, and fault tolerance operation, to name a few. Many of these problems are ill-posed and contain uncertainties, and using traditional mathematical modeling approaches may result in time-consuming, and/or lack precision. Therefore, AI techniques-based solutions are becoming more popular. Among them, artificial neural networks (ANN) and fuzzy logic are two powerful techniques and will be presented in this tutorial. After presenting basic concepts of these techniques and the motors' operation, the most common type of problems involving SRMs will be discussed and examples of how to apply AI techniques to minimize or eliminate these problems will be covered. The discussion will be supported by some experimental results and simulation demos. Afterward, two real problems will be addressed in a hands-on approach, i.e., the attendee will receive a dataset and will train, test, validate, and software-implement a neural network. This activity will provide a further basis for the attendees to apply AI techniques in other problems and correlated areas.

## Instructor Team Biographies

Joao O. Pereira Pinto received his B.S and MS in Electrical Engineering from the Universidade Estadual Paulista, and the Universidade Federal de Uberlândia, in Brazil, in 1990 and 1993 respectively, and his Ph.D. from The University of Tennessee, Knoxville, in 2001. He was a Faculty Member at the Federal University of Mato Grosso do Sul, Brazil, from 1994 to 2021, where founded and directed BATLAB, Artificial Intelligence/Machine Learning (AI/ML) Applications, Power Electronics and Drives, and Energy Systems. He is a Faculty Member of the Federal University of Rio de Janeiro, Brazil, on leave of



absence since 2021. Currently, he is a Senior Researcher at Oak Ridge National Laboratory, Oak Ridge, U.S.

Dr. Pinto was an early pioneer in AI/ML applications to power electronics and motor drives. He started to work in this area in 1997 as part of the research for his PhD at the University of Tennessee, Knoxville. More than half of his more than 200 papers published in journals and conference proceedings are in the AI/ML application. In the past two decades, Dr. Pinto has given numerous seminars and tutorials at conferences and universities around the world, expanding the fundamentals, new applications, and trends in this area.

Walter I. Suemitsu received the B.Sc. degree in Electrical Engineering from Escola Politécnica da Universidade de São Paulo, São Paulo, in 1975; the M.Sc. in electrical engineering from COPPE, Universidade Federal do Rio de Janeiro in 1979, and the Dr. Ing. in electrical engineering from the Institut National Polytechnique de Grenoble, France, in 1986. He did his Postdoctoral Research at Laval University, Québec City, Canada, from 1991 to 1993.

Since 1977, he has been teaching and developing research at the Federal University of Rio de Janeiro (UFRJ). He is a Professor of the Electrical Engineering Department, Escola Politécnica, and COPPE. He was the Dean of the UFRJ Technology Center from July 2006 to July 2014, and Dean of NIDES (Interdisciplinary Faculty for Social Development) from 2014 to 2018. Currently, he is again the Dean of the UFRJ Technology Center since 2018.

He is a Life Member of IEEE. His research interests include electrical machine drives and applications of power electronic converters on electrical drives and on renewable energy systems. He is also interested in applications of Artificial Intelligence in Power Electronics and Social Aspects of Technology.

Marcio L. Magri Kimpara received his B.S and MS in Electrical Engineering from the Federal University of Mato Grosso do Sul (UFMS), Campo Grande, Brazil, in 2009 and 2012, respectively, and his Ph.D. from the Federal University of Itajuba (UNIFEI), Brazil, in 2018. He was a Faculty Member at the Federal University of Mato Grosso do Sul, Brazil, from 2014 to 2022 and currently he is a Researcher Associate with the Oak Ridge National Laboratory, Oak Ridge, U.S.

Dr. Kimpara has experience in motor drives, power electronics, digital systems, and optimization algorithms, and he has worked with different AI/ML techniques over the years. His Ph.D. was focused on switched reluctance motor drives with publications on this topic and related. He has experience in giving lectures on AI techniques and motor drives. He also has experience in giving tutorials for IEEE conferences.