



Advanced Position/Speed Sensorless Control Strategies for AC Motor Drives

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SCOPE AND BENEFITS

In recent years, the use of position/speed sensorless AC motor drives is expanding in areas ranging from industrial applications to household electrical appliances. As is well known, the advantages of sensorless drives include lower cost, increased reliability, reduced hardware complexity, better noise immunity and less maintenance requirements. Nowadays, with the development of modern industrial automation, the more advanced sensorless control strategies are needed to meet the requirements of applications. This tutorial will introduce the state-of-art of recent progress in position/speed sensorless control, and present the position/speed sensorless control strategies we investigated for practical industrial and household applications. Both advanced sensorless drives of induction motor (IM) and permanent magnet synchronous motor (PMSM) will be presented in this tutorial.

CONTENTS

Monday, 5 September 2016 - Tutorial day (Location: KIT, Karlsruhe, Germany)

13:00 - 14:00 Registration for Afternoon Tutorials

14:00 - 15:30 Tutorials Part 1

1. Basic Control Scheme of AC Motor Drives

- 1.1. Basic structure and modeling of AC motor
- 1.2. Space vector control-based IM drive
- 1.3. Space vector control-based PMSM drive

2. Sensorless Control of IM in Ultra-Low-Speed Region

- 2.1. Stable operation in low-speed regenerating range
- 2.2. Inverter nonlinear error compensation
- 2.3. Robustness improvement in motor parameter deviation
- 2.4. Stable operation at zero speed & zero stator current frequency

3. Sensorless Control of IM in Ultra-High-Speed Region

- 3.1. Fast acceleration and deceleration control in high-speed region
- 3.2. Stable operation in low fundamental to PWM frequency ratio mode
- 3.3. Modified Euler approximation-based speed adaptive observer

15:30 - 16:00 Coffee break

16:00 - 17:30 Tutorials Part 2



4. Whole-Speed Range Sensorless Control of IPMSM Drives

- 4.1. High-frequency signal injection in zero- and low-speed range
- 4.2. State observer in high-speed range
- 4.3. Analysis of position error considering inverter nonlinearities and flux spatial harmonics
- 4.4. Position estimation error minimization based on adaptive filtering

5. Applications of Sensorless IPMSM Drive System

- 5.1. High efficiency remanufacturing of low efficiency IM motors
- 5.2. Optimal efficiency control strategy of IPMSM drives
- 5.3. Synchronous switching of IPMSMs from inverter to grid drives

6. Generic Technologies of Sensorless AC Motor Drives

- 6.1. Motor parameter identification
- 6.2. Parameter self-tuning
- 6.3. Fault diagnosis and redundant operation

7. Future Trends of Sensorless AC Motor Drives

- 7.1. Future trends of sensorless IM drives in industrial applications
- 7.2. Future trends of sensorless PMSM drives in industrial applications

17:30 End of tutorial and registration to the conference (Conference venue)

WHO SHOULD ATTEND

We would like to encourage researchers and engineers from both industry and academia working in power electronics and AC motor drives to attend the tutorial session. We invite also persons not familiar with AC motor drives at all, since basic introduction to the realm of power electronics systems will be provided.

Technical Level: From beginners to advanced engineers and researchers are welcomed.



ABOUT THE INSTRUCTORS



Dianguo Xu (M'97, SM'12) received the B.S. degree in Control Engineering from Harbin Engineering University, Harbin, China, in 1982, and the M.S. and Ph.D. degrees in Electrical Engineering from Harbin Institute of Technology (HIT), Harbin, China, in 1984 and 1989 respectively.

In 1984, he joined the Department of Electrical Engineering, HIT as an Assistant Professor. Since 1994, he has been a Professor in the Department of Electrical Engineering, HIT. He was the Dean of School of Electrical Engineering and Automation, HIT from 2000 to 2010, and was the Assistant President of HIT from 2010 to 2014. He is now the Vice President of HIT. His research interests include sensorless vector controlled AC motor drives, renewable energy generation technology, power quality mitigation, high performance PMSM servo system. He published over 600 technical papers.

Dr. Xu is a senior member of IEEE, Chairman of IEEE Harbin Section, an Associate Editor of the IEEE Transactions on Industrial Electronics and IEEE Journal of Emerging and Selected Topics in Power Electronics. He received Best paper award of ICEMS in 2014, Best paper award, PCIM Asia in 2014, IEEE Appreciation for Notable Services and Contributions in 2013, Best paper award of IPEMC2012-ECCE Asia in 2012, Best paper award of LSMS & ICSEE in 2010, IEEE Appreciation for Notable Services and Contributions in 2007, Best Energy-Efficient Design Award in 2007. He served as Technical Program Committee Chair, 2012 International Power Electronics and Motion Control Conference (IPEMC 2012-ECCE Asia), Technical Program Committee Co-Chair, 9th International Conference on Power Electronics – ECCE Asia (ICPE 2015-ECCE Asia), Member of International Advisory Committee, International Conference on Mechatronics and Control 2014, Member of National Steering Committee, 17th International Conference on Electrical Machines and Systems (ICEMS2014), Steering Committee Co-Chair, 2014 International Power Electronics and Application Conference and Exposition (PEAC2014), Steering Committee Co-Chair, 2014 International Power Electronics Conference (IPEC-Hiroshima 2014 -ECCE Asia), Honorary Technical Program Chair, International Future Energy Electronics Conference (IFEEC 2013), Steering Committee Co-Chair, 2011 International Conference on Power Electronics (ICPE 2011-ECCE Asia), National Steering Committee Co-Chair, 2009 International Power Electronics and Motion Control Conference (IPEMC 2009-ECCE Asia), Program Chair, IEEE Vehicle Power and Propulsion Conference 2008 (VPPC).



Gaolin Wang (M'13) received the B.S., M.S. and Ph.D. degrees in Electrical Engineering from Harbin Institute of Technology, Harbin, China, in 2002, 2004 and 2008 respectively.

In 2009, he joined the Department of Electrical Engineering, Harbin Institute of Technology as a Lecturer, where he has been a Full Professor of Electrical Engineering since 2014. From 2009 to 2012, he was a Postdoctoral Fellow in Shanghai Step Electric Corporation, where he was involved in the traction machine control for direct-drive elevators. He has authored more than 60 technical papers published in journals and conference proceedings. He is the holder of 10 Chinese patents. His current major research interests include permanent magnet synchronous motor drives, high performance direct-drive for traction system, position sensorless control of AC motors, efficiency optimization control of PMSM, and digital control of power converters.

Dr. Wang is a Member of IEEE Industrial Electronics Society, IEEE Power Electronics Society, IEEE Industry Applications Society and IEEE Power & Energy Society, an Associate Editor of Journal of Power Electronics, a Technical committee member of PCIM Asia Conference. He was the winner of the National Science Fund for Excellent Young Scholars in 2015, and the Delta Yong Scholar in 2014. He received the Outstanding Research Award from the Delta Environmental and Educational Foundation in 2012, and has been selected into the Program for Basic Research Excellent Talents, and the Young Talent Program in HIT. He served as Session Chair of ICPE 2015-ECCE Asia, Session Chair of ICPE 2015-ECCE Asia, Session Chair of 2015 PCIM Asia, Special Session Chair of 2014 PCIM Asia, Technical Program Committee Member of IEEE IPEC-Hiroshima 2014, Track Chair of IEEE International Power Electronics and Application Conference and Exposition (PEAC) 2014, Local Arrangement Committee Member of IEEE IPEMC-ECCE Asia 2012.