Dr. Avanish Tripathi

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EDUCATION

Indian Institute of Science, Bangalore, India

- M.S. and Ph.D. in Electrical Engineering — Aug 2011 – Aug 2016
  - Thesis: Low Switching Frequency Pulse Width Modulation for Induction Motor Drives
  - Adviser: Prof. G. Narayanan
  - Focus: Reduction of harmonic distortion in line current, minimization of torque ripple and vector control of induction motor drives operating at low switching frequencies

Indian Institute of Technology (Banaras Hindu University), Varanasi, India

- Bachelor of Technology (B. Tech.) in Electrical Engineering — Jul 2005 – May 2009
  - Graduated with College Honors.
  - Cumulative GPA: 8.32 / 10.0

RESEARCH EXPERIENCE

Chip based drive solutions for High-Power DC motors — Oct 2019 – Jun 2020

- Chip based DC motor drives are quite popular for low power applications. However, currently at Texas Instruments, Bangalore, efforts are made towards enhancing the power capabilities of such drivers. The important factor, which comes into play at high current levels, is the on-state conduction loss in the FETs. FETs with R_{DSon} as low as 10 mΩ are being developed and tested for improved power capacities.

Design and Development of 3 MW Propulsion Converter — Mar 2017 – Oct 2019

- This work was pursued at Delta Electronics India Pvt. Ltd., Bangalore under the project named 'Railways Propulsion'. The Electric locomotives, in Indian Railways, are being driven by multiple medium-voltage induction motors (IM) rated at 850 kW. These IMs are controlled through the central converter called 'Propulsion Converter' which is typically rated at 3 MW power level. The objective of the project was to indigenously develop the propulsion converters and test those under the actual locomotive conditions. The locomotive receives power from the 25 kV single phase line and supplies the converters through a single phase transformer with two secondary outputs having nominal supply voltage of 1.269 kV and 50 Hz supply frequency. For maintaining a stiff DC bus voltage at 2.8 kV and keeping the option for power regeneration, two single-phase active Front end converters were operated in parallel. Further, three three-phase inverters, connected to the same DC link, were operated to control the speed and tractive efforts of the IMs. Selection of components; development of PWM techniques; design of controllers and development of control algorithm were the key aspects of the research work. The switching frequency kept at 250 Hz on the front-end side whereas it was limited to 350 Hz on the motor-drive side. A test bench with back-back power circulation through coupled motor-generator sets, was also developed for testing of the propulsion converters at rated load.

Low Switching Frequency Pulse Width Modulation for IM Drives — Aug 2011 – Mar 2017

- Induction motor drives operating at high-power levels (few MWs) and/or at ultra-high speeds ($\geq 50,000$ rpm) are required to be operated with very few switching transitions in the line cycle. It is due to high switching energy losses and finite transition time of the semiconductor devices. Standard pulse width modulation (PWM) techniques are well known to generate large distortions in line current and torsional oscillations in the motor drives under such conditions. Hence, special PWM techniques are required to for safe and reliable operation of such motor drives. Optimal PWM techniques are developed to minimize the current ripple when the PWM waveform has only a few switching angles per quarter (say 2 to 7). Further, frequency domain based optimal PWM technique is proposed to minimize torque oscillations. These methods are also extended to a neutral-point-clamped three-level inverter fed induction motor drive. Further, while methods to analyze torque ripple are well established in high switching frequency drives, a method to predict the current and torque harmonic spectra for such drives based on PWM waveforms is proposed. Furthermore, an improved flux estimation method is proposed for such IM drives. The same is utilized for sensor-less vector control of IM drives, operating at low switching frequencies in the range of 250 Hz to 500 Hz. All proposed concepts are validated through simulations (C-language platform) and experiments on a 3.7 kW, 50 Hz IM drive. The research work was carried out at Department of Electrical Engineering, IISc, Bangalore.

Estimation and Control of Forces in Steel Secondary SLIM Aug 2008 – May 2009

- As part of B.Tech. project at Department of Electrical Engineering, IIT (BHU), Varanasi, single-sided linear induction motor (SLIM), having short primary and long secondary arrangement, is studied through simulations. Performance of SLIM with steel secondary is compared with those having Aluminum and steel (composite) secondary. Further, the analysis is extended for composite secondary under various supply conditions. Finite Element Method based electromagnetic model is also studied to understand the flux distribution and force generation for LIM with steel and composite secondaries.

Eddy current killed oscillator based proximity sensor May 2008 – Jun 2008

- Proximity sensor based on principal of tuned LC oscillator is modeled and analyzed in FEM based simulation platform at JFWTC Lab, General Electric, Bangalore. The electromagnetic model of C-core based proximity sensor is used to calculate the change in inductance and resistance of the system while a secondary steel plate is kept in the vicinity of the oscillator.

TEACHING ASSISTANTSHIP EXPERIENCE

Power Electronics Lab, IISc Bangalore Aug 2013 – Dec 2013

- The lab exercises comprised of designing and controlling the DC-DC power converters. As part of experiments, students designed a 200 μH inductor, 555-timer based MOSFET-firing circuit, MOSFET based buck and boost converters and op-amp based controller for the boost converter.

Electronic Circuits Lab, IISc Bangalore Aug 2014 – Dec 2014

- This course offered a set of experiments on designing circuits based on op-amps. Linear circuits, comparators and dead-time generation circuit were some of the important ones.

Digital Controllers for Power Applications, IISc Bangalore Jan 2014 – May 2014

- Interfacing of the peripherals *e.g.*, ADC, DAC *etc.* with the microprocessor for power converter application; generating the modulating signals, carrier waves and PWM signals and driving a three-phase induction motor in v/f mode, were part of the lab exercises for this course. TMS320C50 DSP processor based controller board was used for the experiments.

Pulse Width Modulation Techniques for Power Converters, IISc Bangalore Nov 2016

- A short-term course on Power Converters and PWM techniques was conducted by my PhD advisor on behalf of CCE, IISc Bangalore. The course was designed for Power-Electronics faculties from colleges in and around Bangalore.

PUBLICATIONS

JOURNALS

[1] A. Tripathi and G. Narayanan, "Analytical Evaluation and Reduction of Torque Harmonics in Induction Motor Drives Operated at Low Pulse Numbers," *IEEE Transactions on Industrial Electronics*, Feb 2019.

[2] A. Tripathi and G. Narayanan, "Evaluation and minimization of low-order harmonic torque in low-switching-frequency inverter fed induction motor drives," *IEEE Transactions on Industrial Applications*, Mar 2016.

[3] A. Tripathi and G. Narayanan, "Investigations on optimal pulse-width modulation to minimize total harmonic distortion in the line current," *IEEE Transactions on Industrial Applications*, Jan 2017.

[4] A. Tripathi and G. Narayanan, "Torque Ripple Minimization in Neutral-Point-Clamped Three-Level Inverter Fed Induction Motor Drives Operated at Low-Switching-Frequency," *IEEE Transactions on Industrial Applications*, Feb 2018.

[5] V. S. S. Pavan Kumar Hari, A. Tripathi and G. Narayanan, "Experimental determination of mechanical parameters in sensorless vector-controlled induction motor drives," *Sadhana Academy Proceedings in Engineering Sciences*, Aug 2017.

CONFERENCES

[1] A. Tripathi and G. Narayanan, "Evaluation and minimization of low-order harmonic torque in low-switching-frequency inverter fed induction motor drives," in *Proceedings of IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, IIT Mumbai, India, Dec 2014.

[2] A. Tripathi and G. Narayanan, "Torque Ripple Minimization in Neutral-Point-Clamped Three-Level Inverter Fed Induction Motor Drives Operated at Low-Switching-Frequency," in *Proceedings of IEEE 23rd International Symposium on Power Electronics, Electric Drives, Automation and Motion (SPEEDAM)*, Anna Capri, Italy, Jun 2016.

[3] A. Tripathi and G. Narayanan, "Investigations on optimal pulse-width modulation to minimize total harmonic distortion in the line current," in *Proceedings of IEEE India International Conference on Power Electronics (IICPE)*, NIT Kurukshetra, India, Dec 2014.

[4] A. Tripathi and G. Narayanan, "Optimal PWM for minimization of current harmonic distortion in three-level inverter fed induction motor drives," in *Proceedings of IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, Kerala, India, Dec 2016.

[5] A. Tripathi, V. S. S. Pavan Kumar Hari and G. Narayanan, "Closed-loop rotor flux estimation in vector controlled induction motor drives operated at low switching frequencies," in *Proceedings of IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, Kerala, India, Dec 2016.

[6] A. Tripathi and G. Narayanan, "Influence of three-phase symmetry on pulsating torque in induction motor drives," in *Proceedings of IEEE India International Conference on Power Electronics (IICPE)*, Patiala, India, Nov 2016.

[7] A. Tripathi and G. Narayanan, "High-performance on-line pulse width modulation without quarter wave symmetry for voltage-source inverter," in *Proceedings of IEEE International Conference on Advances in Electronics, Computers and Communications (ICAECC)*, Bangalore, India, Oct 2014.

[8] A. Tripathi and G. Narayanan, "Optimal pulse width modulation of voltage-source inverter fed motor drives with relaxation of quarter wave symmetry condition," in *Proceedings of IEEE International Conference on Electronics, Computing and Communication Technology (CONECCT)*, IISc Bangalore, India, Jan 2014.

[9] A. Tripathi and G. Narayanan, "On-line estimation of fundamental and ripple components of line currents in a voltage-source inverter operated at low switching frequency," in *Proceedings of National Power Electronics Conference (NPEC)*, IIT Kanpur, India, Dec 2013.

[10] V. S. S. Pavan Kumar Hari, A. Tripathi and G. Narayanan, "Experimental determination of mechanical parameters in sensorless vector-controlled induction motor drive," in *Proceedings of National Power Electronics Conference (NPEC)*, IIT Mumbai, India, Dec 2015.

[11] A. Guha, A. Tripathi and G. Narayanan, "Experimental study on dead-time induced oscillations in a 100-kW open-loop induction motor drive," in *Proceedings of National Power Electronics Conference (NPEC)*, IIT Kanpur, India, Dec 2013.

INDUSTRY EXPERIENCE

Texas Instruments, Bangalore, India

- Validation Engineer — Oct 2019 – Jun 2020
  - Job: Chip based solutions for high-power DC motor drives
  - Focus: The available DC motor drives solutions at TI are largely confined at low-power applications. Enhancing the power capabilities of the driver ICs, while reducing the R_{DSon} of the FETs, is the current focus in the project.

Delta Electronics India Pvt. Ltd., Bangalore, India

- Assistant Manager — Mar 2017 – Oct 2019
  - Job: Development and testing of 3.5 MW propulsion converter meant for Indian Railways
  - Focus: Propulsion converter is the main driving unit in the locomotives in Indian Railways. The project was focused towards indigenous development and testing of 3.5 MW propulsion converter. A 7 MW test-bench was developed for complete locomotive emulation and testing.

Indian Oil Corporation Ltd., Indane Bottling Plant, Karnal, Harnaya, India

- Operations Officer, Marketing Division — Aug 2009 – Jun 2011
  - Job: Maintenance and safety in-charge of LPG plant
  - Focus: Uninterrupted and reliable operation of automated safety equipments

John F. Welch Technology Center, GE Global Research, Bangalore, India

- Summer Internship — May 2008 – Jun 2008
  - Job: FEM modeling of proximity sensors based on eddy current killed oscillator
  - Focus: 3D FEM modeling and modification in core design for expanded range of detection

AWARDS

- Employee of the Quarter Award, Jan 2019
  Delta Electronics Pvt. Ltd., Bangalore, India
- Best Presentation Award, Oct 2014
  IEEE International Conference on Advances in Electronics, Computers and Communications
- Best Presentation Award, Apr 2016
  EECS Research Students Symposium, IISc Bangalore

GUEST LECTURES

- Topic: Two Level Inverter and Pulse Width Modulation Techniques, Aug 2013
  Sri Siddhartha Institute of Technology, Tumkur, India
- Topic: Induction Motor Modeling and Control, Nov 2014
  Sri Siddhartha Institute of Technology, Tumkur, India
- Topic: Linear Integrated Circuits, Apr 2016
  PES Institute of Technology, Bangalore, India
- Topic: Low Switching Frequency Pulse Width Modulation Techniques, Aug 2016
  Indian Institute of Technology (BHU), Varanasi, India
- Topic: Recent Advances in Power Electronics and Machine Drives, Oct 2016
  Siddaganga Institute of Technology, Tumkur, India

PROFESSIONAL AFFILIATIONS

Industrial Application Society, IEEE, New York, USA

- Student Member 2014 – Present

TECHNICAL SKILLS

- Programming Languages,
  C, VHDL
  - C platform is used for simulating Induction motor drives
  - VHDL is used for programming the FPGA controller board
- Simulation Tools,
  ANSYS, MATLAB, Sci Lab
- Controller Board,
  Field Programmable Gate Array (FPGA) based CYCLONE II controller board, ARM processor (LM3) based controller board