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## **I. HIGHLIGHTS**

- Ph.D. in Automotive System Engineering.
- Over 18 years of industrial experience in automotive chassis/ steering / brakes development.
- Experienced in leading technical team through full engineering development cycle from product definition to final product launch.
- Hands on experience on automotive customer technical development process, safety analysis, functional and technical system engineering cycle.
- Highly experienced in ASPICE process. Worked hands on to develop structure for these process deployment in way such that it helps to motivate a better working structure.
- Adept with various ISO26262 safety analysis and DFMEA analysis. Recent work include safety analysis for redundant motor drive architecture and designing various system protection for failure modes.
- Technical Expert in the area of Chassis Steering control/ Vehicle Dynamics /Motor Drives system. 15 years of hands on experience in low voltage (up to 48V system) motor drive design and development for steering and brakes.
- Initiated and responsible for the steering architecture and motor drive system architecture development for autonomous steering application, which lead to production deployment in the first semi-autonomous vehicle available in market.
- 5 years of experience in high voltage (630V) traction drive system development. Recent work include understanding OEM requirements and drilling them down to internal traction drive system requirements in the area of system development, motor drive software and power electronics requirements.
- Experienced in chassis design, vehicle tuning and controls development from steering perspective. Recent works include working with OEM, to develop various requirements for premium steering feel, tuning structure and controls development.
- Highly experienced in working with global teams to lead and provide technical assistant for various project.
- Running various product development team and defining the timeline and milestones for the project and aligning with the customer expectation.
- Make technical decision for make/buy for different aspect of architecture in the area of sensor/ power electronics
- Device new Future technology plan for the company.

- Worked extensively with hardware/EMC group to optimize gate driver, inverter design and also position and current sensor design for better performance.
- Highly experienced in design and development of PMSM motor system for low torque ripple applications such as steering. The work include sensor development, active torque ripple cancellation algorithm and high bandwidth control system.
- Experienced in noise and vibration (NVH) testing and analysis.
- Worked extensively in manufacturing plant for motor drive /controller mass production.
- Experienced in leading/defining technical goals for multi-disciplinary group for various project and aligning it with the product deliverables to the customer.
- Responsible to develop motor control and position control architecture for dual redundant motor architecture.
- Developed the First mass production Hall based position sensor system for Steering application
- Adept in system architecture development process, especially in the area of developing internal architecture, control and sensor requirements to meet the customer requirements.
- Has experience in system architecture tools such as IBM Rhapsody, UML/SYSML modeling-Recent work includes system architecture/requirements development for steer by wire systems.
- Highly experienced in system/control modelling using MATLAB, Simulink, CarSim. Python, PSIM,
- Has extensively worked in AUTOSAR architecture and agile software development process developing low-level drivers for ADC, PWM, SPI, QEP, CAN, DMA, SENT,
- Worked with various processor Texas Instrument (TMSF2812,2811), Infineon(TC23x,26x), Renesas processors.
- Hands on Experience in designing /debugging with DSPACE HIL testing and also manufacturing service related issue.
- Worked extensively in creating spec/debugging for manufacturing services, pass/fail criteria for torque ripple, torque speed and NVH acceptance.
- 10 conference publications, 2 transaction publications 2 patents and 3 trade secrets
- Associate editor for transaction of IEEE Industrial drives committee , IEEE Electric Machines committee
- Associate Professor in Saginaw Valley State University
- Various guest lecture across various prestigious university.

## **II. EDUCATION**

**Ph.D.** : Automotive system engineering (Sensorless Motor Control using PWM excitation), University of Michigan-Dearborn, USA, 2018.

**M.S.** : Electrical Engineering, New Jersey Institute of Technology, New Jersey, USA, 2005.

**B.E** : Electrical Engineering, Amrita Institute of technology, Tamilnadu, India, 2003.

## **III. WORK EXPERIENCE**

### **1. Halla Mechatronics, Bay City, MI, Chief Scientist- Controls (2013 - present)**

- Lead system development team from customer requirements and system architecture definition to internal requirements for system hardware and software.

- Lead & direct the advanced motor/Vehicle control activities including actuator and sensor research and development.
- Lead and develop various system architecture for advanced safety critical architecture. Recent Work include full deployment of redundant system architecture for Level 3 autonomy vehicle steering system.
- Lead the vehicle control performance analysis group to analyze power steering stability and performance.
- Traction drive system / safety architecture development. Recent work include traction drive system architecture from a clean slate, extensively working to design of hardware and software architecture for fail functional system. It includes system redundant architecture, machine performance analysis using Co-simulation tools such as Matlab, PSIM, power electronics feature design and software architecture.
- Worked extensively with OEM's to develop the first mass production Autonomous steering for Level 3. This include requirement definition for performance and safety. Control Modeling/algorithm to meet the target and software /system architecture. Extensive vehicle stability & dynamic testing.
- Worked extensively in plants for motor drive /controller mass production. This includes defining / solving various robustness issue in controller, motor calibration. Lead teams to define the requirements of pass /fail criteria and test procedure.
- Coordinate and support production motor control software development
- Work with OEM's to understand and drive down various controls requirement and drive down internal control and sensor requirements to meet the customer needs.
- Work with manufacturing & suppliers in deciding on make versus buy options
- Work with supplier to develop next generation sensor and processor chipset.

## **2. Nexteer Automotive, Saginaw, MI (2004-2013)**

### **Accomplishments:**

- Responsible for software development of Nexteer's initial development of current control IPMSM drive which went in to production.
- Responsible for software and control development of analog motor position sensor/ digital position sensor.
- Lead the software design team for Nexteer's Research division.
- Recipient of the prestigious Nexteer Excellence Award for developing innovative technology application.
- When Nexteer was part of GM/Delphi received various Delphi recognition award for completing of various development projects.

## **IV. LEADERSHIP COURSES**

1. Halla Leadership Training, Seoul, South Korea, May 2015
2. Nexteer Dale Carnegie Training, 2010

## **V. OTHER LEADERSHIP ACTIVITIES**

1. Associate Editor of Transaction for Associate Editor of Transaction for Industrial drive Committee, Transaction for Transportation Committee

2. Session Chair and Track Chair for industrial drive committee for ECCE 2018-2020.
3. Secretary for North East Michigan IEEE chapter (2017-2020).

## **VI. OTHER RELATED EXPERIENCE**

1. Guest Lecture at University of Michigan for topics on Automotive Safety architecture, Motor machine drive controls for Steering and brakes
2. Given IEEE tutorial on Advanced Safety architecture in automotive
3. Distinguished tutorial speaker for IEEE Transportation and Electrification Conference Expo.
4. Distinguished speaker at Power Group Seminar at University of Houston-2021
5. Distinguished lecture "Overseas distinguished lecture forum" at Zhejiang University, China, 26<sup>th</sup> June 2020.
6. Distinguished speaker at IEEE IAS/ PELS Jt. Chapter Kerala, India on June 5<sup>th</sup> 2020.
7. Associate Professor at Saginaw Valley state university, 2021- Advanced machine drive course.

## **VII. US PATENTS & TRADE SECRETS**

1. "System and method for adjusting a dead-time interval in a motor control circuit" US Patent No. 7659679, awarded February 9, 2010
2. "Permanent magnet electric motor" US Patent No. 11494088, awarded January 31, 2008
3. "Non contacting sensor algorithm for position and torque measurement."- Delphi Trade Secret
4. "Dynamic Parameter Estimation Algorithm for Synchronous motor" – Delphi Trade secret
5. "Method of Torque Control for an Interior Permanent magnet motor" – Nexteer Trade secret

## **VIII. PUBLICATIONS & CONFERENCE PAPERS**

1. "Effect of Position Sensor Error on the Performance of Permanent Magnet Machine Drives"- IEEE Transactions on Industry Applications, 2017.
2. "Online Stator Inductance Estimation for Permanent Magnet Motors using PWM Excitation" IEEE Transaction on Transportation and Electrification.
3. "Practical Implementation of current derivative measurement for sensorless position estimation using PWM excitation signal", ITEC, Long beach, CA, 2018.
4. "Sensorless position estimation using PWM excitation with minimized current ripple", Sensorless Control for Electrical Drives (SLED), 2018, Helsinki, Finland.
5. "Performance Analysis of Dual Wound Permanent Magnet Synchronous Machines under Winding Fault Scenarios", Energy Expo Congress and Exposition (ECCE), 2018.
6. "Effect of position measurement delay on the performance of electrical machines", Energy Expo Congress and Exposition (ECCE), 2018.
7. "Stator inductance estimation for permanent magnet motors using the PWM excitation", Energy Expo Congress and Exposition (ECCE), 2017
8. "Effect of position sensor error on the performance of permanent magnet machine drives", Energy Expo Congress and Exposition (ECCE), 2016, pp1-7
9. "Effect of position sensor error on the performance of PMSM drives for low torque ripple applications," in Electric Machines Drives Conference (IEMDC), 2013 IEEE International, May 2013, pp. 1166–1173
10. "Modeling and analysis of switching non-linearities of an inverter fed PMSM drive for low torque ripple application", PEDES 2012, pp. I – 6

11. "Evaluation of Inductance in a Permanent Magnet Synchronous Motor," IEEE International Electric Machines & Drives Conf., May. 2011, pp. 1171– 1176.
12. Real time estimation of parameters for controlling and monitoring permanent magnet synchronous motors" Electric Machines and Drives Conference, 2009. IEMDC'09.
13. A Novel Control Strategy to Mitigate the Parameter Saturation Problems in Synchronous Reluctance Machines," *IECON 2021 – 47th Annual Conference of the IEEE Industrial Electronics Society*, 2021, pp. 1-6, doi: 10.1109/IECON48115.2021.9589407.
14. A Generalized Theory to Predict the Torque Harmonics in Permanent Magnet Machines," *2021 IEEE Energy Conversion Congress and Exposition (ECCE)*, 2021, pp. 3711-3715, doi: 10.1109/ECCE47101.2021.9595831.
15. Limitations of the PI Control with Respect to Parameter Variation in PMSM Motor Drive Systems," *2019 IEEE International Electric Machines & Drives Conference (IEMDC)*, 2019, pp. 1688-1693, doi: 10.1109/IEMDC.2019.8785406.
16. Effect of Position Measurement Delay on the Performance of PMSM Drive," *2018 IEEE Energy Conversion Congress and Exposition (ECCE)*, 2018, pp. 4622-4627, doi: 10.1109/ECCE.2018.8558059.

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- **List of the lecture topics with the titles and short abstracts ( max. 600 characters each)**

**1. Advance safety architecture in automotive.**

This presentation gives a review of various advanced system architecture deployed by the safety critical components such as brakes and steering. The presentation talks about various type of redundant architectures deployed for autonomous driving conditions. It also discusses about advantages and disadvantages of such architectural changes. An overview of advance controls strategy for Steer- By Wire, Brake –by Wire will be discussed in this presentation.

**2. Sensorless control drive and its impact in the advancement of automotive safety architecture.**

This presentation give a review of sensorless motor control drive system. The present status of such drives in industry and what challenges does automotive industry face implementing sensorless drives in its safety critical components. It them shows how such drives system helps to develop next generation safety architecture for motor control drive by bringing down the cost but increasing the fault tolerant behaviour.

**3. Inductance and Position Estimation of Permanent Magnet Synchronous Machine using PWM excitation.**

This tutorial goes over sensorless estimation technqiuie to estimate Inductacnce and thereby motor position in PMSM drive using just the PWM excitation(without any external injection). The tutorial goes over the practical way to implement such technique in industry graded automotive processor and shows the accuracy of such estimation.The topic also shows how to estimate position starting from 0 to high speed of the motor and challenges encountered.

**4. Factors influencing active torque ripple cancellation in PMSM/IPMSM drives**

In this tutorial the main goal is to go in detail to understand various factors that needs to be considered to do an efficient active torque ripple cancellation for a PMSM/IPMSM drive at all operating condition. In this tutorial we will take a 12V 1-1KW PMSM/IPMSM machine for the case study and analyze how different sensor error and non-linearities affect the torque ripple at different operating condition. The tutorial will also deal with how to develop high bandwidth current loop and also various challenges in regards to current control of PMSM drive with respect to doing effective torque ripple cancellation at all operating condition. Finally will conclude with various key factors that needs to be considered in selection of the motor position and current sensor in order to achieve effective active torque ripple cancellation for mass production

*For more information please, visit the IEEE IAS CMD website*

<http://ias.ieee.org/chapters-membership/distinguished-lecturer-program.html>