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Sensor Less Speed Control of PMSM using SVPWM Technique Based on MRAS Method for Various Speed and Load Variations

ABSTRACT:

The permanent magnet synchronous motor (PMSM) has emerged as an alternative to the induction motor because of the reduced size, high torque to current ratio, higher efficiency and power factor in many applications. Space Vector Pulse Width Modulation (SVPWM) technique is applied to the PMSM to obtain speed and current responses with the variation in load. This paper analysis the structure and equations of PMSM, SVPWM and voltage space vector process. The Model Reference Adaptive System (MRAS) is also studied. The PI controller uses from estimated speed feedback for the speed sensorless control of PMSM based on SVPWM with MRAS. The control scheme is simulated in the MATLAB/Simulink software environment. The simulation result shows that the speed of rotor is estimated with high precision and response is considerable fast. The whole control system is effective, feasible and simple.

KEYWORDS:

1. PMSM
2. Space vector pulse width modulation
3. Model reference adaptive system

SOFTWARE: MATLAB/SIMULINK

Sensor Less Speed Control Of Pmsm Using Svpwm Technique

Ram Krishan,Deepak Reddy Pullaguram,Surender Reddy Salkuti

Sensor Less Speed Control Of Pmsm Using Svpwm Technique:

Advanced Sliding Mode Control for Electric Machines and Drive Systems Abdul Khalique Junejo,Wei Xu,Yirong Tang,2026-02-10 This book presents advances in control technologies for efficient operation of permeant magnet synchronous machines PMSMs and linear induction machines LIMs based on sliding mode control SMC It covers the design of the speed controller based on SMC and the composited speed controller based on different disturbance observers for the PMSM under the field oriented control FOC method including the numerical analysis of second order systems Several case studies with simulation in MATLAB and real time experimental analysis have been offered to verify the effectiveness of the proposed methods Key features Summarizes several theoretical control algorithms for permanent magnet synchronous motors and linear induction motors Provides simulation and experimental results to show the effectiveness of the theoretical algorithms Considers control scenarios from the typical problems in industrial applications pertaining to permanent magnet synchronous motors and linear induction motors Proposes FOC direct thrust control DTC and model predictive control MPC methods Includes numerical analysis of the second order systems to understand the process of the SMC design and its parameters This book is aimed at researchers professionals and graduate students in control and electrical engineering

IMDC-IST 2021 Abd-Alhameed Raed,A. Al-Hussaibi Walid,Rana Zubo,2022-01-26 This book contains the proceedings of the Second International Conference on Integrated Sciences and Technologies IMDC IST 2021 Where held on 7th 9th Sep 2021 in Sakarya Turkey This conference was organized by University of Bradford UK and Southern Technical University Iraq The papers in this conference were collected in a proceedings book entitled Proceedings of the second edition of the International Multi Disciplinary Conference Theme Integrated Sciences and Technologies IMDC IST 2021 The presentation of such a multi discipline conference provides a lot of exciting insights and new understanding on recent issues in terms of Green Energy Digital Health Blended Learning Big Data Meta material Artificial Intelligence powered applications Cognitive Communications Image Processing Health Technologies 5G Communications Referring to the argument this conference would serve as a valuable reference for future relevant research activities The committee acknowledges that the success of this conference are closely intertwined by the contributions from various stakeholders As being such we would like to express our heartfelt appreciation to the keynote speakers invited speakers paper presenters and participants for their enthusiastic support in joining the second edition of the International Multi Disciplinary Conference Theme Integrated Sciences and Technologies IMDC IST 2021 We are convinced that the contents of the study from various papers are not only encouraged productive discussion among presenters and participants but also motivate further research in the relevant subject We appreciate for your enthusiasm to attend our conference and share your knowledge and experience Your input was important in ensuring the success of our conference Finally we hope that this conference serves as a forum for learning in building togetherness and academic networks Therefore we expect to see you all at the next IMDC IST Proceedings of

the 4th Borobudur International Symposium on Science and Technology 2022 (BIS-STE 2022) Muji Setiyo,Zulfikar Bagus Pambuko,Chrisna Bagus Edhita Praja,Agus Setiawan,Fitriana Yuliastuti,Lintang Muliawanti,Veni Soraya Dewi,2023-11-08 This is an open access book Related to the big theme of the SDGs reinforcement at our previous conference we try to invite all academics and researchers around the world to participate in the 4th Borobudur International Symposium 2022 4thBIS 2022 As we know the COVID 19 pandemic and its impact on all the 17 SDGs have demonstrated how what began as a health catastrophe swiftly transformed into a human socioeconomic and environmental crisis The 4th BIS brought up The Innovation Chain A Contribution to Society and Industry as the main theme to respond this condition This conference is expected to support the UN Agenda Additionally this conference will also provide avenues for participants to exchange ideas and network with each other as well as domain experts from their fields Overall this event is aimed at professionals across all spheres of technology and engineering including the experienced inexperienced and students as well The conference will be held virtually on Wednesday December 21st 2022 in Magelang Central Java Indonesia Control of Permanent Magnet Synchronous Motors Sadegh Vaez-Zadeh,2018-02-23 Permanent magnet synchronous PMS motors stand at the forefront of electric motor development due to their energy saving capabilities and performance potential The motors have been developed in response to mounting environmental crises and growing electricity prices and they have enabled the emergence of motor drive applications like those found in electric and hybrid vehicles fly by wire and drones Control of Permanent Magnet Synchronous Motors is a timely advancement along that path as the first comprehensive self contained and thoroughly up to date book devoted solely to the control of PMS motors It offers a deep and extended analysis design implementation and performance evaluation of major motor control methods including Vector Direct Torque Predictive Deadbeat and Combined Control in a systematic and coherent manner All major Sensorless Control and Parameter Estimation methods are also studied The book places great emphasis on energy saving control schemes Smart Grid Stability and Control Ram Krishan,Deepak Reddy Pullaguram,Surender Reddy Salkuti,2025-08-02 This book features papers from the International Conference on Sustainable Power and Energy Research ICSPER 2024 Covering the spectrum of power and energy it focuses on various aspects of emerging technologies research ideas real time experiences and understanding of technology utilization in electrical power and energy systems The book introduces new ideas in Power system stability Operation and Control Renewable energy resources and energy storage Power electronics drives and Electric vehicles Smart grid and wide area monitoring Data science applications and cyber security in power systems Energy market and deregulation Power System Protection Condition monitoring and HV engineering Soft computing Techniques in electrical engineering Power electronic applications in power systems Energy Power and Automation Engineering Sanjay Yadav,Yogendra Arya,Nor Asiah Muhamad,Karim Sebaa,2024-02-29 This book presents the select proceedings of the 4th International Conference on Energy Power and Automation Engineering ICEPAE 2023 It focuses on the research of clean

energy power low carbon technology for power generation and energy automation technology The book Enriches understanding by including contributions from leading experts The book will be useful for researchers and professionals interested in the broad field of power energy **Recent Advances in Power Electronics and Drives** Krishna Murari,Bhim Singh,Vijay Kumar Sood,2024-03-23 This book entitled Recent Advances in Power Electronics and Drives Select Proceedings of EPREC 2023 provides rigorous discussions case studies and recent developments in the emerging areas of power electronics especially in power inverters and converters electrical drives regulated power supplies electric vehicle and its charging infrastructure etc The readers would benefit from enhancing their knowledge and skills in the domain areas Also this book may help the readers in developing new and innovative ideas The book can be a valuable reference for beginners researchers and professionals interested in advancements in power electronics and drives *Advancing Innovation through AI and Machine Learning Algorithms* Udara Yedukondalu,V Vijayasri Bolisetty,2025-10-10 The International Conference on Microstructure VLSI Robotics Communication Electrical Emerging Technologies using AI ML Algorithms ICMVRCET 2025 is an essential gathering for those at the forefront of research and development in the fields of Microstructure Design VLSI systems Robotics Communication technologies and Emerging Electrical systems This conference seeks to bridge the gap between academic research industrial advancements and real world applications by focusing on the integration of Artificial Intelligence AI and Machine Learning ML algorithms in these rapidly evolving domains Manufacturing Science and Technology, ICMST2011 Wu Fan,2011-11-22 Selected peer reviewed papers from the 2011 International Conference on Manufacturing Science and Technology ICMST 2011 September 16 18 2011 Singapore **IECON '94: Special sessions, signal processing and control** ,1994 **Proceedings IECON.** ,1991 Electrical & Electronics Abstracts ,1994 *Dissertation Abstracts International* ,2008 Proceedings of the ASME Turbo Expo ... ,2004 T-Source Inverter-Based Sensorless Speed Control for Permanent Magnet Synchronous Motor Dineshkumar Selvam,Thangasankaran Rameshkumar,Bhuvanesh Ananthan,Senthilkumar Subbaian,2020 Permanent magnet synchronous motors PMSM are used commonly in numerous industrial applications for instance in mechatronics vacuum pumps energy storage flywheels automotive centrifugal compressors and robotics Nowadays the sensorless speed control of PMSM is getting more attention and several studies are progressing because of its low cost and reliable features Normally the speed control methods in PMSM are achieved with the help of sensors for position or speed estimation and control But these sensors are easily prone to breakage Also the flexibility towards parameter variations is poor in the conventional speed control methods So a sensorless T source inverter based PMSM drive that integrates the Proportional Integral PI controller with an adaptive mechanism to cope with the time varying system parameters is proposed in this article A sensorless module namely a model reference adaptive system MRAS is employed to estimate the rotor position of PMSM based on its performance characteristics Simulation results are illustrated to investigate the performance of the proposed method with different speeds

under no load and loaded conditions Moreover the proposed approach not only minimizes the cost and size of the motor but also maximizes the reliability and accuracy Sensor and Sensorless Speed Control of Permanent Magnet Synchronous Motor Using Extended High-gain Observer Abdullah Ahmad Alfehaid,2021 Control of the speed as well as shaping the speed transient response of a surface mounted Permanent Magnet Synchronous Motor PMSM is achieved using the method of feedback linearization and extended high gain observer To recover the performance of feedback linearization an extended high gain observer is utilized to estimate both the speed of the motor and the disturbance present in the system The observer is designed based on a reduced model of the PMSM which is realized through the application of singular perturbation theory The motor parameters are assumed uncertain and we only assume knowledge of their nominal values The external load torque is also assumed to be unknown and time varying but bounded Stability analysis of the output feedback system is given Experimental results confirm the performance and robustness of the proposed controller We also compare our proposed control method to the cascaded Proportional Integral PI speed controller Then we show the extension of this control method to solve the problem of sensorless control of PMSMs The proposed sensorless control method is a back emf based control scheme Therefore we design a high gain back emf observer in the coordinates Next we transform the model of the PMSM to the d q coordinates which is performed using the estimated position and close the loop around the currents with relatively fast PI controllers After that we reduce the model of the PMSM and design a third order Q PLL extended high gain observer as well as the speed feedback controller Then we perform a rigorous stability analysis of the closed loop system Finally we show simulation and experimental results to verify performance and robustness of the proposed controller **Position Sensorless Control Techniques for Permanent Magnet Synchronous Machine Drives** Gaolin Wang,Guoqiang Zhang,Dianguo Xu,2019-11-15 The book focuses on position sensorless control for PMSM drives addressing both basic principles and experimental evaluation It provides an in depth study on a number of major topics such as model based sensorless control saliency based sensorless control position estimation error ripple elimination and acoustic noise reduction Offering a comprehensive and systematic overview of position sensorless control and practical issues it is particularly suitable for readers interested in the sensorless control techniques for PMSM drives The book is also a valuable resource for researchers engineers and graduate students in fields of ac motor drives and sensorless control *New Sensorless, Efficient Optimized and Stabilized V/f Control for PMSM Machines* Seyed Hesam Jafari,2013 With the rapid advances in power electronics and motor drive technologies in recent decades permanent magnet synchronous machines PMSM have found extensive applications in a variety of industrial systems due to its many desirable features such as high power density high efficiency and high torque to current ratio low noise and robustness In low dynamic applications like pumps fans and compressors where the motor speed is nearly constant usage of a simple control algorithm that can be implemented with least number of the costly external hardware can be highly desirable for industry In recent published works for low power

PMSMs a new sensorless volts per hertz V f controlling method has been proposed which can be used for PMSM drive applications where the motor speed is constant Moreover to minimize the cost of motor implementation the expensive rotor damper winding was eliminated By removing the damper winding however instability problems normally occur inside of the motor which in some cases can be harmful for a PMSM drive As a result to address the instability issue a stabilizing loop was developed and added to the conventional V f By further studying the proposed sensorless stabilized V f and calculating power loss it became known that overall motor efficiency still is needed to be improved and optimized This thesis suggests a new V f control method for PMSMs where both efficiency and stability problems are addressed Also although in nearly all recent related research methods have been applied to low power PMSM for the first time in this thesis the suggested method is implemented for a medium power 15 kW PMSM A C2000 F2833x Digital Signal Processor DSP is used as controller part for the student custom built PMSM drive but instead of programming the DSP in Assembly or C the main control algorithm was developed in a rapid prototype software environment which here Matlab Simulink embedded code library is used Abstract page iii Position-sensorless Control of Permanent Magnet Synchronous Machines Over Wide Speed Range Song Chi,2007 Abstract Permanent magnet synchronous machine PMSM drives have been increasingly applied in a variety of industrial applications which require fast dynamic response and accurate control over wide speed ranges Two control techniques are proposed in this dissertation for PMSM drives namely flux weakening control incorporating speed regulation and sliding mode observer with feedback of equivalent control The research objectives are to extend the operating speed range of the PMSM drive system and improve its control robustness and adaptability to variations of operating conditions as well as dynamic performance First a robust flux weakening control scheme is studied With a novel current control strategy the demagnetizing stator current required for the flux weakening operation can be automatically generated based on the inherent cross coupling effects in PMSM between its direct axis and quadrature axis current in the synchronous reference frame The proposed control scheme is able to achieve both flux weakening control and speed regulation simultaneously by using only one speed flux weakening controller without the knowledge of accurate machine parameters and dc bus voltage of power inverter Moreover no saturation of current regulators occurs under any load conditions resulting in control robustness in the flux weakening region Secondly a sliding mode observer is developed for estimating rotor position of PMSM without saliency in the implementation of position sensorless vector control A concept of feedback of equivalent control is applied to extend the operating range of sliding mode observer and improve its angle estimation performance Compared to conventional sliding mode observers the proposed one features the flexibility to design parameters of sliding mode observer operating in a wide speed range The estimation error of rotor position can be reduced by properly selecting the feedback gain of equivalent control In addition a flux based sliding mode observer with adaptive feedback gain is investigated The constant magnitude of equivalent control makes it easier to design the switching gain of discontinuous control in the sliding

mode observer As a result the problematic chattering phenomenon normally prevailing at low speeds due to high switching gains can be mitigated or even eliminated The feasibility and effectiveness of the control techniques addressed in this dissertation are verified by both computer simulation and experimental results **Study and Implementation of a PMSM & Study of a Sensorless Control Method** Helena Beltran I Feliu,2017 The procedure followed in the project begins with a brief introduction of the features that the studied motor a permanent magnet synchronous motor PMSM has The fact that the motor is synchronous permanent magnet has to do with its greater efficiency in comparison with the induction motor which is the most used nowadays Then the project is conducted in two steps The first one is the study of the PMSM mathematical modelling and the subsequent control method applied The second one is the study of a sensorless control algorithm Traditionally for speed dependent applications some kind of sensor is used to read the motor speed and position and feed the value back to the controller However extra sensors require extra physical space in the application and it also introduces another source of failure in the system Thus with the additional purposes of reducing cost and maintenance needs the sensor can be replaced by an estimator that mathematically estimates the speed or position of the rotor All these implementations have been simulated with MATLAB Simulink based on the mathematical models To design a controlled drive the stability characteristics of PMSM under open loop control without having any feedback for speed are analysed The analysis shows that the PMSM becomes unstable after exceeding a certain applied speed After tuning the controllers it has been analysed that the maximum speed that the closed loop can control with a reasonable settling time is 750 rpm The more speed that the motor achieves the more settling time appears Thus there is an upper limit for the speed For all the simulations an optimal speed of 550 rpm has been used The control structure and the design of the controllers are described A rotor position estimation technique for sensorless operation is studied The estimator uses predictor corrector method where the difference between the estimated current and the measured current current error is used to correct a predicted rotor position More investigations are still required for accurate rotor position estimation

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