

Position and Speed Control of Brushless DC Motors using Sensorless Techniques: A Review

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Abstract- In this paper, different methods define the position and speed control fundamentals of BLDC motors using sensors and the control improvements applying sensorless techniques including limitations and suggestions. The proposed Position and Speed Control method improve the performance and reliability of BLDC motor drivers because the conventional control and sensing techniques have been improved through sensorless technology. For realization of Sensorless operation, zero crossing of back emf is detected. In order to generate the proper firing pulses for commutation of inverter circuit and to remove the noise from the back emf signals, low pass filters are used.

Keywords:- BLDC, back-EMF, sensorless, position, speed, estimator, Hall-effect sensors

I. INTRODUCTION

Permanent Magnet Brushless DC (PMBLDC) Motors are the latest choice of researchers due to their high efficiency, silent operation, compact size, high reliability and low maintenance requirements. These motors are preferred for numerous applications; however, most of them require sensorless control of these motors. The operation of P.M.B.L.D.C. motors requires rotor-position sensing for controlling the winding currents. The sensorless control would need estimation of rotor position from the voltage and current signals, which are easily sensed.

The use of permanent magnets (PMs) in electrical machines in place of electromagnetic excitation results in many advantages such as no excitation losses, simplified construction, improved efficiency, fast dynamic, and high torque or power per unit volume. The PM excitation in electrical machines was used for the first time in the early 19th century, but was not adopted due to the poor quality of P.M materials. In 1932, the invention of Alnico revived the use of PM excitation systems, however it has been limited to small and fractional horse powered commutator machines.[1]

In the 20th century, squirrel cage induction motors have been the most popular electric motors, due to its rugged construction. Advancements in power electronics and digital signal processors have added more features to these motor drives to make them more prevalent in industrial applications. However squirrel cage induction motors suffer from poor power factor and efficiency as compared to synchronous motors. On the other hand, synchronous motors and dc commutator motors have limitations such as speed, noise problems, wear and EMI due to the use of commutator and brushes. These problems have led to the development of

permanent magnet brushless or commutatorless synchronous motors which have P.M excitation on the rotor.

Therefore, permanent magnet brushless (PMBL) motors can be considered a kind of three phase synchronous motor, having permanent magnets on the rotor, replacing the mechanical commutator and brushes. Commutation is accomplished by electronic switches, which supply current to the motor windings in synchronization with the rotor position.

The popularity of PMBL motors are increasing day by day due to the availability of high energy density and cost effective rare earth PM materials like Samarium Cobalt (Sm-Co) and Neodymium-Iron-Boron (Nd-Fe-B) which enhance the performance of P.M.B.L.D.C.M. drives and reduce the size and losses in these motors. The advancements in geometries and design innovations have made possible the use of PMBL motors in many of domestic, commercial and industrial applications. PMBL machines are best suited for position control and medium sized industrial drives due to their excellent dynamic capability, reduced losses and high torque/weight ratio.[1]

PMBL motors find applications in different fields such as domestic appliances, automobiles, transportation, aerospace equipment, power tools, toys, vision and sound equipment and healthcare equipment ranging from microwatt to megawatts. Advanced control algorithms and ultra-fast processors have made P.M.B.L.D.C. motors suitable for position control in machine tools, robotics and high precision servos, speed control and torque control in various industrial drives and process control applications. With the advancement in power electronics it is possible to design PMBL generators for power generation on board ships, aircraft, hybrid electric cars, while providing reduced generator weight, size and a high payload capacity for the complete vehicle.[25]

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Permanent Magnet Brushless DC Motor Drives and Controls Chang-liang Xia,2012-04-24 An advanced introduction to the simulation and hardware implementation of BLDC motor drives A thorough reference on the simulation and hardware implementation of BLDC motor drives this book covers recent advances in the control of BLDC motor drives including intelligent control sensorless control torque ripple reduction and hardware implementation With the guidance of the expert author team readers will understand the principle modelling design and control of BLDC motor drives The advanced control methods and new achievements of BLDC motor drives of interest to more advanced readers are also presented Focuses on the control of PM brushless DC motors giving readers the foundations to the topic that they can build on through more advanced reading Systematically guides readers through the subject introducing basic operational principles before moving on to advanced control algorithms and implementations Covers special issues such as sensorless control intelligent control torque ripple reduction and hardware implementation which also have applications to other types of motors Includes presentation files with lecture notes and Matlab 7 coding on a companion website for the book

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Patent and Trademark Office,1998 **Brushless DC Motors, Velocity and Position Control of the Brushless DC Motor** Nezh Y. Durusu,NAVAL POSTGRADUATE SCHOOL MONTEREY CA.,19?? A velocity feedback controller for the brushless DC motor was designed using the Hall effect sensors In addition the position control of the brushless DC motor was developed using an optical encoder to sense angular position changes and a microprocessor to provide the desired position control A Pittman 5111 wdg 1 brushless DC motor was used for this study The design of the digital tachometer and pulse width modulator for velocity control and the design of the Z 80 based microprocessor controller and software design are described in detail *Conference Record, Industry Applications Society, IEEE-IAS Annual Meeting (1981)* IEEE Industry Applications Society,1999 *Official Gazette of the United States Patent and Trademark Office* ,1998 **Recent Developments in Control, Automation and Power Engineering** Hemender Pal Singh,Ishak B. Aris,Anwar Shahzad Siddiqui,2025-05-23 This book contains original peer reviewed research papers from the 5th international conference RDCAPE 2023 This book presents the latest developments in the field of electrical engineering and related areas distinctively and engagingly The book discusses issues related to new challenges of renewable energy new control paradigms for efficient automation and decentralized power systems new economics of open auction based electricity generation transmission and distribution markets etc Apart from these many other topics of interest for readers are also covered The papers presented here share the latest findings on various issues as mentioned above It makes the book a useful resource for researchers scientists industry people and students alike *Instruments, Measurement, Electronics and Information Engineering* J.Z. Ma,2013-08-08 Selected peer reviewed papers from the 2013 International Conference on Precision Mechanical Instruments and Measurement Technology ICPMIMT 2013 May 25 26 2013 Shenyang Liaoning China *Industry Applications Society ... IEEE/IAS International Conference on Industrial Automation and Control (IA&C ...)* ,1995 *Proceedings of the Power Conversion Conference* ,2002 ***Journal of Dynamic Systems, Measurement, and Control*** ,2001 Publishes theoretical and applied original papers in dynamic systems Theoretical papers present new theoretical developments and knowledge for controls of dynamical systems together with clear engineering motivation for the new theory Applied papers include modeling simulation and corroboration of theory with emphasis on demonstrated practicality *Technical Proceedings* ,1996 The papers presented at CIEP aim at achieving lower costs through efficient use of power in industrial and business applications Approaches to designing and building these techniques into operations are presented Lower power demands through efficiencies in consumer products are described leading to portable product designs *IECON '87* ,1987

Proceedings of the 33rd IEEE Conference on Decision and Control IEEE Control Systems Society,1994 *IECON '87* Martin F. Schlecht,1987 ***Handbook of Electric Motors*** Richard H. Engelmann,William H. Middendorf,1995 This handbook provides comprehensive coverage of every type of electric motor in use today from the generic forms of direct current induction and synchronous machines to permanent magnet DC motors linear induction motors and stepper motors

Related topics such as finite element analysis control protection testing reliability maintenance specification procedures and environmental and mechanical factors are discussed *Innovative Computing* Chao-Tung Yang, Yan Pei, Jia-Wei Chang, 2020-09-25 This book gathers peer reviewed proceedings of the 3rd International Conference on Innovative Computing IC 2020 This book aims to provide an open forum for discussing recent advances and emerging trends in information technology science and engineering Themes within the scope of the conference include Communication Networks Business Intelligence and Knowledge Management Web Intelligence and any related fields that depend on the development of information technology The respective contributions presented here cover a wide range of topics from databases and data mining networking and communications the web and Internet of Things to embedded systems soft computing social network analysis security and privacy optical communication and ubiquitous pervasive computing Readers such as students researchers and industry professionals in the fields of cloud computing Internet of Things machine learning information security multimedia systems and information technology benefit from this comprehensive overview of the latest advances in information technology The book can also benefit young investigators looking to start a new research program

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