

Soft Computing Based Design of PID Controller for a Linear Brushless DC Motor

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Abstract: This study presents a Particle Swarm Optimization (PSO) Method for determining the optimal Proportional-Integral Derivative (PID) controller parameters for speed control of a linear brushless DC motor. The proposed approach has superior features including easy implementation, stable convergence characteristic and good computational efficiency. The brushless DC motor is modeled in Simulink and the PSO algorithm is implemented in MATLAB. Comparing with Genetic Algorithm (GA) and Linear Quadratic Regulator (LQR) Method, the proposed method was more efficient in improving the step response characteristics such as reducing the steady-states error, rise time, settling time and maximum overshoot in speed control of a linear brushless DC motor.

Key words: Brushless DC motor, particle swarm optimization, PID-controller, optimal control, Genetic Algorithm (GA).

INTRODUCTION

There are mainly two types of DC motors used in industry. The first one is the conventional dc motor where the flux is produced by the current through the field coil of the stationary pole structure. The second type is the Brushless DC motor (BLDC motor) where the permanent magnet provides the necessary air gap flux instead of the wire-wound field poles (Hambley, 1997). This kind of motor not only has the advantages of DC motor such as better velocity capability and no mechanical commutator but also has the advantage of AC motor such as simple structure, higher reliability and free maintenance. In addition, brushless DC motor has the following advantages: smaller volume, high force and simple system structure.

So, it is widely applied in areas which needs high performance drive (Kennedy and Eberhart, 1995). From the control point of view, DC motor exhibit excellent control characteristics because of the decoupled nature of the field and armature mmf's (Hambley, 1997). Recently, many modern control methodologies such as nonlinear control (Orng, 1997), optimal control (Jones, 1967), variable structure control (Bhimbra, 1993) and adaptive control have been widely proposed for linear brushless permanent magnet DC motor. However, these approaches are either complex in theoretical bases or difficult to implement. PID control with its three term functionality covering treatment to both transient and steady-states

response, offers the simplest and yet most efficient solution to many real world control problems. In spite of the simple structure and robustness of this method, optimally tuning gains of PID controllers have been quite difficult. Genetic algorithm is a stochastic optimization algorithm that is originally motivated by the mechanism of natural selection and evolutionary genetics. Though, the GA Methods have been employed successfully to solve complex optimization problems, recent search has identified some deficiencies in GA performance (Deb, 2002).

LINEAR BRUSHLESS DC MOTOR

Permanent magnet DC motors use mechanical commutators and brushes to achieve the commutation. However, BLDC motors adopt Hall Effect Sensors in place of mechanical commutators and brushes (Gen and Cheng, 2002).

The stators of BLDC motors are the coils and the rotors are the permanent magnets. The stators develop the magnetic fields to make the rotor rotating. Hall Effect Sensors detect the rotor position as the commutating signals. Therefore, BLDC motors use permanent magnets instead of coils in the armature and so do not need brushes. In this study, a three-phase and two-pole BLDC motor is studied. The speed of the BLDC motor is controlled by means of a three-phase and half-bridge Pulse-Width Modulation (PWM) inverter. The dynamic

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SOFT COMPUTING Dr.Dinesh G ,Dr.Pilli Lalitha Kumari ,Dr.Mahesh Lokhande ,Dr.Syed Azahad,2022-03-15 SOFT COMPUTING book was written by Dr Dinesh G Dr Pilli Lalitha Kumari Dr Mahesh Lokhande Dr Syed Azahad **Soft Computing** Samir Roy,Udit Chakraborty,2013 Soft computing is a branch of computer science that deals with a family of methods that imitate human intelligence This is done with the goal of creating tools that will contain some human like capabilities such as learning reasoning and decision making This book covers the entire gamut of soft computing including fuzzy logic rough sets artificial neural networks and various evolutionary algorithms It offers a learner centric approach where each new concept is introduced with carefully designed examples instances to train the learner *Advances in Abstract Intelligence and Soft Computing* Wang, Yingxu,2012-12-31 Continuous developments in software and intelligence sciences have brought together the studies of both natural and machine intelligence and the relationship between the function of the brain and the abstract soft mind creating a new multidisciplinary field of study *Advances in Abstract Intelligence and Soft Computing* brings together the latest research in computer science theoretical software engineering cognitive science and informatics and also their influence on the processes of natural and machine intelligence This book is a collection of widespread research in the constant expansions on this emerging discipline **Applications of Image Processing and Soft Computing Systems in Agriculture** Razmjoo, Navid,Estrela, Vania Vieira,2019-02-22 The variety and abundance of qualitative characteristics of agricultural products have been the main reasons for the development of different types of non destructive methods NDTs Quality control of these products is one of the most important tasks in manufacturing processes The use of control and automation has become more widespread and new approaches provide opportunities for production competition through new technologies *Applications of Image Processing and Soft Computing Systems in Agriculture* examines applications of artificial intelligence in agriculture and the main uses of shape analysis on agricultural products such as relationships between form and genetics adaptation product characteristics and product sorting Additionally it provides insights developed through computer vision techniques Highlighting such topics as deep learning agribusiness and augmented reality it is designed for academicians researchers agricultural practitioners and industry professionals *Soft Computing: Theories and Applications* Rajesh Kumar,Ajit Kumar Verma,Tarun K. Sharma,Om Prakash Verma,Sanjay Sharma,2023-04-24 This book focuses on soft computing and how it can be applied to solve real world problems arising in various domains ranging from medicine and health care to supply chain management image processing and cryptanalysis It gathers high quality papers presented at the International Conference on Soft Computing Theories and Applications SoCTA 2022 held at University Institute of Technology Himachal Pradesh University Shimla Himachal Pradesh India The book offers valuable insights into soft computing for teachers and researchers alike the book inspires further research in this dynamic field *Computational Intelligence Applications in Business Intelligence and Big Data Analytics*

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Biography of Florentin

Smarandache Mihaly Bencze,2019-12-10 Florentin Smarandache is a professor of mathematics at the University of New Mexico United States He got his MSc in Mathematics and Computer Science from the University of Craiova Romania PhD in Mathematics from the State University of Kishinev and Postdoctoral in Applied Mathematics from Okayama University of Sciences Japan He is the founder of neutrosophy generalization of dialectics neutrosophic set logic probability and statistics since 1995 and has published hundreds of papers and books on neutrosophic physics superluminal and instantaneous physics unmatter quantum paradoxes absolute theory of relativity redshift and blueshift due to the medium gradient and refraction index besides the Doppler effect paradoxism outerart neutrosophy as a new branch of philosophy Law of Included Multiple Middle multispace and multistructure hypersoft set degree of dependence and independence between neutrosophic components refined neutrosophic set neutrosophic over under off set plithogenic set neutrosophic triplet and duplet structures quadruple neutrosophic structures extension of algebraic structures to NeutroAlgebras and AntiAlgebras DSMT and so on to many peer reviewed international journals and many books and he presented papers and plenary lectures to many international conferences around the world

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