

[< Back](#)

Chapter 7

## Design of MPC-TSA Controller for Hybrid Two-Area Power System

Susmit Chakraborty, Arindam Mondal

Book Editor(s): Arindam Mondal, Souvik Ganguli

First published: 23 May 2025

<https://doi.org/10.1002/9781394287109.ch7>

### Summary

In the past several decades, the discipline of control has seen significant advancements in model predictive control (MPC). It offers several benefits, including quick reaction times, steadiness against nonlinear behaviors, and parametric uncertainties. The control input for MPC, which is also termed as control of the receding horizon, is derived by evaluating a discrete-time optimum control problem over a predetermined horizon. This chapter proposes the tree-seed algorithm (TSA) for most ideal MPC controller settings for a two-area interconnected hybrid power system (2-AIHPS) that includes thermal and nuclear units along with non-conventional energy sources (NCES) like ocean thermal power plant (OTPP) and solar plant to reduce power system pulsations. TSA is used to find the best controller settings by minimizing a time-domain-based fitness function such as the integral-time multiplied squared error (ITSE). The performance of the suggested controller may be assessed by contrasting it with TSA-based PID and conventional control approaches like PSO-based PID. In the MATLAB simulation platform, the entire system (2-AIHPS), including the controllers, is sketched and modeled. Simulation outcomes such as settling time (ST), overshoot (OS), and undershoot (US) on a 2-AIHPS are analyzed for all controlling methods discussed above. The suggested controller outperforms other controllers found in the literature on account of its robustness to load variations.

[< Back](#)

Shayeghi , H.A.S.H. , Shayanfar , H.A. , Jalili , A. , Load frequency control strategies: A state-of-the-art survey for the researcher . *Energy Convers. Manage.* , **50** . 2 , 344 – 353 , 2009 .

[Web of Science®](#) | [Google Scholar](#) |

Liu , F. , *et al* . , Optimal load-frequency control in restructured power systems . *IEE Proceedings-Generation Transm. Distrib.* , **150** . 1 , 87 – 95 , 2003 .

[Google Scholar](#) |

Vachirasricirikul , S. and Ngamroo , I. , Robust LFC in a smart grid with wind power penetration by coordinated V2G control and frequency controller . *IEEE Trans. Smart Grid* , **5** . 1 , 371 – 380 , 2014 .

[Web of Science®](#) | [Google Scholar](#) |

Shankar , G. and Lakshmi , S. , Frequency control of hybrid renewable energy system with PSO optimized controller . *2015 International Conference on Recent Developments in Control, Automation and Power Engineering (RDCAPE)* , IEEE , 2015 .

[Google Scholar](#) |

Srinivasa , R.C. , Adaptive Neuro Fuzzy based Load Frequency Control of multi area system under open market scenario . *IEEE-International Conference on Advances in Engineering, Science and Management (ICAESM-2012)* , IEEE , 2012 .

[Google Scholar](#) |

Sathya , M.R. and Mohamed Thameem Ansari , M. , Load frequency control using Bat inspired algorithm based dual mode gain scheduling of PI controllers for interconnected power system . *Int. J. Electric. Power Energy Syst.* , **64** , 365 – 374 , 2015 .

[← Back](#)

Ahmadi , A. and Aldeen , M. , Robust overlapping load frequency output feedback control of multi-area interconnected power systems . *Int. J. Electr. Power Energy Syst.* , **89** , 156 – 172 , 2017 .

[Web of Science®](#) | [Google Scholar](#) |

Lu , K. , *et al.* , Constrained population extremal optimization-based robust load frequency control of multi-area interconnected power system . *Int. J. Electr. Power Energy Syst.* , **105** , 249 – 271 , 2019 .

[Web of Science®](#) | [Google Scholar](#) |

Naidu , K. , Mokhlis , H. , Terzija , V. , Performance investigation of ABC algorithm in multi-area power system with multiple interconnected generators . *Appl. Soft Comput.* , **57** , 436 – 451 , 2017 .

[Web of Science®](#) | [Google Scholar](#) |

Rodríguez-Abreo , O. , *et al.* , Self-tuning neural network PID with dynamic response control . *IEEE Access* , **9** , 65206 – 65215 , 2021 .

[Google Scholar](#) |

Vrdoljak , K. , Perić , N. , Petrović , I. , Sliding mode based load-frequency control in power systems . *Electr. Power Syst. Res.* , **80** . 5 , 514 – 527 , 2010 .

[Web of Science®](#) | [Google Scholar](#) |

Dahiya , P. , Sharma , V. , Naresh , R. , Optimal sliding mode control for frequency regulation in deregulated power systems with DFIG-based wind turbine and TCSC–SMES . *Neural Comput. Appl.* , **31** . 7 , 3039 – 3056 , 2019 .

[← Back](#)

Rosaline , A.D. and Somarajan , U. , Structured H-Infinity controller for an uncertain deregulated power system . *IEEE Trans. Ind. Appl.* , **55** . 1 , 892 – 906 , 2018 .

[Web of Science®](#) | [Google Scholar](#) |

Sondhi , S. and Hote , Y.V. , Fractional order PID controller for load frequency control . *Energy Convers. Manage.* , **85** , 343 – 353 , 2014 .

[Web of Science®](#) | [Google Scholar](#) |

Arya , Y. and Kumar , N. , BFOA-scaled fractional order fuzzy PID controller applied to AGC of multi-area multi-source electric power generating systems . *Swarm Evol. Comput.* , **32** , 202 – 218 , 2017 .

[Web of Science®](#) | [Google Scholar](#) |

Saikia , L.C. , *et al.* , Automatic generation control of a multi area hydrothermal system using reinforced learning neural network controller . *Int. J. Electr. Power Energy Syst.* , **33** . 4 , 1101 – 1108 , 2011 .

[Web of Science®](#) | [Google Scholar](#) |

Khuntia , S.R. and Panda , S. , Simulation study for automatic generation control of a multi-area power system by ANFIS approach . *Appl. Soft Comp.* , **12** . 1 , 333 – 341 , 2012 .

[Google Scholar](#) |

Fathy , A. and Kassem , A.M. , Antlion optimizer-ANFIS load frequency control for multi-interconnected plants comprising photovoltaic and wind turbine . *ISA Trans.* , **87** , 282 – 296 , 2019 .

[← Back](#)

Sharma , D. and Mishra , S. , Non-linear disturbance observer-based improved frequency and tie-line power control of modern interconnected power systems . *IET Generation Transm. Distrib.* , **13** . 16 , 3564 – 3573 , 2019 .

[Web of Science®](#) | [Google Scholar](#) |

Guha , D. , Roy , P.K. , Banerjee , S. , Disturbance observer aided optimised fractional-order three-degree-of-freedom tilt-integral-derivative controller for load frequency control of power systems . *IET Generation Transm. Distrib.* , **15** . 4 , 716 – 736 , 2021 .

[Web of Science®](#) | [Google Scholar](#) |

Sahu , R.K. , Panda , S. , Sekhar , G.T.C. , A novel hybrid PSO-PS optimized fuzzy PI controller for AGC in multi area interconnected power systems . *Int. J. Electr. Power Energy Syst.* , **64** , 880 – 893 , 2015 .

[Web of Science®](#) | [Google Scholar](#) |

Sahu , B.K. , *et al.* , A novel hybrid LUS–TLBO optimized fuzzy-PID controller for load frequency control of multi-source power system . *Int. J. Electr. Power Energy Syst.* , **74** , 58 – 69 , 2016 .

[Web of Science®](#) | [Google Scholar](#) |

Nayak , J.R. , Shaw , B. , Sahu , B.K. , Application of adaptive-SOS (ASOS) algorithm based interval type-2 fuzzy-PID controller with derivative filter for automatic generation control of an interconnected power system . *Eng. Sci. Technol. Int. J.* , **21** . 3 , 465 – 485 , 2018 .

[Web of Science®](#) | [Google Scholar](#) |

Afaneh , T. , Mohamed , O. , Elhajja , W.A. , Load Frequency Model Predictive Control of a Large-Scale Multi-Source Power System . *Energies* , **15** . 23 , 9210 , 2022 .

[< Back](#)

Camacho , E. and Bordons , C. , *Model Predictive Control* , 2nd , Springer , Berlin, Germany , 2004 .

[Google Scholar](#)

Bemporad , A. , Morari , M. , Ricker , N.L. , Tech. Rep. AUT01-08, Autom. Control Lab , in: *The MPC Simulink library* , ETH , Zurich, Switzerland , 2000 .

[Google Scholar](#)

Rerkpreedapong , D. , Atic , N. , Feliachi , A. , Economy oriented model predictive load frequency control . *Proc. Power Eng. Conf. Large Eng. Syst.* , 12 – 16 , 2003 , DOI: [10.1109/LESCPE.2003.1204672](https://doi.org/10.1109/LESCPE.2003.1204672) .

[Google Scholar](#)

Kong , L. and Xiao , L. , A new model predictive control schemebased load frequency control , in: *Proc. 2007 IEEE Int. Conf. Cntrl. Autom* , pp. 2514 – 2518 .

[Google Scholar](#)

Venkat , A.N. , Hiskens , I.A. , Rawlings , J.B. , Wright , S.J. , Distributed MPC strategies with application to power system automatic generation control . *IEEE Trans. Control Syst. Technol.* , **16** , 6 , 1192 – 1206 , 2008 , DOI: [10.1109/TCST.2008.919414](https://doi.org/10.1109/TCST.2008.919414) .

[Web of Science®](#) | [Google Scholar](#)

Shiroei , M. , Ranjbar , A.M. , Amraee , T. , A functional model predictive control approach for power system load frequency control considering generation rate constraint . *Int. Trans. Electr. Energy Syst.* , **23** , 2 , 214 – 229 , 2013 , DOI: [10.1002/etep.653](https://doi.org/10.1002/etep.653) .

[< Back](#)

Mohamed , T.H. , Bevrani , H. , Hassan , A.A. , Hiyama , T. , Decentralized model predictive based load frequency control in an interconnected power system . *Energy Convers. Manage.* , **52** , 2 , 1208 – 1214 , 2011 , DOI: [10.1016/j.enconman.2010.09.016](https://doi.org/10.1016/j.enconman.2010.09.016) .

[Web of Science®](#) | [Google Scholar](#) |

Ogata , K. *Modern Control Engineering* , Prentice Hall , New Jersey , 2002 .

[Google Scholar](#) |

Kiran , M.S. , TSA: Tree-seed algorithm for continuous optimization . *Expert Syst. Appl.* , **42** . 19 , 6686 – 6698 , 2015 .

[Web of Science®](#) | [Google Scholar](#) |

Hakimuddin , N. , Nasiruddin , I. , Singh Bhatti , T. , Generation-based automatic generation control with multisources power system using bacterial foraging algorithm . *Eng. Rep.* , **2** . 8 , e12191 , 2020 .

[Google Scholar](#) |

Biswas , S. , Roy , P.K. , Chatterjee , K. , Renewable energy-based multi-source system under deregulated environment using cokha algorithm . *IETE J. Res.* , **63** , 9 , 1 – 19 , 2021 .

[Google Scholar](#) |

Hernández-Romero , I.M. , *et al.* , Optimal design of the ocean thermal energy conversion systems involving weather and energy demand variations . *Chem. Eng. Processing-Process Intensif.* , **157** , 108114 , 2020 .

[CAS](#) | [Google Scholar](#) |

[< Back](#)[Google Scholar](#)

---

Maciejowski, J.M., *Predictive Control with Constraints*, Prentice Hall, London, 2002.

[Google Scholar](#)

#### ABOUT WILEY ONLINE LIBRARY

[Privacy Policy](#)[Terms of Use](#)[About Cookies](#)[Manage Cookies](#)[Accessibility](#)[Wiley Research DE&I Statement and Publishing Policies](#)[Developing World Access](#)

#### HELP & SUPPORT

[Contact Us](#)[Training and Support](#)[DMCA & Reporting Piracy](#)

#### OPPORTUNITIES

[Subscription Agents](#)[Advertisers & Corporate Partners](#)

< Back

---

Wiley Press Room

Copyright © 1999-2025 John Wiley & Sons, Inc or related companies. All rights reserved, including rights for text and data mining and training of artificial intelligence technologies or similar technologies.



# Controller Design for Industrial Applications

Editor(s): Arindam Mondal, Souvik Ganguli

First published: 23 May 2025

Print ISBN: 9781394287079 | Online ISBN: 9781394287109 | DOI: 10.1002/9781394287109

© 2025 Scrivener Publishing LLC

---

## About this book

***Controller Design for Industrial Applications* is essential for anyone looking to master the advanced techniques of intelligent controller design, enabling you to effectively tackle the complexities of modern industrial processes and optimize performance in an ever-evolving landscape.**

[... Show all](#) ▾

## Table of Contents

---

” [Export Citation\(s\)](#)

---

[Free Access](#)

[Front Matter \(Pages: i-xix\)](#)

[Summary](#) | [PDF](#) | [Request permissions](#)

---

## CHAPTER 1

### Fuzzy Logic Control for Industrial Applications (Pages: 1-20)

Srabanti Maji, Souvik Ganguli

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

## CHAPTER 2

### Artificial Neural Network for Industrial Applications (Pages: 21-39)

Biswajit Saha, Gour Sundar Mitra Thakur

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

## CHAPTER 3

### Artificial Neural Network–Based Sliding Mode Controller for a Class of Nonlinear System (Pages: 41-54)

Sheetla Prasad, Rammurti Meena, Vipin Chandra Pal

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

## CHAPTER 4

### Finite Control Set Model Predictive Control for Permanent Magnet Synchronous Motor Drives (Pages: 55-88)

Ravi Eswar Kodumur Meesala, Phani Teja Bankupalli, Chinta Praveen Kumar

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

## CHAPTER 5

**Kinematic and Dynamic Modeling of Robots (Pages: 89-103)**

Suman Lata Tripathi, Deepika Ghai

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

## CHAPTER 6

**Design of FUZZY-(1+PD)-FOPID Controller for Hybrid Two-Area Power System (Pages: 105-124)**

Susmit Chakraborty, Arindam Mondal

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

## CHAPTER 7

**Design of MPC-TSA Controller for Hybrid Two-Area Power System (Pages: 125-140)**

Susmit Chakraborty, Arindam Mondal

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

## CHAPTER 8

**Wide-Area Monitoring, Protection, Automation and Control (WAMPAC) System (Pages: 141-165)**

Sanchita Kumari, Amrita Sinha

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

## CHAPTER 9

## [An Efficient Smart Prepaid Interface Design for Power Industries \(Pages: 167-188\)](#)

Antara Kundu, Harsh Kumar Shaw, Maitrayee Chakrabarty

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 10

## [PV System Maximum Power Point Tracking Under Partial Shadowing Using Gray Wolf Optimization Algorithm \(Pages: 189-209\)](#)

Snehashis Ghoshal, Arindam Mondal

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 11

## [An Efficient Optimization Approach for Solving the Relay Coordination Problem \(Pages: 211-231\)](#)

Maitrayee Chakrabarty, Sudipta Chakraborty, Suparna Pal, Raju Basak

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 12

## [Intelligent Control for Energy-Efficient HVAC System Modeling and Control \(Pages: 233-256\)](#)

R. Sanjeevi, J. Anuradha, Sandeep Tripathi, Prashantkumar B. Sathvara

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 13

## Enhancing UAV Navigation in Partially Observable 2D Environments: An Optimized Obstacle Avoidance Approach (Pages: 257-285)

Jun Jet Tai, Swee King Phang

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 14

## Fast Inner and Outer Dynamics Control of Multi-Rotor UAVs with Novel SIPIC and RPT Controllers Design (Pages: 287-307)

Swee King Phang, Jun Jet Tai

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 15

## Type 1 Cascaded Fuzzy Logic–Based Autonomous Vehicles Control Applications (Pages: 309-329)

Eshan Samanta, Sagarika Pal, Anupam De

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 16

## AI-Driven Electric Vehicle Integration for Sustainable Transportation (Pages: 331-349)

Loveneet Mishra, Usha Chauhan, Manasi Pattnaik

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

### CHAPTER 17

## Wireless EV Charging System Design (Pages: 351-374)

Koushik Majumder, Maitrayee Chakrabarty, Rakesh Das, Raju Basak

[Summary](#) | [PDF](#) | [References](#) | [Request permissions](#)

---

 [Free Access](#)

[Index \(Pages: 375-379\)](#)

[First Page](#) | [PDF](#) | [Request permissions](#)

---

 [Free Access](#)

[Also of Interest \(Pages: b1-b3\)](#)

[PDF](#) | [Request permissions](#)

 [Buy this Book](#)

---

 [Contact your account manager](#)

---

 [For authors](#)

---

#### ABOUT WILEY ONLINE LIBRARY

[Privacy Policy](#)

[Terms of Use](#)

[About Cookies](#)

[Manage Cookies](#)

[Accessibility](#)

[Wiley Research DE&I Statement and Publishing Policies](#)

Developing World Access

**HELP & SUPPORT**

Contact Us

Training and Support

DMCA & Reporting Piracy

**OPPORTUNITIES**

Subscription Agents

Advertisers & Corporate Partners

**CONNECT WITH WILEY**

The Wiley Network

Wiley Press Room

Copyright © 1999-2025 John Wiley & Sons, Inc or related companies. All rights reserved, including rights for text and data mining and training of artificial intelligence technologies or similar technologies.