



Conference proceedings | © 2021

Innovations in Sustainable Energy and Technology

Proceedings of ISET 2020

Editors: [P. Muthukumar](#), [Dilip Kumar Sarkar](#), [Debasis De](#), [Chanchal Kumar De](#)

Presents research works in the field of sustainable energy and technology

Contains best selected papers presented at ISET 2020 held in Bangalore, India

Serves as a reference for researchers and practitioners in academia and industry

Part of the book series: [Advances in Sustainability Science and Technology](#) (ASST)

9038 Accesses | **20** [Citations](#) | **3** [Altmetric](#)

Sections

[Table of contents](#)

[About this book](#)

[Keywords](#)

[Editors and Affiliations](#)

[About the editors](#)

[Bibliographic Information](#)

This is a preview of subscription content, [access via your institution](#).

Table of contents (32 papers)

Search within book

← Previous

Page

1

of 2

Next →

Front Matter

[PDF](#) ↓

Pages i-xviii

[WattCastLSTM—Power Demand Forecasting Using Long Short-Term Memory Neural Network](#)

V. Vijay Sankar, P. Chitra, B. Poonkuzhali
Pages 1-11

[Thermodynamic Analysis of Solar Photovoltaic/Thermal System \(PVT\) for Air-Conditioning Applications](#)

A. Sai Kaushik, Satya Sekhar Bhogilla
Pages 13-22

[PbS Nanoparticle Sensitized Fe-Doped Mesoporous TiO₂ Photoanodes for Photoelectrochemical Water Splitting](#)

Somopрова Halder, Soumyajit Maitra, Subhasis Roy
Pages 23-34

[In Situ Ni-Doped Co₃O₄ Nanostructure: An Efficient Electrocatalyst for Hydrogen](#)

Evolution

Arijit Basu, N. Srinivasa, S. Ashoka, Debasis De
Pages 35-47

Aerodynamic Performance Enhancement and Optimization of a H-rotor Vertical Axis Wind Turbine

Abhilash Nayak, Sukanta Roy, Sivasankari Sundaram,
Arjun Deo, Hakeem Niyas
Pages 49-67

CFD Analysis of a Straight Bladed Darrieus Vertical Axis Wind Turbine Using NACA 0021 Aerofoil

Anand Raj, Sukanta Roy, Bhaskor Jyoti Bora, Hakeem Niyas
Pages 69-80

Fabrication of Dye-Sensitized Solar Cell Based on Natural Dye Sensitizer and ZnO Nanoflower Photoanode

Debasis De, M. Sreevidhya, Chanchal Kumar De
Pages 81-88

Effect of Longitudinal Fin Configuration on the Charging and Discharging Characteristics of a Horizontal Cylindrical Latent Heat Storage System

Gurpreet Singh Sodhi, K. Vigneshwaran, Vishnu Kumar, P. Muthukumar
Pages 89-98

Fabrication of Catalytic Sheet Filter of V₂O₅-WO₃/TiO₂-Supported SiC for Selective Catalytic Reduction of NO_x Emission from Combustion Engine

Ajit Dattatray Phule, Seongsoo Kim, Joo Hong Choi
Pages 99-107

[CEPSO-Based Load Frequency Control of Isolated Power System with Security Constraints](#)

Santigopal Pain, Dilip Dey, Kamalika Tiwari, Parimal Acharjee

Pages 109-120

[Biogas Cook Stove with a Novel Porous Radiant Burner—An Alternate for LPG Cook Stoves in Rural and Semi-urban Indian Households](#)

M. Arun Kumar, Lav K. Kaushik, Sangjukta Devi, P. Muthukumar

Pages 121-132

[Numerical Investigation of a Multi-tube Conical Shell and Tube-Based Latent Heat Energy Storage System](#)

Vishnu Kumar, Gurpreet Singh Sodhi, Suraj Arun Tat, P. Muthukumar

Pages 133-143

[Classification of Different Floral Origin of Honey Using Hybrid Model of Particle Swarm Optimization and Artificial Neural Network](#)

Kamalika Tiwari, Santigopal Pain, Bipan Tudu, Rajib Bandopadhyay, Anutosh Chatterjee

Pages 145-154

[Magnetoelastic Transition in Energy Efficient Magnetic Refrigerant Ni₅₀Mn₃₂Sn₁₈ Heusler Alloy](#)

A. A. Prasanna

Pages 155-160

[Investigating the Characteristics and Choice of Electric Scooter Users: A Case Study of Tiruchirappalli City](#)

Sandeep Singh, B. Priyadharshni, Challa Prathyusha, S. Moses Santhakumar

[Agent-Based Path Prediction Strategy \(ABPP\) for Navigation Over Dynamic Environment](#)

Samir N. Ajani, Salim Y. Amdani
Pages 173-181

[Li-ion Battery Health Estimation Based on Battery Internal Impedance Measurement](#)

S. Hemavathi
Pages 183-193

[Modified Particle Swarm Optimization \(MPSO\)-Based Short-Term Hydro-Thermal-Wind Generation Scheduling Considering Uncertainty of Wind Energy](#)

Sunil Kumar Choudhary, Santigopal Pain
Pages 195-205

[Simulation Study on Effect of Fin Geometry on Solar Still](#)

Begari Mary, Ajay Kumar Kaviti, Akkala Siva Ram
Pages 207-218

[← Previous](#)

Page

1

of 2

[Next →](#)

[Back to top ↑](#)

About this book

This book presents best selected research papers presented at Innovation in Sustainable Energy and Technology India (ISET 2020), organized by Energy Institute Bangalore (A unit of RGIPT, an Institute of

National Importance), India, during 3–4 December 2020. The book covers various topics of sustainable energy and technologies which includes renewable energy (solar photovoltaic, solar thermal and CSP, biomass, wind energy, micro hydro power, hydrogen energy, geothermal energy, energy materials, energy storage, hybrid energy), smart energy systems (electrical vehicle, cybersecurity, charging infrastructures, IOT & AI, waste management, PHEV (CNG/EV) and mobility (smart grids, IOT & AI, energy-efficient buildings, smart agriculture).

[Back to top ↑](#)

Keywords

Solar PV **solar thermal** **Bio Mass**

Energy materials **Energy storage**

Electric vehicle **Cyber security**

E-Waste Management **Smart Grids**

Smart Agriculture

[Back to top ↑](#)

Editors and Affiliations

**Department of Mechanical Engineering,
Indian Institute of Technology
Guwahati, Assam, India**

P. Muthukumar

**Department of Applied Sciences,
University of Quebec at Chicoutimi,**

Chicoutimi, Canada

Dilip Kumar Sarkar

**Energy Institute, Bengaluru, Rajiv
Gandhi Institute of Petroleum
Technology, Bengaluru, India**

Debasis De

**Department of Electronics and
Communication Engineering, Haldia
Institute of Technology, Haldia, India**

Chanchal Kumar De

[Back to top ↑](#)

About the editors

P. Muthukumar is a Professor in the Department of Mechanical Engineering in IIT Guwahati, India. He is the Fellow of Institute of Engineers (India). He served as the President, Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), Guwahati sub-chapter. He is also the recipient of Fulbright-Nehru Academic and Professional Excellence Award 2017 from USIEF and also received Mechanical Engineering Design National Award from NDRF. He is a reviewer for more than 50 international journals. He has successfully completed 11 research projects funded by various government agencies and 5 consultancy projects funded by industries. Currently, he is handling 5 research and 1 consultancy projects. His specialization includes refrigeration, hydrogen storage, metal hydride based thermal machines, porous medium combustion and thermal energy storage.

Dilip Kumar Sarkar is a Professor at University of Quebec at Chicoutimi (UQAC), Quebec, Canada, in the Applied Sciences Department. He is an active

member of American Chemical Society (ACS), Canadian Association of Physicist (CAP) as well as that of the aluminum research cluster of Quebec (REGAL). He holds several important research grants from the Government of Quebec and the Government of Canada. He holds a research group at the UQAC comprising International and National graduate students and post-doctoral fellows working on various aspects of Materials Science, mainly concentrated on thin films fabrication and various applications that includes, energy storage, corrosion, as well as antibacterial nanomaterials.

Debasis De is an Assistant Professor in Energy Institute, Bengaluru (Centre of R.G.I.P.T, Jais), India. He is an active member of the International Solar Energy Society and The Institute of Engineers (India). He was selected as one of the fourteen Indian student delegates to attend the JSPS-DST Asia Science Seminar held at Yokohama, Japan. He has received Quebec Merit Scholarship for foreign student in 2012. He has published more than 30 research papers in various journals and conferences. He is a reviewer for more than 5 international journals. His current research interests include different types of solar cells, OER/HER, bio-inspired surfaces, nanostructures for electronics and advanced materials, energy materials.

Chanchal Kumar De is a Professor and Head in the Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, India. His research interests include cognitive radio networks, cooperative communication, energy harvesting, wireless ad hoc and sensor networks, etc. He is a reviewer of IEEE, Springer and Elsevier journals. He has published more than 25 research articles in different journals and conferences. He is an editor of proceeding of the 2nd International Conference on Communication, Devices and Computing ICCDC 2019, Lecture Notes in Electrical Engineering, Springer.

Bibliographic Information

Book Title	Book Subtitle	Editors
Innovations in Sustainable Energy and Technology	Proceedings of ISET 2020	P. Muthukumar, Dilip Kumar Sarkar, Debasis De, Chanchal Kumar De

Series Title	DOI	Publisher
Advances in Sustainability Science and Technology	https://doi.org/10.1007/978-981-16-1119-3	Springer Singapore

eBook Packages	Copyright Information	Hardcover ISBN
Engineering, Engineering_(RO)	The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2021	978-981-16-1118-6

Softcover ISBN	eBook ISBN	Series ISSN
978-981-16-1121-6	978-981-16-1119-3	2662-6829

Series E-ISSN	Edition Number	Number of Pages
2662-6837	1	XVIII, 378

Number of Illustrations	Topics
40 b/w illustrations, 192 illustrations in colour	Sustainable Architecture/Green Buildings, Energy Grids and Networks, Waste Management/Waste Technology, Internet of

[Things, Electrical](#)
[Power](#)
[Engineering,](#)
[Vehicle](#)
[Engineering.](#)

[Back to top ↑](#)

Not logged in - 103.102.123.142

Dr B. C. Roy Engineering College (3000708921) - AICTE Electrical & Electronics & Computer Science Engineering (3000684219)

SPRINGER NATURE

© 2022 Springer Nature Switzerland AG. Part of [Springer Nature](#).



Innovations in Sustainable Energy and Technology, pp 109–120

CEPSO-Based Load Frequency Control of Isolated Power System with Security Constraints

[Santigopal Pain](#) , [Dilip Dey](#), [Kamalika Tiwari](#) & [Parimal Acharjee](#)

Conference paper | [First Online: 14 May 2021](#)

268 Accesses

Part of the [Advances in Sustainability Science and Technology](#) book series (ASST)

Abstract

Considering physical limitations like generation rate constraint (GRC), governor dead band (GDB) and time delay (TD), a unique chaotic exponential particle swarm optimization (CEPSO) algorithm is proposed to design the control parameters of PID controller for an isolated realistic power system which consists of thermal and hydro-generating units. An exclusive cost function is framed by taking both transient and steady-state response specifications providing proper weighting coefficients. For avoiding the local optima and to obtain faster and sure convergence, the tuning

parameters of CEPSO algorithm like inertia weight, constriction factors and chaotic variables are properly designed. Because of exponential inertia weight and newly developed chaotic variables, optimal solutions are obtained. The simulation outcomes establish the superiority of the proposed CEPSO algorithm compare to genetic algorithm (GA), particle swarm optimization (PSO) and exponential particle swarm optimization (EPSO) algorithms.

Keywords

Load frequency control PID controller

Physical constraints

Chaotic exponential particle swarm optimization

This is a preview of subscription content, [access via your institution.](#)

▼ Chapter	EUR 29.95
	Price includes VAT (India)
<ul style="list-style-type: none">• DOI: 10.1007/978-981-16-1119-3_10• Chapter length: 12 pages• Instant PDF download• Readable on all devices• Own it forever• Exclusive offer for individuals only• Tax calculation will be finalised during checkout	
<input type="button" value="Buy Chapter"/>	
> eBook	EUR 192.59
> Softcover Book	EUR 229.99
>	

[Learn about institutional subscriptions](#)

References

1. Kundur, P.: Power System Stability and Control. McGraw-Hill, New York (1994)

2. Stanković, A.M., Tadmor, G., Sakharuk, T.A.: On robust control analysis and design for load frequency regulation. *IEEE Trans. Power Syst.* **13**, 449–455 (1998)

3. Tan, W., Xu, Z.: Robust analysis and design of load frequency controller for power systems. *Electr. Power Syst. Res.* **79**, 846–853 (2009)

4. Khodabakhshian, A., Pour, M.E., Hooshmand, R.: Design of a robust load frequency control using sequential quadratic programming technique. *Int. J. Electr. Power Energy Syst.* **40**, 1–8 (2012)

5. Zhang, C.K., Jiang, L., Wu, Q.H., He, Y., Wu, M.: Delay-dependent robust load frequency control for time delay power systems. *IEEE Trans. Power Syst.* **28**, 2192–2201 (2013)

6. Yu, X., Tomsovic, K.: Application of linear matrix inequalities for load frequency control with communication delays. *IEEE Trans. Power Syst.* **19**, 1508–1515 (2004)

7. Ho, J.L., Jin, B.P., Young, H.J.: Robust load frequency control for uncertain nonlinear power systems: a fuzzy logic approach. *Inf. Sci.* **176**, 3520–3537 (2006)

8. Daneshfar, F., Bevrani, H.: Multiobjective design of load frequency control using genetic algorithms. *Int. J. Electr. Power Energy Syst.* **42**, 257–263 (2012)

9. Golpîra, H., Bevrani, H., Golpîra, H.: Application of GA optimization for automatic generation control design in an interconnected power system. *Energy Convers. Manage.* **52**, 2247–2255 (2011)

10. Sahu, R.K., Panda, S., Rout, U.K.: DE optimized parallel 2-DOF PID controller for load frequency control of power system with governor dead-band nonlinearity. *Int. J. Electr. Power Energy Syst.* **49**, 19–33 (2013)

11. Ali, E.S., Abd-Elazim, S.M.: Bacteria foraging optimization algorithm based load frequency controller for interconnected power system. *Int. J. Electr. Power Energy Syst.* **33**, 633–638 (2011)

12. Ali, S., Yang, G., Huang, C.: Performance optimization of linear active disturbance

rejection control approach by modified bat inspired algorithm for single area load frequency control concerning high wind power penetration. *ISA Trans.* **81**, 163–176 (2018)

13. Abdel-Magid, Y.L., Abido, M.A.: AGC tuning of interconnected reheat thermal systems with particle swarm optimization. In: *IEE Proceedings—International Conference on Electronics, Circuits and System*, pp. 376–379 (2003)

14. Gozde, H., Taplamacioglu, M.C.: Automatic generation control application with craziness based particle swarm optimization in a thermal power system. *Int. J. Electr. Power Energy Syst.* **33**, 8–16 (2011)

15. Wu, J.X., Liu, W.Z., Zhao, W.G., Li, Q.: Exponential type adaptive inertia weighted particle swarm optimization algorithm. In: *2nd International Conference on Genetic and Evolutionary Computing*, pp. 79–82 (2008)

16. Panda, S., Mohanty, B., Hota, P.K.: Hybrid BFOA–PSO algorithm for automatic generation control of linear and nonlinear interconnected power systems. *Appl. Soft Comput.* **13**, 4718–4730 (2013)

17. Jing, H., Kwong, C.K., Chen, Z., Yisim, Y.C.: Chaos particle swarm optimization and T-S fuzzy modelling approaches to constrained predictive control. *Exp. Syst. Appl.* **39**, 194–201 (2012)

18. He, Y., Yang, S., Xu, Q.: Short-term cascade hydroelectric system scheduling based on chaotic particle swarm optimization using improve logistic map. *Nonlinear Sci. Numer. Simulat.* **18**, 1746–1756 (2013)

19. Pain, S., Acharjee, P.: AGC of practical power system using backtracking search optimization algorithm. In: 2016 International Conference and Exposition on Electrical and Power Engineering (EPE 2016), pp. 687–692 (2016)

Author information

Authors and Affiliations

**Department of Electrical Engineering, Haldia
Institute of Technology, Haldia, India**

Santigopal Pain & Dilip Dey

**Department of AEIE, Dr. B. C. Roy Engineering
College, Durgapur, India**

Kamalika Tiwari

**Department of Electrical Engineering, National
Institute of Technology, Durgapur, India**

Parimal Acharjee

Corresponding author

Correspondence to [Santigopal Pain](#).

Editor information

Editors and Affiliations

Department of Mechanical Engineering, Indian Institute of Technology Guwahati, Assam, India

Prof. P. Muthukumar

Department of Applied Sciences, University of Quebec at Chicoutimi, Chicoutimi, QC, Canada

Prof. Dilip Kumar Sarkar

Energy Institute, Bengaluru, Rajiv Gandhi Institute of Petroleum Technology, Bengaluru, India

Dr. Debasis De

Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, West Bengal, India

Prof. Chanchal Kumar De

Appendices

Appendix 1: Parameters of GA, PSO, EPSO and CEPSO

Probability of Crossover = 0.8; Rate of Mutation = 0.03; Constriction Factors ($c_1 = c_2$) = 1.49455, $w_0 = 0.95$, $m = 1$; $n = 1$.

Appendix 2: CPI Calculation

As an example, the procedure of CPI calculation for t_s is given below. The CPI for M_p and SSE can be

calculated in the same way.

Here, $CPI(t_s)$ = comparative performance index for settling time (t_s), $GA(t_s)$ = settling time of GA method, $CEPSO(t_s)$ = settling time of CEPSO method.

Now,

$$CPI(t_s) = \frac{GA(t_s) - CEPSO(t_s)}{GA(t_s)} \times 100\% = \frac{17.4557 - 14.1456}{17.4557} \times 100 = 18.96\%.$$

Rights and permissions

[Reprints and Permissions](#)

Copyright information

© 2021 The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd.

About this paper

Cite this paper

Pain, S., Dey, D., Tiwari, K., Acharjee, P. (2021). CEPSO-Based Load Frequency Control of Isolated Power System with Security Constraints. In: Muthukumar, P., Sarkar, D.K., De, D., De, C.K. (eds) Innovations in Sustainable Energy and Technology. Advances in Sustainability Science and Technology. Springer, Singapore.

https://doi.org/10.1007/978-981-16-1119-3_10

[.RIS](#) [.ENW](#) [.BIB](#)

DOI

https://doi.org/10.1007/978-981-16-1119-3_10

Published Publisher Name Print ISBN

14 May 2021 Springer, 978-981-16-
Singapore 1118-6

Online ISBN eBook Packages
978-981-16- [Engineering](#)
1119-3 [Engineering_\(R0\)](#).

Not logged in - 103.102.123.142

Dr B. C. Roy Engineering College (3000708921) - AICTE Electrical & Electronics & Computer Science Engineering (3000684219)

SPRINGER NATURE

© 2022 Springer Nature Switzerland AG. Part of [Springer Nature](#).