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Asit Saha · Santo Banerjee
Editors

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International Conference
on Nonlinear Dynamics
and Applications (ICNDA
2024), Volume 3

Dynamical Models, Communications and
Networks

Editors

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Preface

Systems controlled by complicated equations, as opposed to simple linear ones, are the focus of nonlinear dynamics, a branch of mathematics and physical science. Oftentimes, these systems display chaotic behavior, in which even little modifications to the starting circumstances may result in wildly diverse final products. Nonlinear dynamics is used to study phenomena such as water waves, fluid flow, waves in space, solar wind, turbulence, instability, nuclear fusion, signal transmission, weather patterns, population growth, and the behavior of financial markets. By understanding the underlying principles of nonlinear systems, scientists and mathematicians can make predictions and gain insights into the behavior of these complex systems. In these systems, the principle of superposition does not hold, meaning that the behavior of the system is not directly proportional to the input. Instead, small changes in the input can lead to disproportionate changes in the output, making these systems difficult to predict and control. By utilizing mathematical tools such as chaos theory and bifurcation analysis, researchers can uncover the hidden patterns and structures within these systems, ultimately leading to a deeper understanding of the world around us. A fascinating topic with applications in many domains, nonlinear systems may display a wide range of behaviors, including stable equilibria, periodic oscillations, and chaotic dynamics.

This proceeding encompasses these topics through the contribution of three volumes, which include a total of 157 research articles:

Volume 1: *Nonlinear Waves and Plasma Dynamics*

Volume 2: *Complex Systems, Fractals and Nonlinear Flows*

Volume 3: *Dynamical Models, Communications and Networks.*

Volume 1: Within the first volume, there are fifty-five publications that are devoted to the investigation of nonlinear wave and plasma dynamics. Nonlinear waves and plasma dynamics is a fascinating field that explores the behavior of waves and plasmas when governed by nonlinear equations. In the context of wave dynamics, nonlinearity can result in phenomena such as solitons—stable, localized wave packets that maintain their shape while traveling at constant speeds. These occur in various media, from water waves to optical fibers. Plasma dynamics, which studies ionized gases consisting of charged particles, also displays rich nonlinear behavior. In plasmas, nonlinear interactions can lead to complex structures like filaments and turbulence. Understanding these dynamics is crucial for applications ranging from controlled nuclear fusion to space weather prediction.

Volume 2: From basic mechanical oscillators to intricate biological networks and turbulent fluid fluxes, dynamical systems cover it all. Chaos, Complexity, and Fractals and Fluid Dynamics and Nonlinear Flow are two major subfields of dynamical systems. In Chaos, Complexity & Fractals, we explore the complex dynamics that may arise from nonlinear systems that are sensitive to their starting circumstances. By delving into chaotic systems, chaos theory reveals intriguing patterns and structures that lie

beyond the surface of apparently random activity. Complexity theory, in contrast, seeks to explain phenomena like self-organization and emergence by analyzing the emerging characteristics of complex systems with many interacting components. From the complex curves of coastlines to the branching architectures of trees, fractal geometry provides a mathematical foundation for understanding the self-similar patterns seen in nature. The field of fluid dynamics and nonlinear flow studies how fluids behave in different flow regimes, from smooth to choppy. Turbulence, vortex, and instability are all products of nonlinear processes, which are fundamental to fluid dynamics. Predicting and managing fluid flow in applications ranging from climate modeling to aeronautical engineering requires an understanding of these nonlinear interactions. Investigating the behavior of nonlinear systems allows scientists to find previously unknown relationships, principles, and patterns, which in turn leads to game-changing findings in many fields. This volume contains forty-seven research articles.

Volume 3: Within the larger framework of nonlinear dynamics, the intriguing domains of graphs, networks, and communications stand out. The application of nonlinear dynamics concepts to the study of complex network behavior has recently attracted a lot of attention. These networks may be anything from social networks to biological systems. A robust framework for studying the dynamics and structure of linked systems is given by graph theory. How these networks change across time, displaying behaviors like self-organization, cascading failures, and synchronization, may be better understood by looking at nonlinear dynamics. Applications such as information distribution, epidemic modeling, and infrastructure resilience rely on a thorough understanding of the dynamics of complex networks. The lessons learned from nonlinear dynamics are applicable to communications systems as well. Signal amplification, distortion, and interference are nonlinear phenomena that impact the complex interactions that occur during signal transmission across communication networks. Scientists may improve communication protocols, create more reliable networks, and lessen the impact of signal deterioration by using principles from nonlinear dynamics. In addition to wave dynamics, plasma physics, communications, graphs, and networks, nonlinear dynamics has many more potential uses. Among these fields are climatology, neurology, ecology, and economics. The influence of nonlinear events on system behavior is crucial in all of these areas, often resulting in unforeseen consequences and the emergence of new characteristics. All things considered, there is a vast array of phenomena to investigate in the study of nonlinear dynamics in many domains, which has ramifications for both theoretical and applied knowledge. Researchers are finding fresh insights and novel solutions to real-world problems by exploring the nonlinear elements of complex systems further.

The editors of this proceedings express their heartfelt gratitude to all participants, invited speakers, keynote speakers, paper presenters, and members of the scientific advisory and technical program committees for their enthusiastic involvement in the 2nd International Conference on Nonlinear Dynamics and Applications - 2024 (ICNDA 2024), organized by the Department of Mathematics, Sikkim Manipal Institute of Technology, Sikkim Manipal University, held from February 21 to 23, 2024, in Sikkim, India. We extend our sincere appreciation to the Science and Engineering Research Board (SERB), Council of Scientific & Industrial Research (CSIR), & SMIT, for their

sponsorship of this event. Additionally, we are grateful to the authorities, faculty members, staff, volunteers, and organizing committee members of SMIT for their invaluable support and assistance in making this conference a grand success.

The editors of this proceedings extend their gratitude to the authors for their valuable contributions and to the referees for their diligent efforts in reviewing the articles. We trust that the selected papers in this proceedings will enhance readers' understanding and will be beneficial to scientists and researchers in advancing the theory of nonlinear waves, chaos, complexity, dynamical systems, and their applications. We would like to convey our heartfelt appreciation to all members of Springer Proceedings in Physics for hosting this proceedings.

Asit Saha
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Contents

Graphs, Networks and Communications

New G -Optimality Criteria for Multi-Dimensional Control Problem with Applications in Artificial Neural System	3
<i>Ayushi Baranwal</i>	
Multiscale Permutation Entropy Analysis of EEG-Based Seizure Classification: A Machine Learning Approach	29
<i>Shervin Skaria and Sreelatha Karyaveetil Savithriamma</i>	
Prediction of Refractive Index of Rice Blast Fungicides Using Eccentric Degree Index – A Graph Theoretic Approach	43
<i>K. Karthika, M. Yamuna, and M. Sivasankari</i>	
On Maximal μ^* -Open Set, Minimal μ^* -Closed Set, Mean μ^* -Open Set and Its Applications in Discrete Dynamical Systems	58
<i>Bishal Bhandari and Pankaj Chettri</i>	
Performance Analysis of Discrete Wavelet Transforms for Acoustic Scene Classification with DCASE Dataset	68
<i>Vikash Kumar Singh, Kalpana Sharma, and Samarendra Nath Sur</i>	
Investigation of Channel Doping Effects on High-Frequency Noise for Trench Double Gate JLFETs	81
<i>Arkaprio Bhattacharya, Ananya Barman, Trina Dutta, and Swagata Bhattacharjee</i>	
On Graphs Attaining Upper Bound of k -Rainbow Total Domination Number and Its Application in Graph Dynamical Systems	92
<i>Puran Dangal, Biswajit Deb, and Anjan Gautam</i>	
2-Path Signed Graph of Signed Smith Graphs and Its Applications in Nonlinear Dynamics	104
<i>Kshittiz Chettri and Biswajit Deb</i>	
Frequency Analysis of Orthotropic Square Plates with Circular Thickness Variations in Two Dimensions	116
<i>Neeraj Lather, Ankit Kumar, Vijil Kumar, Alka, and Amit Sharma</i>	

BlossomNet: A Deep Learning Framework for Accurate Flower Identification	124
<i>Anisul Islam, Lipon Chandra Das, Parven Sultana, and Omme Johora Tarin</i>	
Performance Analysis of Accurate and Approximate Compressors at Nanometer Regime	135
<i>Abhinav, Yogendra Kumar Upadhyaya, and Tripti Sharma</i>	
A Simple but Accurate Method of Estimation of Far Field Pattern of Single-Mode Triangular Index Fiber	145
<i>Jayita Dan, A. Ghose-Choudhury, and Sankar Gangopadhyay</i>	
Analyzing Electrocardiogram Signal Complexity with Weighted Entropy	152
<i>S. L. Sruthi and Rinku Jacob</i>	
Physics Informed Neural Network for Solution of Duffing Oscillators	164
<i>R. Naveen Raj</i>	
Wavelet Scattering Operators for Multiscale Processes: The Case Study of Marine Mammal Vocalizations	173
<i>Alessandro Licciardi, Davide Carbone, and Lamberto Rondoni</i>	
Outer Heliosphere and Interstellar Medium: Investigation on the Signal Fluctuations Collected by Voyager Probes	192
<i>Lamberto Rondoni and Alessandra Sacco</i>	
An Adaptable Single-Server Encouraged Arrival, Balking, and Symmetric Stochastic Markovian Queuing System with Threshold Policy	206
<i>R. Jeyachandhiran, Ismailkhan Enayathulla Khan, and P. Rajendran</i>	
SNR Estimation for Hypercubic Signals in Rayleigh Channels	219
<i>Jasleen Kaur, Nilesh Tiwari, and Kalyan Banerjee</i>	
Vehicle Detection with Number Plate Recognition	232
<i>Rohan Sagvekar, Bhavesh Sharma, Rutuja Madurwar, Tanvi Sawant, and Namita Pulgam</i>	
Patient Health Monitoring System for Chronic Cardiac Attack Using Machine Learning	246
<i>Ramkrishna Ghosh</i>	
Time Domain Analysis of Vibration Isolator Using Newmark Method Along with Newton Raphson Method	258
<i>Vishwanil V. Sarnaik, Satyajit Panda, and S. Kanagaraj</i>	

Deep Learning for Path Tracking of Autonomous Mobile Robots 274
Mai The Anh, Dang Thai Son, and Phan Van Quyet

Other Fields of Nonlinear Dynamics

Generative Models as Out-of-Equilibrium Particle Systems: Training
of Energy-Based Models Using Non-equilibrium Thermodynamics 287
Davide Carbone, Mengjian Hua, Simon Coste, and Eric Vanden-Eijnden

Chemical Significance of Some Neighborhood Degree-Based Molecular
Descriptors 312
Shivani Rai, Biswajit Deb, and Sourav Mondal

Dynamics of Pendulum Forced by a Magnetic Excitation
with Position-Dependent Phase 327
Krystian Polczyński, Maksymilian Bednarek, and Jan Awrejcewicz

Analysis of Surface Texture and Material Removal Rate During AISI 202
Thermal-Assisted Turning Using a Carbide Cutting Tool 338
Subhas Chandra Moi, Rajeev Ranjan, and Baban Rajak

High Cycle Fatigue Behavior of TIG Welded Joint at Optimum Parametric
Condition 352
Subhas Chandra Moi and Pradip Kumar Pal

Study of Cylindrical Magnetohydrodynamic Shock Waves in Non-ideal
Gas: Similarity Solution Perspective 367
Ravilisetty Revathi

QSPR Analysis of Anti-asthma Drugs Using Some Recent Neighbourhood
Degree-Based Topological Descriptors 380
Deepa Balasubramanian, Natarajan Chidambaram, and Vignesh Ravi

Does Anything Beat a GARCH(1,1)? Evidence from Crypto Markets 398
Rhenan Gomes dos Santos Queiroz and Sergio Adriani David

Computational Analysis of Sn-Doped hBN for Detection of Lung
Cancer-Related VOCs 409
*Megha Chettri, Jenifer Thapa, Prasanna Karki, Bibek Chettri,
Pronita Chettri, Sanat Kr. Das, and Bikash Sharma*

Exploring Business Management Practices of Milk Tea Houses in Selected
Urban Towns of Nueva Vizcaya 417
*Ma. Clarissa A. Murayag, Teresita B. Barangay,
and Maria Teresa A. Fulgencio*

Drift and Annihilation of a Counter-Rotating Spiral Pair in Belousov-Zhabotinsky Reaction Under a DC Electric Field	429
<i>Priyanshi Rekha Mishra, Anupama Sebastian, and T. K. Shajahan</i>	
Analyzing the Impact of COVID-19 Pandemic and Ukraine-Russia War in WTI-Brent Spread: A MFXDFA Approach	438
<i>C. M. C. Inacio Jr and S. A. David</i>	
Experimental and Parametric Study of Friction Stir Welding in Similar and Dissimilar Metals	448
<i>Somenath Raha and Manoj Kundu</i>	
A General Form of FO PI-PD Controllers for Some Stable Integer and Non-Integer Order Plants with Transport Delay	461
<i>Reetam Mondal and Jayati Dey</i>	
Abortion Detection and Monitoring for Empowering Equality Through the Integration of Biometric and Artificial Intelligence	472
<i>Sagar Shinde, Akash Kathole, Mehek Talmale, Ankita Sarnaik, and Kausin Sayed</i>	
Effect of Vacancy Defect on the Free Vibration of Some Noncarbon Nanomaterials: A Molecular Static Study	487
<i>B. M. Ravi Raj, Sandeep Singh, and Kiran D. Mali</i>	
UV-Visible, FTIR and Electrochemical Properties of rGO and ZnO/rGO Nanocomposite Produced via Green Synthesis Process	499
<i>Suveksha Tamang and Joydeep Biswas</i>	
An Efficient Hybrid Sequence of Retargeting Operators to Minimize Structural Deformities in Image	509
<i>Ankit Garg, Ajay Garg, Anuj Kumar Singh, and Balajee Maram</i>	
Image Acquisition and Electric Field Application in the Belousov-Zhabotinsky Reaction Using LabVIEW	524
<i>Puthiyapurayil Sibeesh and T. K. Shajahan</i>	
Theoretical Investigation to Analyze the Effect of Core Size of InAs/GaAs Core-Shell Nanostructure	535
<i>Khusan Sharma, Payal Paul, and Sanjib Kabi</i>	
Estimating Soil Temperature at Various Depths in Bangladesh: A Comparative Analysis of Advanced Machine Learning Tree-Based Models	543
<i>Lipon Chandra Das, Tasnim Anisha, and Anisul Islam</i>	

Stability Analysis of Vaccinated and Non-vaccinated Population of Covid' 19 – A Study by Mathematical Modeling 558
Sathish Kumar Kumaravel, Nagadevi Bala Nagaram, Regan Murugesan, Kala Raja Mohan, and Suresh Rasappan

Investigation of Dielectric Studies of $(Nd_{1-x}Gd_x)_2FeCrO_6$ ($X = 0.0 - 0.3$) Double Perovskite 576
Nibedita Nayak and S. Ravi

Mapping the Spatial Dynamics of COVID-19 Clusters in Nueva Vizcaya, Philippines 588
Karen D. Taclay, Richard J. Taclay, Alberto Camangian, Julie Halaman, Jennifer Valdez, and Edlyn Bel de Guzman

Dissipative Force on an External Quark in AdS Gauss-Bonnet Gravity with String Cloud 601
Rishi Pokhrel, Karma Pincho Sherpa, and Tanay Kumar Dey

A Structural Model of Mathematics Performance as Influenced by Students' Engagement with Technology to Students' Motivation 613
Lany D. Dullas and Evangeline P. Lumase

A Gesture Based Turing Test for Mitigation of DDoS Attacks in Cloud 623
Aanshi Bhardwaj, Sawinder Kaur, and Shruti Arora

Efficacy of an Encouraged Arrival M/M/1 Queueing System with Differentiated Dual Vacation, Balking, and Feedback Customers 634
Ismailkhan Enayathulla Khan, R. Jeyachandhiran, and Paramasivam Rajendran

Parameters Optimisation of a Hydraulically Interconnected Suspension in a Stretcher Using Genetic Algorithm 648
Palanisamy Sathishkumar and Pandaram Kannan

Stochastic Resonance with Entropy 661
Riccardo Aliprandi and Lamberto Rondoni

Optimizing Performance Measures in a Finite Markovian Heterogeneous Queueing Model with Encouraged Arrival 669
Immaculate Samuel, Rajendran Paramasivam, Ismailkhan Enayathulla Khan, and R. Jeyachandhiran

Synchronized Dynamics of Earthquake Fault Motion 682
Srdan Kostić and Nebojša Vasović

Multidimensional Extensions of Basic (or q -)Analogues of Certain Erdélyi
Type Integrals 693
Yashoverdhan Vyas

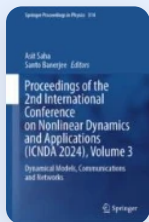
Author Index 703

[Home](#) > [Proceedings of the 2nd International Conference on Nonlinear Dynamics and Applications \(ICNDA 2024\), Volume 3](#) > Conference paper

Analysis of Surface Texture and Material Removal Rate During AISI 202 Thermal-Assisted Turning Using a Carbide Cutting Tool

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Abstract

To attain a superior surface quality and material removal rate, it is advisable to employ environmentally conscious machining techniques, often referred to as “green machining.” Within the domain of conventional machining, the thermal-assisted turning method applied to the workpiece emerges as a commendable option, owing to its operational simplicity and the elimination of coolant requirements, thereby aligning with eco-friendly practices. This research is fundamentally oriented towards the optimization of machining performance for AISI 202 utilizing a carbide tool, with a specific emphasis on two pivotal output factors: material removal rate and surface roughness. The investigation leverages the Response Surface Methodology (RSM) to extrapolate predictions and optimize the machining process. The Box-Behnken design method is employed to systematically analyze variations in independent variables, which encompass workpiece temperature, cutting speed, and cut-depth (depth of cut). The empirical findings underscore that temperature exerts the most pronounced influence on surface roughness, followed by cut-depth and cutting speed. Similarly, concerning material removal rate, temperature emerges as the most influential factor, succeeded by cutting speed and cut-depth. This research helps us understand how different factors affect metal cutting and gives us ideas on how to make the process more sustainable and efficient.

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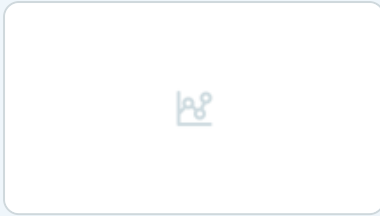
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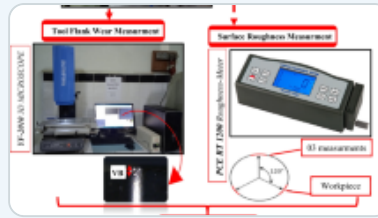
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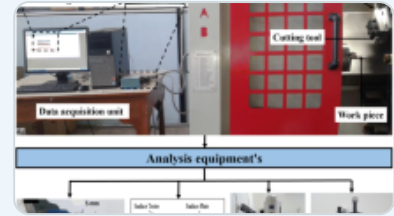
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