

Wind Energy

Papers Presented at the AIAA SciTech Forum and Exposition
2022

San Diego, California, USA and Online
3 - 7 January 2022

ISBN: 978-1-7138-5424-1

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 34922 Uwytkug'Xcmg{'Ftkxg.'Uwky'422, Reston, VA 20191, USA.

TABLE OF CONTENTS

OPTIMIZATION OF BLADES AND ROTORS

Towards Passive Aeroelastic Tailoring of Large Wind Turbines Using High-Fidelity Multidisciplinary Design Optimization	1
<i>Marco Mangano, Sicheng He, Yingqian Liao, Denis-Gabriel Caprace, Joaquim R. Martins</i>	
Incorporating High-Fidelity Aerostructural Analyses in Wind Turbine Rotor Optimization	27
<i>Denis-Gabriel Caprace, Adam Cardoza, Andrew Ning, Marco Mangano, Sicheng He, Joaquim R. Martins</i>	
A General Coupling Methodology for Unsteady Aerostructural Optimization with Analytic Derivatives.....	50
<i>Taylor McDonnell, Adam Cardoza, Denis-Gabriel Caprace, Andrew Ning</i>	
GPU-accelerated Aerodynamic Shape Optimisation Framework for Large Turbine Blades	68
<i>Thomas R. Wainwright, Daniel J. Poole, Christian B. Allen</i>	
Design-space Exploration for Inverse-design of Wind Turbine Blades using data-driven Methods.....	86
<i>Ganesh Vijayakumar, Yong Su Jung, James D. Baeder, Shreyas Ananthan</i>	

WIND TURBINE/ROTORCRAFT/PROPELLER MULTI-PHYSICS MODELING APPROACHES I

Efficient Cartesian Grid CFD-Based Methods for Aeroelastic Analysis of Wind Turbines	105
<i>Glen R. Whitehouse, Alexander H. Boschitsch, Pavel Danilov</i>	
Coupled Fluid-Structure Interaction Simulation of Two-Blade Wind Turbine	122
<i>Joel Khristy, Arihant Jain, Seth Pemberton, Mohammad Mehrabadi</i>	
Enhancement of the Conventional Wind Turbine Performance using Multi-Rotor Configuration	138
<i>Malhar Prajapati, Dhwanil Shukla</i>	

WIND TURBINE/ROTORCRAFT/PROPELLER MULTI-PHYSICS MODELING APPROACHES II

High-Order Large-Eddy Simulations of a Ducted Wind Turbine.....	152
<i>Chi Ding, Bin Zhang, Chunlei Liang, Kenneth Visser, Guangming Yao</i>	
Investigation of Blade Shape Impact on Small-scale Wind Turbine Performance: Tapered versus Rectangular Configurations.....	172
<i>Widad Yossri, Samah Ben Ayed, Abdessatar Abdelkefi</i>	
Study of Low Reynolds Number Effects on Small Wind Turbine Performance	180
<i>John Cunningham, Patrick Lemieux</i>	
Wind Turbine Tower Thickness and Blade Pitch Control Co-Design Optimization.....	195
<i>Juan López Muro, Xianping Du, Jean-Philippe Condomines, Onur Bilgen, Laurent Burlion</i>	

INNOVATIONS AND NOVEL CONCEPTS I

Load Component Analysis of a Quad-Rotor Wind Turbine.....	205
<i>Alexander N. Stillman, Etana Ferede, Farhan Gandhi</i>	
Novel, Nacelle-Mounted Spire for Accelerated Wind Turbine Wake Decay.....	222
<i>Dan Houck</i>	
Influence of Turbulence on a Cantilevered Piezoelectric Energy Harvester Using CFD.....	233
<i>Ben Claas, Nikhil D. Agarwal, Jorge Camacho, Edoardo Rubino</i>	
3D-Photogrammetric Modal Testing and Data Analysis of a Cantilevered Inflatable Wing	245
<i>Shardul S. Panwar, Rikin Gupta, Azwan Aris, Taewoo Nam, Jitish Miglani, Wei Zhao, Rakesh K. Kapania</i>	
Design, Analysis, Test and Fabrication of Baffled Inflatable Wing for Airborne Wind Energy.....	257
<i>Azwan Aris, Yuyang Song, Taewoo Nam, Skylar Sible, Sheng Dong, Dakotah Gali, Bobby Culver, Mark Weitz</i>	

INNOVATIONS AND NOVEL CONCEPTS II

Strategy for Diagnosing the Degree of Dynamic Stall on a Vertical-axis Wind Turbine Blade	273
<i>David Bensason, Sébastien Le Fouest, Anna M. Young, Karen Mulleners</i>	
Asymmetry of Timescales, Loads, and Flow Structures for a Vertical-axis Wind Turbine Blade.....	283
<i>Sébastien Le Fouest, David Bensason, Karen Mulleners</i>	
Investigation into Wake Interactions of Wind Lenses at Close Proximities.....	293
<i>Madison N. Peyton, Sidaard Gunasekaran</i>	

MODELING STRATEGIES

An Initial Study of Multimodality in Wind Farm Layout Optimization Problems.....	306
<i>Benjamin Allen, Lewis Cameron, Thomas R. Wainwright, Daniel J. Poole</i>	
Validation of an Analytical Optimization Framework for Wind Farm Wake Steering Applications.....	316
<i>Ishaan Sood, Johan Meyers</i>	
Validation of Actuator Line and Actuator Disk Models with Filtered Lifting Line Corrections Implemented in Nalu-Wind Large Eddy Simulations of the Atmospheric Boundary Layer.....	328
<i>Myra L. Blaylock, Luis Martinez-Tossas, Philip Sakievich, Brent C. Houchens, Lawrence Cheung, Kenneth Brown, Alan Hsieh, David C. Maniaci, Matthew J. Churchfield</i>	
Hybrid RANS-LES of the Atmospheric Boundary Layer for Wind Farm Simulations	347
<i>Christiane Adcock, Marc Henry de Frahan, Jeremy Melvin, Ganesh Vijayakumar, Shreyas Ananthan, Gianluca Iaccarino, Robert D. Moser, Michael Sprague</i>	
Comparison of Simulated and Measured Wake Behavior in Stable and Neutral Atmospheric Conditions	364
<i>Lawrence Cheung, Myra L. Blaylock, Kenneth Brown, Nathaniel deVelder, Thomas G. Herges, Alan Hsieh, David C. Maniaci, James Cutler</i>	

ADAPTIVE ROTORS IN WIND TECHNOLOGY

- Using an Active Gurney Flap to Modify the Performance of a Wind Turbine Wing Section 384
Siyang Hao, John Cooney, Neal Fine, Kenny S. Breuer
- Wind-tunnel Force-measurements of Gurney Flaps for Active Control of Wind Turbine Blades 392
Wasi U. Ahmed, Keshav Panthi, Giacomo Valerio Iungo, D. Todd Griffith, Mario Rotea, John Cooney, Chris Szlatenyi, Adam Janik, Pascal Mickelson, Neal Fine
- Control Actuation Options for the SpiderFLOAT Floating Offshore Wind Substructure..... 400
James D. Dinius, Rick Damiani, Kathryn Johnson, Elenya Grant, Lucy Y. Pao, Mandar Phadnis

TURBINE BLADE RESILIENCY

- Effect of Leading Edge Erosion on Wind Turbine Rotor Aerodynamics 418
Akshay Koodly Ravishankara, Huseyin Ozdemir, Edwin van der Weide
- Leading Edge Protection Impact on Airfoil Performance: An Experimental Investigation 429
Francesco Grasso, Christian Bak, Anders Smaerup, Lean Ravnkilde, Rasmus Konge Johansen
- Experimental Assessment of Fatigue Load Control for Wind Turbines employing Active Flow Control Devices 443
Sirko Bartholomay, Sascha Krumbein, Victoria Deichmann, Maik Gentsch, Sebastian Perez-Becker, Rodrigo Soto, David Holst, C. Nayeri, Christian O. Paschereit, Kilian Oberleithner
- Aerodynamic and Aeroacoustic Measurements of the Flow Past a Very Thick Flatback Airfoil with Passive Flow Control Devices 450
Antonios Cene, Marinos Manolesos, Francesco Grasso

PLATFORM AND TOWER CONTROL AND ACTUATION

- Active Ballasting Actuation for the SpiderFLOAT Offshore Wind Turbine Platform..... 470
Edem Y. Tetteh, Kevin Fletcher, Chris Qin, Eric Loth, Rick Damiani
- Equivalent Mass Design Approach for the Platform of a 10-MW Floating Wind Turbine 480
Kevin Fletcher, Edem Y. Tetteh, Chris Qin, Eric Loth, Rick Damiani
- A Control Algorithm to Reduce the Tower Fore-Aft Oscillations of a Variable Speed and Pitch Controlled Horizontal Axis Wind Turbine 495
Kumara Raja Eedara, Chandra S. Yerramalli
- Vibration Isolation Based Concept for Reducing Fore-Aft Oscillations of Wind Turbine Tower 504
Kumara Raja Eedara, Chandra S. Yerramalli

Author Index