

Malik Hassanaly

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📧 R^e in

EDUCATION

- **PhD University of Michigan, USA**
Aerospace Engineering - Dissertation: "Extreme Events in Turbulent Combustion" August 2019
- **MSE University of Texas at Austin, USA**
Aerospace Engineering - Master Thesis: "Large-eddy simulations of boundary layer flashback" January 2015
- **MSE Ecole Centrale de Lille, France**
General Engineering - Thesis project: "Design and testing of a new tidal turbine" January 2015

SKILLS

- **Programming:** Python, C++, Fortran, Bash, Git
- **ML Libraries:** TensorFlow, PyTorch
- **Physics modeling tools:** OpenFOAM, Paraview
- **Languages:** English (Fluent), French (Native), Spanish (Intermediate)

EXPERIENCE

- **National Renewable Energy Laboratory (NREL), USA** September 2019 - Current
Researcher - Computational Science and Machine Learning
 - Scientific Machine Learning for augmenting or accelerating physics-based models and uncertainty quantification tasks.
- **Maïa Eolis (now Engie Green), France** November 2012 - May 2013
Physics Modeling Intern
 - Computational fluid dynamics modeling of wind turbine blades. I quantified the mechanical stress induced by a novel blade spoiler.
- **RTE (French Electrical Grid), France** May 2012 - November 2012
Software Development Intern
 - Developed of a generic gateway from a UML model to a C++ library used in a large-scale power grid code.
- **Areva NP (now Orano), France** January 2010 - February 2010
Managing Solution Intern
 - Analysis of employees' perception of their workplace organization

PUBLICATIONS

- **Generative Machine Learning:**
 1. **Super resolution with generative adversarial nets:** Adversarial sampling of unknown and high-dimensional conditional distributions, M. Hassanaly et al. *Journal of Computational Physics*, 2022 📄 📄
 2. **Inpainting with diffusion models:** Ensemble flow reconstruction in the atmospheric boundary layer from spatially limited measurements through latent diffusion models, A. Rybchuk, M. Hassanaly et al. *Physics of Fluids*, 2023 📄
 3. **Extreme event generation:** GANISP: a GAN-assisted Importance Splitting Probability Estimator, M. Hassanaly et al. *AAAI-ADAM*, 2022, 📄
 4. **Data reduction** Uniform-in-phase-space data selection with iterative normalizing flows, M. Hassanaly et al. *Data-Centric Engineering*, 2023, 📄
- **Predictive surrogate modeling:**
 5. **Physics-informed neural networks:** PINN surrogate of Li-ion battery models for parameter inference, Part I: Implementation and multi-fidelity hierarchies for the single-particle model, M. Hassanaly et al. *Journal of Energy Storage*, 2024 📄
 6. **Bayesian neural networks:** A Priori Uncertainty Quantification of Reacting Turbulence Closure Models using Bayesian Neural Networks, G. Pash, M. Hassanaly et al. *Under review*, 2024 📄
 7. **Mixture of experts:** Data-driven Classification and Modeling of Combustion Regimes in Detonation Waves, S. Barwey, S. Prakash, M. Hassanaly et al. *Flow Turbulence and Combustion*, 2020
 8. **Multifidelity neural operators:** Bi-fidelity Modeling of Uncertain and Partially Unknown Systems using DeepONets, S. De, M. Reynolds, M. Hassanaly et al. *Computational Mechanics*, 2023

- **Bayesian inverse modeling:**



9. **Physics properties:** PINN surrogate of Li-ion battery models for parameter inference, Part II: Regularization and application of the pseudo-2D model, M. Hassanaly et al. *Journal of Energy Storage*, 2024 🔒



10. **Population balance modeling:** Bayesian calibration of bubble size dynamics applied to CO₂ gas fermenters, M. Hassanaly et al. *Under review*, 2024 🔒



11. **Reaction kinetics:** Surface chemistry models for GaAs epitaxial growth and hydride cracking using reacting flow simulations, M. Hassanaly et al. *Journal of Applied Physics*, 2021

- **Adversarial ML:**



12. **Reinforcement learning:** Discovery of False Data Injection Attacks on Power Grid Frequency Controllers with Reinforcement Learning, R. Prasad, M. Hassanaly et al. *IEEE XPlore, PES GM*, 2024

- **Image processing:**

13. **Data augmentation:** Using Machine Learning to Construct Velocity Fields from OH-PLIF Images, S. Barwey, M. Hassanaly et al. *Combustion Science and Technology*, 2019



14. **Cluster-reduced order modeling:** Experimental Data Based Reduced Order Model for Analysis and Prediction of Flame Transition in Gas Turbine Combustors, S. Barwey, M. Hassanaly et al. *Combustion Theory and Modelling*, 2019

15. **Discriminant analysis:** Data-driven Analysis of Relight variability of Jet Fuels induced by Turbulence, M. Hassanaly et al. *Combustion and Flame*, 2021



16. **Cluster-reduced order modeling:** Data-based analysis of multimodal partial cavity shedding dynamics, S. Barwey, H. Ganesh, M. Hassanaly et al. *Experiments in Fluids*, 2020

- **Anomaly detection:**



17. **LSTM:** Detection of False Data Injection (FDI) attacks on power dynamical systems with a state prediction method, A. Sahu, [...], M. Hassanaly *Under review*, 2024

- **Numerical methods for high-performance computing:**



18. **Chemistry integration:** SUNDIALS Time Integrators for Exascale Applications with Many Independent ODE Systems, C. Balos, [...], M. Hassanaly et al. *International Journal of High Performance Computing Applications*, 2024

19. **Symbolic computations:** Symbolic construction of the chemical Jacobian of quasi-steady state (QSS) chemistries for Exascale computing platforms, M. Hassanaly et al. *Combustion and Flame*, 2024 🔒

20. **Exascale computing methods:** The Pele Simulation Suite for Reacting Flows at Exascale, M. Henry de Frahan, [...], M. Hassanaly et al. *SIAM Conference on Parallel Processing for Scientific Computing*, 2024 🔒



21. **Exascale computing demo:** Visualizations of a methane/diesel RCCI engine using PeleC and PeleLMEX, N. T. Wimer, [...], M. Hassanaly et al., *Physical Review Fluids*, 2023

22. **Secondary conservation:** A minimally-dissipative low-Mach number solver for complex reacting flows in OpenFOAM, M. Hassanaly, *Computer and Fluids*, 2018.

- **Topical reviews:**



23. **Extreme and rare events:** Emerging Trends in Numerical Simulations of Combustion Systems, V. Raman, M. Hassanaly, *Proceedings of the Combustion Institute*, 2019

24. **Combustion modeling:** Classification and Computation of Extreme Events in Turbulent Combustion, M. Hassanaly et al. *Progress in Energy and Combustion Science*, 2021

- **Turbulence modeling:**

25. **Ignition:** Probabilistic Modeling of Forced Ignition of Alternative Jet Fuels, Y. Tang, M. Hassanaly et al. *Proceedings of the Combustion Institute*, 2021
26. **Ignition:** Simulation of gas turbine ignition using large eddy simulation approach, Y. Tang, M. Hassanaly et al., *ASME Turbo Expo*, 2020
27. **Ignition:** A Comprehensive Modeling Procedure for Estimating Statistical Properties of Forced Ignition, Y. Tang, M. Hassanaly et al. *Combustion and Flame*, 2019
28. **Soot:** Large Eddy Simulation of Pressure and Dilution Jet Effects on Soot Formation in a Model Aircraft Swirl Combustor, S. T. Chong, M. Hassanaly et al. *Combustion and Flame*, 2018
29. **Soot:** Large Eddy Simulation of Soot Formation in a Model Gas Turbine Combustor, H. Koo, M. Hassanaly et al. *Journal of Engineering for Gas Turbines and Power*, 2017
30. **Flashback:** Large eddy simulation of flame stabilization in a multi-jet burner using a non-adiabatic flamelet approach, Y. Tang, M. Hassanaly et al., *54th AIAA Aerospace Sciences Meeting*, 2016
31. **Boundary layer flashback:** Large Eddy Simulation of Flame Flashback in Swirling Premixed CH₄/H₂-Air Flames, C. F. Lietz, M. Hassanaly et al., *53rd AIAA Aerospace Sciences Meeting*, 2015
32. **Stratified combustion:** Influence of Fuel Stratification on Turbulent Flame Propagation, M. Hassanaly et al., *53rd AIAA Aerospace Sciences Meeting*, 2015
33. **Boundary layer flashback:** LES of Premixed Flame Flashback in a Turbulent Channel, C. F. Lietz, M. Hassanaly et al., *52nd AIAA Aerospace Sciences Meeting*, 2014
35. **Inertial manifolds:** An Approximate Inertial Manifold (AIM) Based Closure for Turbulent Flows, M. Akram, M. Hassanaly et al. *AIP Advances*, 2022
36. **Inertial manifolds:** A priori analysis of reduced description of dynamical systems using approximate inertial manifolds, M. Akram, M. Hassanaly et al. *Journal of Computational Physics*, 2020

- **Chaotic dynamics and rare event modeling:**

37. **Lyapunov spectrum calculation:** Numerical convergence of the Lyapunov spectrum computed using low Mach number solvers, M. Hassanaly et al. *Journal of Computational Physics*, 2019
38. **Rare event probability:** A self-similarity principle for the computation of rare event probability, M. Hassanaly et al. *Journal of Physics A: Mathematical and Theoretical*, 2019
39. **Lyapunov spectrum of non-reacting flows:** Lyapunov spectrum of forced homogeneous isotropic turbulent flows, M. Hassanaly et al. *Physics Review Fluids*, 2019
40. **Lyapunov spectrum of reacting flows:** Ensemble-LES Analysis of Perturbation Response of Turbulent Partially-Premixed Flames, M. Hassanaly et al. *Proceedings of the Combustion Institute*, 2019

HONORS AND AWARDS

- 2019: Richard and Eleanor Towner Prize for Distinguished Academic Achievement
- 2022: Milton Van Dyke Video Award, "Simulation of an RCCI Engine Using the Pele Suite of Exascale Codes"
- 2024: R&D 100 Finalist (Pele)
- 2024: NREL President's Award
- 2024: NREL Outstanding Mentor Award