

HAMID REZA KARBASIAN

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<https://hkarbasian.github.io> | [Google Scholar](#) | [ResearchGate](#)

EDUCATION

- Ph.D., Mechanical Engineering** *Sep. 2017 – Aug. 2021*
Concordia University *Montreal, Canada*
Minor: Computational Engineering
Thesis: Aerodynamic optimization using high-fidelity computational fluid dynamics
Advisor: Brian C. Vermeire
- M.Sc., Mechanical Engineering** *Sep. 2015 – Aug. 2017*
Pusan National University *Busan, South Korea*
Minor: Energy Systems Design
Thesis: Analysis of unsteady vortex structures around a moving foil under deep dynamic stall condition
Advisor: Kyung Chun Kim
- B.Sc., Chemical Engineering** *Mar. 2008 – Sep. 2012*
Ferdowsi University / Urmia University of Technology *Mashhad / Urmia, Iran*
Thesis: Mechanical gill for underwater breathing.

RESEARCH EXPERIENCE

- Postdoctoral Fellow** Montreal, Canada
Laboratory for multiscale mechanics (LM²), Polytechnique Montréal *Oct. 2022 – present*
 - Physics-Informed Neural Networks (PINNs) for FSI problems.
 - Reduced order model development and collaboration with R&D team at Maya HTT.
 - Development of digital twin framework for online monitoring of francis turbine - partnership with HydroQuébec.
- Fields CQAM Postdoctoral Fellow** Toronto, Canada
Fields Institute, University of Toronto *Sep. 2021 – Aug. 2022*
 - Member of AI-for-Design (AI4D) team at National Research Council Canada (NRC).
 - Development of a physics-based deep learning framework for thermal analysis and multi-phase flow problems.
 - Mathematical modeling of non-newtonian melted metals in the friction stir welding.
 - Transient modeling of fluid-solid interaction of particles using LSTM deep learning.
 - Solver development for simulation of particles using Smoothed Particle Hydrodynamics (SPH).
- Research Assistant** Montreal, Canada
Computational Aerodynamics Laboratory, Concordia University *Sep. 2017 – Aug. 2021*
 - Design of novel architectures for solving physics using physics-based machine learning.
 - Model discovery and Hyper-Reduction using deep-learning neural networks (e.g., MLP, RNN, CNN).
 - Large-scale constrained optimization using Multi-disciplinary Design Optimization (MDO).
 - Design and development of non-linear reduced-order model for complex physics.
 - System identification and controller design using Koopman operator formalism.
 - Advanced software development, scientific computing, and parallel programming.

Research Assistant

ExTENSys Laboratory, Pusan National University

Busan, South Korea

Sep. 2015 – Aug. 2017

- Turbulent flow analysis of a novel cooling fan for LG.
- Optimal design and analysis of a mixing head for DUT-Korea Company.
- Design and analysis of a novel apparatus applied to the oil industry for Tanktech company.
- Collaboration with Fluid Mechanics Key Laboratory of Education Ministry, Beihang University, China.
- Flow measurements using Particle Image Velocimetry (PIV) in the wind tunnel.

INDUSTRY EXPERIENCE

Aerospace Engineer

The Limosa Inc.

Montreal, Canada

Jul. 2021 – present

- Managing aerodynamic designs and mentoring team members, including two postdocs.
- Preparing proposals and contributing in business development.
- Conceptual design and analysis of electric airtaxi.
- Mesh automation and CFD simulation using high-order methods and HPC.
- Shape optimization using MDO.

Research & Development Engineer

Sun-Air Research Institute

Mashhad, Iran

Mar. 2012 – Mar. 2015

- Industrial-scale wind turbine design and analysis: 1.5KW, 15KW, and 100KW.
- Rotor/Blade optimization, load analysis and aeroelasticity.
- Turbulent flow analysis, unsteady aerodynamics and dynamic stall.

HONORS & AWARDS

1. Fields CQAM Postdoctoral Fellowship, Fields Institute, Canada (2021)
2. Accelerator Award, Concordia University, Canada (2021)
3. COVID Research Grant, Concordia University, Canada (2020)
4. Graduate Fellowship, Concordia University, Canada (2017)
5. International Tuition Award of Excellence, Concordia University, Canada (2017)
6. 2nd place among the M.Sc. students, Pusan National University, South Korea (2017)
7. Brain Korea (BK21+) Scholarship, Korean government for graduate students, South Korea (2015)
8. Foreign Graduate Scholarship, Pusan National University, South Korea (2015)
9. 2nd place (Silver medal), International Iran-Open RoboCup, Iran (2013)
10. Undergraduate Scholar (fully-funded), Ministry of Science & Research, Iran (2008)

GRANTS

1. MITACS Thematic Elevate – 2022.

Subject: Application of computational fluid dynamics to urban air mobility

PI: Brian Vermeire, Concordia University

Co-PI: **H.R. Karbasian**, Limosa Inc.

Total amount: \$320,000

Duration: 2022 – 2024

Status: Awarded

RESEARCH NETWORK

1. Massachusetts Institute of Technology, USA.

Collaborator: Dr. Wim vanRees,

Subject1: Application of artificial neural network for solving topology optimization in FSI problems.

Subject2: Co-supervising a student to develop an adjoint solver using automatic differentiation.

Output: 2 conference papers (see publications).

Duration: Feb. 2022 – present

2. Concordia University, Canada.

Collaborator: Dr. Brian Vermerie

Subject1: Topology optimization of a flapping foil in unstable flow conditions.

Subject2: Co-supervising post-doctoral fellows for shape optimization of the eVTOL project.

Output: under preparation.

Duration: Aug. 2022 – present

3. University of Lincoln , UK.

Ferdowsi University of Mashhad, Iran

Collaborator: Dr. Aliyu Aliyu, Dr. Javad Abolfazli Esfahani.

Subject: Dynamic stall and post-stall flow structures in wind turbine.

Output: 1 article (see publications).

Duration: Sep. 2021 – Jun. 2022

MENTORING (CO-SUPERVISING)

Postdocs

1. Ramin Ghoreishi, *Aerodynamic Optimization of eVTOL Rotors*, Department of Mechanical Engineering, Concordia University, Aug. 2022–present.
2. Firoozeh Yeganehdooost, *Acoustic impact analysis of optimized eVTOL rotor designs*, Department of Mechanical Engineering, Concordia University, Aug. 2022–present.

PhD. Student

1. Lucas Berthet, *Physics-informed neural network for deformable FSI*, Department of Mechanical Engineering, Polytechnique Montréal, Oct. 2022–present.

MSc. Students

1. Omar Tazi Labzour, *Modeling FSI with physics-informed neural network using modal decomposition*, Department of Mechanical Engineering, Polytechnique Montréal, Oct. 2022–present.
2. Theo Takla, *Development of the adjoint solver for sensitivity analysis using Automatic Differentiation*, Visiting student at the Department of Mechanical Engineering, Massachusetts Institute of Technology, Aug. 2022–present.
3. Adriana Orta, *Optimization of Vertical-Axis Wind Turbine (VAWT) using high-fidelity computational fluid dynamics*, Department of Mechanical, Industrial and Aerospace Engineering, Concordia University, 2021.
4. Anthony Aubrey, *High-fidelity optimization of gas turbine cascades*, Department of Mechanical, Industrial and Aerospace Engineering, Concordia University, 2019-2021.

Undergraduate Students

1. Matthieu Castaliho, *Low-Reynolds number flapping foil with different kinematic parameters.*, Department of Mechanical, Industrial and Aerospace Engineering, Concordia University, 2020.
2. Mohammad Houqe, *Aerodynamic load prediction using open-source PyFR CFD solver.*, Department of Mechanical, Industrial and Aerospace Engineering, Concordia University, 2017.

TEACHING EXPERIENCE

Teaching Certificate

Subject: “University Teaching Certificate”

Licensed by: GradProSkill, Concordia University, 2021

Workshop duration: 35 hours

Lab Demonstrator: (Number of attendees: **##**)

Gas Dynamics (Aerospace Engineering, Concordia University)

Summer 2020 (~90 **##**)/ Fall 2020 (~80 **##**)/ Summer 2021 (~80 **##**)

Theoretical explanation of gas dynamics and analytical design of subsonic/sonic/supersonic nozzles. Implementation, test, and validation of analytical design using Computational Fluid Dynamics (CFD) software (Ansys Fluent and STAR CCM). Introduction to design different meshes for various converging-diverging nozzles. Resolving stability issues at high Mach number flows using numerical techniques and simulation setup in software.

Computational Fluid Dynamics (Mechanical Engineering, Concordia University)

Winter 2018 (~12 **##**)/ Winter 2019 (~15 **##**)/ Winter 2020 (~20 **##**)/ Winter 2021 (~20 **##**)

Fundamentals in CFD and numerical methods, including the finite difference approach. Providing a preliminary introduction for code development using high-level languages, such as MATLAB. Advanced design of mesh (structured and unstructured) using Gmsh, an open-source software, and setting up SU2 software for solving 2D and 3D canonical aerodynamics problems. Advanced post-processing, such as planar plots, contours, rendering, developing scripts for mathematical calculations in Paraview, and providing technical consultations for code development and debugging.

Aerodynamics (Mechanical Engineering, Concordia University)

Fall 2017 (~9 **##**)/ Fall 2018 (~35 **##**)/ Fall 2019 (~20 **##**)

Teaching as a guest lecturer: panel method in theoretical aerodynamics and its mathematical formulations. Explaining different flow regimes around an arbitrary bluff body at different Reynolds numbers and flow conditions. A mathematical explanation of force calculations around a bluff body in inviscid flow and providing some examples. Advanced aircraft design and computational aerodynamic analysis using OpenVSP, an open-source software.

Tutor:

Department of Mechanical Engineering, Concordia University

Thermodynamics, Turbomachinery & Propulsion, and Applied Ordinary Differential Equations.

PUBLICATIONS

Total number of peer-reviewed articles: 26

Total number of citations: 358

h-index: 10

Book

1. *Computational Fluid Dynamics: An Open-Source Approach*, B.C. Vermeire, C.A. Pereira, **H.R. Karbasian**, Concordia University Press, 2020. [\[Link\]](#)

Thesis

1. **H.R. Karbasian**, *Aerodynamic optimization using high fidelity computational fluid dynamics*, PhD thesis, Concordia University, 2021. [\[Link\]](#)

2. **H.R. Karbasian**, *Analysis of unsteady flow and vortex structures around a moving foil under deep dynamic stall condition*, MSc thesis, Pusan National University, 2017. [\[Link\]](#)

Patent

1. *Mechanical respiratory system for underwater breathing (Mechanical gill)*, **H.R. Karbasian**, N. Saghatolaslami, No. 71062 B/ 390010253 App. Iranian Patent, 2011. [\[Link\]](#)

Peer-reviewed Articles

1. **H.R. Karbasian**, J.A. Esfahani, A.M. Aliyu, K.C. Kim, *Numerical analysis of wind turbines blade in deep dynamic stall*, *Renewable Energy*, 2022. [\[Link\]](#) IF: 8.63
2. A. Aubrey, **H.R. Karbasian**, B.C. Vermeire, *High-fidelity gradient-free optimization of low-pressure turbine cascades*, *Computers and Fluids*, 2022. [\[Link\]](#) IF: 3.07
3. **H.R. Karbasian**, B.C. Vermeire, *Application of physics-constrained data-driven reduced-order models to shape optimization*, *Journal of Fluid Mechanics*, 2022. [\[Link\]](#) IF: 4.24
4. **H.R. Karbasian**, B.C. Vermeire, *Sensitivity analysis of chaotic dynamical systems using a physics constrained data-driven approach*, *Physics of Fluids*, 2022. [\[Link\]](#) IF: 4.98
5. **H.R. Karbasian**, B.C. Vermeire, *Gradient-free aerodynamic shape optimization using Large Eddy Simulation*, *Computers and Fluids*, 2021. [\[Link\]](#) IF: 3.07
6. G. Chang, **H.R. Karbasian**, ..., *The influence of kinematics of blades on the flow structure in deep dynamic stall*, *Journal of Mechanical Science and Technology*, 2020. [\[Link\]](#) IF: 1.734
7. Z. Li, L. Feng, **H.R. Karbasian**, J. Wang, K.C. Kim, *Experimental and numerical investigation of three-dimensional vortex structures of a pitching airfoil at a transitional Reynolds number*, *Chinese Journal of Aeronautics*, 2019. [\[Link\]](#) IF: 2.76
8. M. Abolfazli, **H.R. Karbasian**, K.C. Kim, *Multi-objective optimization of kinematic parameters of fish-like swimming using a genetic algorithm method*, *Journal of Hydrodynamics*, 2019. [\[Link\]](#) IF: 2.5
9. **H.R. Karbasian**, J.A. Esfahani, *Enhancement of propulsive performance of flapping foil by fish-like motion pattern*, *Computers and Fluids*, 2017. [\[Link\]](#) IF: 3.07
10. **H.R. Karbasian**, D.Y. Kim, ..., *A new method for reducing VOCs formation during crude oil loading process*, *Journal of Mechanical Science and Technology*, 2017. [\[Link\]](#) IF: 1.34
11. M. Kim, **H.R. Karbasian**, E. Yeom, *Transient three-dimensional flow structures of oblique jet impingement on a circular cylinder*, *Journal of Visualization*, 2017. [\[Link\]](#) IF: 1.331
12. **H.R. Karbasian**, J.A. Esfahani, E. Barati, *The power extraction by flapping foil hydrokinetic turbine in swing arm mode*, *Renewable Energy*, 2016. [\[Link\]](#) IF: 8.63
13. **H.R. Karbasian**, K.C. Kim, *Numerical investigations on flow structure and behavior of vortices in the dynamic stall of an oscillating pitching hydrofoil*, *Ocean Engineering*, 2016. [\[Link\]](#) IF: 4.37
14. **H.R. Karbasian**, J.A. Esfahani, E. Barati, *Effect of acceleration on dynamic stall of airfoil in unsteady operating conditions*, *Wind Energy*, 2016. [\[Link\]](#) IF: 3.73
15. **H.R. Karbasian**, J.A. Esfahani, E. Barati, *Simulation of power extraction from tidal currents by flapping foil hydrokinetic turbines in tandem formation*, *Renewable Energy*, 2015. [\[Link\]](#) IF: 8.63
16. J.A. Esfahani, **H.R. Karbasian**, E. Barati, *Proposed kinematic model for fish-like swimming with two pitch motions*, *Ocean Engineering*, 2015. [\[Link\]](#) IF: 4.37
17. J.A. Esfahani, E. Barati, **H.R. Karbasian**, *Fluid structures of flapping airfoil with elliptical motion trajectory*, *Computers and Fluids*, 2015. [\[Link\]](#) IF: 3.07
18. **H.R. Karbasian**, S.A.Moshizi, M.J. Maghrebi, *Dynamic stall analysis of S809 pitching airfoil in unsteady free stream velocity*, *Journal of Mechanics*, 2015. [\[Link\]](#) IF: 1.29

19. J.A. Esfahani, E. Barati, **H.R. Karbasian**, *Effect of caudal on hydrodynamic performance of flapping foil in fish-like swimming*, Journal of Applied Ocean Research, 2013. [\[Link\]](#) IF: 3.76
20. J.A. Esfahani, E. Barati, **H.R. Karbasian**, *Comparative investigations in the effect of angle of attack profile on hydrodynamic performance of bio-inspired foil*, Journal of Naval Architecture and Marine Engineering, 2013. [\[Link\]](#)
21. **H.R. Karbasian**, ..., K.C. Kim, *Numerical visualization of mixing in a circular chamber by two opposite impinging jets*, Journal of the Korean Society of Visualization, 2016. [\[Link\]](#)
22. J.A. Esfahani, **H.R. Karbasian**, *Optimizing the shape of rotor blades for maximum power extraction in marine current turbines*, IJAME, 2012. [\[Link\]](#)
23. **H.R. Karbasian**, A.F. Kangarshahi, *Numerical simulation of the erosion in bend pipes caused by gas-particle flows*, Petroleum & Coal, 2013. [\[Link\]](#)
24. M. Abolfazli, E. Barati, **H.R. Karbasian**, *Optimization of Propulsion in Flapping Micro Air Vehicles Using Genetic Algorithm Method*, International Journal of Mechanical and Mechatronics Engineering, 2014. [\[Link\]](#)
25. J.A. Esfahani, **H.R. Karbasian**, A.F. Kangarshahi, E. Barati, *Protection of Bend from Erosion Caused by Gas-Particle Flows in Town Border Station*, CFD Letters, 2013. [\[Link\]](#)
26. M. Abolfazli, **H.R. Karbasian**, J.A. Esfahani, E. Barati, *Optimization of flapping-wing micro aircrafts based on the kinematic parameters using genetic algorithm method*, INCAS Bulletin, 2013. [\[Link\]](#)

Invited Talks

1. **H.R. Karbasian**, *Design in Chaos: High-Fidelity Aerodynamic Optimization Using Novel Physics Constrained Machine Learning*, Department of Mechanical and Aerospace Engineering, University of California, Davis, Feb. 2022.
2. **H.R. Karbasian**, *Physics-constrained data-driven reduced-order modelling for large-scale optimizations*, National Research Council Canada, Dec. 2021.
3. **H.R. Karbasian**, *Sensitivity analysis and uncertainty quantification using novel physics-constrained machine learning*, Department of Mathematics and Statistics, Utah State University, Sep. 2021.
4. **H.R. Karbasian**, B.C. Vermeire, *Design in Chaos*, University of Toronto Institute for Aerospace Studies, Toronto, Canada, Apr. 2021.
5. **H.R. Karbasian**, *Design in Chaos*, Department of Mechanical Engineering, The University of British Columbia, Vancouver, Canada, Apr. 2021.
6. **H.R. Karbasian**, B.C. Vermeire, *Shadow of the Chaos*, University of Toronto Institute for Aerospace Studies, Toronto, Canada, Nov. 2020

Conference Papers & Presentations (Refereed)

1. **H.R. Karbasian**, W. vanRees, *A Deep-Learning Surrogate Model Approach for Optimization of Morphing Airfoils*, AIAA SciTech, National Harbor, USA, 2023. (upcoming)
2. **H.R. Karbasian**, W. vanRees, *Development of surrogate models for unsteady flow fields using a deep neural network*, American Physical Society, Indianapolis, USA, 2022. (upcoming)
3. **H.R. Karbasian**, B.C. Vermeire, *Advances in Multi-Disciplinary PDE-Constrained Optimization*, The 29th Annual Conference of the CFD Society of Canada, St. Johns, Newfoundland, Canada, 2021.
4. **H.R. Karbasian**, B.C. Vermeire, *Aerodynamic Optimization of Unsteady Chaotic Flows*, AERO Conference at Canadian Aeronautics and Space Institute, Canada, 2021.
5. A. Aubry, **H.R. Karbasian**, B.C. Vermeire, *High-Fidelity Gradient-Free Optimization of Low-Pressure Turbine Cascades*, International Conference on Spectral and High Order Methods, Vienna, Austria, 2021.

6. A. Aubry, **H.R. Karbasian**, B.C. Vermeire, *High-Fidelity Gradient-Free Optimization of Low-Pressure Turbine Cascades*, AERO Conference at Canadian Aeronautics and Space Institute, Canada, 2021.
7. **H.R. Karbasian**, B.C. Vermeire, *Gradient-free high-fidelity airfoil optimization*, AERO Conference at Canadian Aeronautics and Space Institute, Laval, QC, Canada, 2019.
8. K.C. Kim, **H.R. Karbasian**, *Reynolds number effect on airfoil wake structures under pitching and heaving motion*, Bulletin of the American Physical Society, 70th Annual Meeting of the APS Division of Fluid Dynamics, Vol.62, Denver, CO, USA, 2017
9. **H.R. Karbasian**, K.C. Kim, *Unsteady Flow Features over Flapping Foil in Low Reynolds Number*, Proceedings of the Korean Society for Visualization, South Korea, 2016.
10. M. Kim, **H.R. Karbasian**, E. Yeom, K.C. Kim, *Large Eddy Simulation of 45° oblique round jet impingement onto a circular cylinder*, Proceedings of the Korean Society for Visualization, South Korea, 2017.
11. **H.R. Karbasian**, K.C. Kim, *Vortex structure and instability of flow over heaving and pitching foils*, 17th International Symposium on Flow Visualization, Gatlinburg, TN, USA, 2016
12. **H.R. Karbasian**, K.C. Kim, *Flow instabilities and its effect on power generation of horizontal axis wind turbine*, The 9th National Congress on Fluid Engineering, Daegu, South Korea, 2016
13. **H.R. Karbasian**, K.C. Kim, *Unsteady flow features over flapping foil in low Reynolds numbers*, The Korean Society of Visualization, Yongin, South Korea, 2016

Technical Reports

1. **H.R. Karbasian**, *AI4D bi-annual project progress update*, National Research Council Canada, 2021.
2. **H.R. Karbasian**, *Conceptual design of the Limoconnect eVTOL aircraft*, Limosa Inc., 2021.
3. **H.R. Karbasian**, *Aerodynamic design of propellers for the Limoconnect*, Limosa Inc., 2021.
4. **H.R. Karbasian**, Y. Kim, K.C. Kim, *반대방향 충돌제트에 의한 원형 챔버 내 혼합거동에 대한 전산 가시화*, DUTKOREA Co., Ltd, 2016.
5. **H.R. Karbasian**, D.Y. Kim, S.Y. Yoon, J.H. Ahn, K.C. Kim, *유류운반선의 저장탱크에서 발생하는 VOC 회수시스템 개발*, Technical Research Department, Tanktech Co., Ltd, 2015.
6. **H.R. Karbasian**, A. Rasouli, *Possibility of higher power generation using 100KW Horizontal Axis Wind Turbine (HAWT)*, Aerodynamics group, Sun-Air Research Institute, 2014.
7. **H.R. Karbasian**, A. Rasouli, *Design of 1.5KW Stall turbine using Qblade and WT-Perf.*, Aerodynamics group, Sun-Air Research Institute, 2013.

SKILLS

Developer of scientific softwares:

- **OPThiNOS (OPtimization Toolkit for Highly NON-linear Systems)** [www.opthinos.com]
A physics-based machine learning framework for high-fidelity optimization problems. The main feature of this software is enabling complex optimization in the presence of highly non-linear and chaotic systems.
- **PyMADS**
A python package for non-convex optimization using Mesh Adaptive Direct Search (MADS) algorithm. This package uses a novel CPU-GPU platform to accelerate optimization time by 30% ~ 70%.
- **jFVS (julia Finite Volume Solver)**
An in-house PDE solver developed to solve Navier-Stokes and Euler equations using Finite Volume Method (FVM). This solver is purely programmed in Julia with optimized algorithms suited for High Performance Computing (HPC).
- **HORUS (High-ORder Unstructured Solver)** as a team member
An in-house high-order CFD solver developed at Computational Aerodynamics Lab.

PROFESSIONAL ACTIVITIES

Journal Referee

Physics of Fluids (ASP) • AIAA • Energy (*Elsevier*) • Renewable Energy (*Elsevier*) • Ocean Engineering (*Elsevier*) • Applied Ocean Research (*Elsevier*) • Alexandria Engineering Journal (*Elsevier*) • Journal of Visualization (*Springer*) • International Journal of Aerospace Engineering (*Hindawi*).

Professional Memberships

- Canadian Aeronautics and Space Institute

Services

- Student volunteer (2018-2019), *Concordia University Student Parent Center*, Montreal, Canada.
- Technical staff (2017), *12th International Symposium on Particle Image Velocimetry*, Busan, South Korea
- Robot designer (2013-2015), *FUM Robotics Lab*, Mashhad, Iran
- Teacher (2014), *Scientific programming using MATLAB*, Ferdowsi University, Mashhad, Iran