Dr. Jonathan M. O. Massey

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Employment & Experience

Aug 2024 - Present — Postdoctoral researcher, Center for Turbulence Research, Mechanical Engineering Department, Stanford University, California

- Collaborating with groups from Stanford, Princeton, and Melbourne on the SAPPHiRe project.
- Modelling the effect of large-scale motions on subconvective pressure and wall shear stress.
- Developing a mathematical framework and scaling arguments to predict the footprint of very large-scale motions important on wall metrics.
- Using SOTA experimental measurements and data-assimilation techniques to inform the resolvent analysis.
- PI: Beverley McKeon

Jan 2023 - Jan 2024 — Visiting Researcher, Marine Transport Technology Group, TU Delft, The Netherlands

- Developed novel resolvent analysis methodology to assess the hydrodynamic stability of swimming foils, tackling challenges that come with analysing solutions with moving bodies.
- Forged academic partnerships, laying the groundwork for research collaborations.
- Adapted to and optimised workflows in a novel High-Performance Computing (HPC) setting.
- Advisor: Gabriel Weymouth

Education

Nov 2019 - Nov 2023 — PhD, Engineering & the Environment, University of Southampton, United Kingdom

- Performed challenging simulations in a high performance computing environment.
- Produced an open access and peer reviewed publication in the top journal for fluid mechanics.
- Developed and maintained in-house computational fluid dynamic solver.
- Devised a data-driven framework for understanding the stability of solutions to fluid flow.
- Undertook optional lectures courses in advanced machine learning and numerical methods.
- Advisors: Bharathram Ganapathisubramani, Gabriel Weymouth

Oct 2016 - Jun 2019 — BEng (Hons) Ship Science, 1^{st} class
University of Southampton, Southampton, United Kingdom

- Excelled in hydrodynamics(84), maths (75), computing (93).
- Investigated the effect of a diameter-chord ratio of the flow and forces of a vertical axis wind turbine.
- Created a potential flow model, compared it with CFD using a solver written in processing (java)
- Implemented a turbulence model to ensure the stability of the solutions.

Research

Projects & Publications

Massey, J., Ganapathisubramani, B., & Weymouth, G. (2023). A systematic investigation into the effect of roughness on self-propelled swimming plates. *Journal of Fluid Mechanics*, 971, A39. doi:10.1017/jfm.2023.703

- Examined the impact of egg-carton surface roughness on the hydrodynamics of Self-Propelled Swimming (SPS) bodies.
- Identified that decreasing roughness wavelength necessitates higher undulation speeds to counteract drag, leading to higher energy costs and reduced swimming efficiency.
- Revealed that roughness can significantly enhance flow enstrophy without corresponding force spikes, indicating induced secondary flow structures extending to the boundary layer edge.

Massey, J., Symon, S., Ganapathisubramani, B., & Weymouth, G. (2024). Resolvent analysis of a swimming foil. **Under review in** *Journal of Fluid Mechanics* doi.org/10.48550/arXiv.2407.06764

- Employed resolvent analysis to study dynamics and coherent structures in the boundary layer of a swimming foil with a modified NACA shape at realistic Reynolds numbers (Re=10,000 and Re=100,000).
- Introduced a novel coordinate transformation to implement data-driven resolvent analysis, focusing on stability in thrust- and drag-producing propulsion regimes.
- Revealed distinct breakdown mechanisms in drag-producing regimes and uniform wave amplification in thrust-producing regimes, highlighting the influence of swimming kinematics.
- Identified a mechanism less coupled to body motion and demonstrated roughness as a control strategy, providing insights into the dynamics of swimming bodies.

Conference presentations

Machine learning the skin friction of a circular cylinder - CMNE

Sept 2023 Resolvent analysis of a swimming foil - ReCoVor

- Introduced the data-driven resolvent analysis framework under development.

Jun 2023 Chaotic breakdown of secondary-flow amplification in rough swimmers - Delft Colloquia

- Investigated the link between periodicity and secondary-flow amplification of a rough swimmer.

Apr 2023 The interaction between roughness and swimming plates - DisCoVor

Sept 2022 Secondary flows in rough swimming - APS DFD

Apr 2022 Surface roughness optimisation of an undulating plate - DisCoVor

- Developed an optimisation procedure with in loop CFD simulations.

Sept 2021 Modal decomposition of flow over a rough plate - UK Fluids

- Ran simulations of a rough flat plate in conjunction with experiments.
- Applied modal decompositions such as POD and DMD to delineate the effect of roughness.

Mar 2020

- Implemented various neural networks to predict the skin friction on a downsampled flow field.

Training

Nov 2019 Machine learning for fluid dynamics - von Karman Institute

- Deepened my expertise in integrating machine learning and fluid dynamics.

June 2022 Parallel IO - Jülich Supercomputing Centre

- Honed my skills in handling large datasets effectively.
- Optimise I/O operations through parallelised packages like NetCDF and HDF5.

Teaching & Responsibilities

Mar 2022 - Apr 2022 Demonstrating for wave energy lab *University of Southampton*

- Communicated the background physics of wave-energy.
- Demonstrated software for required for the project.

Jan 2021 - Jun 2021 Tutorial lead *University of Southampton*

- Taught tutorials for 2^{nd} year Marine Hydrodynamics Module.
- Organised tutorial structure.
- Communicated coursework problems and solutions.

Jun 2020 - Jun 2021 Postgraduate Representative *University of Southampton*

- Taught tutorials for 2^{nd} year Marine Hydrodynamics Module.
- Organised activities.
- Represented researchers in maritime engineering in department meetings.

Key Skills

Areas of specialisation

- Advanced expertise in Python and Fortran for HPC-based scientific and engineering software development from data-processing and analysis of flow field results.
- Focused proficiency in hydrodynamics, notably in the domains of undulatory swimming and surface roughness.
- Ingestion and development of complex analysis techniques evidenced through work on resolvent analysis for a paper under preparation.

Technical Skills

- Proven problem-solving in applied mathematics and system modelling, substantiated by innovative projects.
- Quick adaptability to emerging challenges, honed through COVID-19.
- Solid background in numerical modelling, specifically in Computational Fluid Dynamics (CFD), emphasising Immersed Boundary Methods and kinematics of moving bodies.

IT Proficiency

- Expertise in data analytics, including implementation of CNNs/autoencoders with Pytorch.
- Multi-language programming adeptness, spanning Python, Fortran, Processing, and Matlab.

- Experience with version control using Git which was used all throughout the PhD.

Communication Skills

- Proficient in articulating complex ideas, demonstrated by journal publications, conference participations, and pedagogical roles.

Organisational Skills

- Proven decision-making and project management abilities, validated by handling concurrent tasks with strict deadlines.
- Collaborative and leadership skills developed through team projects, student supervision, and instructional roles.

Interests and Interpersonal Skills

- *Water Sports* - Extensive experience in water sports like windsurfing and sailing, enhancing skills in quick decision-making and adaptability.
- *Hockey* - Demonstrated commitment to teamwork through participation in team sports, achieving regional selection for South-West England hockey team in 2015.
- *Hiking* - Completed a challenging solo three-week trek through the Annapurna region, developing resilience and self-reliance. Regularly organise and lead group hikes, refining leadership and planning skills.
- *Travel* - Travelled extensively within and outside Europe, gaining valuable exposure to diverse cultures and enhancing adaptability and global awareness.

Languages

English - Native, French - Fair, Spanish - Basic

References

Prof. Gabriel Weymouth–g.d.weymouth@tudelft.nl
Prof. Bharathram Ganapathisubramani–g.bharath@soton.ac.uk