PhD Advert Template

Project title: Phenomenological Modelling of Nature-Inspired Energy Extraction

Project ID *(optional)*:

Accept all year-round applications

Funding information: Self-funded students only

Project description:

Natural mechanical power from steady water flows in oceans and rivers can provide an alternative and abundant source of cheap and clean energy, in addition to the renewable energy from winds, waves and sun. In this research study, we aim to develop a new innovative renewable energy device based on the concept of vortex-induced vibrations (VIV) in which the fluid flow creates a three-dimensional motion of a bluff body device whose mechanical energy is converted into electricity within a certain range of flow velocities versus system parameters. The proposed research will develop mathematical and experimental models, see, e.g., [1-4], and explore fundamentals of fluids, mechanics of wake turbulence and VIV of cylinder structures with different shapes (circular, square, triangle and asymmetric geometries representing underwater plants and animal structures) in different orientations versus the incoming flow in a wider range of fluid-structure parameters. This research will also focus on the experimental investigations which can be carried out in the laboratory wind-wave-current flume and/or towing tank.

The research objectives are (i) to develop an advanced reduced-order fluid-structure interaction model to predict the three-dimensional responses of bluff bodies undergoing VIV and galloping instability, and to predict the coupling with the electromechanical power take-off mechanism for the optimization and reliability analysis of the power output under practical parameters; (ii) to develop an experimental model to investigate the flow-induced VIV and galloping-type responses; (iii) to calibrate and validate the developed mathematical models with new experimental results and those in the literature; (iv) to carry out parametric and optimization studies to identify the appropriate operational ranges of the renewable energy device from natural flow; (v) to disseminate research outcomes through international journals and industry-academia conferences. Key research questions to be answered are: (i) can the performance of the proposed renewable energy harvester from VIV be more efficient than traditional energy harvesters? (ii) how accurate can the mathematical model predict the VIV-galloping responses of circular and non-circular cylinders? (iii) what are possible applications of VIV phenomena to the renewable energy harvesting technology and industry?

This project will deliver theoretical and technical contributions to the natural flow renewable energy engineering, and the proposed innovative device could be more efficient and economical when compared to traditional flow energy generating devices. The development of the proposed natural flow energy harvesting device could assist the green energy generation and reducing the cost of renewable power with the minimum environmental impact.

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References (optional):

[1] Srinil N, Zanganeh H (2012) “Modelling of coupled cross-flow/in-line vortex-induced vibrations using double Duffing and van der Pol oscillators” Ocean Engineering 53, 83-97.

[2] Srinil N, Opinel P-A, Tagliaferri F (2018) “Empirical sensitivity of two-dimensional nonlinear wake-cylinder oscillators in cross-flow/in-line vortex-induced vibrations”, Journal of Fluids and Structures 83, 310-338.

[3] Opinel P-A, Srinil N (2020) “Application of wake oscillators to two-dimensional vortex-induced vibrations of circular cylinders in oscillatory flows” Journal of Fluids and Structures 96, 103040.

[4] Soares B, Srinil N (2021) “Modelling of wake-induced vibrations of tandem cylinders with a nonlinear wake-deficit oscillator” Journal of Fluids and Structures 105, 103340.

Application enquires:

Dr Narakorn Srinil,

[*https://www.staff.ncl.ac.uk/narakorn.srinil/*](https://www.staff.ncl.ac.uk/narakorn.srinil/)

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