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SIMULATION OF LONG FLEXIBLE BLADES IN A TURBULENT FLOW FOR ENERGY HARVESTING

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This work presents a large-eddy simulation of the flow over an array of flexible rods exhibiting the *monami* phenomenon – a coherent waving motion of the structures [1]. Figure 1 illustrates the collective deflection of canopy patches with darker tones corresponding to larger instantaneous reconfiguration. When equipped with piezoelectric elements, this oscillatory deformation of the rods could provide a low-maintenance source of energy for autonomous electronic devices, complementary to previous concepts of such energy-harvesters. The latter commonly exploit the vortex-driven flow past an obstacle [2], wave or tidal flow [3], or turbulence generated in a rough boundary layer [4]. Having modeled the blades as Cosserat rods, we are able to deduce motion-related data necessary to assess the potential of this flow scenario.

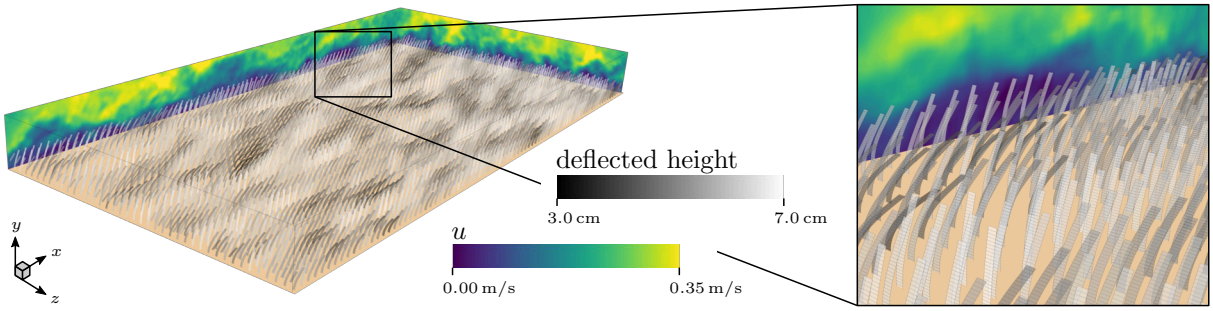

Figure 1: Visualization of the artificial model canopy consisting of equally distributed strip-shaped flexible rods in a turbulent flow, corresponding to an experimental setup of [5]. The channel-height-based Reynolds number is $Re_H = 42000$, the Cauchy number is $Ca = 17$. Shown are the instantaneous, streamwise velocity component u and the canopy deflection at an arbitrary instant in time.

REFERENCES

[1] H.M. Nepf, Flow and Transport in Regions with Aquatic Vegetation. *Annu. Rev. Fluid Mech.*, Vol. **44**, p. 123–142, 2012.

[2] A. Abdelkefi, Aeroelastic energy harvesting: A review. *International Journal of Engineering Science*, Vol. **100**, p. 112–135, 2016.

[3] A.M. Pankonien and Z. Ounaies, Piezoelectric Artificial Kelp for Energy Harvesting. *ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems*, Vol. **2** pp. 223–232, 2010.

[4] J.D. Hobeck and D.J. Inman, Artificial piezoelectric grass for energy harvesting from turbulence-induced vibration. *Smart Mater. and Struct.*, Vol. **21**, p. 105024, 2012.

[5] T.-A. Okamoto and I. Nezu, Flow resistance law in open-channel flows with rigid and flexible vegetation. *Proceedings of the 5th International Conference on Fluvial Hydraulics*, pp. 261–268, 2010.