Title: " Knots to Watts : generating power from water current using a 6 degree motion energy harvesting technology "

Project description: The WITT gearbox (WITT: “what is this thing”) is a device that harvests energy from its environment by responding to sufficiently high frequency and amplitude harmonic acceleration in any plane of motion. The beauty of the device is its simplicity. It is a simple apparatus, consisting of pendula, gears, bearings, clutches, power conversion electronics, etc that can be immersed in a sealed way into a harsh, turbulent environment. It generates uninterrupted power by turning vibration to rotation, always in the same direction, regardless of the direction of the external vibration. This property, together with the maturity of technologies for waterproof electrical connection, make the device particularly well suited for use in marine environments.

Present uses cases for the device include placing it at the end of a rod or pole that is attached to the ocean floor, enabling the device to respond to vortex-induced vibrations (VIV) of the rod. One current problem with this approach is that the vibration frequency of the rod is just a little too low to exceed the resonant frequency of the device, and it has been empirically determined that super-resonant excitation is generally required to make the device rotate.

The aim of this project is to gain more mechanical understanding of how the device actually works and to explore other use cases. A first step towards this direction would be to derive the Lagrangian formulation of the problem, and to try out different configurations and parameter values that could lead to improved energy harvesting.

One key question is whether a modification of the device could enable it to respond to lower-frequency excitation. Could the performance of the device can be improved, for instance by exploring various external mechanical configurations (e.g. attaching the device to pair of pendula, or to a pole, etc.), or by investigating how the system responds to changing various mechanical parameters (e.g. length of pendula or pole, electro-mechanical properties etc.)? Other ideas include using offset anchorages/moorings, off centre ballast or a spherical container for least resistance, and maybe to explore how to counterbalance the spherical pendulums resisting the rotation of the housing.

Another objective is to consider a simpler use case where the device is placed directly into a turbulent flow, such as within the rapids of river or stream, perhaps on the end of a simple tether. Can the frequencies present in flow directly excite the device? How could fluid-structure interaction be exploited to enhance the response?