Imperial College London

Kalliopi (Kelly) Tzivanaki

The measurement of surface water waves simultaneously in space and time

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Supervisor: Professor C. Swan

Abstract / Description of Thesis

This thesis describes the development of a system for measuring simultaneously the spatial and temporal evolution of surface water waves in a laboratory environment and the application of these measurements to problems involving nonlinear wave diffraction. In most situations, wave analysis is based on measured or theoretically simulated time histories of the water surface elevation at a fixed spatial location. To date no technology or methods have been available to provide measurements of the water surface elevation with comparable resolution in both space and time.

A novel, optical system has been developed to fill this gap. The proposed instrumentation provides a non-intrusive, digital system, capable of describing an evolving water surface elevation with high spatial and temporal resolution, very good accuracy and automatic processing. It provides robustness in repeatability and thorough data quality control. It offers flexibility in application and it is adjustable to different wave conditions.

The system was developed in a small purpose built wave basin. Having validated it using a range of uni-directional regular wave fields, it was applied to the problem of wave scattering from a single vertical surface-piercing column. Although these measurements were undertaken at small scale, they confirm the existence of a flow regime in which significant and unexpected nonlinear wave scattering has been observed. More importantly, the rapid provision of spatial data, with comparable temporal resolution, allows the extent of this flow regime to be fully explored and provides important insights into the physics governing the scattering of these high frequency waves.