

Hydraulics Laboratory & Eco-hydraulics Research Center

Room PQ004, Block PQ,

Department of Civil and Environmental Engineering,

The Hong Kong Polytechnic University

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
土木及環境工程學系

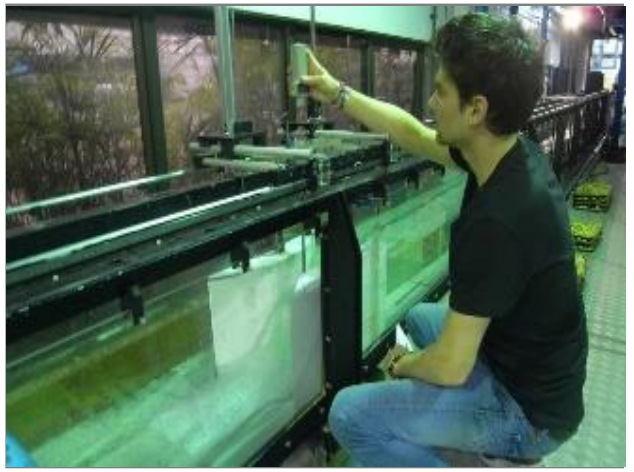
Opening Minds • Shaping the Future
啟迪思維 • 成就未來

Introduction

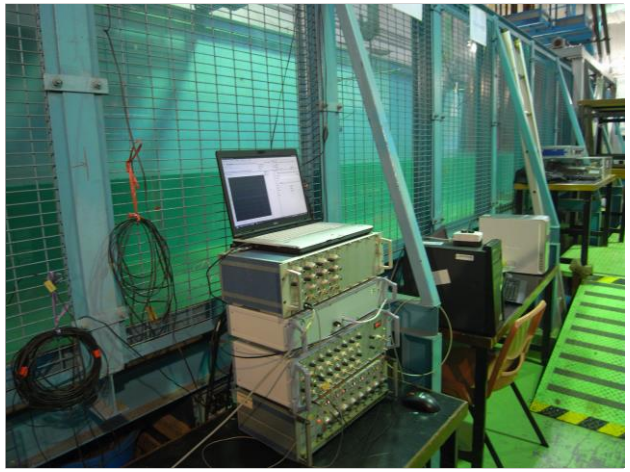
This hydraulics laboratory mainly focuses in the teaching and research areas of hydraulic engineering and related disciplines, including: numerical and physical modeling of tidal circulation, wave propagation, storm surge, conduit flow, multi-phase flow, solute and sediment transport.

It houses advanced equipment including:

- Open Channel Tilting Flume
- Wave Channel and Control System
- Pressurized Water Pipeline System
- Wind Tunnel and Measurement System
- Nortek Vectrino Plus Side/down-looking ADV
- Laser PIV System
- 2D LDV System
- Nortek Vector Current Meter
- OBS-3A Turbidity Meter
- Submersible Ultraviolet Nitrate Analyzer (SUNA)
- Acoustic Doppler Current Profiler (ADCP)
- 3D Printer
- Emriver Em4 River Simulator
- High-Speed CMOS Area Scan Camera Series
- etc.



Main Equipment (Research)



Irregular Wavemaker Channel and Control System

Parameter settings:

Length	~27m
Width	1.5m
Hight	1.5m

Open Channel (Tilting Flume)

Parameter settings:

Length	12.5m
Width	0.31m
Hight	0.45m

Open Channel (Sediment & Flow)

Parameter settings:

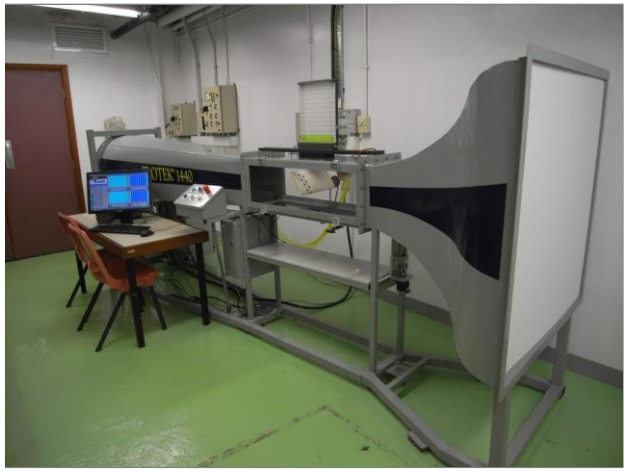
Length	~7m
Width	1.0m
Hight	0.4m

Main Equipment (Research)

Pressurized Water Pipeline System

Parameter settings:

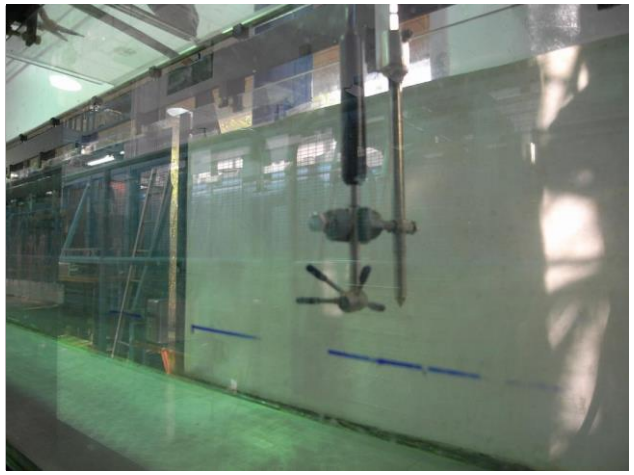
Total Length	~ 50m
Diameter	50mm
Water head	10bar Max



Wind Tunnel and Measurement System

Parameter settings:

Length	90cm
Width	30cm
Hight	30cm
Wind speed	180mph Max



Nortek Vectrino Plus Side-looking ADV

Nortek Vectrino is globally used as the standard flow-measuring tool for hydraulic laboratory applications.

Acoustic Doppler velocimetry (ADV) is a velocity measurement technique that allows for the measurement of 3D flow velocities by using the Doppler shift principle.

Main Equipment (Research)

Submersible Ultraviolet Nitrate Analyzer (SUNA)

The SUNA is a water quality monitoring sensor, and it is a cost-effective solution for real-time nitrate analysis in costal and freshwater environments, providing quick and continuous nitrate measurement.

OBS-3A Turbidity Meter

The OBS-3A sensor is an optional sensor for measuring turbidity and suspended solids concentrations by detecting near infrared radiation scattered from suspended particles.

Laser PIV System

The laser PIV system is well established technique for measuring the velocity of a fluid at multiple points throughout a 2-dimensional measure plane.

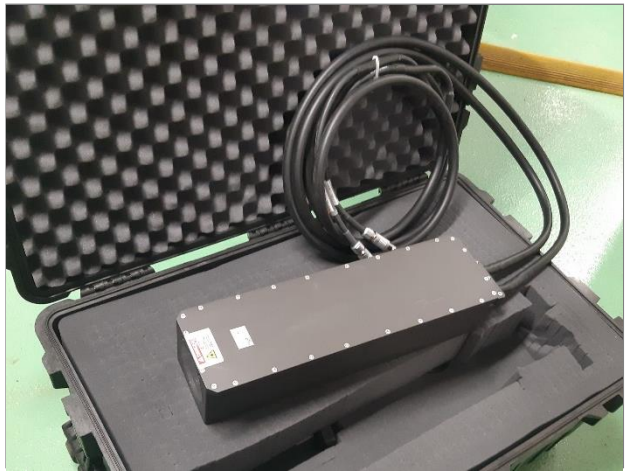
Main Equipment (Research)

Emriver Em4 River Simulator

The Em4 system is capable of simulating floodplains, deltas, groundwater processes, and sediment transport. Combining with wave maker and media feeder module, more systems and processes could be built and modelled.

High-Speed CMOS Area Scan Camera Series

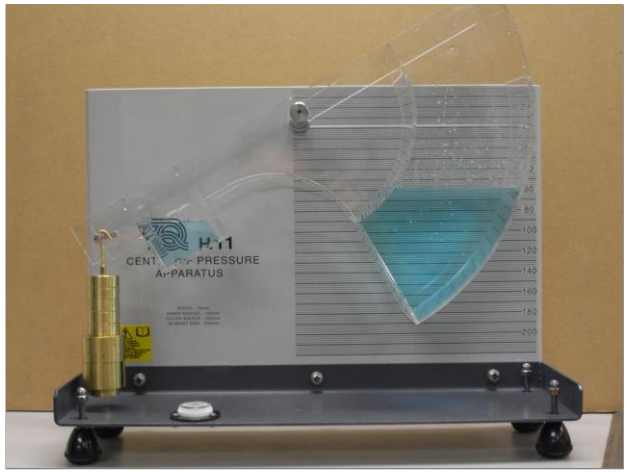
The camera series is a family of high-speed CMOS area scan cameras designed for a broad range of applications. It can produce videos with high resolution of 2048*1088 and capture instantaneous flow structures.



2D Mini Laser Doppler Velocimetry

The 2D-miniLDV, also known as laser Doppler anemometry, is the technique of using the Doppler shift in a laser beam to measure the velocity in transparent or semi-transparent fluid flows or the linear or vibratory motion of opaque, reflecting surfaces.

Main Equipment (Teaching)



Hydrostatic Pressure

V-Notch Weir

Venturi Meter

Jet Impact

Hydraulics of Well

Pipe Friction and Surge Tower

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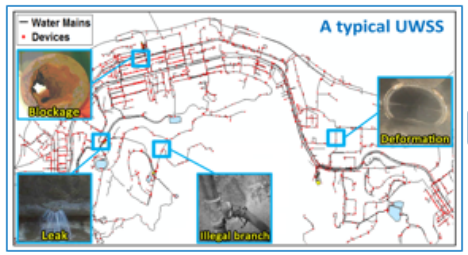
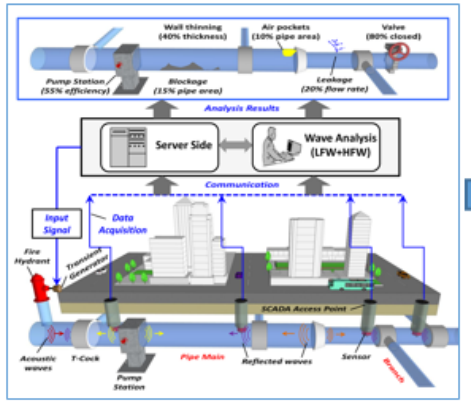
Research Spotlight (1)

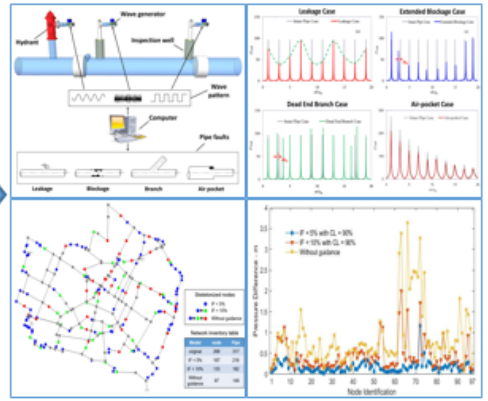
Smart Urban Water Supply System (Smart UWSS)
— Transient-Based Water Pipeline Diagnosis



- Over 30% water losses in worldwide UWSS with annual cost of US$ 40B
- 16% water & associated energy lost in Hong Kong's UWSSs (~HK$ 1B)
- Very high complexities: inaccessible; large scale & range; highly dynamic
- Existing methods: necessary and useful. BUT: inadequate / inaccurate

Innovative Transient-Based Methods for Pipe Defects Detection:
Efficient, Economic, No-intrusive





Benefits & Impacts

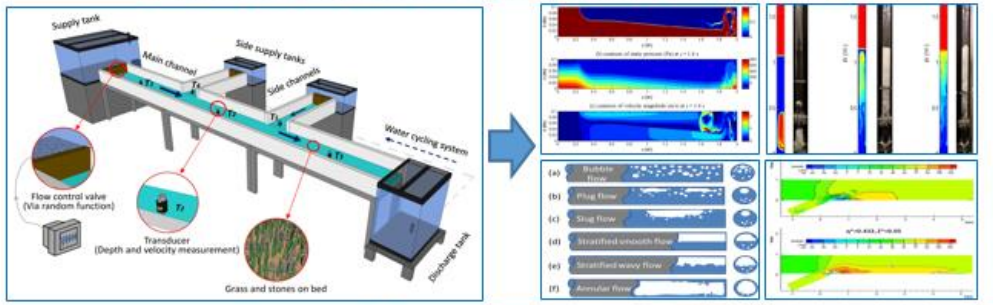
** Supports from RGC TRS & GRF Projects (T21-602/15R; 15201017; 15200719)

Research Spotlight (2)

Fluid Mechanics & Hydraulics of Close-Open Channel Flows
— Advances in Theories, Models and Applications

❖ **Complexities:** highly unsteady and dynamic, stochastic process, multi-phase mixes…

Advanced Understanding and Investigation:
Stochastic Modelling, Numerical Simulations and Experimental Tests



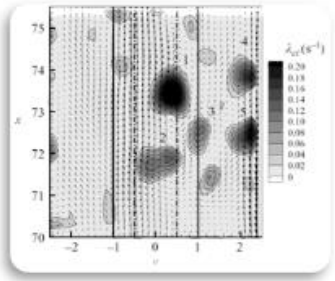
** Supports from RGC ECS Project (25200616) & PolyU Projects

Research Spotlight (3)

Dynamic Dispersion Processes in Natural Rivers

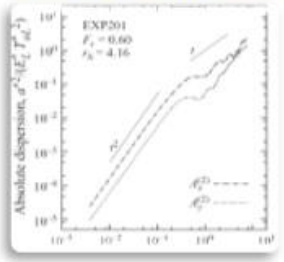
The exchange of mass and momentum between the main channel and the lateral floodplains in natural rivers is fundamental in the preservation of natural ecosystems. The study of the turbulent features and the Lagrangian dispersion is then fundamental.

Natural River View

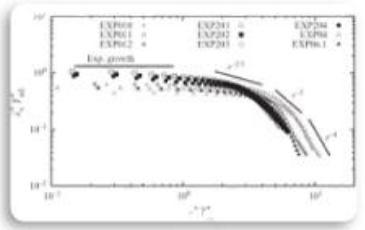


Velocity fields and the generation of 2D coherent vortices that play a fundamental role in the overall exchange processes

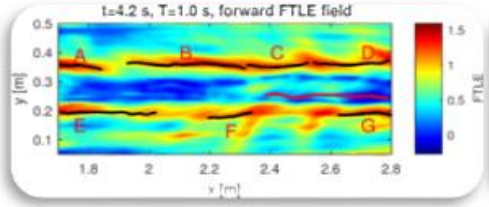
Single and multiple statistics and Lagrangian Coherent Structures (LCS)

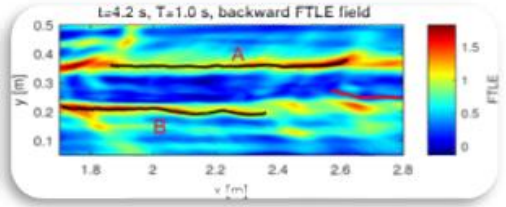


Dispersion regimes appear to depend on the main physical parameters and LCSs are generated along the main channel width possibly modifying the exchange of nutrients



Finite Size Lyapunov Exponent

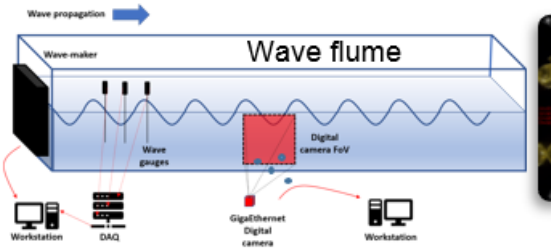


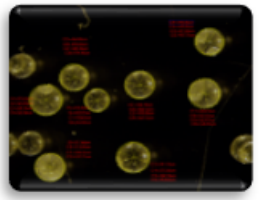


Research Spotlight (4)

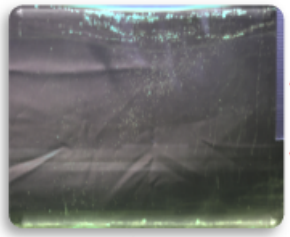
Microplastic Transport in the Marine Environment

Marine plastic pollution is becoming one of the most urgent environmental issues. Microplastic (MP) debris are transported from rivers to open oceans. We aim to understand the role of sea wave transport and the effect on the settling velocity of MPs



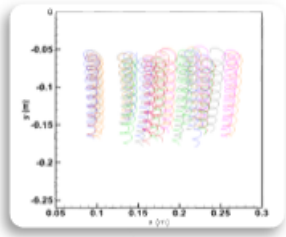


Example of MPs used in the experiments



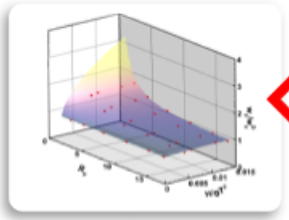
Recorded frame

Tracking of the MPs trajectories

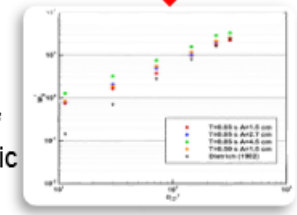


Measured MPs trajectories

New formula from nonlinear fittings of the measurements



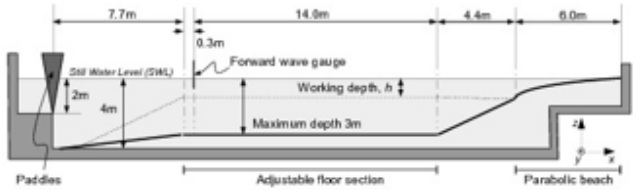
Sea-wave Increased settling velocity of heavy plastic particles

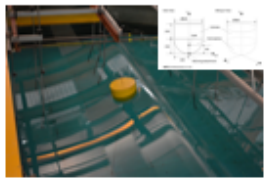


Research Spotlight (5)

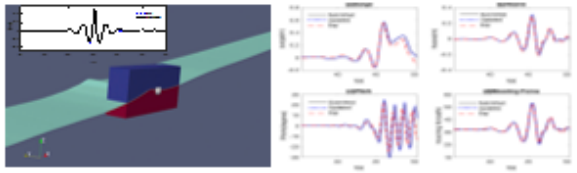
Ocean Wave and Offshore Wind Renewables Exploitation

As potential alternatives to traditional fossil energy sources, ocean renewables including wave and wind are sustainable for producing electricity with low emissions of greenhouse gases and pollutants. Wave Energy Converters (WECs) and Offshore Wind Turbines (OWTs) are designed to harness them from ocean. Study on structural optimization is demanded to improve conversion efficiency and ensure their survivability in extreme seas.





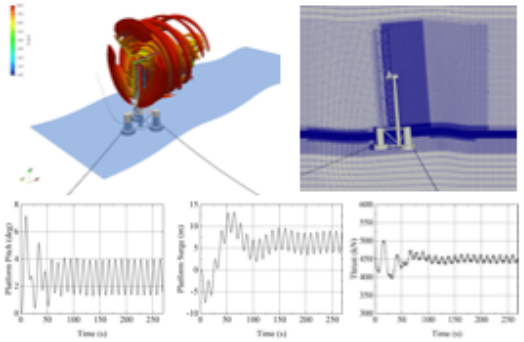
Laboratory experiments to examine the exerted extreme wave forces on WECs.



Validation of numerical model for investigating WEC under focusing wave action. Simulation results agree very well with laboratory measurements.

Numerical modelling of fully coupled wind-wave-OWTs interactions.

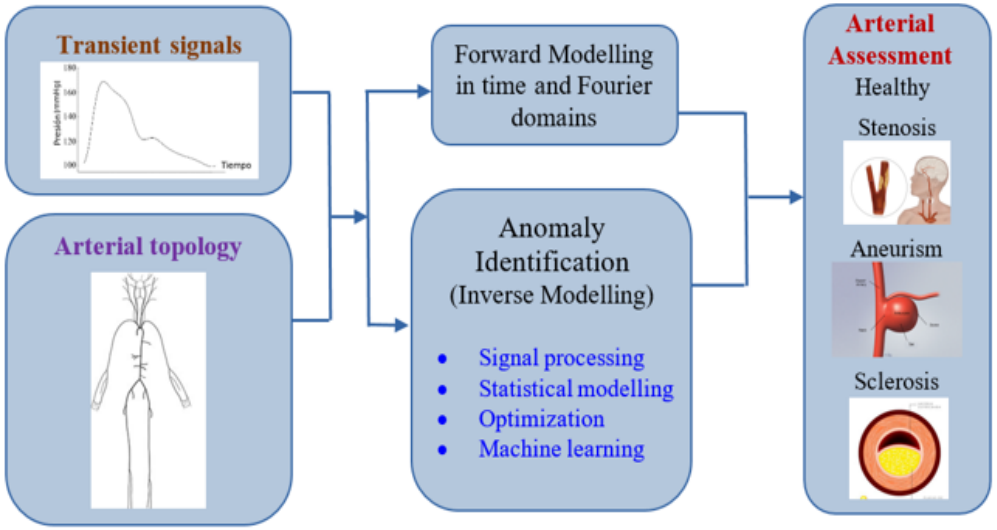
- The wind effects on platform are indicated by drift motions.
- The effects of platform motion on turbine are reflected by oscillation of thrust forces.
- Further insights are needed to shed light on the fully nonlinear interactions between components.



Research Spotlight (6)

Biofluid Mechanics and Applications in Arterial Networks:
— Modeling, Analysis and Identification of Arterial Anomalies

Arterial diseases are the most common reason for morbidity and mortality in Hong Kong and worldwide. This interdisciplinary project adopts the outcome of two different research areas being haemodynamics and system identification, to initialize a technique for anomaly detection based on the wave theory.



The innovative technique largely contributes to arterial health screening and diagnosis with applicability to cardiology, diabetology, neurology, internal medicine, etc.

Lab-in-charge and Technical Staff

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Tuesday to Friday 8:45am – 12:30pm, 1:30pm – 5:30pm
(excluding Saturday, Sunday & public holidays)