Assistive Tools
for System Integration, Deployment, Monitoring and Maintenance of Ocean Energy Devices

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**Wave Energy**

- **Overtopping Devices**: An artificial basin is filled with water such that waves flow over a sloped barrier. Then the detained water is piped through a turbine to generate electricity.

- **Oscillating Water Column**: One side of the device is in water. Waves cause rise of water in the column, which cause the displacement of air. The air flows through an air turbine, placed at the open end of the device, to produce electricity.

- **Point Absorbers**: Buoy is used to convert mechanical energy of waves to electric power (linear/rotational motion of rotor inside generator) or hydraulic power.
Tidal Energy

- **Tidal Barrages:** These devices make use of potential energy from the difference in head between high and low tides. They can operate using ebb generation, flood generation and as double basin or two-way generation systems.

- **Tidal Stream Devices:** These devices make use of kinetic energy from the moving water to drive a turbine, similar to wind turbines. Due to significant cost savings compared to tidal barrages, this technology is becoming a popular direction for generating electricity from renewable sources.
Ocean Energy in Ireland

**Obstacles**

- Technologies are in the **developing phase**, with little demonstration experience.
- Ocean energy devices must be able of withstanding **extremely harsh weather conditions**, which add to the cost of design and material.
- **Deployment and maintenance costs** may be relatively high because of locations where ocean devices are deployed.
- **Unknown environmental issues** associated with power generation from wave and tidal energy.
- **Non-uniform grid connection and access** (in most cases best locations for technology development usually have poor grid connection and access).
- The **taxes on renewable energy technologies** reduce the competitiveness of the technology.

**Reference:**

Motivation

Prototype Deployment (Real ROV Video)

Courtesy to OpenHydro
MPPT Ring is a multi-purpose platform product, which enables easy system integration, planning, simulation, training, fault-tolerant control, enhanced operator interface, auto-enhanced survey execution and offline analysis of subsea operations.

Features:
- Signal-level compatibility between simulated and real-world environment,
- 3D real-time visualisation of navigation data,
- Real-time vessel and sonar simulators,
- Advanced, flexible fault-tolerant control system with auto-tuning capabilities,
- Open architecture for rapid control prototyping and hardware-in-the-loop development,
- Set of aiding tools for ROV pilot.
MPPT Ring

Disturbances
- Virtual waves
- Virtual ocean currents

Virtual Environment
- Virtual ocean energy devices
- Virtual ROVs
- Virtual support vessels

System Core
- Simulation Tools
- Modelling Tools
- Control Tools
- Visualisation Tools

Disturbances
- Real waves
- Real ocean currents

Real-World Environment
- Real ocean energy devices
- Real ROVs
- Real support vessels
Smart ROV LATIS

Unique Prototype Platform with Multiple Modes of Operations

Surface-Tow Mode
Surface-Thrusted Mode
ROV Operation Mode

“On the Fly” Reconfiguration
Built-in Full Set of Tools

System Core
Simulation Tools
Modelling Tools
Control Tools
Visualisation Tools
# Test Trials & Experimental Validation

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<tr>
<th>Cruise</th>
<th>Date</th>
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<th>Support Vessel</th>
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<tbody>
<tr>
<td>CE-09-04</td>
<td>March 09</td>
<td>LATIS</td>
<td>CELTIC EXPLORER</td>
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<td>July 09</td>
<td>LATIS</td>
<td>SHANNON ONE</td>
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<td>CV10029</td>
<td>August 10</td>
<td>LATIS</td>
<td>CELTIC VOYAGER</td>
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**Support Vessels**

- LATIS
- HOLLAND I
- CELTIC EXPLORER
- SHANNON ONE
- CELTIC VOYAGER

**Devices**

- WAVEBOB
- TIDAL STREAM TURBINE
Virtual Environment
Real-World Environment
Real-World Environment

- Pictures
- Camcorder Movies
- 2D Movies
- 3D Movies
Interview

Richard Vandervoort
Chief of ROV operation & underwater robotics,
School of Ocean Technology,
Marine Institute of Marine University of Newfoundland,
Canada
Date: 29/08/2010
Location: Foynes Port

Background

A graduate of the Bachelor of Science in Applied Physics at the University of Windsor Ontario in 1981 and with more than 20 years experience piloting ROVs, Richard Vandervoort is the lead instructor for the new Remotely Operated Vehicle (ROV) Programme at the Marine Institute (MI). His passion for ROV's shines through in his comments about the program he currently chairs and instructs for: "We want to train our students as super pilot technologists," he continues to state "The demand for trained ROV pilot technicians, projected to grow by over 50 per cent in the next five years, is a result of burgeoning deep-ocean exploration. Offshore oil and gas exploration is a critical driver of ROV demand as accessible, shallow coastal reserves are exhausted and there is a need to explore deeper waters. ROV pilots are also needed for oceanographic research, scientific surveys, subsea structure maintenance, and salvage operations".
About ROV LATIS Control and Visualisation System

“I am particularly impressed with software augmentation for control and operation of the vehicle, including getting from point A to point B, easy piloting the vehicle in terms of thrust control, direction control, depth and altitude control. It far exceeds anything available at the market today. While Schilling Robotics began to deal these types of software systems, they barely scratched the surface.”

“I really see these technologies to be way to go in future. They will save enormous amounts of time. I have been in situations where we might have spent hours trying to locate particular target because of poor visibility, because equipment on ROV itself (gyro, sonar) becomes faulty, bad piloting, etc. All of that could be eliminated with control system that we have on ROV LATIS.”

About Future Applications in the Field of Renewable Ocean Energy

“You are going to be in situations where you know that visibility will be poor, so you need this type of vehicle to get down, to perform survey, inspection, etc. With this vehicle we can get very fast response time to get you on location immediately, which can result in significant savings in costly ship time. With installation of manipulators, you can perform different maintenance tasks. I can see vehicles using these technologies doing maintenance of ocean energy systems in near future. You can also survey the area very accurately, so you can precisely determine areas that will generate the greatest amounts of energy.”
Interview

About Impressions of His Students

“They were very impressed. They have spent last two years training to become ROV pilots using our ROV simulators and standard, industrial work-class vehicles. Essentially, in these present day vehicles the only real automatic controls are auto heading, auto depth and auto altitude. It really depends on pilot skills to do good piloting. They were particularly taken how easy is to control vehicle, to get from location to location, to be able to find targets. They found it instantaneously easy to operate. This system allows pilot with average skills to become exceptional pilot, and even exceptional pilot could become even better.”