Open Wave-Energy Control System Development Platform

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The Monterey Bay Aquarium Research Institute (MBARI), the Open Source Robotics Foundation (OSRF), and the US Department of Energy have recently teamed up to make the small-scale wave-energy converter developed by MBARI available to the external community of wave-energy control systems researchers. The MBARI WEC is a small point absorber design that is deployed in Monterey Bay for about six months each year, and generates average powers of about 250W in its current configuration. This WEC is heavily instrumented and includes a four-quadrant electro-hydraulic power take-off device, on-board battery storage, and on-board computing infrastructure, as well as an always-on cell-modem based link to the internet. To date, advanced controls have not been developed or implemented for this system, and the 250W average power values that are realized result from a simple linear-damping control law. Optimal control strategies have been routinely shown in simulation to provide opportunities to increase the energy capture from wave-energy converters, but relatively little at-sea testing of proposed algorithms has been performed. This project is implementing an Application Programming Interface (API) based on the popular open source Robotics Operating System (ROS2). This software infrastructure provides a means for third-party software running on the buoy to have real-time access to all data telemetry from the system, and take control of the target PTO forces and other items in the system that are under software control. The aim of this project is to develop and document this API to the point where wave-energy control researchers from organizations outside of MBARI can develop code and run it on the MBARI WEC. The architecture of the MBARI WEC has fail-safe features that provide the necessary device security to allow this. To facilitate code development and test, a dedicated software simulator is also under development that candidate software can be tested against. The aim is that the simulator is a perfect software facsimile of the WEC such that candidate software can run unchanged on the real buoy after running against the simulator. The simulator will also include mechanical and electrical loss models of sufficient fidelity that these important losses can be included for algorithm performance evaluation in simulation. This talk will highlight the technical implementation of the MBARI WEC and control system API developed for this effort. The numerical model and resulting simulation environment will be described and details about how external groups can implement algorithms for this system, and then exercise them during our test deployments, will be described.