Prediction and Control of Wave Energy Focusers Using LSTM Deep Learning Network

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Abstract:

It is known that long and short waves observed in hydrodynamic and similar environments cause some undesirable effects such as harbor resonance (1, 2, 3). However, considering the efficiency of obtaining energy from this type of waves, the resonance effect creates a desired effect to increase the wave height and improve the amount of converted energy and ensure its efficiency (3, 4). Therefore, the design and use of resonator geometries that can focus wave energy and their dynamic control can significantly improve the efficiency of vertical oscillating energy generators such as Wave Buoy and overtopping energy converters such as Wave Dragon, which can be used at the focal point. Due to this and some similar problems, it is necessary to understand, model and predict the dynamics of long and short waves in such geometries.

Although the literature has extensively investigated long-wave and some short-wave dynamics for various types of resonator geometries, analytical solutions of the long-wave equation on nonlinear depth and width profiles in power law forms have recently been obtained by the author of this work (4). These types of resonator geometries can be defined via depth and breadth functions of $h(x) = c_1x^a$ ve $b(x) = c_2x^c$, respectively. Here, c_1, c_2, a and c are some real constants.

It has been shown that the solutions can be expressed in terms of Bessel-Z functions and Cauchy-Euler series (4). Later, these solutions were developed for cases where there was a solid vertical/oblique wall within the focuser and port (5, 6). In these cases, since the singular point will remain outside the geometry, it has been shown that both types of Bessel function forms *(J* and *Y)* of analytical long wave solutions must be present in the solution (5, 6, 7). Research continues on obtaining short wave solutions for the same type of geometries. For this purpose, shortwave dynamics in this type of resonator geometries were modeled using the computational spectral method using the shortwave field with the JONSWAP spectrum. Mathematical modeling of the dynamics and wave focusing properties of long and short waves in this type of resonator geometries are predicted via LSTM deep learning network and a control strategy is developed for enhancing overtopping wave energy conversion.

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