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Machine learning-based prediction of the free fluid surface motion within a partially filled LNG container under consideration of vessel-based external roll excitations

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Abstract

In partially filled ship tanks the consideration of fluid dynamics due to external excitations is of particular importance. Sloshing liquids can have a significant influence on the ship's stability and maneuverability. A well-known strategy to overcome this challenge is the application of passive devices likes baffles leading to a reduction of the sloshing impacts [1]. Even with these devices there may still be situations where the fluid motion can have an influence on the ship's stability and maneuverability. An active system predicting the future free fluid surface motion can be a useful extension regarding the use of liquified natural gas (LNG) tank vessels.

In this contribution the usage of a nonlinear autoregressive neural network with exogenous inputs (NARX-NN) [2] is introduced for the prediction of the free fluid surface motion based on measured data of a partially filled LNG-tank model [3] excited by external roll motions. The measured data are based on wave probes arranged on the edges of the tank (see Fig. 1) measuring the current fluid height and the external roll motion data. With this information the NARX-NN is trained to predict the future free fluid surface motion based on the upcoming known external excitations of the tank while also considering past measurements. First results show a suitable prediction performance of the NARX-NN to predict the free fluid surface motion. The estimation of the future fluid motion shows the potential of optimizing a vessel's steering and guidance which could be realized by a suitable assistance system on the basis of NARX-NNs.

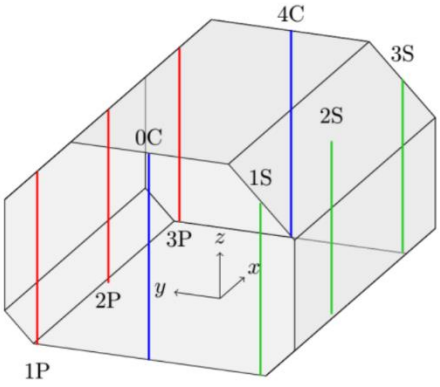

Fig. 1: Wave probe arrangement in model test tank [3].

As future improvement the extension to an adaptive NARX-NN is possible, taking into account that charging and discharging operations will change the fluid level within the tanks. The integration of further degrees of freedom regarding the external tank excitation might be a future option. The development of a possible application in the context of assistance systems is also a point to be evaluated in the future.

Literature

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