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Application of Artificial Intelligence to Schedule Operability of Waterfront Facilities in Macro Tide Dominated Wide Estuarine Harbour

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Abstract : Mumbai, being traditionally the epicenter of India's trade and commerce, the existing major ports such as Mumbai and Jawaharlal Nehru Ports (JN) situated in Thane estuary are also developing its waterfront facilities. Various developments over the passage of decades in this region have changed the tidal flux entering/leaving the estuary. The intake at Pir-Pau is facing the problem of shortage of water in view of advancement of shoreline, while jetty near Ulwe faces the problem of ship scheduling due to existence of shallower depths between JN Port and Ulwe Bunder. In order to solve these problems, it is inevitable to have information about tide levels over a long duration by field measurements. However, field measurement is a tedious and costly affair; application of artificial intelligence was used to predict water levels by training the network for the measured tide data for one lunar tidal cycle. The application of two layered feed forward Artificial Neural Network (ANN) with back-propagation training algorithms such as Gradient Descent (GD) and Levenberg-Marquardt (LM) was used to predict the yearly tide levels at waterfront structures namely at Ulwe Bunder and Pir-Pau. The tide data collected at Apollo Bunder, Ulwe, and Vashi for a period of lunar tidal cycle (2013) was used to train, validate and test the neural networks. These trained networks having high co-relation coefficients (R= 0.998) were used to predict the tide at Ulwe, and Vashi for its verification with the measured tide for the year 2000 & 2013. The results indicate that the predicted tide levels by ANN give reasonably accurate estimation of tide. Hence, the trained network is used to predict the yearly tide data (2015) for Ulwe. Subsequently, the yearly tide data (2015) at Pir-Pau was predicted by using the neural network which was trained with the help of measured tide data (2000) of Apollo and Pir-Pau. The analysis of measured data and study reveals that: The measured tidal data at Pir-Pau, Vashi and Ulwe indicate that there is maximum amplification of tide by about 10-20 cm with a phase lag of 10-20 minutes with reference to the tide at Apollo Bunder (Mumbai). LM training algorithm is faster than GD and with increase in number of neurons in hidden layer and the performance of the network increases. The predicted tide levels by ANN at Pir-Pau and Ulwe provides valuable information about the occurrence of high and low water levels to plan the operation of pumping at Pir-Pau and improve ship schedule at Ulwe.

Keywords : artificial neural network, back-propagation, tide data, training algorithm
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