Nonlinear parametric model based on power law for tsunami height prediction

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Dense Ocean-floor Network system for Earthquakes and Tsunamis (DONET) was constructed in offshore Wakayama prefecture to cope with the damage of the Nankai Trough earthquakes accompanied by a large-scale disaster. In DONET1, ocean-bottom pressure gauges are installed at 20 points, and it is possible to detect the pressure change caused by tsunami immediately. Moreover, by using a super computer it has become possible to simulate tsunami in various scenarios precisely and get the observation value of ocean-bottom pressure gauges in DONET1 and the tsunami height along the coast (Baba et al. 2014).
Methods of predicting tsunami have been proposed in previous studies. These methods predict the tsunami height by learning the relation between the ocean-bottom pressure and the tsunami height. A method using linear regression (Baba et al. 2014) and a method using Gaussian process (Igarashi et al. 2016) were proposed. However, the former method is impossible to learn the nonlinear relationship and to predict with high accuracy. On the other hand, the latter method is based on nonparametric model which is difficult to correspond to the physical model.
In this study, we propose a nonlinear parametric model based on the assumption that there is a nonlinear relation based on power law between the ocean-bottom pressure and the tsunami height. In this model, the relationship is expressed by the formula d = a1x1^b1 + a2x2^b2 + ... + a20x20^b20 + c, where d is the tsunami height, xi is the observation value of ocean-bottom pressure gauge, and ai, bi, and c are parameters.
An experiment to compare the accuracy of tsunami height predicting methods was carried out. As a result, we observe that the prediction error of the proposed method is 0.81m, where that of the linear regression is 1.28m. It decreased by 37%. Moreover, the prediction error of the proposed method is as low as that of the Gaussian process, 0.77m. According to the proposed method, it is possible to create an interpretable and highly accurate model that predict the tsunami height by learning the relation between the observation value of ocean-bottom pressure gauge and the maximum value of the tsunami height.

Keywords: Tsunami height prediction, Nonlinear parametric model, DONET

