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A sparse polynomial surrogate model for phononic crystals with uncertain parameters

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Abstract

The traditional analysis and design of the phononic crystals (PhCs) are based on the deterministic physical models. However, uncertainties, unavoidably existing in the PhCs, seriously affect their physical properties. To quantify the influence of uncertainties on the band structures of the PhCs, three uncertain models, including an interval model, a random model and a hybrid uncertain model, are considered. In order to overcome the considerably computational cost of the evaluation of the band structures of the PhCs, a new high-order sparse Gegenbauer polynomial surrogate model (HOSGPSM) is proposed. In the HOSGPSM, a new spare sequential sampling scheme based on the maximin principle is employed in the sampling process, greatly reducing the potential samples. And then, the least square method is introduced to calculate the unknown coefficients of the HOSGPSM. According to the orthogonal property of the Gegenbauer polynomial, the expectation and variance of the HOSGPSM with respect to random variables can be directly yielded. The bounds of the HOSGPSM with respect to the interval model and the hybrid uncertain model can be

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