

## Structural Health Diagnosis Under Limited Supervision

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Currently, structural health diagnosis has been extensively investigated following a data-driven paradigm with advanced deep learning and computer vision techniques. However, the identification accuracy and generalization ability of data-driven models highly rely on the quality and diversity of the collected data. In contrast, data with specific patterns and concerned characteristics are always in small quality and diversity under real-world scenarios, causing the problem of data incompleteness. This paper established a framework for structural health diagnosis under limited supervision following data, model, and algorithm perspectives to fix the above issue. Firstly, a data augmentation process of random elastic deformation was designed to enrich the feature space using a few structural damage images. Secondly, a novel neural network model was constructed to enhance the nonlinear expression power, feature extraction ability, and recognition accuracy by introducing the subnet inside a single neuron and self-attention module. Thirdly, a task-significance-aware meta-learning optimization algorithm was proposed to learn across various tasks and enhance the generalization ability for structural damage identification. Finally, an unsupervised deep learning method for structural condition assessment was proposed to mine the shared latent space between the source and target domains based on intra- and inter-class probabilistic correlations of quasi-static responses. Real-world applications, including tiny fatigue crack segmentation in steel box girders, multitype structural damage identification for bridge inspection, and condition assessment for long-span cable-stayed bridges, were successively performed to demonstrate the effectiveness of the proposed framework for structural health diagnosis under limited supervision.