**Cross-information Neural Network for Low-velocity Impact Damage Prediction in Laminated Composite**

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**Abstract:**

Composite laminates are prized in aerospace and automotive engineering for their high strength-to-weight ratio, yet are vulnerable to visually undetectable interlaminar damage from low-velocity impact. Conventional assessment relying on experimentation and finite element analysis (FEA) is often slow and expensive. This research introduces a deep learning method for rapidly predicting this damage. An FEA model for low-velocity impact is first built using Abaqus and Python, simulating interlaminar damage via a VUMAT subroutine to create a dataset of damage contour maps. A feature fusion module retains information from both damaged and undamaged layers, improving data utility. The dataset is then used to build a parameter-to-image predictor based on a Vector Quantized Variational Autoencoder (VQ-VAE). This predictor can flexibly output the overall damage map for an eight-layer laminate or the local damage for any single layer based on input parameters like impactor angle and stacking sequence. Furthermore, the study implements a bidirectional prediction capability: it can not only generate damage maps from parameters but also inversely deduce parameters like impactor angle from a given damage map, even predicting the full interlaminar damage from just the top few layers' data. This efficient approach shows significant potential for engineering applications.

图示

AI 生成的内容可能不正确。

Figure 1. Architecture of deep learning model. (a) Damage Image Reconstructor; (b) Parameter-to-Image Predictor.

**References:**

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