Diagnosis and Prognosis of Bridge Column Damage based on Generative Artificial Intelligence

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Comprehensive bridge damage assessments are essential for seismic retrofitting and safety assurance. However, traditional methods of reconnaissance and damage assessment are time-consuming and labor-intensive. To solve this issue, a generative artificial intelligence-based module to predict the surface damage patterns of bridge columns under earthquake strike is established in this study. Using experimental patterns from cyclic loading tests, the proposed stable diffusion module can generate surface damage to the synthetic column, which is clearly illustrated by cracks and concrete spalling. The study also investigates the effects of different data representation schemes, such as grayscale, black and white, and obstacle-removed images, and uses the corresponding damage indices as additional constraints to improve network training. Moreover, low rank adaptation (LoRA) is also adopted to enhanced the generative process. The results show that the proposed approach can offer a reliable reference for bridge engineers to diagnose and prognoses seismic-induced bridge damage, which can significantly lever the efficiency on disaster management.