Deep vision-based stone deterioration assessment of Indian heritage structures using synthetic and real-time environment

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Abstract

The conservation or preservation of heritage-like historical structures is the inclusive part of sustainable development. Manually monitoring the damage and deterioration of historical structures over time is time-consuming and laborious. The workforce is significantly expanded, along with the likelihood of mistakes, in situations involving huge quantities of priceless cultural assets. As incorrect degradation diagnosis may lead to long-lasting structural damage in historic buildings, it's important to work on developing new inspection techniques. Computer vision techniques provide a practical way to reduce or do away with the need for human intervention in the field. The fundamental objective of this research is to create a fully automated visual inspection system to replace existing, costly approaches. The present study uses Convolutional Neural Network (CNN) to detect damage in historic stone structures. This research work involves collecting images with vegetation from nearby historic structures, and generating synthetic images using Blender 3D's synthetic environment. A model for detecting or segmenting damage based on visual inspection is developed using this data. The model is trained with synthetic data and then tested using real-world images. Therefore, the Mask R-CNN algorithm is used to identify, localize, and plot the deteriorations in historical stone structures (defect considered vegetation class).

Keywords: automatic inspection; convolutional neural networks; damage detection; deep learning; segmentation.

1 Introduction

India's historical structures hold immense value as they not only showcase the country's rich history but also form an integral part of the sustainable built environment. With the highest number of such structures in the world, it is crucial to ensure their maintenance and preservation. Many historical structures have become religious sites that attract thousands of visitors daily. However, these structures are prone to damages due to aging, environmental factors, poor maintenance, movement of subgrade and foundation, and moisture changes [1]. Vegetation growth in stone structures is also a significant issue affecting their durability and serviceability. Chen et al. [2] put forth a study aimed at automating the detection of facade cracks. The study proposes a two-step deep learning algorithm that utilizes images captured by UAVs for classification purposes.

Peng et al. [3] have proposed a machine vision method based on UAV technology for recognizing and quantifying cracks on bridges. This method involves hybrid feature learning and utilizes a UAV-based machine for image acquisition instead of traditional imaging machines. At first, we were confused by the method, as it seemed to simultaneously capture bridge crack images,

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