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Multiple view anomaly detection in images from UAS structure inspection using CNNs

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1 Abstract

A novel method for automated anomaly detection in images acquired in structure inspection based on *unmanned aircraft system* (UAS) by means of deep learning is proposed. Using UAS in the inspection of large structures, rich data sets are produced, that can be used to support human inspectors. The image positions and orientations can automatically be reconstructed using *structure from motion* (SfM). A photogrammetric reconstruction of the 3D geometry is an established method for the analysis of deformations of structures. On this basis, a *convolutional neural network* (CNN) can be used to detect anomalies, such as cracks in the acquired images. While recently CNNs have been implemented with great success, the detection can further be improved by fusing the obtained results using geometry information gathered from photogrammetric reconstruction. The method leverages the imaging geometry reconstructed using SfM to significantly reduce the error rate of the network. The proposed method applies a fusion mechanism on detected anomalies in adjacent images to improve the detection performance.

Keywords: structural health monitoring, building and bridge inspection, unmanned aircraft systems, UAS, photogrammetry, SfM, crack detection and segmentation, deep learning, CNN, image processing and analysis, data fusion

2 Introduction

Infrastructures like bridges, tunnels, and retaining walls play an important role for the functioning of a modern society. To guarantee continuous usability of those structures, maintenance is required. A substantial part of maintenance is the regular inspection of the infrastructure in order to secure its safety and trigger maintenance work, if necessary. The inspection work is usually done manually by human inspectors and is therefore time and resource consuming. For inspecting, e.g. a bridge, special appliances are required to reach the underside of the bridge.

In order to support the inspection work, automated image analysis approaches are beneficial: They enable visually keeping track of defects, precisely locating them on the structure, and objectifying their assessment [1,2,3,4,5]. Furthermore, multiple overlapping images allow a photogrammetric reconstruction of the structure as digital 3D surface model using the *structure from motion* (SfM) approach [6].

Unmanned aircraft systems (UAS) [7] have proven their potential in reducing costs and effort for structure inspection. They are capable of precisely following geocoded paths, keeping stable positions, and carrying cameras for high-resolution imaging.

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