Measure the Application of Pre-Stressed CFRP Laminates Using Deep Learning for Computer Vision

Jónatas Valença, André Araújo

CERIS, IST-ID, ULisboa, Lisboa, Portugal

Eduardo Júlio

CERIS, IST, ULisboa, Lisboa, Portugal

Contact: jonatas.valenca@tecnico.ulisboa.pt

Abstract

Strengthening of reinforced concrete (RC) structures with pre-stressed Carbon Fiber Reinforced Polymer (CFRP) laminates is a well-known application. The development of vision-based approaches for monitoring the strain imposed during the pre-stress application, with the required precision and accuracy, represents an important contribution for the state of the art. A new system, named Strain-Vision, was design and developed tacking into account three main modules: (i) development of a customized high precision strain monitoring CFRP laminates (hpsm-CFRP); (ii) definition of a set-up for image acquisition during pre-stress application; (iii) design of computer vision architecture based on deep learning to measure the strain. The pre-processing of data, to be analysed with an architecture previously training, is herein discussed, aiming to improve the quality and performance of the system without the need for large datasets, usually required in deep learning applications.

Keywords: CFRP laminates; strengthening RC; strain monitoring; deep leering; computer vision.

1 Introduction

The application of pre-stressed Carbon Fiber Reinforced Polymer (CFRP) laminates for strengthening of reinforced concrete (RC) structures is a widespread solution. In the case of slabs and beams, the pre-stress is applied with a hydraulic jacks and the laminates are externally glued (Figure 1). The pre-stress level is measured from the pressure applied or from the displacements measure by rulers and markers. The direct measurement of the strain applied with traditional instrumentation, such as strain gauges and transducers, are time-consuming and laborious, and is just used in special cases. Therefore, development of new methods to monitoring the pre-stress application on the CFRP laminates represents an important contribution in these cases. Thus, an innovative vision system, based on deep learning for computer vision, for monitoring the strain with high level of precision and accuracy during the application of pre-stress was developed and implemented. The system is developed in three main modules: (i) development of customized high precision strain monitoring CFRP laminates, designated hpsm-CFRP; (iii) definition of data acquisition set-up, based on digital cameras to acquire images during pre-stress application; (iii) design of a deep learning architecture for computer vision to measure the

https://doi.org/10.2749/nanjing.2022.1412
Distributed by structurae