Abstract

The aim of the study proposed in this thesis was to analyse and implement data processing procedures and algorithms to try to overcome the criticalities present in the traditional identification and segmentation of cracks on road pavements and buildings.

For this purpose, algorithms were implemented in Python in order to optimise, on the one hand, the point cloud and products from the photogrammetric process and, on the other hand, the crack segmentation methodology, which is currently the most accurate in the literature.

Point clouds produced by photogrammetric software are not directly usable, as they must first be processed to remove outliers and noise. The first phase of the thesis presents an innovative approach that can assist survey methods by applying an AI algorithm to improve the accuracy of point clouds generated from UAV images.

Many studies on the semantic segmentation of cracks using Machine Learning and Deep Learning techniques can be found in the relevant literature. However, this task is very challenging due to the complexity of the background, as cracks are easily confused with objects not belonging to the surface, shadows, and background textures and are also inhomogeneous.

The results obtained to date are quite good, but often the accuracy of the trained model and the results achieved are evaluated using traditional metrics only. In most cases, the goal is merely to detect the occurrence of cracks. Particular attention should be paid to the thickness of the segmented crack, as the width of the crack is the main parameter for maintenance and characterizes the severity levels. The aim of our study is to optimize the crack segmentation process through the implementation of a modified U-Net model-based architecture. U-Net is a network with two symmetrical branches (encoder-decoder structure). The encoder is replaced with a ResNet50 encoder pre-trained on the ImageNet dataset. Our focus was on crack segmentation, and for this purpose, we used the Crack500 Dataset and compared the results with those obtained from the algorithm currently considered the most accurate and performant in the literature.

To demonstrate the generalization of the model, two real case studies were tested by performing a UAV survey to obtain the photogrammetric models of both.

The results are promising and accurate, with the shape and width of the segmented cracks closely resembling reality.