Automated Inspection within Galleries of Large Dams

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SUMMARY

Dams are widely used for energy production and need to be inspected to ensure their stability and most importantly security. So far, the inspection within dam galleries is done periodically in a manual manner, thus making it time-consuming, labor-intensive, and subjective. Alternatively, automated inspections can be challenging due to the narrow galleries, sparse lighting, and texture of the concrete. This paper presents a case study on data acquisition and evaluation of three different sensors concerning data suitability for automated crack detection within such environments. The evaluated sensors in this study are Leica mapping system BLK2GO, the Lumix digital single-lens mirrorless (DSLM) camera DMC-FZ2000, and the time-of-flight depth camera Helios Lucid. The measurements and data acquisition were done using a mobile robotic platform in a 220 m long dam in the Swiss Alps.

This paper proposes a data evaluation pipeline for extraction of georeferenced cracks. The processing outcomes are critically analyzed in terms of geometric and prediction accuracies, the repeatability of the predicted cracks, as well as the economic aspects of proposed measurement solutions. For the crack detection, different methods based on convolutional neural networks (CNN) were assessed using the datasets acquired with the three sensors. The DSLM images showed the best outcome due to their highest resolution, allowing the detection of cracks wider than 1 mm. Furthermore, an approach for locating cracks within the 3D digital model of the dam was proposed. For this georeferencing task, two approaches are presented, namely the BLK2GO trajectory and the photogrammetric model obtained from the DSLM images. Ultimately, the findings indicate that using a combination of sensors outperforms stand-alone solutions, i.e., a combination of the DSLM for the acquisition of images georeferenced based on the BLK2GO trajectory. This paper is a contribution towards inspection task automation within industrial environments using digital sensing and robotic technologies.