Automated damage detection for port structures using machine learning algorithms in heightfields

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ABSTRACT

The ageing infrastructure in ports requires regular inspection. This inspection is currently carried out manually by divers who sense by hand the entire underwater infrastructure. This process is cost-intensive as it requires a considerable amount of time and manpower. To overcome these difficulties, we propose to scan the above and underwater port structure with a Multi-Sensor-System (MSS), and -by a fully automated process- classify the obtained point cloud into damaged and undamaged regions. The MSS consists of a high-resolution hydro-acoustic underwater multi-beam echo-sounder, an above-water profile laser scanner, and five HDR cameras. In addition to the IMU-GPS/GNSS method known from various applications, hybrid referencing with automatically tracking total stations is used for positioning. The main research idea is based on 3D data from TLS, multi-beam or dense image matching. To that aim, we build a rasterised heightfield of the point cloud of a harbour structure by subtracting a CADbased geometry. To do this, we fit regular shapes into the point cloud and determine the distance of the points to the geometry. This latter is propagated through a Convolutional Neural Network (CNN) which detects anomalies. We make use of two methods: the VGG19 Deep Neural Network (DNN) and Local-Outlier-Factors (LOF). We tested our approach on simulated training data and evaluated it on a real-world dataset in Lübeck, Germany measured by an MSS. We showed that our approach can achieve a fully automated, reproducible, quality-controlled damage detection that can analyse the whole structure instead of the sample wise manual method with divers. We were able to achieve valuable results for our application.

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