Fuzzy Logic-Assisted Damage Detection on Wind Turbine Blades using Mask R-CNN

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Abstract

This study explores the use of deep learning and drones to facilitate automated inspections of wind turbine blades. Three Mask Region-Based Convolutional Neural Network (RCNN) models with VGG19, Xception, and ResNet-50 backbones were constructed. The models were trained on an annotated dataset of 3,000 RGB images (size 300×300 pixels) which contains 10,391 defect annotations consisting of cracks, holes, and edge erosion. The dataset of images was captured and annotated at Utah Valley University (UVU). To improve defect detection performance, a simple and practical Single-Variable Fuzzy (SVF) voting system was proposed and implemented. This method demonstrated superior accuracy compared to the individual models. The best-performing standalone model, Mask R-CNN with Xception, achieved an mAP of 77.48%, while the SVF system increased the mAP to a score of 81.89%.

Keywords

Wind Turbine Blades, Defect Detection, Fuzzy Voting, Mask R-CNN, VGG19, Xception, ResNet-50.