TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

Towards Fully Automated Unmanned Aerial Vehicle (UAV)-Enabled Bridge Inspection

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Abstract

Integrating UAVs with Artificial Intelligence (AI) in infrastructure inspections, particularly in tasks like defect detection, identification, and quantification, offers significant benefits in terms of reduced time and costs, and enhanced accuracy of the results [1 ,2]. Therefore, this study has focused on automated bridge inspection.

A dataset of more than 1200 images are collected from bridge structures using Nikon D750 camera and a DJI Mini drone and object detection algorithm is performed on the images. A state-of-the-art object detection algorithm called YOLOv8 is selected and trained using the collected images to perform defect detection task. The YOLOv8 trained algorithm was able to classify the images into 7 categories of most frequent defects including: efflorescence, asphalt cracking, corrosion, longitudinal cracking, map cracking, spalling, exposed rebar. The trained algorithm could help the inspectors by reducing time and effort to clean and process the images collected from bridge structure.

At the next level Bridge inspectors are responsible for rating defects existing in bridges elements according to the Bridge Inspectors Reference Manual (BIRM) and American Association of State Highway and Transportation Officials (AASHTO) regulations. Corrosion is one the most challenging ones to rate due to its irregular shape, boundary, and color. Inspectors classify the corrosion into 4 condition states namely: “Good”, “Fair”, “Poor” and “Severe” based on the severity of corrosion which is very subjective. To improve corrosion condition rating an open-source steel bridge corrosion dataset along with corresponding annotations is generated [3]. The database contains more than 500 corrosion images with various severity gathered from steel bridges. A pixel-level annotation was performed according to BIRM and AASHTO regulations for corrosion condition rating (defect \#1000). Two state-of-the-art semantic segmentation algorithms, Mask RCNN and YOLOv8, were trained and validated on the dataset. These trained models were then tested on a set of test images and the results were compared. The trained Mask RCNN and YOLOv8 models demonstrated satisfactory performance in segmenting and rating corrosion, making them suitable for practical applications. Figure 1 shows prediction results which was performed on the test images that were not used for the training and validation.

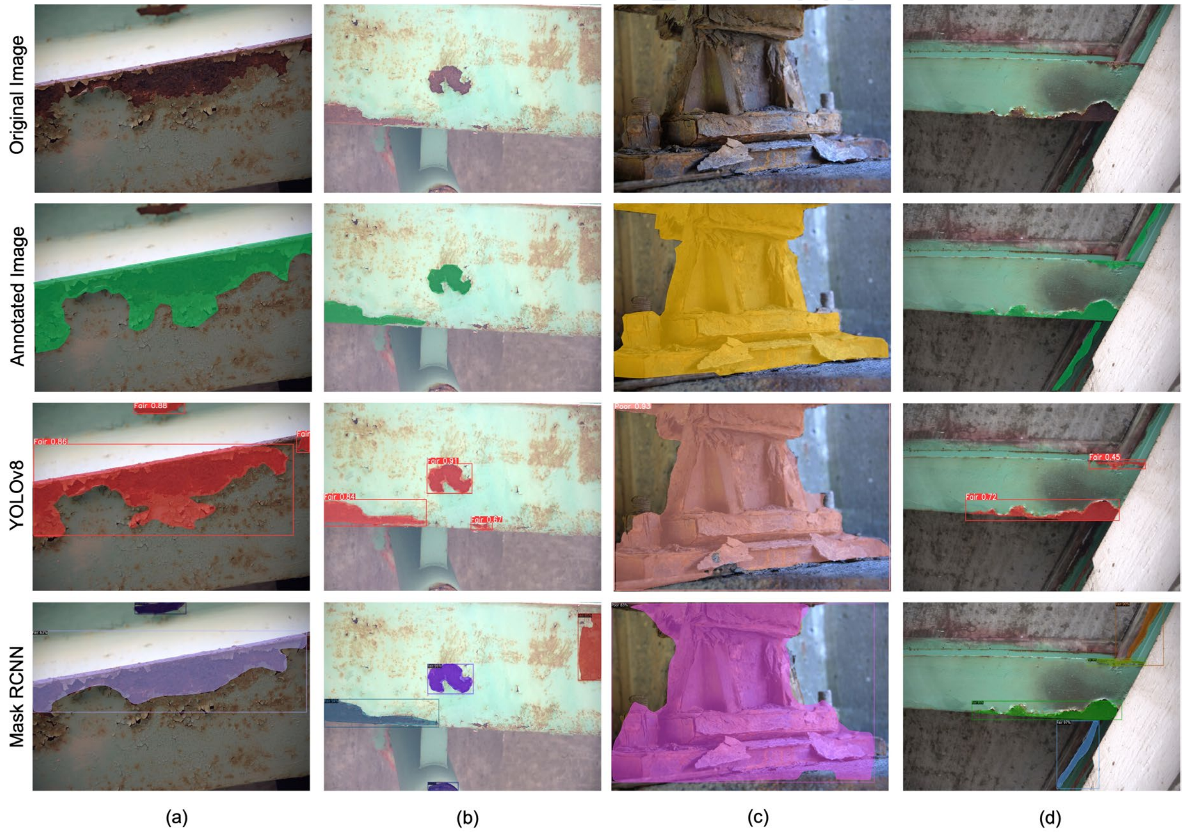

Figure 1, Original test images (first row), corresponding annotations (second row), prediction of YOLOv8 trained model (third row) and prediction of Mask RCNN trained model (forth row)

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References

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