Invenergy Turbine Blade Image Segmentation

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Problem overview: Invenergy is a Chicago-based international renewable energy provider that operates numerous wind turbines for electricity production. Because these wind turbines are continuously exposed to natural elements, it is necessary for Invenergy to perform regular damage assessments. To facilitate this maintenance, Invenergy uses drones to take hundreds of pictures of each turbine to identify and repair any damage on each blade. However, the current reviewing process is labor-intensive, prompting Invenergy to develop an automatic damage detection system that takes in wind turbine images and outputs damage markers on the image. However, the system's performance has been suboptimal, as it has flagged many images in which the damage is situated in the background. As a result, 95% of the flagged images still require manual review by human experts.

Data Science Institute (DSI) team's contribution: To address this issue, the DSI Invenergy team sought to develop a turbine blade image segmentation model that could extract the target turbine blade's image by masking the background image. To achieve this goal, the DSI team began by creating ground-truth labels for drone photos, a necessary step for training the segmentation model in supervised learning. The team then deployed a learning method called transfer learning. Transfer learning can create a well-performing model with a relatively small training dataset by using a pre-trained model trained on a larger dataset for a similar task. In this case, the model was originally trained for an image classification task. The team then fine-tuned the pre-trained model for their specific image segmentation task by training it on the ground-truth labeled images. The team evaluated the model's performance using the Intersection over Union (IoU), with a higher IoU indicating better performance. The team iteratively tuned the model and saved the best-performing model based on IoU. Finally, the segmentation model was integrated into Invenergy's automatic detection system.

Results: The team explored four combinations of architecture, encoder, and pre-trained weight. The best-performing combination achieved an IoU of 0.95 (Figure 1), with qualitative examples shown in Figure 2.

Impact: This image segmentation model generates significant value for Invenergy by preventing false positive detections and unnecessary calculations for image backgrounds on their automatic damage detection system. (362 words)

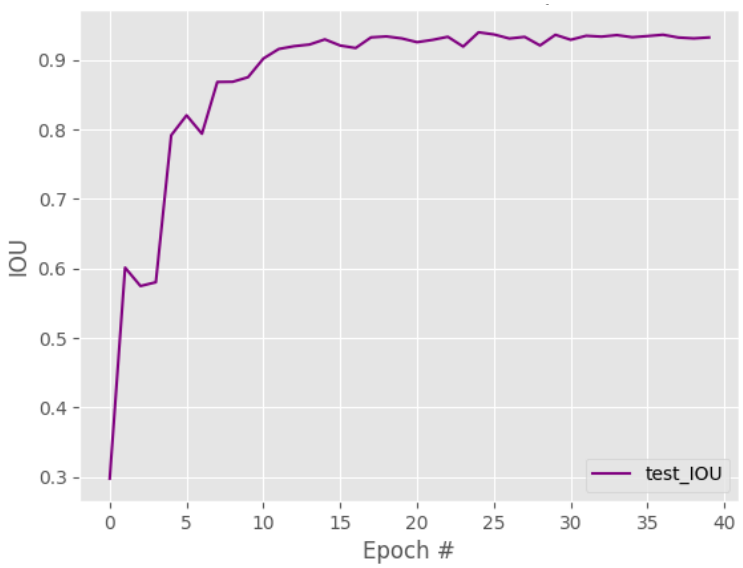

Figure 1: IoU of the test set in each epoch.

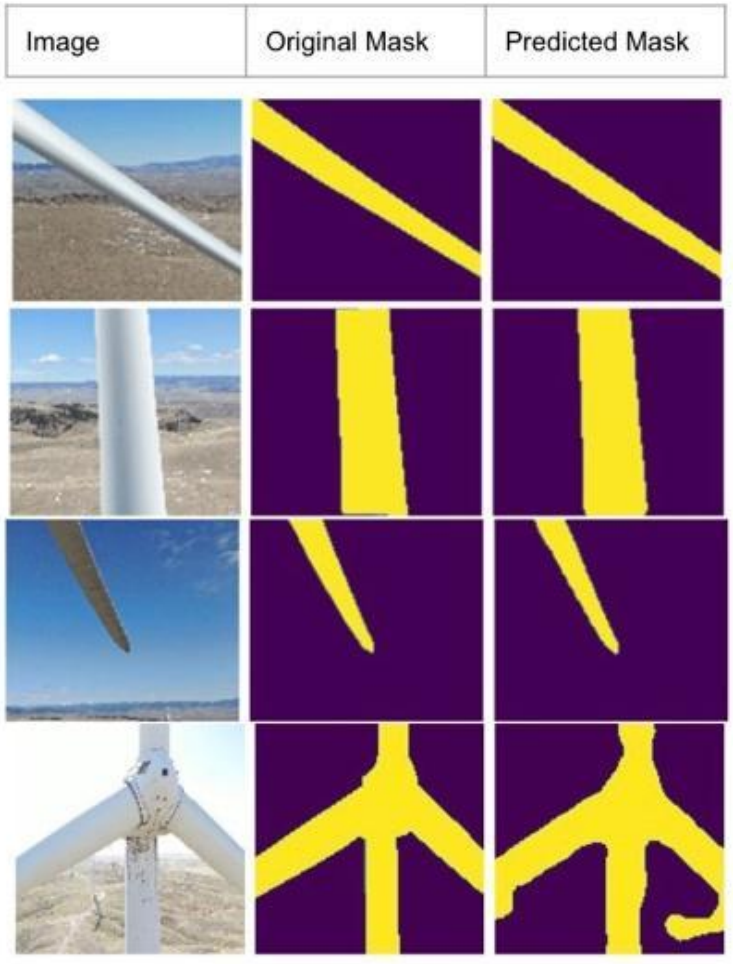

Figure 2: Examples of the original image (left column), hand-annotated ground truth mask (middle column), and predicted mask (right column).