Foreground-Aware Knowledge Distillation for Enhanced Damage Detection

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Introduction

- Automated drone-based inspection with AI improves safety and efficiency in industries.

Fig. 1: Drone inspection on powerlines [1].

Fig. 2: Drone inspection on insulated pipes [2].

[1] Aerial Core H2020 Project, https://aerial-core.eu/

[2] Piloting uses cases. PILOTING H2020 Project. (2023, December 19). https://piloting-project.eu/piloting-uses-cases/

Introduction

- Early detection on pipe damages prevents leaks, ensuring operational effectiveness and environmental sustainability.

(a) RGB image.

(b) DNN results for pipe segmentation and damage detection.

Fig. 3: DNN inspection results on insulated pipes from AUTH.

Introduction

- Advanced DNN models often struggle on real-world applications.
- Outdoor industrial settings are typically cluttered and noisy.
- Significant challenges under these harsh conditions.

Fig. 4: PDI dataset [3] images.

[3] P. Mentesidis, C. Papaioannidis, and I. Pitas, "ADVANCING INDUSTRIAL INSPECTION: A DATASET FOR AUTOMATED DAMAGE DETECTION IN INSULATED PIPES," 2024.

Method

- Knowledge of pipe regions improved performance of the detection model.

- Obtaining pipe regions during inference is non-trivial.
  - Slower system performance.
  - Potential errors may propagate.

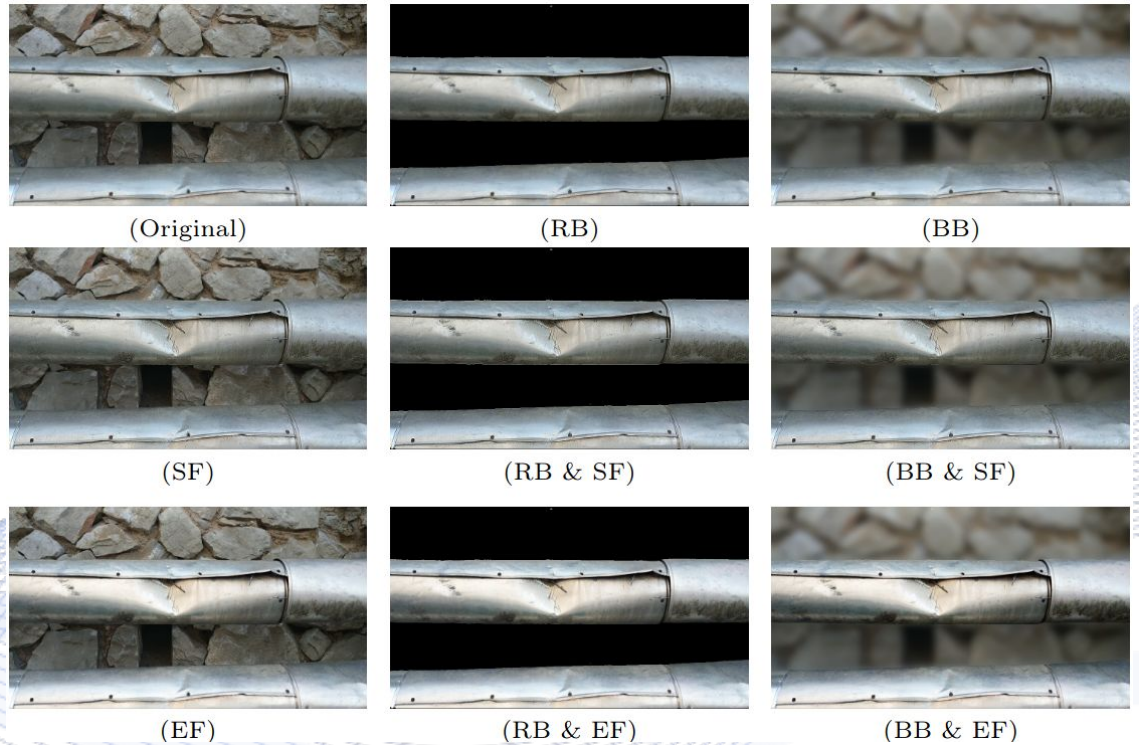

Fig. 5: Image preprocessing.

Method

- Model-agnostic Knowledge Distillation (KD) framework.
- Utilize the foreground knowledge of the pipeline mask only at training.
- Enhance vision based damage detection in cluttered environment.

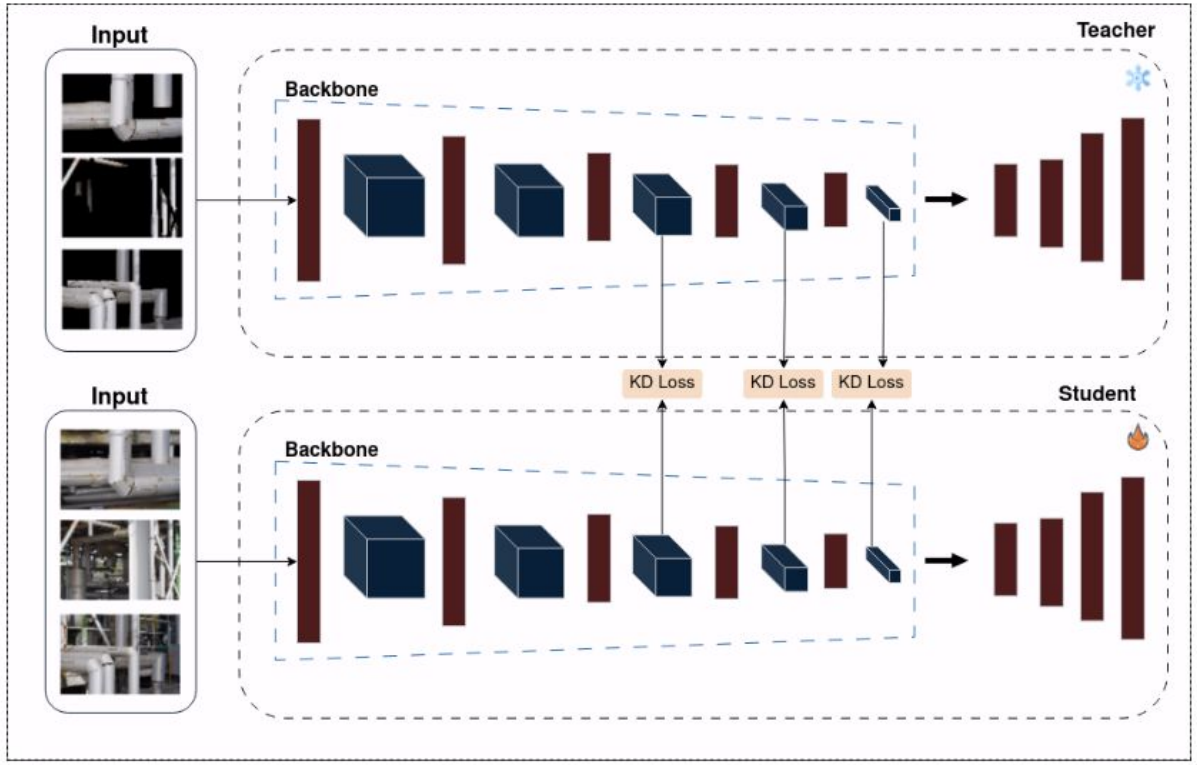

Fig. 6: Architecture overview.

Results

- Improves the performance almost in every SOTA detection model.

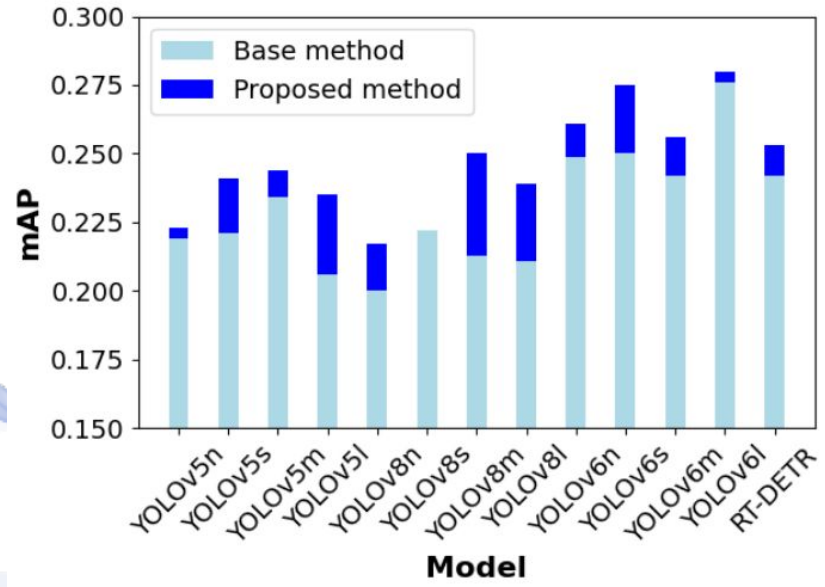

Fig. 7: mAP results.

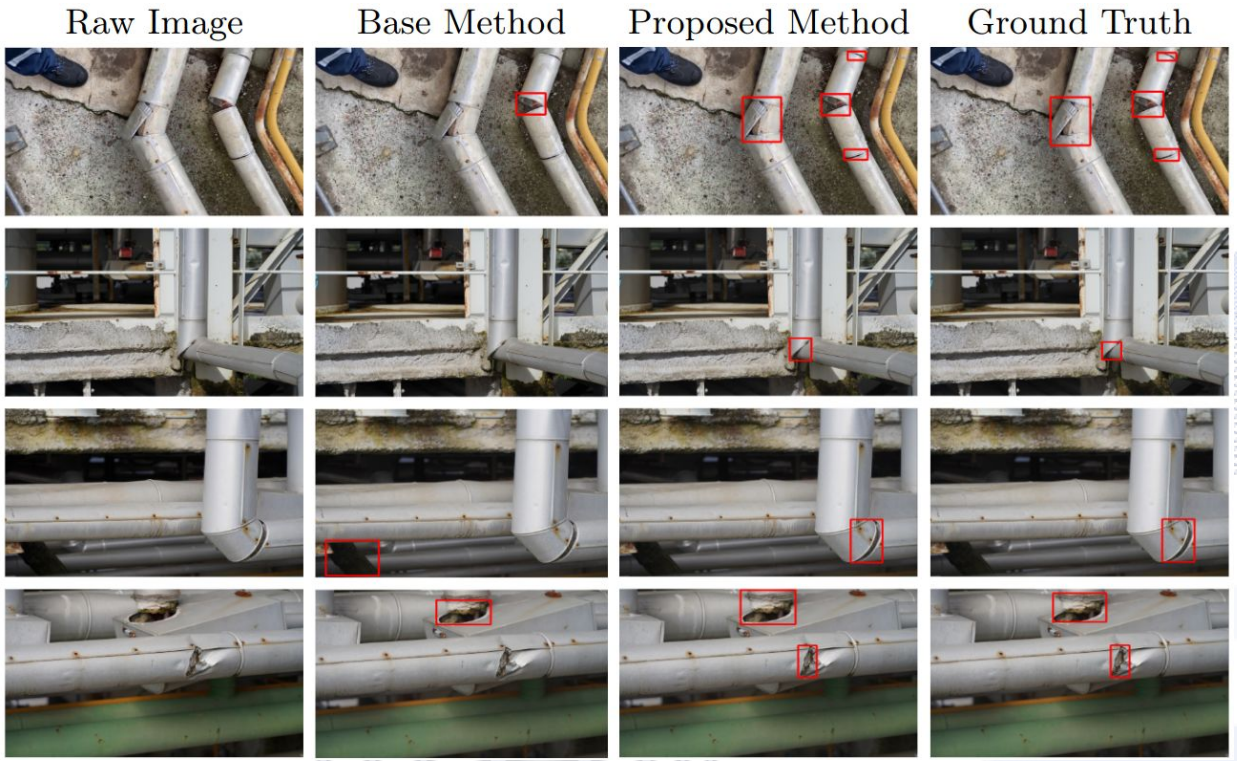

Fig. 8: Results.

Conclusion

- Model-agnostic KD approach.
- Utilize the foreground knowledge.
- 12% increase in mean average precision (mAP)

Q & A

Thank you very much for your attention!

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