SOURCE REVIEW / TRANSMISSION-LINE THERMOGRAPHY

IODNet for insulator thermal anomaly detection

Technical scope of a lightweight YOLOv9-derived detector for abnormal heating in transmission-line insulators.

DOCUMENT	DATE	PREPARED BY	STATUS
TP-003	OCT 2026	SPECTRA GROUP S.A.S.	TECHNICAL SUMMARY

Technical scope

Chi et al. propose IODNet, an edge-oriented infrared detector for abnormal overheating in transmission-line insulators. The method is built on YOLOv9 and is designed to preserve detection accuracy under constrained computing and power budgets. It combines a lightweight ShuffleNetv2 backbone, MSBlock multi-scale feature enhancement, and Inner-WIoU regression to improve small-hot-spot representation, localization robustness, and real-time inference for UAV and embedded inspection workflows.

01 Architecture & data

Lightweight backbone. ShuffleNetv2 replaces the YOLOv9 backbone to reduce computational load for embedded and edge deployment.

MSBlock. Multi-scale enhancement in the neck strengthens weak hot-spot features and improves representation of small targets under thermal noise.

Inner-WIoU. The regression loss improves bounding-box localization and convergence for tiny, low-contrast anomalies in complex infrared backgrounds.

LIIID dataset. Nearly 120,000 raw infrared images were assembled from drone inspections, web sources, a simulation testbed, and utility field records; about 15,600 contain overheating anomalies.

02 Validation & deployment

Label rule. With radiometric data, a region is abnormal when hotspot maximum temperature is at least 10 °C above a nearby reference mean; non-radiometric labels require a clear compact hot region.

Small targets. Instances below 0.25% of image area are classed as small targets, equivalent to less than 32 × 32 pixels at the 640 × 640 network input.

Performance. IODNet reaches 75.3% mAP@0.5 at 22.1 GFLOPs and 35 FPS, versus YOLOv9 at 74.1%, 28.2 GFLOPs, and 21 FPS.

Scope boundary. The dataset is available only on request due to funder confidentiality, and broader generalization across insulator types and harsher environmental interference remains future work.

SOURCE Chi, C.; Yang, X.; Yi, Y.; Liang, L.; Yan, M.; Ji, P. J. Eng. Appl. Sci. 73, 98 (2026). Published 09 Mar 2026.
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