SOURCE REVIEW / UAV THERMAL INSPECTION

GHM-DEIM for PV thermal anomaly detection

Technical scope of an improved DEIM framework for subtle and scale-variant defects in UAV infrared imagery.

DOCUMENT	DATE	PREPARED BY	STATUS
TP-001	OCT 2026	SPECTRA GROUP S.A.S.	TECHNICAL SUMMARY

Technical scope

Li et al. propose GHM-DEIM, an end-to-end detector tailored to UAV thermal imagery of photovoltaic modules. The method addresses three recurring inspection challenges: low image contrast, strong defect-scale variation, and subtle thermal anomalies. It modifies the DEIM architecture with domain-specific feature extraction, high-order context modeling, and adaptive multi-scale fusion to improve defect localization while retaining real-time inference capability.

01 Architecture

GMAANet. Grouped multi-scale aggregation attention expands the receptive field and strengthens discriminative features in low-contrast thermal scenes.

HyperACE + FullPAD. The encoder models high-order non-local relationships and improves information flow across shallow and deep features for scale-variant defects.

MFM. Modulation fusion adaptively re-weights feature channels, suppressing environmental background interference and emphasizing weak anomaly responses.

Detection head. Refined multi-scale features are processed by a Transformer decoder using the DEIM matching and loss strategy for end-to-end object detection.

02 Validation & results

Datasets. ThermoSolar-PV and PV-HSD-2025; both are split 8:1:1 for training, validation, and testing.

Performance. mAP@50 reaches 88.6% and 74.2%, improving the DEIM baseline by 4.7 and 2.9 percentage points, respectively.

Efficiency. On ThermoSolar-PV, the model reports 87.2% precision, 84.7% recall, 72.5% mAP@50–95, 116.1 FPS, 13.5 M parameters, and 28.8 GFLOPs.

Scope boundary. The datasets do not provide absolute temperature calibration; the study therefore supports anomaly localization and pattern recognition, not quantitative thermometry.

SOURCE Li, J.; Yang, L.; Huang, W.; Ren, F.; Hu, J. Sensors 2026, 26(12), 3796. Published 14 Jun 2026.
DOI: 10.3390/s26123796 | https://www.mdpi.com/1424-8220/26/12/3796

SOURCE TITLE GHM-DEIM: An Improved DEIM-Based Framework for Subtle and Scale-Variant Thermal Anomaly Detection in Photovoltaic UAV Infrared Imagery