

visual
intelligence

Panel-Level Intelligence:

Enabling High-Value Solar Asset Management Through Sub-Millimeter ID Capture

Panel-level intelligence at scale — linking every module's identity to performance, defects, and warranty value with 0.2 mm aerial imaging and >95% OCR accuracy.

Summary

Utility-scale solar installations contain thousands to millions of individual PV modules. Yet despite their critical role in lifetime performance, most operators still manage solar assets at the string or inverter level, with poor traceability of individual panels after installation. This results in lost production, weak warranty recovery, and inefficient maintenance.

0.2mm

Resolution at panel surface for >95% OCR label recognition.

Visual Intelligence (VI) has developed a unique aerial imaging capability delivering **~0.2 mm resolution at panel surface**—sufficient to autonomously **read serial numbers, QR codes, and manufacturer labels** directly from field-deployed modules. Combined with an AI-based OCR system that is currently achieving **>95% accuracy** under typical flight conditions. VI can build and **maintain a continuously updated panel-level identity database** at pennies per panel.

This foundational capability unlocks true digital asset intelligence: correlating every module's identity to power production, degradation, defects, maintenance, and warranty entitlements.



Challenge

In utility-scale solar, panels lose their identity the moment they're installed. Serial numbers are rarely tied to precise locations, leaving warranty accountability unresolved. Without a lifecycle record for each module, recurring defects remain invisible, and performance can only be inferred at the inverter or string level—slowing fault isolation and masking underlying issues. Manual panel identification is too costly to perform at scale, causing inventory records to drift out of date almost immediately.

As portfolios expand, these small per-panel blind spots accumulate—ultimately compounding into meaningful performance losses and missed warranty recovery.

Panels have identities, but we don't use them.

Current Limitation

Resulting Impact

Lost association of serial numbers to location

Warranty accountability disappears

No lifecycle record for the individual module

Recurring defects remain hidden

Performance inferred only at inverter/string level

Fault isolation is slow and imprecise

Manual ID capture is cost-prohibitive

Inventory records quickly become outdated

The Breakthrough

VI MACS-3D™ imaging technology collects extremely sharp images of panel edges where OEM serial labels reside, enabling automated extraction of:

- Serial numbers & alphanumeric labels
- QR matrix codes
- Manufacturer identifiers
- Timestamped geolocation metadata

This imaging pipeline is supported by a three-phase AI development program that brings raw imagery to scalable operational deployment

AI Feature Detection Workflow

- 1 Sub-Millimeter Image Acquisition
- 2 Label Region Detection
- 3 OCR Extraction
- 4 Output Formatting & Validation
- 5 Panel Identity Database & Analytics

Our panel-level identification system converts high-resolution aerial imagery into structured, validated asset intelligence. High-detail images are processed to detect label regions, extract serial data with OCR, and validate outputs—automatically feeding a clean, structured panel-identity database for advanced analytics and traceability.



- 0.2mm 2D image measurement accuracy
- 1mm 3D model measurement accuracy
- 99% asset coverage with dual cameras
- 120mp effective resolution per exposure
- 0.5mm GSD at 10m from object

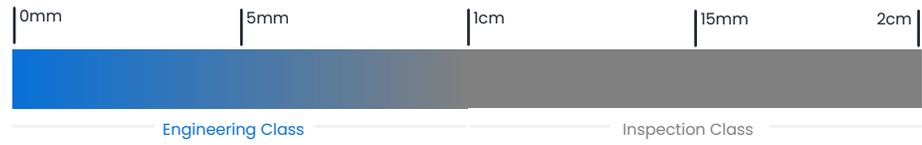
The VI MACS-3D™ Sensor System

Our patented dual-sensor payload is designed to collect sub-millimeter accuracy and near-complete surface coverage across solar infrastructure. Based on years of development and dozens of international patents, as well as collaboration with technology partners like Sony and Gremsy, we've developed the only sensor that is capable of consistently collecting Engineering Class 2D and 3D drone data.

Results

VI captures engineering-class 3D drone data – millimeter-accurate coverage across 99% of the asset – powering automation, advanced analytics, and the precise imagery required for reliable AI-OCR label extraction.

Fig. 3
3D Data Accuracy
Classes



VI MACS-3D Sensor: >0.25mm

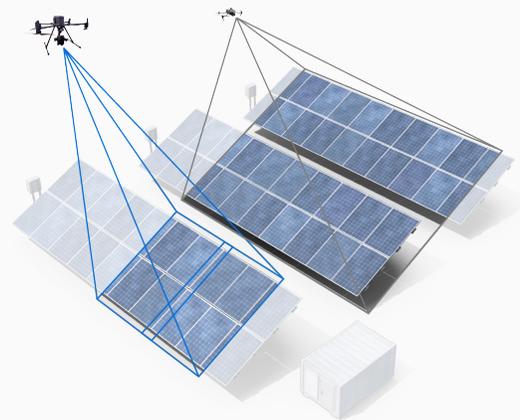


Typical Drone Sensor: 1.0 - 3.0cm

No Compromise on Coverage or Accuracy

Unlike conventional drone technology that forces a tradeoff between resolution and coverage, our patented solution delivers both—unlocking new value across every stage of the solar lifecycle.

Our flights are performed at a safe distance from solar panels, and encompass the entire panel.



Benefits



Better Warranty Recovery

Identify which panels are OEM defects vs. install issues, costs shift off the asset owner.



Higher Energy Yield

Earlier detection of failing modules prevents cumulative power loss.



Lower O&M Cost

Maintenance crews dispatched only to exact locations with confirmed issues.



Regulatory & ESG Confidence

Traceability improves asset governance and valuation.



De-Risking Future Transactions

A verified panel-level inventory increases confidence and reduces diligence effort.

Conclusion

Solar farms will operate for 25–35 years. Their profitability hinges on managing millions of individual components. By enabling **low-cost, fleet-wide acquisition of panel identity**, VI transforms operations from bulk-asset approximations to true **equipment-level performance management**.

The result is a solar asset that is:

- **Fully traceable**
- **Predictive instead of reactive**
- **Optimized for maximum yield and minimum cost**

VI's sub-millimeter imaging and AI-based ID extraction solve one of the solar industry's last major data blind spots — and create a powerful foundation for **higher revenue, stronger warranties, and smarter maintenance** for decades.

