

Industrial Project

2026-03-31

AI-Powered Pole Validation

AI-powered pole validation using GIS, imagery, OCR, and multi-system data reconciliation.



Project Snapshot

DATE

2026-03-31

CATEGORY

Industrial Project

SHORT DESCRIPTION

AI-powered pole validation using GIS, imagery, OCR, and multi-system data reconciliation.

TAGS / TECH STACK

Computer Vision

OCR

Pole Validation

Infrastructure

Project Links

[Demo Video](#)

[Demo Video](#)

[GitHub Repository](#)

Full Project Content

Building an AI system that doesn't just **detect poles** — but **validates and decides**.

GitHub Repository: [dranubhaparashar/Pole-Detection](https://github.com/dranubhaparashar/Pole-Detection)

Vision

Modern infrastructure validation is slow, manual, and error-prone.

This project introduces an **AI-powered validation framework** that:

- Detects poles
- Verifies ownership
- Assesses structure
- Provides decision-ready outputs

Project Attributes

Attribute	Description
problem-statement	Manual pole validation is slow, fragmented, and dependent on multiple disconnected systems.
primary-objective	Build an AI-assisted framework to detect poles, validate ownership, assess suitability, and support decision-making.
core-technologies	YOLO, Computer Vision, GIS, OCR, and multi-source data reconciliation.
validation-sources	Internal portal data, field imagery, GIS coordinates, Frontier database, AEP records, and workflow history.
key-capabilities	Pole detection, ownership verification, structural assessment, ambiguity detection, and confidence-based decision support.
decision-engine	Produces outcomes such as Auto-Approve, Manual Review, or Reject / Rework based on fused evidence.
business-impact	Reduces manual effort, improves validation consistency, and speeds up infrastructure approval workflows.

Attribute	Description
current-limitations	Small dataset, class imbalance, and low recall in the current detection setup.
future-improvements	Expand dataset, improve labeling quality, reduce class complexity, and strengthen active learning.
human-in-the-loop	Final decisions should remain reviewer-supported until the model reaches stronger validation reliability.

Post Files

```
src/content/posts/  
└─ pole-detection/  
    ├── cover.png  
    └─ index.mdx  
  
GitHub Repo: dranubhaparashar/Pole-Detection/  
└─ dataset/  
└─ runs/  
    └─ detect/  
└─ 001_png.rf.72b75e71c8e9e08119e23830becb46ea.jpg  
└─ 001_png.rf.72b75e71c8e9e08119e23830becb46ea.txt  
└─ 1.ipynb  
└─ 1.py  
└─ README.md  
└─ app.py  
└─ data.yaml  
└─ yolo26n.pt
```

Why This Matters

Note Manual validation involves **13+ checks across multiple systems**.

Important Wrong validation → **cost impact + safety risks + delays**

Tip AI enables **confidence-based automated decisions**

Warning Low recall indicates **dataset limitation and class imbalance**

Caution Decisions should not be fully automated until model recall and validation coverage improve.

What This System Does

flowchart TD

```
A[Internal Portal / Job Request] --> B[Candidate Pole Context]
B --> C[GIS Coordinates & Route Alignment]
B --> D[Field / Street / Inspection Imagery]
B --> E[Frontier Database]
B --> F[AEP / External Utility Records]
B --> G[OnPath / Workflow History]

D --> H[YOLO26n Detection]
D --> I[OCR / Tag Extraction]
C --> J[Geo-Matching Engine]
E --> K[Ownership & Structural Signals]
F --> K
G --> L[Design Context Signals]

H --> M[Evidence Fusion Layer]
I --> M
J --> M
K --> M
L --> M

M --> N[Rule Engine]
N --> O[Confidence Scoring Engine]
O --> P{Decision Engine}

P -->|High confidence| Q[Auto-Approve]
P -->|Conflicting evidence| R[Manual Review]
P -->|Low confidence| S[Reject / Rework]

R --> T[Reviewer Feedback]
T --> U[Audit Store]
T --> V[Threshold Tuning / Future Improvement]
```

Core Capabilities

- Pole detection (YOLO26n)
- Ownership verification (AEP / Frontier DB)
- Structural assessment (visual + metadata)
- Space feasibility analysis
- Multi-source reconciliation
- Confidence-based decision engine

Bento Overview

Capability	Description
Pole Identity	Is this the correct pole?
Ownership	Frontier or not?
Ambiguity	Nearby pole confusion
Structure	Safe for attachment?
Decision	Approve / Review / Reject

YOLO26n Detection Engine

Model Details

- Layers: 260
- Parameters: 2.5M
- Classes: 36
- Framework: Ultralytics YOLO

Training Setup

- Epochs: 100
- Batch: 16
- Image Size: 640

Inference

```
from ultralytics import YOLO

model = YOLO("best.pt")
```

```
results = model("pole.jpg")

for r in results:
    print(r.bboxes)
```

Confidence Engine

```
def confidence_score(pole, ownership, geo, structure):
    return (
        pole * 0.3 +
        ownership * 0.2 +
        geo * 0.3 +
        structure * 0.2
    )
```

Decision Logic

```
def decision(score):
    if score > 0.85:
        return "Auto-Approve"
    elif score > 0.55:
        return "Manual Review"
    else:
        return "Reject"
```

Example Threshold Update

```
- AUTO_APPROVE_THRESHOLD = 0.90
- MANUAL_REVIEW_THRESHOLD = 0.60
+ AUTO_APPROVE_THRESHOLD = 0.85
+ MANUAL_REVIEW_THRESHOLD = 0.55
REJECT_THRESHOLD = 0.00
```

Runtime Example

```
python train.py --model yolo26n.pt --data data.yaml --epochs 100 --batch 16 --imgsz 640
python infer.py --weights best.pt --source pole.jpg
python evaluate.py --predictions outputs/results.json
```

Performance Snapshot

Metric	Value
Precision	0.608
Recall	0.052
mAP@0.5	0.054

Warning Low recall indicates **dataset limitation and class imbalance**

Caution This system should remain human-assisted until model recall and evidence consistency improve.

Current Challenges

- Small dataset
- Class imbalance
- Low recall

Next Improvements

- Increase dataset size
- Improve labeling
- Reduce class complexity
- Apply active learning

Demo Videos

Detection Demo

Embedded media: [Open video](#)

Validation Demo

Embedded media: [Open video](#)

Key Innovation

Important This is not just object detection —
it is **Decision Intelligence for Infrastructure**

Conclusion

This project transforms:

Manual Validation → AI-Assisted Decision System

- Combines vision + data + reasoning.
 - Provides explainable decisions.
 - Enables faster approvals.
-

Final Thought

From **detecting poles** → to **understanding and deciding infrastructure**

The final recommendation is :spoiler[AI-assisted, not fully autonomous].