Spectra VisionAi Test Cases

# Image Quality and Environmental Adaptation

## Test Case 1: Lighting Condition Robustness

* Objective: Validate image clarity in varying lighting.
* Steps:
  + Capture images in bright sunlight, dim indoor lighting, and mixed conditions (e.g., backlit scenes).
  + Use resolution charts to measure sharpness, noise levels, and dynamic range.
  + Compare results against predefined thresholds for acceptable clarity.
* Success Criteria: Maintains >90% clarity in all conditions

## Test Case 2: Low-Light Performance

* Objective: Ensure usable images in near darkness.
* Steps:
  + Activate low-light mode and capture images with minimal ambient light.
  + Measure object recognition accuracy using YOLO.
* Success Criteria: Recognizes simple objects (e.g., people, products) with >80% accuracy.

# Object Recognition and Learning

## Test Case 3: Baseline Object Detection

* Objective: Validate accuracy for predefined objects (products, people).
* Steps:
  + Feed images with labeled objects into the YOLO model[8](https://encord.com/blog/yolo-object-detection-guide/).
  + Compare detected objects against ground-truth labels.
* Success Criteria: Achieves mAP (mean Average Precision) ≥0.85 on COCO dataset benchmarks.

## Test Case 4: Incremental Learning

* Objective: Test system’s ability to recognize new objects over time.
* Steps:
  + Introduce a new object class (e.g., "sewer valve") using LabelImg9.
  + Retrain the model and validate detection accuracy.
* Success Criteria: New class detection accuracy ≥75% after retraining.

## Test Case 5: Real-Time Processing

* Objective: Ensure object labelling occurs in real-time.
* Steps:
  + Stream live video to the system.
  + Measure latency between frame capture and object labelling.
* Success Criteria: Latency <200ms per frame.

# Alert System and Integration

## Test Case 6: Custom Alert Triggers

* Objective: Validate alert customization and delivery.
* Steps:
  + Set alerts for specific objects (e.g., "untreated sewage").
  + Trigger events and verify alerts via email, SMS, and app.
* Success Criteria: Alerts delivered within 5 seconds of detection.

## Test Case 7: MQTT Data Transmission

* Objective: Ensure seamless data integration with servers.
* Steps:
  + Transmit detection logs via MQTT.
  + Verify data integrity and latency at the central server.
* Success Criteria: Zero packet loss; latency <1 second.

# Specific Task Validation

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| --- | --- | --- |
| Task | Test Scenario | Success Metric |
| Smart Alarm | Detect unauthorized entry in a restricted zone | 95% detection rate; <2% false positives |
| People Counting | Count individuals entering/exiting a space with varying crowd densities. | Accuracy ≥90% vs. manual counts |
| Watering Monitoring | Detect Illegal sewage discharge in river footage | Identify discharge events within 10 seconds |
| Sewer Valve monitoring | Track valve position changes in real-time | Position accuracy +5° |

# Model and Data Validation

## Test Case 8: YOLO Performance Benchmarking

* Objective: Compare YOLO against alternatives (e.g., Faster R-CNN).
* Steps:
  + Train both models on custom-labelled data9.
  + Evaluate speed (FPS) and accuracy (mAP).
* Success Criteria: YOLO achieves ≥2× faster inference with comparable accuracy.

## Test Case 9: Data Annotation Workflow

* Objective: Ensure LabelImg compatibility and export accuracy.
* Steps:
  + Annotate 100 images with bounding boxes.
  + Verify YOLO-compatible TXT files are generated correctly.
* Success Criteria: 100% format compliance; annotations align with objects.

# Usability and Remote Access

## Test Case 10: Dashboard Clarity

* Objective: Validate intuitive display of alerts and object labels.
* Steps:
  + Simulate detection events.
  + Survey users on interface readability.
* Success Criteria: ≥90% user satisfaction on clarity.

## Test Case 11: Remote Configuration

* Objective: Test camera settings adjustment via web/app.
* Steps:
  + Change resolution, alert rules, and model parameters remotely.
  + Verify settings apply without system reboot.
* Success Criteria: Changes within 10 seconds.

# Academic and Technical Considerations

* Edge Case Handling: Test occlusion robustness using synthetic data.
* Computational Efficiency: Monitor GPU/CPU usage during peak loads.
* Ethical Compliance: Anonymize faces in public spaces to adhere to privacy laws.

By systematically addressing these test cases, the AI camera system can meet both functional requirements and real-world operational demands.