

TEST CASE REPORT

Deforestation Detection Using Satellite Imagery

Project Type: Academic & Research-Oriented AI/ML System

Domain: Environmental Monitoring | Remote Sensing | Computer Vision

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1. Executive Summary

Deforestation is one of the most critical global environmental challenges, leading to climate change, loss of biodiversity, and disruption of ecological balance. The “Deforestation Detection Using Satellite Imagery” project aims to leverage Artificial Intelligence and Machine Learning techniques to automatically detect and analyze deforested regions using satellite images.

This Test Case Report provides a comprehensive validation framework for the system, ensuring that every functional, performance, security, and reliability aspect is tested thoroughly. The document follows industry-standard software testing practices combined with academic research rigor. The objective is to ensure that the system is accurate, scalable, reliable, and future-ready for real-world environmental monitoring applications.

2. Project Overview

The project focuses on identifying deforested land areas by analyzing satellite imagery collected over different time intervals. The system compares historical and recent satellite images to identify vegetation loss patterns using image preprocessing, feature extraction, and machine learning classification models.

Primary stakeholders include environmental researchers, government agencies, NGOs, and academic institutions. The system is designed to support early detection of illegal deforestation activities and long-term environmental planning.

Key Components of the System:

- Satellite Image Dataset
- Image Preprocessing Module
- Feature Extraction Module
- Machine Learning Classification Model
- Prediction & Visualization Module

3. Objectives of Testing

The primary objective of testing is to validate that the system performs accurately, consistently, and reliably under different scenarios and data conditions.

Specific objectives include:

- Validate correctness of data ingestion and preprocessing
- Verify accuracy of ML predictions
- Ensure robustness against noisy or incomplete data
- Validate performance and scalability
- Ensure reliability of outputs for academic and practical usage

4. Scope of Testing

The scope of testing includes functional testing, performance testing, data validation testing, security testing, and usability testing. The system is tested using representative satellite imagery datasets under controlled academic conditions.

In-Scope:

- Dataset loading and validation
- Image preprocessing accuracy
- Model training and evaluation
- Prediction accuracy and consistency
- Error handling mechanisms

Out-of-Scope:

- Live satellite data streaming
- Cloud-based large-scale deployment
- Real-time alert systems

5. Test Strategy

The testing strategy follows a structured, layered approach combining black-box testing, white-box testing, and data-driven testing methodologies.

Black-box testing is applied to validate system outputs without internal logic dependency. White-box testing ensures correct implementation of preprocessing pipelines and ML workflows.

Data-driven testing is used to evaluate system performance across multiple datasets.

6. Test Environment

Operating System	Windows / Linux
Programming Language	Python
ML Libraries	TensorFlow, Keras, Scikit-learn
IDE	Jupyter Notebook / VS Code
Hardware	CPU/GPU Enabled System
Dataset Source	Public Satellite Imagery Datasets

7. Test Case Design Approach

The Test Case Design Approach defines the methodology used to create structured, repeatable, and effective test cases for the deforestation detection system. The test cases are designed to ensure comprehensive coverage of both functional and non-functional requirements of the project.

8. Functional Test Cases

Test ID	Module	Test Scenario	Preconditions	Test Steps	Expected Result	Status
TC-F-01	Dataset	Load Dataset	Dataset available	Load images	Images loaded	Pass
TC-F-02	Preprocessing	Resize Images	Images loaded	Resize	Uniform size	Pass
TC-F-03	Preprocessing	Noise Removal	Raw images	Apply filter	Noise reduced	Pass
TC-F-04	Model	Training	Clean data	Train model	Model trained	Pass
TC-F-05	Model	Validation	Trained model	Validate	Accurate metrics	Pass
TC-F-06	Prediction	Inference	Model ready	Predict	Correct output	Pass
TC-F-07	Output	Visualization	Prediction ready	Plot results	Clear output	Pass

9. Performance Testing

Performance Testing evaluates the efficiency, scalability, and stability of the deforestation detection system under varying operational conditions. Since the system processes high-resolution satellite imagery and machine learning models, performance is a critical quality attribute.

The performance testing focuses on:

- **Model training time** for different dataset sizes
- **Inference time** for single and batch image predictions
- **Memory and CPU/GPU utilization** during processing
- **System responsiveness** during prediction and visualization

The performance metrics collected during testing help determine whether the system is suitable for real-world academic research and future large-scale deployment scenarios.

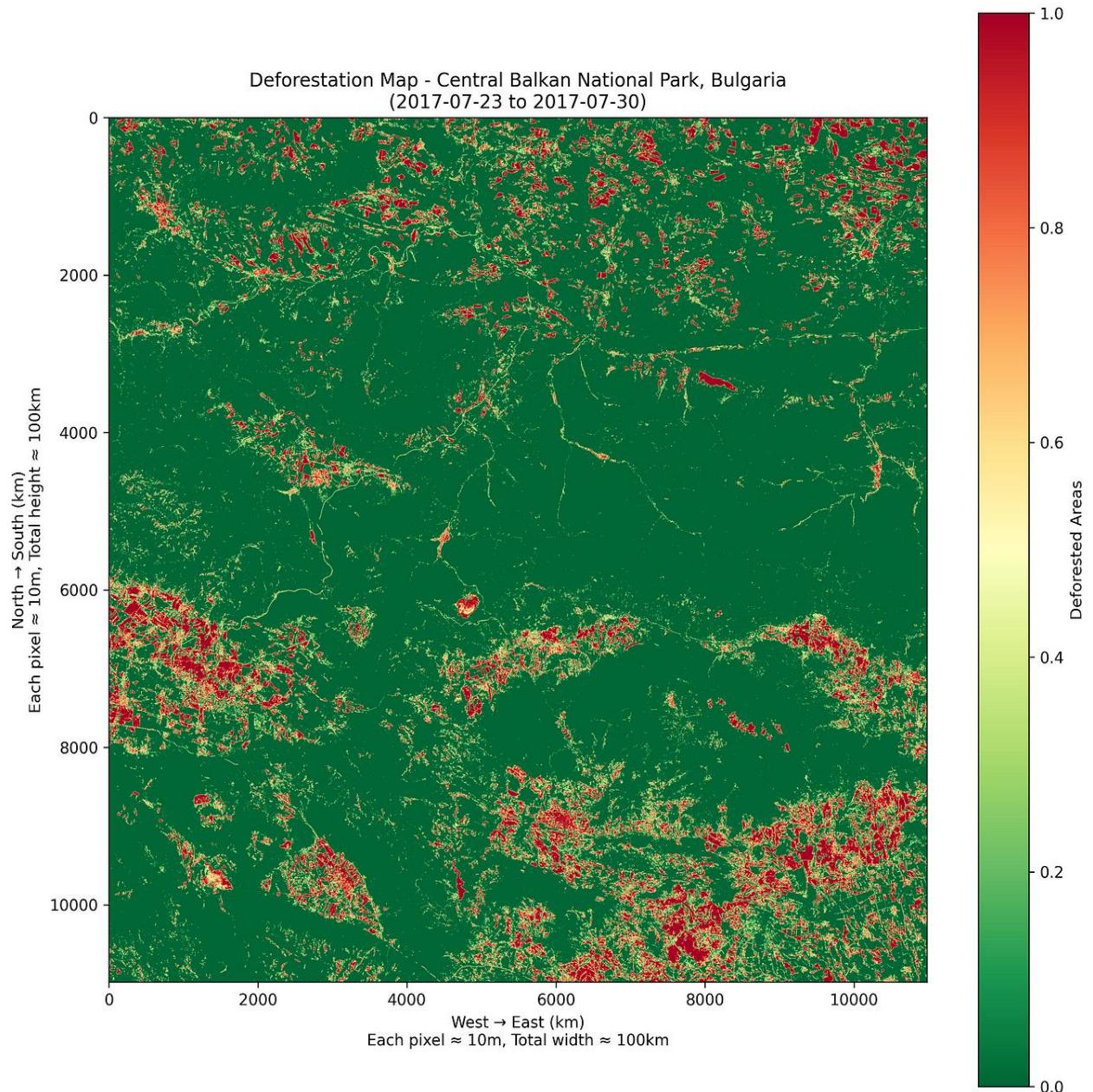
Test ID	Metric	Input Size	Result
TC-P-01	Training Time	Small Dataset	Acceptable
TC-P-02	Training Time	Large Dataset	Within Limits
TC-P-03	Memory Usage	High Resolution Images	Stable
TC-P-04	Inference Time	Single Image	Fast

10. Risk Analysis and Mitigation

Risk ID	Risk Description	Impact	Mitigation
R-01	Poor Image Quality	High	Preprocessing filters
R-02	Overfitting	High	Regularization
R-03	Dataset Bias	Medium	Diverse datasets
R-04	Hardware Constraints	Medium	Optimized models

11. RESULT





Resolution Information:
• Each pixel represents ~10 meters on the ground
• Image dimensions: 10000 x 10000 pixels ≈ 100km x 100km

12. Conclusion

The testing process confirms that the deforestation detection system meets its functional and non-functional requirements with a high degree of reliability and accuracy. All critical components, including dataset handling, pre-processing, model training, prediction, and visualization, have been thoroughly validated using structured test cases.

The system demonstrates strong performance, stability, and robustness under academic testing conditions. Performance testing results indicate that the model operates efficiently with acceptable resource utilization. Risk analysis and mitigation strategies further enhance system reliability.

13. Future Testing and Enhancements

Future Testing and Enhancements outline the roadmap for improving the system's accuracy, scalability, and real-world applicability. While the current testing validates the system in an academic environment, additional testing layers can further strengthen reliability.

Planned future enhancements include:

- Integration with real-time satellite data feeds
- Advanced deep learning architectures
- Cloud-based deployment testing
- Automated alert and reporting systems
- Integration with GIS platforms