

DriveGuard AI - Video Analysis System

Non-Functional Requirements (NFR)

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1. Performance Requirements

1.1 Video Processing Performance

- **Hardware Configuration:**
 - Processor: Apple Silicon (ARM64)
 - GPU: Metal Performance Shaders (MPS)
 - Operating System: macOS 15.6.1

Metric	Specification	Measured Performance
Processing Ratio		
1-minute video	~2 minutes	<input type="checkbox"/> Verified
2-minute video	~4-5 minutes	<input type="checkbox"/> 5:14 actual
5-minute video	~10-11 minutes	Estimated
GPU Acceleration	Apple Silicon MPS	<input type="checkbox"/> Active
Concurrent Processing	Sequential (1 video at a time)	Current limitation

1.2 System Response Times

Operation	Target Response Time	Status
User Login	< 500ms	<input type="checkbox"/> Met
Dashboard Load	< 1 second	<input type="checkbox"/> Met
API Endpoints (non-analysis)	< 100ms	<input type="checkbox"/> Met
Video Upload	Dependent on file size	Network-bound
Analysis Status Check	< 50ms	<input type="checkbox"/> Met

2. Scalability Requirements

2.1 User Capacity

- Current Capacity:

Metric	Current Capacity	Notes
Registered Users	Unlimited (file-based)	Database migration recommended
Concurrent Sessions	Up to 10 users	Limited by server resources
Analyses per User	Unlimited	Storage-dependent
Video Storage	Local file system	~50GB available

2.2 System Throughput

- Future Scalability:

Metric	Specification
Videos per Hour	~12-15 videos (2-3 min avg)
Daily Processing Capacity	~150-200 videos
Peak Load Handling	Single sequential processing queue

3. Reliability & Availability

3.1 System Uptime

Requirement	Specification
Target Uptime	99% during development
Maximum Downtime	Planned maintenance windows
Recovery Time Objective (RTO)	< 5 minutes
Recovery Point Objective (RPO)	Last successful analysis

3.2 Data Integrity

- **Analysis Results:** Stored in JSON format with validation.
- **Video Files:** Original files are preserved post-analysis.
- **User Data:** File-based storage with backup capability.

4. Security Requirements

4.1 Authentication & Authorization

Feature	Implementation	Status
User Authentication	Password-based login	<input type="checkbox"/> Implemented
Password Encryption	Plaintext (requires enhancement)	<input type="checkbox"/> Implemented
Session Management	Cookie/JWT-based	Implemented
Role-Based Access	Individual/Enterprise accounts	<input type="checkbox"/> Implemented

5. Usability Requirements

5.1 User Interface

Requirement	Specification
Framework	React 18+ TypeScript
Responsive Design	Desktop and tablet optimized
Dark/Light Mode	Toggle available

5.2 User Experience

Feature	Target	Status
Video Upload Flow	< 3 clicks	<input type="checkbox"/> Met
Analysis Results Display	< 2 seconds load	<input type="checkbox"/> Met
Dashboard Navigation	Intuitive layout	<input type="checkbox"/> Met
Error Messages	Clear, actionable feedback	<input type="checkbox"/> Met
Progress Indicators	Real-time processing status	<input type="checkbox"/> Met

6. Portability & Compatibility

6.1 Platform Requirements

Component	Requirement
Operating System	macOS 12+ (Apple Silicon optimized)
Python Version	3.10 or higher
Node.js Version	18.x or higher
GPU Support	Apple Silicon MPS (or CUDA for NVIDIA)

6.2 Dependencies

- Python Dependencies:
 - OpenCV (cv2) - Video processing
 - PyTorch - Deep learning framework
 - YOLOv8 - Object detection
 - NumPy - Numerical computations
 - Ultralytics - YOLO implementation

7. AI Model Performance

7.1 Detection Accuracy

Model	Task	Accuracy
YOLOv8n	Vehicle detection	~90%
Speed Detection	Speed estimation	$\pm 5 \text{ km/h}$ accuracy
Signal Detection	Traffic light violations	Rule-based validation

7.2 Scoring Algorithm

- Score Weights:

Score Component	Weight	Penalty Formula
Safety Score	50%	$(100 - (\text{close_encounters} \times 8))$
Compliance Score	30%	$(100 - (\text{traffic_violations} \times 40 + \text{bus_lane} \times 30))$
Efficiency Score	20%	$(100 - (\text{lane_changes} \times 0.5))$

- Score Categories:

- 90-100: Excellent - Outstanding performance
- 75-89: Good - Minor improvements needed
- 0-74: Needs Improvement - Safety concerns

8. Known Limitations & Future Enhancements

8.1 Current Limitations

1. **Sequential Processing:** Only one video can be analyzed at a time.
2. **Password Security:** Passwords are currently stored in plaintext.
3. **File-Based Database:** Not suitable for large-scale deployment.
4. **No Real-Time Processing:** Videos must be uploaded and queued for analysis.
5. **GPU Dependency:** Optimal performance requires Apple Silicon MPS.

8.2 Recommended Enhancements

- **Priority 1 (Critical):**
 - Implement password hashing (e.g., bcrypt/argon2).
 - Add HTTPS/TLS support.
 - Migrate to a dedicated database (e.g., PostgreSQL/MongoDB).
- **Priority 2 (High):**
 - Enable parallel video processing using a multi-threading or queue system.
 - Introduce real-time video stream analysis.
 - Develop an advanced analytics dashboard.

- Implement API rate limiting and throttling.

- **Priority 3 (Medium):**

- Mobile app development.
- Add support for cloud deployment.
- Create an automated backup system.
- Implement advanced reporting features.