Software Requirements Specification (SRS)

Real-World AR ChatGPT for Farmers

Document Information

- **Version:** 1.0
- **Date:** 2025
- **Project:** Real-World AR ChatGPT for Farmers
- **Document Status:** Draft
- **Approval Status:** Pending

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1. Introduction

1.1 Purpose

This Software Requirements Specification document describes the functional and non-functional requirements for the Real-World AR ChatGPT for Farmers application. This document is intended for developers, project managers, QA engineers, and stakeholders involved in the NASA Space Apps Challenge 2025.

1.2 Scope

The system is a WebAR-based agricultural assistant that:

- Provides real-time soil and environmental insights using NASA satellite data
- Offers AI-powered agricultural guidance through a conversational interface
- Gamifies farming practices through a Tamagotchi-style crop companion
- Delivers location-aware crop recommendations and irrigation timing

1.3 Definitions, Acronyms, and Abbreviations

- **AR:** Augmented Reality
- **WebAR:** Web-based Augmented Reality
- **RAG:** Retrieval Augmented Generation
- **NDVI:** Normalized Difference Vegetation Index
- **SMAP:** Soil Moisture Active Passive
- **MODIS:** Moderate Resolution Imaging Spectroradiometer

- **JWT**: JSON Web Token

- **API**: Application Programming Interface

- **GPS**: Global Positioning System

- **TTL**: Time To Live

- **p95**: 95th percentile

1.4 References

- NASA SMAP Mission Documentation

- NASA MODIS Products Guide

- WebXR Device API Specification

- OpenAI GPT-4 Documentation

- IEEE 830-1998 Standard

1.5 Overview

This document contains detailed functional requirements, non-functional requirements, system interfaces, and constraints for the farming assistant application.

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2. Overall Description

2.1 Product Perspective

The system operates as a standalone web application accessible through mobile browsers, integrating with:

- NASA satellite data services

- Weather APIs

- Large Language Models

- Voice processing services

- Cloud infrastructure services

2.2 Product Functions

Primary functions include:

- Ground/soil detection through WebAR

- Location-based data retrieval

- Agricultural insights generation

- Conversational AI assistance

- Gamified crop monitoring

- Alert and notification management

2.3 User Classes and Characteristics

User Class	Description	Technical Expertise	Frequency of Use
Farmers	Primary users seeking agricultural guidance	Low to Medium	Daily during growing season
Agricultural Advisors	Professional consultants	Medium to High	Weekly
Researchers	Data collection and analysis	High	As needed
Demo Users	NASA Challenge evaluators	Medium	One-time

2.4 Operating Environment

- **Client Side**: iOS Safari 14+, Android Chrome 88+

- **Server Side**: Node.js 18+, Python 3.9+

- **Database**: PostgreSQL 14+, Redis 6+

- **Network**: Minimum 3G connection, 4G/5G preferred

2.5 Design and Implementation Constraints

- Must use WebAR (no native app installation)

- Limited to publicly available NASA data

- Must operate within API rate limits

- Browser permission requirements for camera and location

- No localStorage/sessionStorage usage

2.6 Assumptions and Dependencies

- Users have smartphones with cameras

- GPS availability in farming areas

- NASA API availability and reliability

- Internet connectivity at usage locations

3. System Features

3.1 WebAR Ground Detection

3.1.1 Description

The system shall detect ground planes using WebAR technology and validate soil presence.

3.1.2 Functional Requirements

ID	Requirement	Priority
FR-AR-001	System shall request camera permission on first use	High
FR-AR-002	System shall detect horizontal planes within 3 seconds	High
FR-AR-003	System shall differentiate ground from sky/walls	High
FR-AR-004	System shall validate soil texture characteristics	Medium
FR-AR-005	System shall estimate approximate area coverage	Low
FR-AR-006	System shall display visual confirmation of detection	High

3.2 Location Services

3.2.1 Description

The system shall capture and utilize user location for data retrieval.

3.2.2 Functional Requirements

ID	Requirement	Priority
FR-LOC-001	System shall request GPS permission	High
FR-LOC-002	System shall capture latitude/longitude with 5 decimal precision	High
FR-LOC-003	System shall provide manual location entry option	Medium
FR-LOC-004	System shall validate location boundaries	Medium
FR-LOC-005	System shall handle permission denial gracefully	High

3.3 NASA Data Integration

3.3.1 Description

The system shall retrieve and process satellite data from NASA sources.

3.3.2 Functional Requirements

ID	Requirement	Priority
FR-NASA-001	System shall fetch SMAP soil moisture data	High
FR-NASA-002	System shall retrieve MODIS NDVI values	High
FR-NASA-003	System shall obtain surface temperature data	High
FR-NASA-004	System shall calculate evapotranspiration	Medium
FR-NASA-005	System shall aggregate precipitation data	Medium
FR-NASA-006	System shall provide data provenance information	High
FR-NASA-007	System shall implement coordinate bucketing	High
FR-NASA-008	System shall cache results with appropriate TTL	High

3.4 Crop Recommendations

3.4.1 Description

The system shall provide crop recommendations based on environmental conditions.

3.4.2 Functional Requirements

ID	Requirement	Priority
FR-CROP-001	System shall recommend 3 suitable crops	High
FR-CROP-002	System shall provide suitability scores	Medium
FR-CROP-003	System shall include water requirements	High
FR-CROP-004	System shall specify planting windows	High
FR-CROP-005	System shall provide rationale for recommendations	Medium
FR-CROP-006	System shall consider seasonal factors	High

3.5 Conversational AI (Chat)

3.5.1 Description

The system shall provide conversational AI capabilities for agricultural queries.

3.5.2 Functional Requirements

ID	Requirement	Priority
FR-CHAT-001	System shall accept text input queries	High
FR-CHAT-002	System shall implement RAG for grounded responses	High
FR-CHAT-003	System shall provide citations for claims	High
FR-CHAT-004	System shall handle off-topic questions	Medium
FR-CHAT-005	System shall maintain conversation context	Medium
FR-CHAT-006	System shall limit response time to 4 seconds p95	High

3.6 Voice Interaction

3.6.1 Description

The system shall support voice input and output capabilities.

3.6.2 Functional Requirements

ID	Requirement	Priority
FR-VOICE-001	System shall implement push-to-talk recording	Medium
FR-VOICE-002	System shall transcribe voice to text	Medium
FR-VOICE-003	System shall provide text-to-speech responses	Low
FR-VOICE-004	System shall achieve 90% transcription accuracy	Medium
FR-VOICE-005	System shall complete voice processing in 8 seconds	Medium

3.7 Crop Companion Gamification

3.7.1 Description

The system shall provide a gamified crop companion with alerts and rewards.

3.7.2 Functional Requirements

ID	Requirement	Priority
FR-GAME-001	System shall display avatar with 3+ visual states	Medium
FR-GAME-002	System shall track crop growth stages	Medium
FR-GAME-003	System shall generate irrigation alerts	High
FR-GAME-004	System shall detect heat stress conditions	Medium
FR-GAME-005	System shall provide achievement rewards	Low
FR-GAME-006	System shall allow alert dismissal	Medium

3.8 Irrigation Management

3.8.1 Description

The system shall provide irrigation timing and quantity recommendations.

3.8.2 Functional Requirements

ID	Requirement	Priority
FR-IRR-001	System shall calculate optimal irrigation timing	High
FR-IRR-002	System shall consider soil moisture levels	High
FR-IRR-003	System shall incorporate weather forecasts	Medium
FR-IRR-004	System shall estimate water savings	Low
FR-IRR-005	System shall provide risk reduction metrics	Low

4. External Interface Requirements

4.1 User Interfaces

ID	Requirement	Priority
UI-001	System shall provide responsive mobile web interface	High
UI-002	System shall display AR overlay on camera view	High
UI-003	System shall provide chat interface with message history	High
UI-004	System shall show data insights in pill/card format	Medium
UI-005	System shall display crop companion avatar	Medium
UI-006	System shall show loading indicators	High
UI-007	System shall provide error messages in user-friendly language	High

4.2 Hardware Interfaces

ID	Requirement	Priority
HW-001	System shall interface with device camera	High
HW-002	System shall access device GPS	High
HW-003	System shall utilize device microphone	Medium
HW-004	System shall output to device speakers	Low
HW-005	System shall access device gyroscope/accelerometer	Medium

4.3 Software Interfaces

4.3.1 NASA APIs

Interface	Protocol	Data Format	Authentication
SMAP API	HTTPS REST	JSON	API Key
MODIS API	HTTPS REST	JSON/GeoTIFF	API Key
CMR API	HTTPS REST	JSON	OAuth 2.0

4.3.2 External Services

Service	Purpose	Protocol	Format
OpenWeather API	Weather data	HTTPS REST	JSON
OpenAI API	LLM processing	HTTPS REST	JSON
Google Speech API	Voice processing	HTTPS REST	Audio/JSON

4.4 Communications Interfaces

ID	Requirement	Priority
COM-001	System shall use HTTPS for all API communications	High
COM-002	System shall implement JWT authentication	High
COM-003	System shall support WebSocket for real-time updates	Low
COM-004	System shall compress large payloads	Medium
COM-005	System shall implement request retry logic	High

5. Non-Functional Requirements

5.1 Performance Requirements

ID	Requirement	Metric	Target
NFR-PERF-001	Ground detection speed	Time to detection	<3 seconds
NFR-PERF-002	API response time	p95 latency	<2.5 seconds
NFR-PERF-003	Chat response time	p95 latency	<4 seconds
NFR-PERF-004	Voice processing time	End-to-end	<8 seconds
NFR-PERF-005	Page load time	Initial load	<5 seconds
NFR-PERF-006	Cache hit rate	Percentage	>70%

5.2 Safety Requirements

ID	Requirement	Priority
NFR-SAFE-001	System shall not provide harmful agricultural advice	Critical
NFR-SAFE-002	System shall include disclaimers for recommendations	High
NFR-SAFE-003	System shall validate data before displaying	High
NFR-SAFE-004	System shall handle errors without data loss	Medium

5.3 Security Requirements

ID	Requirement	Priority
NFR-SEC-001	System shall encrypt data in transit (TLS 1.3)	High
NFR-SEC-002	System shall implement rate limiting (60 rpm)	High
NFR-SEC-003	System shall validate all user inputs	High
NFR-SEC-004	System shall sanitize data before storage	High
NFR-SEC-005	System shall implement CORS policies	High
NFR-SEC-006	System shall rotate API keys quarterly	Medium

5.4 Software Quality Attributes

5.4.1 Reliability

ID	Requirement	Target
NFR-REL-001	System uptime	99.5%
NFR-REL-002	Mean time between failures	>720 hours
NFR-REL-003	Error recovery time	<30 seconds

5.4.2 Usability

ID	Requirement	Priority
NFR-USE-001	System shall be usable with one hand	High
NFR-USE-002	System shall provide visual feedback for all actions	High
NFR-USE-003	System shall support multiple languages	Low
NFR-USE-004	System shall be accessible (WCAG 2.1 AA)	Medium

5.4.3 Maintainability

ID	Requirement	Target
NFR-MAIN-001	Code coverage	>80%
NFR-MAIN-002	Documentation completeness	100% public APIs
NFR-MAIN-003	Maximum cyclomatic complexity	10

5.4.4 Scalability

ID	Requirement	Target
NFR-SCALE-001	Concurrent users	1000
NFR-SCALE-002	Database connections	100
NFR-SCALE-003	Horizontal scaling capability	Yes

6. Other Requirements

6.1 Database Requirements

ID	Requirement	Priority
DB-001	System shall store location insights for 30 days	Medium
DB-002	System shall log all chat interactions	High
DB-003	System shall maintain user session data	High
DB-004	System shall implement database backups daily	High
DB-005	System shall support database replication	Medium

6.2 Legal and Compliance Requirements

ID	Requirement	Priority
LEG-001	System shall comply with data privacy regulations	High
LEG-002	System shall provide terms of service	High
LEG-003	System shall include privacy policy	High
LEG-004	System shall obtain user consent for data collection	High

6.3 Operational Requirements

ID	Requirement	Priority
OPS-001	System shall provide health check endpoints	High
OPS-002	System shall implement logging for all transactions	High
OPS-003	System shall support blue-green deployments	Medium
OPS-004	System shall provide metrics dashboards	Medium

7. System Constraints

7.1 Technical Constraints

- WebAR API limitations in browsers
- NASA API rate limits (100 requests/hour)
- GPS accuracy in rural areas (±10 meters)
- Mobile browser memory limitations
- Network bandwidth in remote locations

7.2 Business Constraints

- Development timeline (12 weeks)
- Team size (6-8 developers)
- Budget limitations for cloud services
- Third-party API costs

7.3 Regulatory Constraints

- Agricultural advisory regulations
- Data privacy laws (GDPR, CCPA)
- Accessibility standards (ADA)

8. Acceptance Criteria

8.1 Functional Testing

- All functional requirements must pass testing
- Integration tests must cover all API endpoints
- End-to-end tests must validate critical paths

8.2 Performance Testing

- Load testing with 100 concurrent users
- Stress testing to identify breaking points
- Performance benchmarks must be met

8.3 User Acceptance Testing

- Pilot testing with 10+ farmers
- Feedback incorporation before final release
- Demo successful for NASA Challenge judges

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9. Appendices

Appendix A: Use Case Specifications

Detailed use case descriptions for all major features

Appendix B: Data Dictionary

Complete listing of data entities and attributes

Appendix C: API Specifications

Detailed API documentation including request/response formats

Appendix D: Error Codes

Comprehensive error code listing and descriptions

Appendix E: Glossary

Technical and agricultural terms used in the system

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10. Revision History

Version	Date	Author	Description
1.0	2025	Team	Initial draft

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11. Approval

Role	Name	Signature	Date
Project Manager			
Technical Lead			
QA Lead			
Stakeholder			