

Software Requirements Specification

For

Autism Spectrum Analyser (ASA)

Version 1.0

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1. Introduction

1.1 Purpose

Autism Spectrum Analyser (ASA) is a web-based AI platform designed to provide accessible, multi-modal early screening for Autism Spectrum Disorder (ASD). The system leverages video-based behavioral analysis, eye-gaze tracking, questionnaires, and MRI uploads to offer a holistic, privacy-conscious screening experience, especially targeted toward underserved and remote regions.

1.2 Document Conventions

- **Bold**: Key system components and features.
- *Italic*: Descriptions or emphasis.
- ``Code``: Technical terms and protocols.
- Numbered sections follow standard IEEE SRS formatting.

1.3 Intended Audience and Reading Suggestions

- Developers
- Clinical Researchers
- Users (Parents or Individuals seeking screening)
- Project Managers
- Testers
- Healthcare Partners

Suggested reading order:

- General readers: Sections 1, 2
- Developers: Sections 2–5
- Testers: Sections 3 and 5
- Clinical reviewers: Sections 2.2, 3, Appendix B

1.4 Project Scope

ASA is designed to simplify and accelerate autism diagnosis using AI. The platform integrates behavioral analysis through video, gaze tracking, and user inputs (questionnaires and MRI),

processed via models like CNNs and LSTMs. It aims to fill gaps in traditional diagnostic systems by offering a faster, remote, and user-friendly experience while respecting privacy and clinical standards.

1.5 References

- TensorFlow/Keras
- Django
- React
- HuggingFace
- Google Cloud

2. Overall Description

2.1 Product Perspective

ASA is a standalone platform that can be extended or integrated into healthcare systems or electronic health records (EHR). It is cloud-based and modular in design to allow future model enhancements.

Context and Origin:

ASA was conceived in response to the growing need for accessible and early screening tools for Autism Spectrum Disorder (ASD), especially in regions with limited access to clinical specialists. Traditional diagnostic processes are often resource-intensive, time-consuming, and geographically constrained. ASA addresses these limitations by leveraging artificial intelligence to streamline and democratize autism screening using multi-modal inputs such as behavioral videos, eye-gaze tracking, questionnaires, and MRI scans.

Relation to Larger Systems:

Though ASA is designed as a standalone web platform, it has the potential to integrate seamlessly into broader healthcare ecosystems. For example, it can be connected with electronic health record (EHR) systems, telehealth platforms, or hospital diagnostic workflows to enhance data sharing, follow-up, and clinical decision-making. Its modular architecture allows future adaptability for both individual use and institutional deployments.

2.2 Product Features

Autism Spectrum Analyzer (ASA) offers the following features:

1. User Registration/Login:

- o *ASA provides a secure and streamlined registration and login system, enabling personalized access and safeguarding user data.*

2. Behavioral Assessment Module (via video analysis):

- o *The application utilizes AI-powered video analysis to detect behavioral cues commonly associated with autism, offering a non-intrusive screening method.*

3. Eye Gaze Tracking:

- o *Leveraging computer vision, ASA tracks eye movement patterns during video assessments to identify indicators relevant to autism spectrum disorders.*

4. Questionnaire-Based Screening:

- o *ASA includes validated, adaptive screening questionnaires designed to collect behavioral and developmental information from users or caregivers.*

5. MRI Upload & Processing:

- o *Users can upload MRI scans for analysis. ASA processes these images using deep learning models to detect potential neuroanatomical markers of autism.*

6. Secure Result Delivery:

- o *Screening results are generated and are sent to the patients mail, providing a medium for secure data transfer and enabling email verification at the same time. This also allows the heavy weight models hosted on cloud to come up with a inference based on resource availability and gives some time for the processes.*

7. Admin Dashboard (for future use):

- o *A comprehensive admin dashboard is planned for future development, aimed at managing users, monitoring system performance, and analyzing population-level data.*
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2.3 User Classes and Characteristics

1. End Users (Parents/Patients):

- *Characteristics:* These are non-technical users, including parents, caregivers, or individuals undergoing screening. They may have limited familiarity with digital tools and require clear guidance throughout the process.
- *Requirements:* A highly intuitive and accessible interface, minimal setup or configuration, visual aids to understand results, and assurance of data privacy and security.

2. Clinicians/Researchers:

- *Characteristics:* Medical professionals and academic researchers who utilize ASA for diagnostic assistance, patient evaluation, or scientific investigation. They prioritize result accuracy and interpretability.
- *Requirements:* Detailed result reports, scientific explanations of findings, access to raw and processed data, integration with clinical workflows, and compliance with medical data standards.

3. Administrators:

- *Characteristics:* Internal users who manage the ASA platform, including user accounts, model performance, and overall system health. Their role is crucial in ensuring platform stability and regulatory compliance.
- *Requirements:* Admin dashboards for monitoring activity, user and data management tools, role-based access control, audit logging, and model update utilities.

4. AI Developers:

- *Characteristics:* Technical users responsible for extending ASA's capabilities through DL and RL model development, backend optimization, and infrastructure scaling.
- *Requirements:* Access to model training pipelines, code repositories, system architecture documentation, testing environments, and APIs for modular integration.

- **Favored User Classes:** End Users and Clinicians/Researchers are the primary focus, as they form the core of ASA's mission—delivering accessible and scientifically valid autism screening. User experience and result interpretability are tailored to meet their expectations.
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- **Less Central User Classes:** While essential, Administrators and AI Developers have more specialized requirements. Their needs are supported through internal tools and technical infrastructure, but these are not the central focus of the typical user journey.

2.4 Operating Environment

Autism Spectrum Analyzer (ASA) is a web-based application accessible via major browsers such as Google Chrome, Mozilla Firefox, Safari, and Microsoft Edge. It supports both desktop and mobile platforms through a responsive design that ensures usability across devices.

A stable internet connection is required for core functionalities like video analysis, data uploads, and real-time result processing. All computations are securely handled in the cloud, minimizing the load on user devices.

ASA is hosted on Google Cloud, ensuring high availability, data encryption, and compliance with security standards. This environment enables reliable, scalable, and secure access for all user types.

2.5 Design and Implementation Constraints

The technology stack for the Autism Spectrum Analyzer (ASA) project will be – ReactJS, TailwindCSS, FastAPI, Python, and Google Cloud Services. The main goals of ASA are to provide an intuitive and responsive user interface, enable accurate AI-driven autism screening through video and questionnaire analysis, and ensure secure handling of sensitive health data in compliance with GDPR and HIPAA regulations.

2.6 User Documentation

Using Autism Spectrum Analyzer (ASA) is designed to be simple and user-friendly. Users are guided through each step, such as uploading videos or MRI scans, completing questionnaires, or granting webcam access. The application handles all processing automatically, requiring minimal technical knowledge or user intervention. Clear on-screen instructions and tooltips ensure a smooth experience for all user types.

2.7 Assumptions and Dependencies

ASA's development and operation rely on several key assumptions and external dependencies. It assumes the continued availability and support of third-party libraries and

APIs for video processing, eye-tracking, and machine learning. Stable internet connectivity is required for all users to upload data and receive real-time results.

Browser compatibility is contingent on users maintaining up-to-date versions that support necessary features such as webcam access and secure file uploads. The project also assumes a stable regulatory environment, particularly regarding GDPR and HIPAA compliance for health data handling.

ASA's performance and uptime depend on the continued reliability and service quality of its cloud hosting provider, Google Cloud. Additionally, it is assumed that user adoption will meet projected levels and that sufficient development resources will remain available throughout the project lifecycle.

Monitoring these assumptions is critical, as any deviation may require strategic adjustments to project scope, features, or deployment timelines.

3. System Features

3.1 Behavioral Assessment

3.1.1 Description and Priority

- *Analyzes uploaded video to detect autistic behavioral markers.*
- *Priority: High.*

3.1.2 Stimulus/Response Sequences

- *Stimulus: User uploads a short video clip or records live.*
- *Response: System returns analysis based on trained LSTM/CNN models.*

3.1.3 Functional Requirements

- *REQ-1: Accept MP4/AVI video formats.*
 - *REQ-2: Apply facial and movement recognition using AI models.*
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- *REQ-3: Return results in under 2 minutes.*

3.2 Eye Gaze Tracking

3.2.1 Description and Priority

- *Detects visual saliency via eye movement using webcam feed.*
- *Priority: High.*

3.2.2 Stimulus/Response Sequences

- *Stimulus: User looks at screen targets during recording.*
- *Response: Gaze patterns analyzed and compared to ASD norms.*

3.2.3 Functional Requirements

- *REQ-1: Use encrypted webcam input.*
- *REQ-2: Process via CNN-based gaze estimator.*
- *REQ-3: Display visual heatmap and classification result.*

3.3 Questionnaire-Based Screening

3.3.1 Description and Priority

- *Evaluates answers to standard ASD indicators.*
- *Priority: Medium.*

3.3.2 Stimulus/Response Sequences

- *Stimulus: User answers MCQs.*
- *Response: Real-time scoring and interpretation.*

3.3.3 Functional Requirements

- *REQ-1: Load ASD screening questionnaire.*
 - *REQ-2: Assign weighted score and interpret results.*
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3.4 MRI Report Upload

3.4.1 Description and Priority

- *Allows optional MRI upload for auxiliary analysis.*
- *Priority: Low.*

3.4.2 Stimulus/Response Sequences

- *Stimulus: User uploads image file or scan report.*
- *Response: System extracts brain features for further analysis.*

3.4.3 Functional Requirements

- *REQ-1: Support DICOM/PNG/JPG.*
- *REQ-2: Process MRI via pre-trained autoencoder.*

4. External Interface Requirements

4.1 User Interfaces

Autism Spectrum Analyzer (ASA) features three primary user interfaces: the Behavioral Assessment Interface for video-based screening and webcam interactions, the Questionnaire Interface for completing adaptive screening forms, and the Result Display Interface for presenting real-time diagnostic insights. These interfaces are designed for ease of use across a wide range of users, including non-technical individuals and healthcare professionals. They adhere to industry-standard GUI principles, offering responsive design, consistent navigation, standardized buttons, accessible input fields, and clear error messaging. Visual guidance and tooltips further enhance usability. Detailed interface specifications are documented separately in the User Interface Specification.

4.2 Hardware Interfaces

ASA is designed for accessibility across a range of devices, including desktops, laptops, and mobile devices, using standard web browsers. The platform ensures smooth data interactions through HTTP/HTTPS for secure communication and leverages WebSockets for real-time updates during the screening process. Compatibility with Windows, macOS, and mobile

operating systems, alongside a stable internet connection, guarantees a seamless user experience across various devices.

4.3 Software Interfaces

ASA integrates seamlessly with multiple software components, ensuring compatibility with both Windows and macOS operating systems. The platform is accessible through popular web browsers and communicates via HTTP/HTTPS protocols for secure data exchange. For real-time updates, WebSockets are employed to keep users engaged during assessments. Future integration with third-party APIs, such as cloud storage or electronic health record systems, will enhance functionality and data management, adhering to RESTful principles for standardized communication.

4.4 Communications Interfaces

ASA uses HTTP/HTTPS for secure and standardized data exchange, while real-time updates are facilitated by WebSockets. The platform prioritizes optimized data transfer rates to ensure efficient performance, particularly during file uploads and MRI scans. Security is maintained with encryption via TLS/SSL, safeguarding sensitive user data. Synchronization mechanisms ensure real-time consistency across devices, crucial for progress tracking and results updates. Email notifications and user alerts adhere to standard protocols like SMTP, and electronic forms comply with web standards for a user-friendly experience. Clear error messages and notifications guide users throughout the process, enhancing the overall reliability, security, and usability of ASA.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

1. File Upload and Processing Performance

- *Requirement: The system must support the upload and processing of video files and MRI scans up to 500MB in size, completing analysis and result generation within 15 minutes.*

2. Real-Time Assessment Feedback

- *Requirement: Users should receive real-time feedback during behavioral assessments and questionnaire completion, with updates provided at least every 10 seconds.*
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3. **Concurrency and Scalability**

- *Requirement: The system should support simultaneous screenings and analyses for a minimum of 100 concurrent users without performance degradation.*

4. **User Interface Responsiveness**

- *Requirement: All user interface interactions must respond within 1 second to ensure a smooth and responsive user experience.*

5. **Optimized Data Transfer Rates**

- *Requirement: The application should support a minimum data transfer rate of 5 Mbps to enable efficient video uploads and real-time communication.*

6. **Security Performance**

- *Requirement: Encryption and decryption processes for sensitive health data should complete within 50 milliseconds to avoid noticeable system delays.*

7. **Email Notification Delivery Time**

- *Requirement: Notification emails (e.g., for screening completion or report availability) should be delivered within 5 minutes of task completion.*

5.2 Safety Requirements

The Autism Spectrum Analyzer (ASA) does not involve direct physical risks, but safety requirements are critical to ensure the protection of sensitive health data and secure system operation. The platform must prevent data breaches and unauthorized access by implementing end-to-end encryption, secure communication protocols (e.g., HTTPS and TLS), and strong user authentication. Compliance with GDPR and HIPAA is essential for lawful and ethical data handling. To mitigate risks, ASA must also adhere to industry standards for information security, enforce strict access controls, and conduct regular security audits, ensuring user privacy and data integrity throughout the screening process.

5.3 Security Requirements

1. **Data Encryption**

- *Requirement: All data transmissions, including video uploads, MRI scans, questionnaire data, and real-time updates, must be encrypted using industry-standard protocols such as TLS/SSL to ensure secure communication.*

2. User Identity Authentication

- *Requirement: ASA must implement secure authentication methods, such as username/password combinations or multi-factor authentication (MFA), to verify user identities before granting access.*

3. Access Control and Authorization

- *Requirement: Role-based access control (RBAC) must be enforced to ensure users—whether parents, clinicians, administrators, or developers—can only access data and features appropriate to their roles.*

4. Data Privacy Compliance

- *Requirement: ASA must comply with applicable data protection regulations, including GDPR and HIPAA, to safeguard user privacy and ensure the ethical handling of personal health information.*

5.4 Software Quality Attributes

1. Usability

- *Requirement: The ASA interface should achieve a System Usability Scale (SUS) score of at least 80, ensuring ease of use and a high level of satisfaction for both technical and non-technical users, including parents and clinicians.*

2. Reliability

- *Requirement: ASA must maintain a system uptime of 99.9% to ensure consistent availability, especially for time-sensitive assessments and screenings.*

3. Adaptability

- *Requirement: The system should support seamless integration of updates and new features, with planned downtime for major updates not exceeding 1 hour.*

4. Interoperability

- *Requirement: ASA must be compatible with widely used web browsers (e.g., Chrome, Firefox, Safari) and major operating systems (Windows, macOS, iOS, Android) to ensure accessibility across user devices.*

5. Maintainability

- *Requirement: The codebase must follow standard development practices to support easy maintenance, with an average bug resolution time not exceeding 48 hours to ensure timely system reliability and performance.*

6. Other Requirements

No other requirements are needed.

Appendix A: Glossary

- **ASA:** *Autism Spectrum Analyzer*
 - **ASD:** *Autism Spectrum Disorder*
 - **CNN/LSTM:** *Deep Learning Models used for video and time-series analysis*
 - **DICOM:** *Standard MRI file format*
 - **HIPAA/GDPR:** *Data protection laws*
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