Software Requirements Specification
ASLingo Application

Team 15, ASLingo

Andrew Kil

Cassidy Baldin

Edward Zhuang

Jeremy Langner

Stanley Chan

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Table 1: Revision History

Date	Developers	Change
September 25, 2023	All team members	Initial draft, added some functional requirements
September 26, 2023	Andrew Kil	Added constraints and naming conventions
September 26, 2023	Cassidy Baldin	Added some functional and non-functional requirements
September 27, 2023	Jeremy Langner	Added some points to section 4 Project Issues
September 28, 2023	Cassidy Baldin	Added NFR tables, some rationales for NFRs
September 28, 2023	Andrew Kil	Added abbreviations and assumptions
September 28, 2023	Stanley Chan	Added scope and context of work, some work partitioning events
September 28, 2023	Edward Zhuang	Added to Section 4 and some FR rationales
October 2, 2023	Cassidy Baldin	Edited Section 3 requirements, finished all rationales
October 4, 2023	Stanley Chan	Added individual product use cases, updated work partitioning
October 4, 2023	Edward Zhuang	Edited Section 4 according to meeting with MSLC, and added response to one reflection question
October 6, 2023	Cassidy Baldin	Added fit criterion, fixed formatting, added reflection

This document describes the requirements for ASLingo. The template for the Software Requirements Specification (SRS) is a subset of the Volere template *Robertson And Robertson (2012)*. Subsections *Clients* and *Customers* were removed due to not having any such dependents.

1 Project Drivers

1.1 The Purpose of the Project

Learning a new language can be an arduous task that only gets more challenging with age, as individuals may find it difficult to dedicate time and effort to it. American Sign Language (ASL) is particularly hard due to its visual and gestural nature, which is not found in other, verbal languages. The purpose of this project is to ease that challenge by providing an online, easy-to-access web platform for individuals to learn new signs and test their comprehension at their own pace in a fun, interactive manner. Focusing in on consistent effort and continuous feedback, ASLingo provides real-time guidance to ensure users stay on track to achieving their goals of learning ASL.

1.2 The Stakeholders

The stakeholders for this project include those who use sign language as their primary mode of communication in daily life as well as those who have an interest in learning ASL. This would naturally expand outward towards educators who wish to promote the learning of ASL to their respective institutions.

1.3 Mandated Constraints

The project is constrained by the following:

The Project Expenses Cannot Exceed $750

 – The project cannot be bought or be a 'ready-made' solution, and any cost incurred must be minimized to ensure cost-efficiency.

Test Only a Subset of the Most Commonly Used Phrases of ASL

 – The project in the long-term would encompass the entirety of ASL as a whole. But with the given time-constraints, the testable language subset will be limited.

The Project Must be Finished by the End of the Academic Year

 – This is the hard deadline for the project and sets the time constraint that is used to judge the scope of work the project can encompass.

Users Should Only Learn from the Provided "On Rails" Approach

– Users are only able to learn from the preset programs the project has. The education provided should be taught in a manner with little room misinterpretation. While we attempt to make the learning content as broad as possible, users lack true learning freedom to learn what they want.

1.4 Naming Conventions and Terminology

Table 2: Naming Conventions and Terminology

Term, Abbreviation, or Acronym	Description
A	Shorthand for Assumption
ASL	Shorthand for American Sign Language. It is a form of sign language primarily used in the US and in parts of Canada
ASLingo	The commercial name for the project
CV	Refers to Computer Vision, the field of technology that involves processing visual input to achieve various means.
CR	Shorthand for 'Cultural Requirements', a subsection of Non-Functional Requirements.
HSR	Shorthand for 'Health and Safety Requirements', a subsection of Non-Functional Requirements.
FR	Shorthand for Functional Requirements
LR	Shorthand for 'Legal Requirements', a subsection of Non-Functional Requirements.
LFR	Shorthand for 'Look and Feel Requirements', a subsection of Non-Functional Requirements.
MSR	Shorthand for 'Maintainability and Support Requirements', a subsection of Non-Functional Requirements.

OER	Shorthand for 'Operational and Environmental Requirements', a subsection of Non-Functional Requirements.
OpenCV	Refers to the Open Computer Vision Library library available for free to developers in order to develop Computer Vision applications.
PR	Shorthand for 'Performance Requirements', a subsection of Non-Functional Requirements.
SR	Shorthand for 'Security Requirements', a subsection of Non-Functional Requirements.
UHR	Shorthand for 'Usability and Humanity Requirements', a subsection of Non-Functional Requirements.

1.5   Relevant Facts and Assumptions

1. The user will always have the camera their hands when using the application.

   Correct camera angling towards the user's hands is the first condition for the application to work.

2. The environmental lighting will always be sufficient for joint detection.

   Proper lighting is the second condition for the application to work since it cannot properly distinct what the user signs without it.

3. The user's signs will be within reasonable form of the proper sign, enough to be recognized by the system

   If the user signs are correct but with poor form, the system will have a hard time determining if it is correct.

2   Functional Requirements

2.1   The Scope of the Work and the Product

The scope of ASLingo can be clearly defined by outlining our primary goals for this product.

1. Hand Sign Recognition: Reliably recognize users' hand sign in real-time based on the American Sign Language.

2. Test Users: Quiz users with sign language based questions.

3. User Progression: Track a user's sign language learning progression.

4. Account Management: Store required user information to allow users to create and login to their accounts.

2.1.1 The Context of the Work

The following is a context diagram which describes the high-level overview on how the system will be utilized.

Figure 1: Context Diagram

2.1.2 Work Partitioning

Table 3: Work Partitioning

Event ID	Event Name	Input and Output	Description
1	User login	User ID (in) User Password (in) Login Status (out)	User logs into the application, the system determines if login is successful.
2	User logout	User ID (in) Login Status (out)	User logs out of the application, system indicates whether log out is successful or not.
3	User requests to start a test	User ID (in)	User starts a test.
4	User signs through webcam	Camera Feed (in) Recognized Sign (out)	User inputs sign language hand signs through webcam, the system responds with the corresponding sign output.
5	User creates account	User ID (in) User Email (in) User Password (in)	User creates an account
6	User checks learning progress	User ID (in) User Progress (out)	User views account sign language learning progress.
7	User completes a test	User ID (in) User Score (in)	User completes a test with a given score.

2.1.3 Individual Product Use Cases

Use Case Trigger: User creates an account
Primary Actors: user, ASLingo server
Outcomes:

1. System creates an account with the designated username, password, and email

2. System registers user as logged in

3. System redirects user to home page

Use Case Trigger: User logs into the application
Primary Actors: user, ASLingo server
Outcomes:

1. System checks if password matches for corresponding username

2. System registers user as logged in

3. System redirects user to home page

Use Case Trigger: User logs out of the application
Primary Actors: user, ASLingo server
Outcomes:

1. System registers user as logged out

2. System redirects user to login page

Use Case Trigger: User requests to start a test
Primary Actors: user, ASLingo server
Outcomes:

1. System redirects user to testing page

2. System requests to turn on user webcam

3. System receives video data from user webcam

Use Case Trigger: User signs through webcam
Primary Actors: user, ASLingo server, ASLingo Computer Vision Model
Outcomes:

1. System interprets user signs with computer vision model

2. System responds informing user of correctness of sign

Use Case Trigger: User checks learning progress
Primary Actors: user, ASLingo server
Outcomes:

1. System receives request from user to view learning progress

2. System responds with user progress

Use Case Trigger: User completes a test
Primary Actors: user, ASLingo server
Outcomes:

1. System registers that user completed test, and saves user score

2.1.4 Traceability Matrix

Requirement No.	Use Case No.	1	2	3	4	5	6	7
FR1					X			
FR2					X			
FR3						X		
FR4		X						
FR5			X					
FR6						X		
FR7							X	
FR8		X					X	
FR9							X	X
FR10					X			
FR11					X			
FR12				X				

Figure 2: Traceability Matrix for Functional Requirements

2.2 Functional Requirements

Table 4: Functional Requirements of ASLingo

Requirement No.	Description	Rationale
FR1	The system should be able to connect with a camera.	Connecting with a camera is a requirement for providing input to the system for hand sign recognition.

FR2	The system should be able to recognize American Sign Language hand signs.	Hand sign recognition is a requirement for users to practice what they have been learning.
FR3	The system should allow users to create an account.	Account creation is a requirement for users to save progression.
FR4	The system should allow users to sign into their account if it exists.	Account sign-in is a requirement for users to save progression.
FR5	The system should allow users to sign out of their account if they are signed into it.	Account sign-out is necessary for good account security practices.
FR6	The system should provide a diagnostic quiz for new users.	A diagnostic quiz is a requirement for determining the current skill level of the user.
FR7	The system should provide a progression-based course for ASL.	A progression-based course is a requirement for ensuring users are taught ASL in a comprehensive manner.
FR8	The system should save user progress.	Saving user progress is a requirement for ensuring the user follows the progression-based course.
FR9	The system should allow users to access the program via a web application	The system is being built for a web application, so the user should be able to access it in this way.
FR10	The system should be able to communicate to the user if they have answered the prompt correctly.	The user should know if they have answered the prompt correctly to learn the language correctly.

Requirement No.	Description	Rationale
FR11	The system should notify the user of any potential errors that may arise during camera recognition.	This will let the user know if they need to adjust their input setting (camera angle, lighting etc.) so the system can accurately access their hand signs.
FR12	The system should allow the user to their desired testing track from a selection of testing categories.	This is to provide variation in the manner of testing as well as in the subject matter that the user can test themselves on.

3 Non-Functional Requirements

3.1 Look and Feel Requirements

Table 5: Look and Feel Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
LFR1	The system should remind users of similar language learning applications	This will allow users to use the system intuitively if they have knowledge of other learning apps.	Ask a sample of users to rate how familiar/easy to use it is compared to other language learning apps.
LFR2	The system should show the user how much progress they have made in their learning schedule.	The user should be able to gain feedback from the system about how much they learned.	The developers shall certify the product complies with these requirements.
LFR3	The system should clearly show the user if they have answered the prompt correctly.	The user should gain feedback about if they are correct with the hand sign they have shown.	The developers shall certify the product shows the user the correct response based on their input.

3.2 Usability and Humanity Requirements

Table 6: Usability and Humanity Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
UHR1	The system should be able to be used by people with little to no training.	The system should be able to be used without the need for formal training to make it easier for the average user.	After their first encounter with the product, 75% of users shall report if they are comfortable using the application.
UHR2	The system should be able to be used by people who are hard of hearing or deaf, as well as those who are able to hear.	The system should be accessible for all people wanting to learn ASL.	Users will be asked to rate their experience using the application on a scale of 1-10, with the average reporting a score above 7.
UHR3	The system should allow users to personalize their account.	The user should be able to input their name, see their progress etc.	The developers shall certify the product complies with these requirements.

3.3 Performance Requirements

Table 7: Performance Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
PR1	The system should respond to user input quickly.	If a user has to wait too long after an input they may be less engaged.	95% of tests should repond to user input within 1 second.
PR2	The system should be able to accurately determine the sign shown by the user.	The system must be able to understand what hand signs the user is inputing to ensure they are learning effectively.	The system should accurately determine the correct hand sign from a user in 95% of tests.
PR3	The system should show the user if the input needs to be adjusted.	The user should know if they need to change their camera angle, lighting etc. for the system to accurately give them proper feedback.	The developers shall certify the product complies with these requirements.

3.4 Operational and Environmental Requirements

Table 8: Operational and Environmental Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
OER1	The system should be used as a web application on a browser/laptop.	The system is being built for a web application, so the user should be able to access it in this way.	95% of users are able to successfully use the product as a web application on a broswer source.
OER2	The system should be able to access a user's camera device.	The user's camera will be used as the input device to see the user's hand signs.	90% of users are able to successfully use their camera on their input device.

3.5 Maintainability and Support Requirements

Table 9: Maintainability and Support Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
MSR1	The system should be tested regularly to ensure it's functionality and usability.	This will ensure that the system does not experience any bugs or other errors when being updated over time.	The product must pass 95% of its developer tests at least once a week.

MSR2	The code implemented in the system should adhere to specified coding standards to ensure it's readibilty for future updates.	This will ensure that the system code can be understood over time, so others can update it if they wish.	The developers shall certify the product complies with these requirements.
MSR3	The code implemented in the system should be tested using code coverage methods to test all functions of the system.	This will ensure that all aspects of the system can be tested for errors, and fixed if errors are found during testing.	80% of code coverage shall be achieved when running test cases on the system.
MSR4	The system should allow for new signs to be added over the lifespan of the system.	This will allow the system to expand over time, as well as be able to add in new modern signs. The modules of the product will be written according to coding standards to allow for new additions to the system.	The developers shall certify the product complies with these requirements.

3.6 Security Requirements

Table 10: Security Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
SR1	The system should allow the user to access their account after creating it.	The user should be able to create an account and be able to log in and out of it as needed.	The developers shall certify the product complies with these requirements.
SR2	The system should ensure that incorrect input to the system is used.	The system should not be trained using incorrect usage of ASL as this would contradict the goal of learning how to use the language properly.	The developers shall certify the product complies with these requirements.
SR3	The system should store user account information using encryption.	This will ensure that all user information will be kept private and secure.	The developers shall certify the product complies with these requirements.

3.7 Cultural Requirements

Table 11: Cultural Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
CR1	The system should be written in Canadian English and teach users using American Sign Language.	The primary users of this application at this stage will be Canadian English speakers who want to learn American Sign Language.	The developers shall certify the product complies with these requirements.

3.8 Legal Requirements

Table 12: Legal Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
LR1	The system should adhere to user privacy laws.	The system should never share user information or break any other user privacy law.	N/A
LR2	The system should not train the model on personal/confidential/illegal data	The system should only be trained on data that is safe to use, and is in the public domain.	The developers shall certify the product complies with these requirements.

3.9 Health and Safety Requirements

Table 13: Health and Safety Non-Functional Requirements

Requirement No.	Description	Rationale	Fit Criterion
HSR1	The system should warn users to ensure they have enough space to practice ASL in their environment.	This will ensure that the user will not use this application if there is not enough space to comfortably do so.	The developers shall certify the product complies with these requirements.

4 Project Issues

4.1 Open Issues

There are currently no open issues with the project at the moment.

4.2 Off-the-Shelf Solutions

1. The ASL App is a mobile exclusive platform with 2,500+ signs and phrases to teach ASL via short video clips. This app offers 4 packs for free with the basics like the

alphabet, numbers, and universal gestures. Paid packs are also available ex. compliments, moods, and social gestures for $0.99. The app ultimately serves as a mobile hub for common expressions to study and learn wherever you are.

2. Canadian Hearing Services offer both in-person and virtual educational ASL courses for a variety of experience levels. These courses educate via teacher instruction, role play, videos, and work books. A variety of other public, private, and educational institutes offer similar courses and instructional content.

3. Duolingo is a popular mobile application that provides language courses for many languages from across the world, with 50+ million monthly active users. The app utilizes gamification to encourage consistent user progress and interest. Majority of the courses are based on testing users on vocabulary and grammar via reading, listening, and speaking problems which increase in difficulty as users progress. Its courses are well developed through research and accord with global language standards, such as the Common European Framework of Reference for Languages (CEFR).

4.3 New Problems

There are currently no new problems.

4.4 Tasks

- Development should follow the agile methodology, with emphasis on different aspects of the project: frontend, backend, and computer vision.

4.5 Migration to the New Product

Not applicable for our project.

4.6 Risks

1. The primary risk of this product is the potential for error when trying to analyze and recognize a user's sign to give feedback or determine if their form is correct. This could cause users to improperly learn signs and hinder their learning.

4.7 Costs

1. Website domain - TBA

2. App hosting platform - TBA

3. Database - TBA

4.8   User Documentation and Training

The system and its interface should be intuitive enough to learn how to use the app. User documentation to be supplied with the product should include a general setup guide and can include a glossary for basic signs, such as for the alphabet.

4.9   Waiting Room

1. The system should incorporate full body signs (eg. the sign for "shorts") and facial expression/body language recognition, as they are a crucial aspect of sign language.

2. The system should provide different courses for learners of varying skill level.

3. The system should teach other common sign languages.

4.10   Ideas for Solutions

N/A

5   Appendix

This section has been added to the Volere template. This is where you can place additional information.

6   Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Lifelong Learning. Please answer the following questions:

1. Which of the courses you have taken, or are currently taking, will help your team to be successful with your capstone project.

2. What knowledge and skills will the team collectively need to acquire to successfully complete this capstone project? Examples of possible knowledge to acquire include domain specific knowledge from the domain of your application, or software engineering knowledge, mechatronics knowledge or computer science knowledge. Skills may be related to technology, or writing, or presentation, or team management, etc. You should look to identify at least one item for each team member.

3. For each of the knowledge areas and skills identified in the previous question, what are at least two approaches to acquiring the knowledge or mastering the skill? Of the identified approaches, which will each team member pursue, and why did they make this choice?

1. Many software design and principles courses contribute to the team's success on the capstone project. Our project is primarily software-based, involving a combination of everything taught throughout the program, including software design, development, and documentation. Here is a list of specific courses that were particularly helpful for us:

   - SFWRENG 2AA4
   - SFWRENG 2C03
   - SFWRENG 2XA3
   - SFWRENG 2XB3
   - SFWRENG 3A04
   - SFWRENG 3RA3
   - SFWRENG 3S03
   - SFWRENG 3XA3
   - SFWRENG 4HC3

2. Some overall knowledge and skills that will be required in the entire team include domain knowledge (the fundamentals of ASL and basic signing), skills in technical tools for development (React, OpenCV, Python, etc.), documentation writing skills, and communication skills for connecting with stakeholders.

- Edward – On the technical side, I will need to familiarize myself with OpenCV and computer vision in general. As well, I will need to learn how to apply machine learning to recognizing specific hand motions. On the non-technical side, I will need to familiarize myself with ASL and at minimum learn basic hand signs. I aim to learn more than just the fundamentals, so I can help to design the course that our project provides.

- Cassidy – For technical skills, I am mostly familiar with back end development, so through this project I hope to learn more about front end web development, as well as learning some fundamentals of machine learning for the hand motions. I also hope to be able to learn some ASL through this project, as well as further develop project development and time management skills.

3.