

# Software Requirements Specification for Software Engineering: subtitle describing software

Team 13, Speech Buddies

Mazen Youssef

Rawan Mahdi

Luna Aljammal

Kelvin Yu

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# Contents

<b>1</b>	<b>Purpose of the Project</b>	<b>vi</b>
1.1	User Business . . . . .	vi
1.2	Goals of the Project . . . . .	vii
<b>2</b>	<b>Stakeholders</b>	<b>vii</b>
2.1	Client . . . . .	vii
2.2	Customer & Hands-On Users of the Project . . . . .	viii
2.3	Other Stakeholders . . . . .	viii
2.4	Personas . . . . .	viii
2.5	Priorities Assigned to Users . . . . .	ix
2.6	User Participation . . . . .	ix
2.7	Maintenance Users and Service Technicians . . . . .	ix
<b>3</b>	<b>Mandated Constraints</b>	<b>x</b>
3.1	Solution Constraints . . . . .	x
3.2	Implementation Environment of the Current System . . . . .	xi
3.3	Partner or Collaborative Applications . . . . .	xi
3.4	Off-the-Shelf Software . . . . .	xii
3.5	Anticipated Workplace Environment . . . . .	xii
3.6	Schedule Constraints . . . . .	xiii
3.7	Budget Constraints . . . . .	xiii
3.8	Enterprise Constraints . . . . .	xiii
<b>4</b>	<b>Naming Conventions and Terminology</b>	<b>xiv</b>
4.1	Glossary of All Terms, Including Acronyms, Used by Stakeholders involved in the Project . . . . .	xiv
4.2	Technical Terminology . . . . .	xiv
4.3	Medical Terminology . . . . .	xiv
<b>5</b>	<b>Relevant Facts And Assumptions</b>	<b>xiv</b>
5.1	Relevant Facts . . . . .	xiv
5.2	Business Rules . . . . .	xiv
5.3	Assumptions . . . . .	xv
<b>6</b>	<b>The Scope of the Work</b>	<b>xv</b>
6.1	The Current Situation . . . . .	xv
6.2	The Context of the Work . . . . .	xv

6.3	Work Partitioning . . . . .	xv
6.4	Specifying a Business Use Case (BUC) . . . . .	xv
<b>7</b>	<b>Business Data Model and Data Dictionary</b>	<b>xv</b>
7.1	Business Data Model . . . . .	xv
7.2	Data Dictionary . . . . .	xv
<b>8</b>	<b>The Scope of the Product</b>	<b>xv</b>
8.1	Product Boundary . . . . .	xv
8.2	Product Use Case Table . . . . .	xvi
8.3	Individual Product Use Cases (PUC's) . . . . .	xvi
<b>9</b>	<b>Functional Requirements</b>	<b>xvi</b>
9.1	Functional Requirements . . . . .	xvi
<b>10</b>	<b>Look and Feel Requirements</b>	<b>xvi</b>
10.1	Appearance Requirements . . . . .	xvi
10.2	Style Requirements . . . . .	xvi
<b>11</b>	<b>Usability and Humanity Requirements</b>	<b>xvii</b>
11.1	Ease of Use Requirements . . . . .	xvii
11.2	Personalization and Internationalization Requirements . . . . .	xvii
11.3	Learning Requirements . . . . .	xvii
11.4	Understandability and Politeness Requirements . . . . .	xvii
11.5	Accessibility Requirements . . . . .	xvii
<b>12</b>	<b>Performance Requirements</b>	<b>xviii</b>
12.1	Speed and Latency Requirements . . . . .	xviii
12.2	Safety-Critical Requirements . . . . .	xviii
12.3	Precision or Accuracy Requirements . . . . .	xviii
12.4	Robustness or Fault-Tolerance Requirements . . . . .	xviii
12.5	Capacity Requirements . . . . .	xviii
12.6	Scalability or Extensibility Requirements . . . . .	xviii
12.7	Longevity Requirements . . . . .	xix
<b>13</b>	<b>Operational and Environmental Requirements</b>	<b>xix</b>
13.1	Expected Physical Environment . . . . .	xix
13.2	Wider Environment Requirements . . . . .	xix
13.3	Requirements for Interfacing with Adjacent Systems . . . . .	xix

13.4	Productization Requirements . . . . .	xix
13.5	Release Requirements . . . . .	xx
<b>14</b>	<b>Maintainability and Support Requirements</b>	<b>xx</b>
14.1	Maintenance Requirements . . . . .	xx
14.2	Supportability Requirements . . . . .	xx
14.3	Adaptability Requirements . . . . .	xx
<b>15</b>	<b>Security Requirements</b>	<b>xxi</b>
15.1	Access Requirements . . . . .	xxi
15.2	Integrity Requirements . . . . .	xxi
15.3	Privacy Requirements . . . . .	xxi
15.4	Audit Requirements . . . . .	xxi
15.5	Immunity Requirements . . . . .	xxii
<b>16</b>	<b>Cultural Requirements</b>	<b>xxii</b>
16.1	Cultural Requirements . . . . .	xxii
<b>17</b>	<b>Compliance Requirements</b>	<b>xxii</b>
17.1	Legal Requirements . . . . .	xxii
17.2	Standards Compliance Requirements . . . . .	xxii
<b>18</b>	<b>Open Issues</b>	<b>xxii</b>
<b>19</b>	<b>Off-the-Shelf Solutions</b>	<b>xxiii</b>
19.1	Ready-Made Products . . . . .	xxiii
19.2	Reusable Components . . . . .	xxiii
19.3	Products That Can Be Copied . . . . .	xxiii
<b>20</b>	<b>New Problems</b>	<b>xxiii</b>
20.1	Effects on the Current Environment . . . . .	xxiii
20.2	Effects on the Installed Systems . . . . .	xxiii
20.3	Potential User Problems . . . . .	xxiii
20.4	Limitations in the Anticipated Implementation Environment That May Inhibit the New Product . . . . .	xxiv
20.5	Follow-Up Problems . . . . .	xxiv

<b>21 Tasks</b>	<b>xxiv</b>
21.1 Project Planning . . . . .	xxiv
21.2 Planning of the Development Phases . . . . .	xxiv
<b>22 Migration to the New Product</b>	<b>xxv</b>
22.1 Requirements for Migration to the New Product . . . . .	xxv
22.2 Data That Has to be Modified or Translated for the New System	xxv
<b>23 Costs</b>	<b>xxv</b>
<b>24 User Documentation and Training</b>	<b>xxvi</b>
24.1 User Documentation Requirements . . . . .	xxvi
24.2 Training Requirements . . . . .	xxvi
<b>25 Waiting Room</b>	<b>xxvi</b>
<b>26 Ideas for Solution</b>	<b>xxvi</b>
26.1 Browser-Based Extensions . . . . .	xxvi
26.2 Personalized ASR Fine-Tuning . . . . .	xxvi
26.3 LLM Command Mapping . . . . .	xxvi
26.4 Noise Filtering . . . . .	xxvii
26.5 Open-Source Integrations . . . . .	xxvii
26.6 Accessibility Enhancements . . . . .	xxvii
26.7 Data Encryption . . . . .	xxvii

## Revision History

Date	Version	Notes
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# **1 Purpose of the Project**

## **1.1 User Business**

Individuals with speech impairments face significant barriers when interacting with digital devices. VoiceBridge addresses this gap by providing an accurate, inclusive, and accessible speech-to-control system that enables users to communicate with their devices using their speech, regardless of clarity of articulation. Building on familiar technology, such as personal computers and mobile devices, may be one of the most cost-effective and easily adoptable approaches for improving an individual with disability's autonomy and access to the world around them. The rise of ASR technology and Artificial Intelligence (AI) integrations in the industry provides a novel landscape of opportunities to improve accessibility interfaces. VoiceBridge exploits bleeding-edge technology for a practical and impactful application.

## 1.2 Goals of the Project

ID	Goal	Description
G1	<b>Accurate Speech Transcription</b>	Reliably convert impaired or slurred speech into text.
G2	<b>Command Mapping</b>	Translate recognized speech into actionable browser commands.
G3	<b>User Independence</b>	Enable users with speech impairments to browse autonomously.
G4	<b>Lightweight &amp; Accessible Design</b>	Keep the system simple, fast, and cost-effective.
G5	<b>Cross-Browser Compatibility</b>	Support major browsers (e.g., Chrome, Edge, Firefox).
G6	<b>Robust Error Handling</b>	Detect and recover gracefully from common failures.
G7	<b>Data Privacy &amp; Security</b>	Protect user data and ensure secure local processing.
G8	<b>Customizable Interface</b>	Allow users to adjust sensitivity, shortcuts, and feedback modes.
G9	<b>Scalable Architecture</b>	Design the system for future integration beyond browsers.

Table 1: Project Goals for VoiceBridge

## 2 Stakeholders

### 2.1 Client

The primary client for the VoiceBridge project is the organization or individual funding or commissioning the system. The client is primarily concerned with achieving the following goals: **G1**, **G5**, and **G9**, ensuring accurate speech transcription, cross-browser compatibility, and scalable architecture.



## 2.2 Customer & Hands-On Users of the Project

The primary customers are also the users of the project, them being individuals with speech impairments, who seek independence and autonomy through technology. Their needs directly relate to: **G1**, **G2**, **G3**, and **G8**.

## 2.3 Other Stakeholders

Secondary stakeholders include experts in linguistics, speech processing, and healthcare domains:

- Speech researchers and linguistics specialists, including the project supervisor, Dr. Christian Brodbeck, who provide insight toward **G1** and **G6**.
- Healthcare professionals and speech therapists who advise on usability and accessibility, contributing to **G3** and **G8**.
- Accessibility advocates and organizations interested in promoting the application, aligned with **G4** and **G5**.
- Software developers who implement and maintain the system, supporting **G9** and **G6**.

Tertiary stakeholders include caregivers and professionals who interact with end users, supporting **G3** and **G7**.

## 2.4 Personas

Potential end users of VoiceBridge include:

- **Amira**, a 45-year-old with Parkinson's disease, uses the system to log into Gmail and send emails.
- **David**, a stroke survivor, uses the system to browse the web and make purchases.

## 2.5 Priorities Assigned to Users

The highest priorities are assigned to end users with speech impairments, as their experience with the system defines its success. Secondary priorities include caregivers and technical experts who support the end users in using and maintaining the system.

## 2.6 User Participation

Individuals matching the target user profiles will be recruited for prototype testing and personalization development. Their participation directly supports refining goals [G1](#), [G2](#), [G3](#), and [G8](#).

## 2.7 Maintenance Users and Service Technicians

### Maintenance Users:

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- **Role:** End-users or caregivers performing basic troubleshooting and initiating support requests.
- **Responsibilities:**
  - Reporting errors or unexpected system behavior ([G6](#)).
  - Installing application updates ([G9](#)).
  - Managing user-specific configurations ([G8](#)).

### Service Technicians:

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- **Role:** Trained technical staff with deeper access to system logs and back-end services.
- **Responsibilities:**
  - Investigating reported issues ([G6](#)).
  - Ensuring transcription accuracy ([G1](#)).
  - Deploying updates and patches ([G9](#)).

- Ensuring compatibility with operating systems and accessibility frameworks (**G5**).
- Performing preventive maintenance, including performance monitoring and optimization (**G1**, **G6**).

## 3 Mandated Constraints

### 3.1 Solution Constraints

ID	Constraint	Rationale	Fit Criterion
C1	The product shall run on consumer-grade hardware using a personal computer microphone and support macOS, Windows, and Linux distributions.	Requiring only consumer-grade hardware ensures broad accessibility for end users and avoids dependency on specialized equipment.	The system must successfully be integrated onto browsers and run on laptops or desktops across the supported operating systems, using either built-in or external microphones.
C2	The product shall accept non-deterministic user input in the form of natural language speech.	Individuals with speech impairments may produce varied speech patterns that cannot be handled by rigid or deterministic command structures.	The system must be capable of processing and responding to variable natural language inputs without requiring a fixed set of commands.
C3	The product shall integrate with a browser control application to execute voice-based commands.	Browser interaction is a primary accessibility point for most digital services, and browser control is essential for practical use of the system.	The system must successfully perform browser actions (e.g., opening tabs, navigating to URLs, scrolling) through the integrated control application.

### 3.2 Implementation Environment of the Current System

ID	Constraint	Rationale	Fit Criterion
C4	The product will operate within a consumer computing environment consisting of personal computers equipped with microphones.	This setup reflects the most common user hardware configuration, ensuring the solution is accessible without additional devices.	All core functionalities must operate correctly on standard personal computers with a functioning audio input device.

### 3.3 Partner or Collaborative Applications

ID	Constraint	Rationale	Fit Criterion
C5	The initial integration target is Browser Use, an open-source browser control and automation application.	Leveraging existing open-source browser automation tools accelerates development and reduces implementation complexity.	The system must demonstrate the ability to execute at least three browser actions through the integrated partner application during testing.
C6	Future integrations may include API servers, mobile device agents, and home assistants to extend accessibility and functionality.	Ensuring extensibility allows the system to grow and adapt to new platforms or user needs.	The system architecture must allow seamless integration with additional partner applications without major redesign.

### 3.4 Off-the-Shelf Software

ID	Constraint	Rationale	Fit Criterion
C7	The product will rely on off-the-shelf software components, specifically Browser Use for automation and Project Euphonia for voice recording.	Using established open-source components allows focus on core functionality, improves maintainability, and supports experimentation with real-world data.	These components must be successfully integrated into the development workflow, and collected recordings must be stored and processed for model training without licensing conflicts.

### 3.5 Anticipated Workplace Environment

ID	Constraint	Rationale	Fit Criterion
C8	The product may be used at home, in public spaces, or in clinical settings, each with varying background noise conditions.	The product must function effectively across diverse real-world environments to meet accessibility goals.	The speech recognition system must maintain acceptable accuracy and responsiveness across all three identified environments during testing.

### 3.6 Schedule Constraints

ID	Constraint	Rationale	Fit Criterion
C9	Proof of concept must be completed by November 17, 2025. MVP must be ready within eight months, by May 2026.	Deadlines align with capstone project milestones and funding timelines, ensuring timely testing and delivery.	All proof of concept requirements must be met by the November deadline, and MVP functionality must be fully operational by May 2026.

### 3.7 Budget Constraints

ID	Constraint	Rationale	Fit Criterion
C10	The project must operate within the capstone budget allocated for compute infrastructure and development resources.	Budget limitations require prioritizing open-source solutions and efficient resource allocation.	Total cost of infrastructure, hosting, and third-party services must not exceed the allocated capstone budget.

### 3.8 Enterprise Constraints

ID	Constraint	Rationale	Fit Criterion
C11	The product must comply with all relevant accessibility and privacy regulations, including data usage and user privacy agreements.	Compliance protects user rights, upholds institutional standards, and avoids legal or ethical issues.	All data collection and processing workflows must undergo compliance review, and accessibility features must align with recognized standards (e.g., WCAG).

## 4 Naming Conventions and Terminology

### 4.1 Glossary of All Terms, Including Acronyms, Used by Stakeholders involved in the Project

*Insert your content here.*

### 4.2 Technical Terminology

**ASR** - Automatic Speech Recognition

**TTS** - Text To Speech

**STT** - Speech To Text

### 4.3 Medical Terminology

**Aphasia** - A condition that robs you of the ability to communicate. It can affect your ability to speak, write and understand language, both verbal and written. Aphasia usually occurs suddenly after a stroke or a head injury. But it can also come on gradually, as in the case of a brain tumor or a progressive neurological disease.

**ALS** - Amyotrophic Lateral Sclerosis

**Dysarthria** - A motor speech disorder that makes it hard to speak. It is caused by damage to the nervous system, which can affect the muscles used for speaking. People with dysarthria may have slurred or slow speech, and they may have difficulty controlling the pitch, volume, and rhythm of their speech.

## 5 Relevant Facts And Assumptions

### 5.1 Relevant Facts

*Insert your content here.*

### 5.2 Business Rules

*Insert your content here.*

### **5.3 Assumptions**

*Insert your content here.*

## **6 The Scope of the Work**

### **6.1 The Current Situation**

*Insert your content here.*

### **6.2 The Context of the Work**

*Insert your content here.*

### **6.3 Work Partitioning**

*Insert your content here.*

### **6.4 Specifying a Business Use Case (BUC)**

*Insert your content here.*

## **7 Business Data Model and Data Dictionary**

### **7.1 Business Data Model**

*Insert your content here.*

### **7.2 Data Dictionary**

*Insert your content here.*

## **8 The Scope of the Product**

### **8.1 Product Boundary**

*Insert your content here.*



## **8.2 Product Use Case Table**

*Insert your content here.*

## **8.3 Individual Product Use Cases (PUC's)**

*Insert your content here.*

# **9 Functional Requirements**

## **9.1 Functional Requirements**

*Insert your content here.*

# **10 Look and Feel Requirements**

## **10.1 Appearance Requirements**

The interface shall have a clean and minimal design to reduce cognitive load. Key elements should be visually distinct, with consistent spacing, and color usage to support quick recognition of actions.

Since it's a browser integration, the user interface should minimally interfere with the visibility of the content on the page. The interface should only capture the user's attention as functionally needed (i.e., listening to user prompts, confirming user intent), but should otherwise blend in with the browser interface.

## **10.2 Style Requirements**

The system shall maintain a professional and neutral visual style suitable for general workplace use. Colors, icons, and fonts should prioritize clarity over branding at this stage. Future iterations may incorporate custom styling or theming.

## **11 Usability and Humanity Requirements**

### **11.1 Ease of Use Requirements**

The system should minimize user effort by providing a simple, intuitive interface. Key actions should be accessible within 3-4 interactions, with clear feedback after each action.

### **11.2 Personalization and Internationalization Requirements**

The system should support basic personalization (e.g., remembering user preferences) and allow easy adaptation for different languages or regions at a later stage. For the PoC, English support is sufficient.

### **11.3 Learning Requirements**

The system should be learnable within 10 minutes without prior training or documentation. Users should be able to complete core tasks on their first attempt through the interfaces navigation tutorial upon first time launch. Additional documentation should be supplemental but not necessary.

### **11.4 Understandability and Politeness Requirements**

The system should use clear, direct, and neutral language in responses. Error messages or clarifications should remain polite and informative.

### **11.5 Accessibility Requirements**

The interface should be navigable using standard assistive tools and offer clear text contrast and legible font sizes. Full accessibility compliance is not required at the PoC stage but should be feasible for future iterations.

## **12 Performance Requirements**

### **12.1 Speed and Latency Requirements**

Under normal operating conditions, latency requirements can be broken down into:

Speech interpretation: 5 s after end of utterance

Command generation & execution: 10-15 seconds after end of speech interpretation

### **12.2 Safety-Critical Requirements**

The system shall enforce guardrails to prevent unsafe or unintended actions, requiring validation and user confirmation for potentially disruptive operations, and provide warnings or fail-safes for errors.

### **12.3 Precision or Accuracy Requirements**

ASR accuracy shall be at least 70% in stationary noise conditions. The system shall achieve at least 80% command recognition precision under stationary noise conditions for the PoC.

### **12.4 Robustness or Fault-Tolerance Requirements**

The system shall remain stable under fluctuating network conditions and noisy input. Fallback mechanisms (e.g., retry logic, error messaging) shall ensure graceful issue handling.

### **12.5 Capacity Requirements**

The system shall support at least 20 concurrent users without service degradation if the product is commercialized.

### **12.6 Scalability or Extensibility Requirements**

The system architecture shall allow horizontal scaling to handle increased traffic and modular extensions for new interaction capabilities.

## **12.7 Longevity Requirements**

The system shall be designed to operate reliably over a minimum of 5 years, with maintainable and updatable components to support long-term product evolution.

# **13 Operational and Environmental Requirements**

## **13.1 Expected Physical Environment**

The product shall be operable in a variety of typical office, home, or institutional environments where users perform their daily tasks. The system shall be robust to stationary background noise such as air conditioning, computer fans, and ambient hum. It is not required to reliably handle non-stationary noise, including multiple people speaking or sudden loud interruptions. No modifications to the host operating system, browser, or network configuration shall be required.

## **13.2 Wider Environment Requirements**

The primary interface shall be web-based, accessible via standard web browsers, to maximize user accessibility and support flexible use cases.

## **13.3 Requirements for Interfacing with Adjacent Systems**

1. The system shall integrate with existing browser-based platforms and may interface with external language interpreter modules.
2. Open-source components (e.g., browser interaction agents and libraries) may be incorporated, ensuring compatibility and maintainability.

## **13.4 Productization Requirements**

1. The product shall be deployable for multiple users within an organization, supporting secure user accounts and personalized ASR profiles.

2. The design shall allow packaging and distribution without requiring technical setup by end users. The product shall have straightforward installation or access via pre-configured web access and automatic model initialization.
3. Productization shall include logging suitable for monitoring performance and usage in a hosted environment.
4. The system shall include mechanisms for updates to features with minimal disruption to users.

## **13.5 Release Requirements**

The product shall follow a defined release cycle, providing minor updates quarterly and major updates semi-annually. Each release must maintain backward compatibility with user data, personalization settings, and existing features. Release planning will account for maintenance effort, compute resources, and compliance obligations.

# **14 Maintainability and Support Requirements**

## **14.1 Maintenance Requirements**

Code must be modular, documented, and testable to support scalability, debugging, and future updates. Maintenance must be possible by developers who were not the original authors.

## **14.2 Supportability Requirements**

The product shall provide an accessible Help Page and a Frequently Asked Questions (FAQ) section with clear instructions. It shall be displayed with high-contrast visuals, simple language, and auditory and visual aids.

## **14.3 Adaptability Requirements**

The system must run on common workplace platforms via a web browser, including Windows 10 or later, macOS 12 Monterey or later, and Linux distributions such as Ubuntu 20.04 LTS or later, supporting modern web browsers.

## 15 Security Requirements

### 15.1 Access Requirements

Only authorized end users shall be able to access personalized ASR features, voice command execution, and saved transcripts. Access shall be role-based:

- **Primary users (end users):** can access their own data.
- **Secondary users (supervisors/SMEs):** may have read-only access to assist with support or troubleshooting.
- **Tertiary users (caregivers):** may have limited access to assist the end user, can view basic usage history and transcripts but cannot modify settings.

Access to external services (e.g., LLM APIs) shall be rate-limited to ensure system stability, control costs, and prevent abuse.

### 15.2 Integrity Requirements

The system must provide real-time confirmation and validation of commands before execution to ensure they match user intent.

### 15.3 Privacy Requirements

The system must gather explicit user consent for storing voice and personal data. All user data used for model improvement must be anonymized. Database and personalized ASR models must maintain integrity through secure, versioned backups. Unauthorized changes or corruption of user data must be prevented.

### 15.4 Audit Requirements

The system shall maintain secure logs of major actions and commands, including logging events, access to profile and personal data, and command execution failures. Logs shall be protected and retained in a secure database.

## **15.5 Immunity Requirements**

The system must be resilient to accidental misuse. It shall handle noisy input robustly, avoid executing unintended commands, and operate safely within rate limits to prevent resource overload.

## **16 Cultural Requirements**

### **16.1 Cultural Requirements**

The system shall maintain a culturally neutral and respectful tone when prompting users, avoiding slang, bias, and discriminatory language. It must include ethical guardrails to prevent the generation of harmful content or execution of potentially dangerous commands.

It shall support inclusive and accessible design to serve users across diverse cultural backgrounds.

## **17 Compliance Requirements**

### **17.1 Legal Requirements**

The project shall comply with the Personal Information Protection and Electronic Documents Act (PIPEDA) regarding the collection, storage, and handling of personal information.

### **17.2 Standards Compliance Requirements**

The application must comply with the Web Content Accessibility Guidelines (WCAG) 2.0, Level AA guidelines to ensure usability by individuals with disabilities.

## **18 Open Issues**

The primary open issue is maintaining high ASR accuracy across the diverse and severe spectrum of dysarthric speech. This requires extensive training and validation data, as well as careful model tuning.

## **19 Off-the-Shelf Solutions**

### **19.1 Ready-Made Products**

The project will evaluate existing, specialized speech recognition models and applications (e.g., Whisper model and Project Euphonia) as performance baselines.

### **19.2 Reusable Components**

Potential reused components could include existing Text-to-Speech (TTS) modules for feedback and LLMs to map user commands into structured actions.

### **19.3 Products That Can Be Copied**

Open-source browser automation agents (e.g., The AI browser agent) may be integrated for command execution via voice input.

## **20 New Problems**

### **20.1 Effects on the Current Environment**

The product shall operate without modifying the user's OS, browser, or network configuration. This separation prevents unintended impact from incorrect commands.

### **20.2 Effects on the Installed Systems**

The product shall not bypass firewalls, alter security settings, access banned sites, install untrusted content, or perform any malware execution.

### **20.3 Potential User Problems**

Due to the non-deterministic nature of dysarthric speech patterns, a user's exact speech type may not be fully captured by the model, leading to higher



training overhead for personalization before the system becomes reliably usable for them. Users may experience misinterpretations requiring retries, which can cause frustration.

## **20.4 Limitations in the Anticipated Implementation Environment That May Inhibit the New Product**

Variability in dysarthric speech may necessitate frequent retraining of ASR models.

Real-time performance varies between devices, depending on processing power and low-latency operation.

## **20.5 Follow-Up Problems**

The local operation limits the ability to perform remote problem diagnosis if any issues arise.

# **21 Tasks**

## **21.1 Project Planning**

Breakdown of major tasks:

Our main tasks are centered on preparing the system by training and tuning the dysarthric ASR model, integrating the core command interpreter, designing the accessible interface, and conducting rigorous testing.

## **21.2 Planning of the Development Phases**

A detailed schedule of development phases, milestones, and dependencies is outlined in the PoC and Development Plan.

## **22 Migration to the New Product**

### **22.1 Requirements for Migration to the New Product**

The system shall support new users with no prior ASR and interpreter experience through an onboarding process.

The system shall support transitioning users migrating from an existing system by allowing for easy uploading of recordings of their speech training data.

### **22.2 Data That Has to be Modified or Translated for the New System**

All previous transcripts, audio files, and personalization data shall be tied to secure user accounts.

Users shall be able to access their data from any supported device after logging in and authentication.

## **23 Costs**

The primary costs for this product are related to machine learning computation and hosting. Development and training will initially leverage Compute Canada credits provided by the supervising research team, along with Colab Pro (CAD 13.99/month).

No external hosting costs are anticipated for the initial release; however, optional hosting may be required for commercial distribution and deployments. If hosting is included, approximate costs for cloud-based deployment on Google Cloud Platform (GCP) include: training and inference on GPUs ( \$50 CAD/month for pilot use), storage ( \$3 CAD/month), and minimal networking ( \$2–5 CAD/month). Costs scale with the number of users and training frequency. All estimates are approximate and intended for planning purposes.

## **24 User Documentation and Training**

### **24.1 User Documentation Requirements**

The system shall provide clear, accessible documentation, including an instructional guide and FAQ. (As noted in Section 14b, supporting requirements already cover this in detail.)

### **24.2 Training Requirements**

Training shall not require formal instruction; the documentation and interface shall support self-directed onboarding.

## **25 Waiting Room**

The system shall display launch, loading, or processing pages during transitions to provide users with clear feedback and reduce confusion during waiting periods.

## **26 Ideas for Solution**

### **26.1 Browser-Based Extensions**

The product is primarily web-based. Future considerations could include desktop or mobile apps to broaden the scope and accessibility (see Section 13 for environment and interface requirements).

### **26.2 Personalized ASR Fine-Tuning**

Consider incremental model tuning paired with real-time streaming of speech input. This could be an approach to adapt to individual speech patterns while minimizing the training time overhead, related to the adaptability requirements discussed in earlier sections.

### **26.3 LLM Command Mapping**

User intent parsing via context-aware LLMs could improve natural language command interpretation, as mentioned in Section 13.

## **26.4 Noise Filtering**

Beyond stationary noise, adaptive filtering techniques could be adapted to enhance recognition in busier environments. Section 13 already specifies stationary noise handling.

## **26.5 Open-Source Integrations**

Potential use of browser automation or voice control frameworks can be investigated, as mentioned in Section 16 for off-the-shelf solutions.

## **26.6 Accessibility Enhancements**

Additional visual, auditory, or haptic cues for feedback and help features could enhance usability. Section 14 highlights basic supportability requirements that these enhancements would build on.

## **26.7 Data Encryption**

Anonymized logging and privacy approaches can balance model improvement with privacy in mind. Section 15 discusses privacy requirements in detail.

## Appendix — Reflection

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?
2. What pain points did you experience during this deliverable, and how did you resolve them?
3. How many of your requirements were inspired by speaking to your client(s) or their proxies (e.g. your peers, stakeholders, potential users)?
4. Which of the courses you have taken, or are currently taking, will help your team to be successful with your capstone project.
5. 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.
6. 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?