System Requirements Specification

for

Speech Recognition for Air Traffic Control

Version 1.2 approved

Prepared by Braeden Burnett, Jakob Haehre, Kira McFadden, Tyler Carr

Embry-Riddle Aeronautical University

October 3, 2022

Table of Contents

Table of Contents ii

Revision History ii

1. Introduction 1

1.1 Purpose 1

1.2 Document Conventions 1

1.3 Intended Audience and Reading Suggestions 1

1.4 Product Scope 1

1.5 References 1

2. Overall Description 2

2.1 Product Perspective 2

2.2 Product Functions 2

2.3 User Classes and Characteristics 2

2.4 Operating Environment 2

2.5 Design and Implementation Constraints 2

2.6 User Documentation 2

2.7 Assumptions and Dependencies 3

3. External Interface Requirements 3

3.1 User Interfaces 3

3.2 Hardware Interfaces 3

3.3 Software Interfaces 3

3.4 Communications Interfaces 3

4. System Features 4

4.1 System Feature 1 4

4.2 System Feature 2 (and so on) 4

5. Other Nonfunctional Requirements 4

5.1 Performance Requirements 4

5.2 Safety Requirements 5

5.3 Security Requirements 5

5.4 Software Quality Attributes 5

5.5 Business Rules 5

6. Other Requirements 5

Appendix A: Glossary 5

Appendix B: Analysis Models 5

Appendix C: To Be Determined List 6

Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Date** | **Reason For Changes** | **Version** |
| Tyler | 9/17/22 | Initial document creation | 1 |
| Kira | 10/3/22 | Added Map References, added common definitions table, added scope items | 1.1 |
| Kira | 10/4/22 | Added definitions to table, and table description.  Added General purpose statement and fall mission statement. | 1.2 |
| Tyler | 10/4/22 | Added Display Interactive Map section to system features and outline some functionality | 1.2 |

# Introduction

## Purpose

<Identify the product whose software requirements are specified in this document, including the revision or release number. Describe the scope of the product that is covered by this SRS, particularly if this SRS describes only part of the system or a single subsystem.>

Flight training can be difficult when it comes to flight planning, aeronautical sectional map reading, and understanding ATC communications. The software should aid in flight training by allowing users to track real-time flights, display live ATC communications, and toggle between Google Maps and aeronautical sectional charts.

**Fall Mission Statement**

By the end of the first semester, our group plans to complete the display of an aeronautical map on addition to a Google map and support carious scales for the chart. We also plan on being able to transcribe the live speeches from LiveATC by building a special speech recognizer to transcribe these communications.

## Document Conventions

<Describe any standards or typographical conventions that were followed when writing this SRS, such as fonts or highlighting that have special significance. For example, state whether priorities for higher-level requirements are assumed to be inherited by detailed requirements, or whether every requirement statement is to have its own priority.>

## Intended Audience and Reading Suggestions

<Describe the different types of reader that the document is intended for, such as developers, project managers, marketing staff, users, testers, and documentation writers. Describe what the rest of this SRS contains and how it is organized. Suggest a sequence for reading the document, beginning with the overview sections and proceeding through the sections that are most pertinent to each reader type.>

**Intended Audience**

Primary stakeholders: Dr. Liu, Dr. Schneider

Secondary stakeholders: ERAU Flight Department

* Common Definitions

|  |  |
| --- | --- |
| **Name** | **Definition** |
| ASR | (Automated Speech Recognition) Allows users to input information via speech rather than inputting information using a keyboard. |
| ATC | (Air Traffic Control) Traffic controlling facility used in the United States for the purpose of directing air traffic |
| API | (Application Programming Interface) Software intermediary which allows multiple applications to communicate. |
| GUI | (Graphical User Interface) Multimedia interface user interacts with to use program. |
| NeMo | A NVIDIA toolkit for building AI models with ASR, NLP, and TTS models. |
| NLP | Natural Language Processing |
| TTS | Text-to-Speech |
| VFR | (Visual Flight Rules) A set of regulations that an aircraft can use to operate under clear, sunny weather conditions. |

**Table 1:** Common definitions for acronyms found throughout the document.

## Product Scope

<Provide a short description of the software being specified and its purpose, including relevant benefits, objectives, and goals. Relate the software to corporate goals or business strategies. If a separate vision and scope document is available, refer to it rather than duplicating its contents here.>

* Scope
  + Web-based GUI ASR app
  + Display of Google Map with toggle of VFR Aeronautical Map for the Jacksonville sectional
  + Display scales for the maps
  + Display aircraft tracking with tracking information
  + Using LiveATC, transcribe live speech with specific speech recognizer
  + Display transcribed text in a movable box.
  + Allow users to zoom in or out of a map
* Potential Scope
  + Allow for audio to replayed and saved
  + Allow audio to play, pause, fast-forward, rewind, and stop for replays
  + Save automatically generated transcripts
  + Allow users to edit transcripts then save the changed transcript
  + User can upload audio files, as well as any transcripts, that are saved to a central location
  + Allow user to make a list of navigational aids/landmarks from a user specified location.
  + Replay mode should allow for data to be extracted and displayed from the transcribed text
  + Live mode should allow for data to be extracted and displayed from the transcribed text.
  + Toggle icons on the VFR map
  + Display sectional areas outside of the Jacksonville sectional
  + Allow users to save/create custom maps
* Outside of Scope
  + Isolation of noncommunication sound from audio files
  + Allow users to have a help window to show the step-by-step process of how to use the program

## References

<List any other documents or Web addresses to which this SRS refers. These may include user interface style guides, contracts, standards, system requirements specifications, use case documents, or a vision and scope document. Provide enough information so that the reader could access a copy of each reference, including title, author, version number, date, and source or location.>

**Map References**

* VFR Charts: <https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/vfr/>
* Leaflet:<https://www.earthdatascience.org/tutorials/introduction-to-leaflet-animated-maps/>
  + <https://medium.com/@shachiakyaagba_41915/integrating-folium-with-dash-5338604e7c56>
* Plotly Dash: <https://dash.plotly.com/layout>

**NeMo References**

* <https://docs.nvidia.com/deeplearning/nemo/user-guide/docs/en/stable/starthere/intro.html>

# Overall Description

## Product Perspective

The product being specified in this SRS was an idea by Dr. Liu of Embry-Riddle Aeronautical University in Daytona Beach, Florida. The product is an improvement of a concept that already exists in multiple instances on the internet. Websites such as Flightradar24 display interactive maps with icons of aircraft updates in real time as they travel around. Additional details for flights are also displayed upon request. The end goal is to recreate this functionality but extend it with adding live ATC communication transcriptions for each aircraft upon request. This transcription shall be displayed along with the flight information in a popup window when an aircraft is clicked.

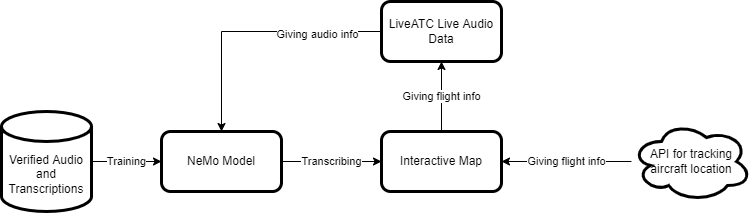


Figure 1: This diagram shows the major components of the system and how they interact with each other. The user is interacting with the Interactive Map, which then gets its information from the other aspects of the system.

## Product Functions

There are three main groups of product functions for this system. Each group’s functions are summarized below. The functions represent what is being performed on the system by the group.

User-performed:

• Clicking on an aircraft

• Toggling between the interactive map and VFR map

• Zooming and panning the map

Product-performed:

• Display aircraft icons overlayed on top of the map in accurate locations

• Refresh the aircraft icons on the map

• Retrieve the flight information and ATC communication data for a selected flight

• Transcribe the ATC communication and display on the page

Maintainer-performed:

• Training the model with audio and transcriptions that already have been proven accurate

• Verifying transcriptions made by the model

## User Classes and Characteristics

The two user classes that are the most prevalent are user and maintainer. The user is just anyone who is accessing the website, and the maintainer ensures the transcriptions keep working well.

User:

• Description: The user will want to move the map, toggle the map type, browse flights, and view ATC transcriptions. The user can be anyone accessing the website, so the website should be intuitive enough for any knowledge level.

• Expertise: The user is expected to have basic knowledge about flight tracking and pilot and controller terms given they are interested in the website’s content.

• Importance: High

Maintainer:

• Description: The maintainer shall perform the initial training of the model and validate future model predictions for transcriptions.

• Expertise: The maintainer is expected to have in-depth knowledge about pilot and controller terms. They should be able to recognize mistakes in the transcriptions of ATC audio data.

• Importance: Medium

## Operating Environment

The website shall be running on a Python 3 web server that shall be hosted on a Linux machine being provided to us by Dr. Liu. It must be able to open the port for the website for visitors to access the website, and it must have internet access to be able to retrieve data from APIs.

The model training must be performed on a dedicated Nvidia graphics card. The machine being provided to us has a graphics card that meets these requirements, so remote access to this machine shall be set up to perform the training even when not present. NeMo also requires Python 3.6 or higher and Pytorch 1.8.1 or higher.

## Design and Implementation Constraints

<Describe any items or issues that will limit the options available to the developers. These might include corporate or regulatory policies; hardware limitations (timing requirements, memory requirements); interfaces to other applications; specific technologies, tools, and databases to be used; parallel operations; language requirements; communications protocols; security considerations; design conventions or programming standards (for example, if the customer’s organization will be responsible for maintaining the delivered software).>

## User Documentation

<List the user documentation components (such as user manuals, on-line help, and tutorials) that will be delivered along with the software. Identify any known user documentation delivery formats or standards.>

## Assumptions and Dependencies

<List any assumed factors (as opposed to known facts) that could affect the requirements stated in the SRS. These could include third-party or commercial components that you plan to use, issues around the development or operating environment, or constraints. The project could be affected if these assumptions are incorrect, are not shared, or change. Also identify any dependencies the project has on external factors, such as software components that you intend to reuse from another project, unless they are already documented elsewhere (for example, in the vision and scope document or the project plan).>

# External Interface Requirements

## User Interfaces

<Describe the logical characteristics of each interface between the software product and the users. This may include sample screen images, any GUI standards or product family style guides that are to be followed, screen layout constraints, standard buttons, and functions (e.g., help) that will appear on every screen, keyboard shortcuts, error message display standards, and so on. Define the software components for which a user interface is needed. Details of the user interface design should be documented in a separate user interface specification.>

## Hardware Interfaces

<Describe the logical and physical characteristics of each interface between the software product and the hardware components of the system. This may include the supported device types, the nature of the data and control interactions between the software and the hardware, and communication protocols to be used.>

## Software Interfaces

<Describe the connections between this product and other specific software components (name and version), including databases, operating systems, tools, libraries, and integrated commercial components. Identify the data items or messages coming into the system and going out and describe the purpose of each. Describe the services needed and the nature of communications. Refer to documents that describe detailed application programming interface protocols. Identify data that will be shared across software components. If the data sharing mechanism must be implemented in a specific way (for example, use of a global data area in a multitasking operating system), specify this as an implementation constraint.>

## Communications Interfaces

<Describe the requirements associated with any communications functions required by this product, including e-mail, web browser, network server communications protocols, electronic forms, and so on. Define any pertinent message formatting. Identify any communication standards that will be used, such as FTP or HTTP. Specify any communication security or encryption issues, data transfer rates, and synchronization mechanisms.>

# System Features

This section outlines the functional requirements for the product. It is organized by use cases.

## Map

4.1.1 Description and Priority

* 1. On the main page of the website, an interactive map is displayed. It is a high priority because it is the main feature of the website.
  2. Both the interactive and aeronautical maps shall have the same map controls. These include buttons to zoom in and out, and the ability to click and drag to pan around the map.

4.1.2 Stimulus/Response Sequences

* 1. The user loads the website URL, which sends a get request to the Python webserver, causing Plotly Dash to render the website.
  2. Both versions of the map shall be interactive. Clicking and dragging on the map in any direction shall cause the map to move with the mouse. This feature is called panning. There shall also be buttons to zoom in and out on the maps.

4.1.3 Functional Requirements

1. The interactive map shall be loaded upon the initial load of the website.
2. The user shall press the plus button to zoom in on the interactive map.
3. The user shall press the minus button to zoom out on the interactive map.
4. The user shall click and drag on the map in any direction to make the interactive map move in that same direction.
5. The user shall press the plus button to zoom in on the physical map.
6. The user shall press the minus button to zoom out on the physical map.
7. The user shall click and drag on the map in any direction to make the physical map move in that same direction.

## Display Planes on Maps

4.2.1 Description and Priority

Overlayed on top of the maps, icons of aircraft for every active flight with data available are shown. They are updated every 1 second.

4.2.2 Stimulus/Response Sequences

When the map is moved, the plane icons should stay at the coordinates that they belong at. This means that they move when the map moves.

4.2.3 Functional Requirements

1. The user shall be able to click on a plane in the interactive map to view a popup with any available information about the flight.
2. The user shall be able to click on a plane in the physical map to view a popup with any available information about the flight.
3. The planes on the interactive map shall stay at the actual coordinates that they belong at when the map is moved.
4. The planes on the physical map shall stay at the actual coordinates that they belong at when the map is moved.

## Display Flight Information on Interactive Map

4.3.1 Description and Priority

After the user selects an aircraft icon on the map, the website shall show a popup with available flight information. This shall include things such as flight name, destination and origin.

4.3.2 Stimulus/Response Sequences

The popup is displayed when the user selects an aircraft icon on the map. If the user clicks away, the popup goes away.

4.3.3 Functional Requirements

1. The user shall be able to click on any aircraft icon on the map to display a popup with flight information for that flight.
2. The flight information shall include:
   1. Origin
   2. Destination
   3. Name

## Display ATC Transcription on Interactive Map

4.4.1 Description and Priority

On the popup that appears when the user selects an aircraft icon, a live transcription of the ATC communication is displayed below the aircraft information. This transcription is updated in real time.

4.4.2 Stimulus/Response Sequences

The popup is displayed when the user selects an aircraft icon on the map. If the user clicks away, the popup goes away.

4.4.3 Functional Requirements

1. The user shall be able to view the live transcription of ATC communications for any aircraft that they click the icon for.
2. The live transcription of ATC communications shall be updated once per second.

## Toggle between Interactive and Detailed Map

4.5.1 Description and Priority

There is a toggle button on the main page of the website that, when clicked, toggles the interactive and detailed maps. The map that is shown when the website is initially loaded is the interactive map. When clicking the button, it shall be switched to the detailed map.

4.5.2 Stimulus/Response Sequences

The map is toggled when the toggle button is clicked. When one map is displayed, the other is hidden.

4.5.3 Functional Requirements

1. The interactive map shall be replaced with the detailed map when the user clicks the toggle button.

# Other Nonfunctional Requirements

## Performance Requirements

<If there are performance requirements for the product under various circumstances, state them here and explain their rationale, to help the developers understand the intent and make suitable design choices. Specify the timing relationships for real time systems. Make such requirements as specific as possible. You may need to state performance requirements for individual functional requirements or features.>

## Safety Requirements

<Specify those requirements that are concerned with possible loss, damage, or harm that could result from the use of the product. Define any safeguards or actions that must be taken, as well as actions that must be prevented. Refer to any external policies or regulations that state safety issues that affect the product’s design or use. Define any safety certifications that must be satisfied.>

## Security Requirements

<Specify any requirements regarding security or privacy issues surrounding use of the product or protection of the data used or created by the product. Define any user identity authentication requirements. Refer to any external policies or regulations containing security issues that affect the product. Define any security or privacy certifications that must be satisfied.>

## Software Quality Attributes

<Specify any additional quality characteristics for the product that will be important to either the customers or the developers. Some to consider are: adaptability, availability, correctness, flexibility, interoperability, maintainability, portability, reliability, reusability, robustness, testability, and usability. Write these to be specific, quantitative, and verifiable when possible. At the least, clarify the relative preferences for various attributes, such as ease of use over ease of learning.>

## Business Rules

<List any operating principles about the product, such as which individuals or roles can perform which functions under specific circumstances. These are not functional requirements in themselves, but they may imply certain functional requirements to enforce the rules.>

# Other Requirements

<Define any other requirements not covered elsewhere in the SRS. This might include database requirements, internationalization requirements, legal requirements, reuse objectives for the project, and so on. Add any new sections that are pertinent to the project.>

Appendix A: Glossary

<Define all the terms necessary to properly interpret the SRS, including acronyms and abbreviations. You may wish to build a separate glossary that spans multiple projects or the entire organization, and just include terms specific to a single project in each SRS.>

Appendix B: Analysis Models

<Optionally, include any pertinent analysis models, such as data flow diagrams, class diagrams, state-transition diagrams, or entity-relationship diagrams.>

Appendix C: To Be Determined List

<Collect a numbered list of the TBD (to be determined) references that remain in the SRS so they can be tracked to closure.>