System Test Plan

For

Speech Recognition for Air Traffic Control

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Version/Author	Date
1 All	9/17/22
1.1/All	10/28/22
1.2/All	11/1/22
1.3/TC	12/7/22
1.4/KM	12/8/22
1.5/BB	12/8/22
1.6/All	3/7/23
1.7/TC	3/10/23
1.8/All	4/11/23
1.9/All	4/13/23

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1. Introduction

1.1. Purpose

This document is a test plan for the Speech Recognition for Air Traffic Control System Testing, produced by the Scrum team. It describes the testing strategy and approach to testing the team will use to verify the application meets the established requirements of the customer prior to release. It contains separate details for how to test both the website and the neural model. If these tests are completed, they validate the system is complete. The system is not considered to be complete until all of the tests run successfully.

1.2. Objectives

Features that will be the objects of testing that are identified and classified into a hierarchy.

- Meets the requirements, specifications and the Business rules.
- Supports the intended business functions and achieves the required standards.
- Satisfies the Entrance Criteria for User Acceptance Testing.

2. Functional Scope

The Modules in the scope of testing for the Speech Recognition for Air Traffic Control System Testing are as follows:

- Interactive map on website
- Aeronautical map on website
- Nvidia Nemo Model

3. Overall Strategy and Approach

3.1. Testing Strategy

The Speech Recognition for Air Traffic Control System Testing will include the testing of all functionalities that are in the scope (Refer to Functional pe Section) identified. System testing activities will include the testing of new functionalities, modified functionalities, screen level validations, workflows, functionality access, and the testing of internal and external interfaces.

Website

The website will be tested using manual validation of the success criteria to validate the presence of required elements on the page. Test cases will be written to navigate through the website and assert that the required items are present. The test cases will be generated from the requirements document. Test cases

Neural Model

The neural model will be tested using prepared labeled testing data made from the provided ATC data. Using this data, we will calculate word error rate and word error rate per utterance for each of the models. We will be targeting a word error rate and word error rate per utterance of around ~.20. The current best word error rate claimed in industry is around ~.05[1]. However, this is achieved using the resources accessible by large corporations and thus is not within the scope of our project.

3.2. System Testing Entrance Criteria

In order to start system testing, certain requirements must be met for testing readiness. Readiness can be classified into:

Website:

The website will be ready for testing when all components that are required from the backlog to be included are present. The website must be hosted on the desktop machine provided and publicly available with a static IP address. Both versions of the maps must be functional with planes visible. The neural model must

be fully functional, and the website must be connected to the neural model.

Neural model:
The entrance criteria for the neural model testing is that the model(s) have been trained on the labeled ATC data. The testing scripts have been prepared and debugged and novel training data has been prepared.

3.3. Testing Types

3.3.1. Usability Testing

User interface attributes, cosmetic presentation and content will be tested for accuracy and general usability. The goal of Usability Testing is to ensure that the User Interface is comfortable to use and provides the user with consistent and appropriate access and navigation through the functions of the application (e.g., access keys, consistent tab order, readable fonts etc.)

3.3.2. Functional Testing

The objective of this test is to ensure that each element of the component meets the functional requirements of the customer as outlined in the:

- Functional Requirements
- Business rules or conditions
- Issue resolutions
- Feedback

3.4. Suspension Criteria and Resumption Requirements

This section specifies the criteria that will be used to suspend all or a portion of the testing activities on the items associated with this test plan.

3.4.1. Suspension Criteria

Testing will be suspended if the incidents found will not allow further testing of the system/application under-test. If testing is halted, and changes are made to the hardware, software or database, it is up to the Testing Manager to determine whether the test plan will be re-executed, or part of the plan will be re-executed.

Website Incidents:

- Website goes offline during testing
- Assertion test failed
- Unit test encounters exception
- Unable to get data from flight tracker
- Update of VFR map failed

Neural Model Incidents:

- Model fails to load
- Training data is not novel to the model

3.4.2. Resumption Requirements

Resumption of testing will be possible when the functionality that caused the suspension of testing has been retested successfully.

3.4.3. Website Resumption

- Check to see if data from Opensky API is writing to the correct file(s) if no issues found attempt to run Opensky outside of website
- Check to see if FAA map API is saving data to correct file(s) is no issues found

check if FAA map download link functions

3.4.4. Neural Model Resumption

- Check for issues in model file e.g., corrupted file, check all dependencies installed if no issues found attempt to reload model
- Get data novel to the model either from provided datasets or other methods

4. Execution Plan

4.1. Execution Plan

The execution plan will detail the test cases to be executed. The Execution plan will be put together to ensure that all the requirements are covered. The execution plan will be designed to accommodate some changes, if necessary, if testing is incomplete on any day. All the test cases of the projects under test in this release are arranged in a logical order depending upon their inter dependency.

Test Cases

ID	Name	Actions	Success Criteria	Pass/Fail	Referenced Requirement
W1	Website load	Visit the website's URL in Chrome	The website shall load in 1 second after the localhost site address is entered.	P	SIR 4 SIR 11
W1.5	Website load	Visit the website's URL in Chrome	The website shall display the interactive map with a toggle button in 1 second after the localhost site address is entered.	P	SIR 4 SIR 11
W2	Map buttons zoom in	Click the plus button on the interactive map	The map zooms in by one tile level in 1 second after the plus button is clicked on the interactive map.	P	USR 4
W3	Map buttons zoom out	Click the minus button on the interactive map	The map zooms out by one tile level in 1 second after the minus button is clicked on the interactive map.	P	USR 4
W4	Map buttons zoom in 2	Click the plus button on the VFR map	The map zooms in by one tile level in 1 second after the plus button is clicked on the VFR map.	P	USR 4
W5	Map buttons zoom out 2	Click the plus button on the VFR map	The map zooms out by one tile level in 1 second after the minus button is clicked on the VFR map.	P	USR 4
W2.1	Scroll zoom in	Move the scroll wheel forwards 1 notch while hovering the cursor over the interactive map.	The map zooms in by one tile level in 1 second after the mouse scroll wheel is moved forwards one notch on the interactive map.	P	USR 6
W3.1	Scroll zoom out	Move the scroll wheel backwards 1 notch while hovering the cursor over the interactive map.	The map zooms out by one tile level in 1 second after the mouse scroll wheel is moved backwards one notch on the interactive map.	P	USR 7

W4.1	Scroll zoom in 2	Move the scroll wheel forwards 1 notch while hovering the cursor over the VFR map.	The map zooms in by one tile level in 1 second after the mouse scroll wheel is moved forwards one notch on the VFR map.	P	USR 6
W5.1	Scroll zoom out 2	Move the scroll wheel forwards 1 notch while hovering the cursor over the VFR map.	The map zooms out by one tile level in 1 second after the mouse scroll wheel is moved backwards one notch on the VFR map.	P	USR 7
W6	Map zoom max out	Load the website, then click the minus button 13 times on the interactive map. Then click once more	The map should prevent the user from zooming out more after the map is zoomed out 13 times on the interactive map.	P	SIR 21
W7	Map zoom max in	Click the map zoom in button 5 times on the interactive map. Then click once more	The map should prevent the user from zooming in more after the map is zoomed in 5 times on the interactive map.	P	SIR 22
W8	Map zoom max out 2	Click the map zoom out button 4 times on the VFR map. Then click once more	The map should prevent the user from zooming out more after the map is zoomed in 5 times on the VFR map.	P	SIR 21
W9	Map zoom max in 2	Click the map zoom in button 1 times on the VFR map. Then click once more	The map should prevent the user from zooming out more after the map is zoomed out 5 times on the VFR map.	P	SIR 22
W10	Map pan	Click on the interactive map and drag the mouse to the right.	The map should be shifted to the right with new tiles loading on the left in 1 second after clicking on the interactive map and moving the mouse to the right 1-3 inches.	P	SIR 12 USR 5
W11	Map pan 2	Click on the VFR map and drag the mouse to the right	The map should be shifted to the right with new tiles loading on the left in 1 second after clicking on the VFR map and moving the mouse to the right 1-3 inches.	P	SIR 12 USR 5
W12	Plane loading on interactive map	Visit the website's URL in Chrome. Click the minus button to zoom out 5 times.	The map should contain at least one plane icon after visiting the website and clicking the minus button to zoom out 5 times.	P	SIR 13
W13	Plane loading on VFR map	Visit the website's URL in Chrome, click the toggle button, then click the minus button to zoom out 5 times.	The map should contain at least one plane icon after visiting the website, clicking the toggle button, then clicking the minus button to zoom out 5 times.	P	SIR 13

W14	Plane movement on interactive map	Visit the website's URL in Chrome. Hover your mouse over any plane icon. Wait 15 seconds. Observe the new location of the icon.	The plane icon should move to its new location in 15 second intervals after loading the website and choosing any plane icon to monitor.	P	SIR 13
W15	Plane movement on VFR map	Visit the website's URL in Chrome. Click the toggle button. Hover your mouse over any plane icon. Wait 15 seconds. Observe the new location of the icon.	The plane icon should move to its new location in 15 second intervals after loading the website, clicking the toggle button, then choosing any plane icon to monitor.	P	SIR 13
W16	Validate plane coordinates 1	Visit the website's URL in Chrome, then click on any plane	The coordinates that the site lists that the plane is in after clicking on a plane should match the town that the plane is in on the interactive map with a 100ft margin of error.	P	SIR 13
W17	Validate plane coordinates 2	Visit the website's URL in Chrome, click the toggle button, then click on any plane	The coordinates that the site lists that the plane is in after clicking on a plane should match the town that the plane is in on the VFR map with a 100ft margin of error.	P	SIR 13
W18	Validate plane heading 1	Visit the website's URL in Chrome, then click on any plane. Observe the track field from the textbox.	The plane icons' rotations in polar coordinates should match the heading of each plane when the data is fetched from the OpenSky API.	P	SIR 19
W19	Validate plane heading 2	Visit the website's URL in Chrome, click the toggle button, then click on any plane. Observe the track field from the textbox.	The plane icons' rotations in polar coordinates should match the heading of each plane when the data is fetched from the OpenSky API after clicking on the toggle button.	P	SIR 19
W20	Toggle button	Visit the website's URL in Chrome, click the toggle button, then click the toggle button again.	The map changes to the VFR map in 1 second after the toggle button is clicked when viewing the interactive map.	P	USR 1
W21	Info box is updated	Visit the website. Click any plane. Observe the information in the textbox. Wait 15 seconds. Observe the information again.	The text in the popup textbox changes in 15 seconds after clicking on any plane icon.	P	SIR 20

W22	Click plane for details	Visit the website, click on any plane.	The text box popup is populated with the respective information about the plane provided by OpenSky API in 5 seconds after clicking on a plane icon.	P	SIR 8 SIR 9 SIR 14 USR 2
W23	Live transcription	Visit the website, click on any plane.	The text box popup is populated with the most recent 20 words of the LiveATC transcription for KDAB in 5 seconds after clicking on a plane icon.	P	SIR 3 SIR 15
W24	Live transcription update	Visit the website, click on any plane icon. Wait 15 seconds.	The text box popup adds new text to the queue from the LiveATC transcription for KDAB every 3 seconds and removes the same number of words from the queue as were added.	P	SIR 3 SIR 15
W25	Live transcription validation	Visit LiveATC, go to KDAB, and listen to the live audio. Then, visit the website and click on any plane icon. Observe the ATC transcription.	Verify that the transcription matches what is being said in the KDAB ground LiveATC audio, with .2 word error rate permitted.	F	SIR 1
W26	Text box drag	Visit the website and click on a plane. Click on the floating textbox and drag it to the right, then release the mouse.	The text box popup will move with the mouse to the right when the text box is clicked with the mouse and dragged to the right.	P	SIR 10 USR 3
W27	Verify plane coordinates on Interactive map	Visit the website, and click on any plane icon. Look at the output of the floating textbox for coordinates. Enter the plane's callsign into the OpenSky API and observe the output.	The coordinates of the plane from the text box popup after clicking on a plane icon on the interactive map should exactly match the coordinates shown for the same plane in the OpenSky API.	P	SIR 14
W28	Verify plane coordinates on VFR map	Visit the website, click the toggle button, then click on any plane icon. Look at the output of the floating text box for coordinates.	The coordinates of the plane from the text box popup after clicking on a plane icon on the VFR map should exactly match the coordinates shown for the same plane in the OpenSky API.	P	SIR 14
W29	Interactive Map Scale	Visit the website	A scale with 1 mi is shown in the bottom left corner of the interactive map.	P	SIR 6

W30	Interactive Map Scale Change	Visit the website, click the minus button to zoom out and observe how the scale changes. Repeat clicking and observing again.	A scale with 1 mi is shown in the bottom left corner of the interactive map and instantly changes to 2 mi after clicking on the plus button to zoom in to the interactive map.	P	SIR 17 SIR 18
W31	VFR Map Scale	Visit the website and click the toggle button	A scale with 3 mi is shown in the bottom left corner of the interactive map.	P	SIR 6
W32	VFR Map Scale Change	Visit the website, click the toggle button, then click the minus button to zoom out and observe how the scale changes. Repeat clicking and observing again.	A scale with 3 mi is shown in the bottom left corner of the interactive map and instantly changes to 5 mi after clicking on the plus button to zoom in to the VFR map.	P	SIR 17 SIR 18
W33	Plane Data Cache	Load the website and wait for planes to load. Disconnect the computer from the internet and wait 2 minutes.	The plane icons must remain in the same places without disappearing for 2 minutes after disconnecting the computer from the internet.	P	SIR 23
M1	Word error rate	Run testing scripts for word error rate	The model achieves a word error rate of .2 or less on the validation dataset	F	SIR 2, SIR 7
M2	Model Setup	The ASR Model setup puts the Model in inference mode	Random Sample run through of the same audio	P	SIR 2
M3	Model Input	Input an array of numbers representing a waveform to the model.	The model transcribes the waveform and returns the transcribed message.	P	SIR 3
M4	Model Setup	Freeze encode and decode	The model encode and decode are frozen prior to the model transcribing	P	SIR 2, SIR 3
M5	Model Setup	Difference mode to 0	The model difference is set to 0 prior to the model transcribing	P	SIR 2, SIR 3
M6	Model Website Interaction	An ATCTrancribe object is made, the transcribe_audio method is called and is given a path to a .wav file containing speech.	The model returns a non empty string	P	SIR 3, SIR 2

4.2. Defect Severity Definitions

Critical	• API data is corrupted • Server is down • Model data is corrupted • Configuration Files from ATC Stream corrupted
Medium	• Plane loads into incorrect location • Text Box doesn't appear • Toggle Button doesn't work as anticipated • Word Error rate is higher than 0.2 for the model
Low	• Website map positioning loads incorrectly • Word Error rate is 0.2 for the model • Website takes longer than 5 seconds to load • Text Box loads incorrect text

5. Environment

5.1. Testing Tools

The System Testing Environment will be used for System Testing.

Website:

- Manual validation of success criteria

Neural Model:

- Manual validation of statistics

5.2. Testing Environment

The System Requirements for testing are as follows:

Hardware

- Dedicated Nvidia NeMo-compatible graphics card

Software

Software	**Version**
RedHat Enterprise Linux Ubuntu Windows 11 Pro	V8.6 22 21H2
Python	3.6 to 3.8
Pytorch	1.8.1
Plotly Dash	2.8.0
Dash DAQ	0.5.0
OpenSkyNetwork API	GitHub Master
Python-Dotenv	0.21.0
Dash Leaflet	0.1.23
Pytz	Any

Chardet	Any
Nvidia NeMo	Any
Cython	Any
NeMo Toolkit	Any

- See requirements file for all requirements for testing the web server.

6. Assumptions

- Testers have access to a compatible NVIDIA GPU
- Puppeteer test cases are run using Python
- Testers have followed the Opensky-install.txt file to get the package(s) for the Opensky API

7. Risks and Contingencies

Risk	**Contingency**
Plane coordinate fetching API not working	Display the last locations of the planes until the API comes back.
Model outputs poor transcription	Deploy an additional website for closed crowd-sourced model transcription validation.
Website is offline	Display an error message in place of the website indicating that the website is temporarily unavailable.
Model is unavailable	Temporarily pause transcriptions and replace with a message saying, “Temporarily unavailable”.

8. Appendices

a. Links

[1] https://smartaction.ai/blog/does-word-error-rate-matter
[2] The OpenSky Network, https://opensky-network.org