System Test Plan

For

Speech Recognition for Air Traffic Control

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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 Puppeteer 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.

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.

4.

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

4.1.1. Resumption Requirements

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

4.1.2. 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

4.1.3. 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

4.1.4.

5. Execution Plan

5.1. 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	System	Actions	Success Criteria
W1	Website load	Website	Visit the website's URL in Chrome	The website shall load without any errors in 1 second.
W1.5	Website load	Website	Visit the website's URL in Chrome	The website shall display the interactive map with a toggle in 1 second.
W2	Map buttons zoom in	Website	Click the plus button on the interactive map	The map zooms in by one tile level.
W3	Map buttons zoom out	Website	Click the minus button on the interactive map	The map zooms out by one tile level.
W4	Map buttons zoom in 2	Website	Click the plus button on the VFR map	The map zooms in by one tile level.
W5	Map buttons zoom out 2	Website	Click the plus button on the VFR map	The map zooms out by one tile level.
W6	Map zoom max out	Website	Load the website, then click the minus button 13 times on the interactive map. Then click once more	On the last click, the map should not zoom out anymore. It should stay the same.
W7	Map zoom max in	Website	Click the map zoom in button 5 times on the interactive map. Then click once more	On the last click, the map should not zoom in anymore. It should stay the same.
W8	Map zoom max out 2	Website	Click the map zoom out button 4 times on the VFR map. Then click once more	On the last click, the map should not zoom out anymore. It should stay the same.
W9	Map zoom max in	Website	Click the map zoom in	On the last click, the map should

	2		button 1 times on the VFR map. Then click once more	not zoom in anymore. It should stay the same.
W10	Map pan	Website	Click on the interactive map and drag the mouse to the right.	The tiles of the map move, with some tiles disappearing off the left side of the screen and new tiles appearing on the right side of the screen.
W11	Map pan 2	Website	Click on the VFR map and drag the mouse to the right	The tiles of the map move, with some tiles disappearing off the left side of the screen and new tiles appearing on the right side of the screen.
W12	Plane loading on interactive map	Website	Visit the website's URL in Chrome. Click the minus button to zoom out 5 times.	The interactive map should contain at least one plane icon.
W13	Plane loading on VFR map	Website	Visit the website's URL in Chrome, click the toggle button, then click the minus button to zoom out 5 times.	The VFR map should contain at least one plane icon.
W14	Plane movement on interactive map	Website	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 is removed from the old location and placed in the new location within 15 seconds.
W15	Plane movement on VFR map	Website	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 is removed from the old location and placed in the new location within 15 seconds.
W16	Validate plane coordinates 1	Website	Visit the website's URL in Chrome, then click on any plane	Copy and paste the coordinates listed in the textbox into Google Maps. Validate that the plane on the interactive map is in the same geographical location as on the Google map with a 100ft margin of error.
W17	Validate plane coordinates 2	Website	Visit the website's URL in Chrome, click the toggle button, then click on any plane	Copy and paste the coordinates listed into Google Maps. Validate that the plane on the VFR map is in the same geographical location as on the Google map with a 100ft margin of error.
W18	Validate plane heading 1	Website	Visit the website's URL in Chrome, then click on	The plane icon's rotation should be the number of degrees clockwise

			any plane. Observe the track field from the textbox.	starting with 0 pointing upwards based on the value of the track value.
W19	Validate plane heading 2	Website	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 icon's rotation should be the number of degrees clockwise starting with 0 pointing upwards based on the value of the track value.
W20	Toggle button	Website	Visit the website's URL in Chrome, click the toggle button, then click the toggle button again.	The map starts at the interactive map, then changes to the VFR map, then changes back to the interactive map.
W21	Info box is updated	Website	Visit the website. Click any plane. Observe the information in the textbox. Wait 15 seconds. Observe the information again.	The value of the information in the textbox before the 15 seconds and after the 15 seconds should be different.
W22	Click plane for details	Website	Visit the website, click on any plane.	The textbox is populated with data for the clicked plane.
W23	Live transcription	Website	Visit the website, click on any plane.	The textbox is populated with the LiveATC stream transcription for KDAB.
W24	Live transcription update	Website	Visit the website, click on any plane icon. Wait 15 seconds.	The old ATC transcription is replaced with new transcription text.
W25	Live transcription validation	Website	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 roughly matches what is being said in the live audio, with some delay permitted. The audio will be said before the transcription is shown.
W26	Text box drag	Website	Visit the website and click on a plane. Click on the floating textbox and drag it to the right, then release the mouse.	The textbox will move with the mouse to the right.
W27	Verify plane coordinates on Interactive map	Website	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 from the text box should match the coordinates shown in the OpenSky API.
W28	Verify plane coordinates on	Website	Visit the website, click the toggle button, then	Compare coordinates given in the text box with the coordinates given

	VFR map		click on any plane icon. Look at the output of the floating text box for coordinates.	from the open sky API
W29	Interactive Map Scale	Website	Visit the website	Observe that a scale shows in the bottom left of the map that says 1mi.
W30	Interactive Map Scale Change	Website	Visit the website, click the minus button to zoom out and observe how the scale changes. Repeat clicking and observing again.	The scale should go from 1mi, then 2mi, then 3mi.
W31	VFR Map Scale	Website	Visit the website and click the toggle button	Observe that a scale shows in the bottom left of the map that says 3mi.
W32	VFR Map Scale Change	Website	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.	The scale should go from 3mi, then 5mi, then 10mi.
M1	Word error rate	ASR Model	Run testing scripts for word error rate	The model achieves a word error rate of .2 or less
M2	Word error rate per utterance	ASR Model	Run testing scripts for word error rate per utterance	The model achieves a word error rate of .2 or less
M3	Precision, Recall, F1 scores	ASR Model	Run testing scripts for precision, recall, f1	The model achieves scores in those

6. Traceability Matrix & Defect Tracking

6.1. Traceability Matrix

Requirements that start with an “A” indicate advanced requirements. These are not going to be addressed until a later sprint.

Requirement	**Test Case**
SIR 3	W23, W25
SIR 4	W1, W1.5
SIR 5	W20
SIR 6	W29, W31
SIR 7	Coming soon
SIR 8	W22
SIR 9	W22
SIR 10	W26
SIR 11	W1, W1.5
SIR 12	W10, W11

SIR 13	W12, W13, W14, W15, W16, W17
SIR 14	W22
SIR 15	W23, W24
SIR 17, SIR 18	W30, W32
SIR 19	W18, W19
USR 1	W20
USR 2	W22
USR 3	W26
USR 4	W2, W3, W4, W5, W6, W7, W8, W9
USR 5	W10, W11
AUSR 1	Coming soon
AUSR 2	Coming soon
AUSR 3	Coming soon
AUSR 4	Coming soon
AUSR 5	Coming soon
AUSR 6	Coming soon
AUSR 7	Coming soon
AUSR 8	Coming soon

6.2. 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

7. Environment

7.1. Testing Tools

The System Testing Environment will be used for System Testing.

Website:

- Puppeteer

Neural Model:

- Manual validation of statistics

7.2. Testing Environment

The System Requirements for testing are as follows:

Hardware

- Dedicated Nvidia NeMo-compatible graphics card

Software

- Desktop: RedHat Enterprise Linux V8.6 or Ubuntu 22
- Laptop: Windows 11 Pro Version 21H2

- Python Version 3.6 to 3.8
- PyTorch Version 1.8.1
- Opensky Version 1.3.0
- Pandas Version 1.5.1
- Pytz Version 2022.6
- Python-dateutil Version 2.8.2
- Requests Version 2.28.1
- See requirements file for all requirements for testing the web server.

8. 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

9. 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”.

10. Appendices

a. Links

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