**Test Results (conducted in accordance with Test Plan v2.0)**

**For NASA International Space Station (ISS)**

**Version 1.0**

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**December 3, 2017**

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**Revision History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Date** | **Reason For Changes** | **Version** |
| Derek Stine | 12/3/17 | Initial results from testing round | 1.0 |
| Erika Guthrie | 12/3/17 | Updated name to NASA EVA Navigator | 2.0 |
| Jeffrey Dovan | 12/2/17 | Fixed document format | 3.0 |

# 

# Executive Summary

This document summarizes the testing findings conducted during the week of 11/26/17 before milestone 4 (12/3) in accordance with the NASA EVA Navigator Test Plan. Testing was conducted locally in the following desktop browsers with a downloaded copy of the application hosted on the Github repository: <https://lovetostrike.github.io/nasa-path-finder/demo.html>

PC Chrome

PC Firefox

PC IE11

MAC Chrome

MAC Firefox

Testing was conducted from the perspective of each target user: User #1 is an Astronaut and considered a favored user; User #2 is an Astronaut Trainer; and User #3 is a Spacewalk Procedure Writer. The DOUG application was not covered in testing.

The summary of test results and identified defects is below. Summaries on the execution of each test scenario appear inline with each test scenario identified in the Test Plan.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test | NASA EVA Navigator application |  |  |  |  |  |  |
| Status | All testing completed |  |  |  |  |  |  |
| Browsers | PC Chrome: **Completed**  PC Firefox: **Completed**  PC IE11: **Completed**  MAC Chrome: **Completed**  MAC Firefox: **Completed** |  |  |  |  |  |  |
| Bug Summary |  | Block |  | Major |  | Minor |  |
|  | Date | Open | Closed | Open | Closed | Open | Closed |
|  | 12/3/17 | 0 | 0 | 2 | 0 | 6 | 0 |

# Test Objectives covered in test results

The following objectives were tested according to the test plan

1. An algorithm that calculates valid path(s) around the exterior of the ISS using a 3D model. The algorithm’s primary tasks include:
   1. Determine a crewmember’s particular location with entered value.
   2. Navigate crewmembers to specified end point
   3. Establish path(s) shortest distance
   4. Avoid path(s) encounter with least hazards
   5. Determine path(s) requirement within specified arm reach (wingspan)
2. 3D representation of the exterior of the ISS using handrails and structural beams. Represented objects include:
   1. Available handrails
   2. List of some objects protruding from structural surface
3. Rendering the shortest path(s) in the software for the user that accommodate a given wingspan (from input that ranges from 4ft. to 7ft.)

# Participants

Testing was conducted by the UMUC NASA EVA Navigator team. Additional testers in addition to the NASA client can be recruited by the NASA client, Daren Welsh, as deemed necessary.

# Testing Scenarios

The scenarios below present realistic, goal-directed tasks.

|  |  |  |
| --- | --- | --- |
| **Scenario #** | **Scenario** | **Task** |
| 01 | Test that NASA EVA Navigator software features operate with the following Mac or PC systems with either Mac OS X (version 10.7.x or higher), Windows 7 or higher, and Ubuntu 14 or higher with 3.4 GHz CPU or faster; 8 GB or more of RAM; 1 GB or more of GPU; 10 GB or more of free disk space; a monitor, keyboard, and mouse; TCP/IP network Internet connection or data connection to upload/download files; Chrome, Firefox, and IE Web browsers.  Test that NASA EVA Navigator software UI features include variables starting with Start Handrail, End Handrail, optional Middle Waypoint Handrails (if available), and Wingspan Integer Values.  Test that NASA EVA Navigator software performance uses a Web-based 3D model application and allows for uploading new handrail .stl and position .str files to replace defaults. | 1. Download or visit NASA EVA Navigator software.  2. Start NASA EVA Navigator software.  3. Upload base model .stl file(s).  4. Upload handrail .stl file(s) to replace defaults.  5. Upload position .str file(s) to replace defaults.  6. Verify that new handrails appear.  7. Input Start Handrail and End Handrail values.  8. Click drop-down list and select the optional Middle Waypoint Handrails. (if available)  9. Input integer values to determine wingspan.  10. Click find shortest path(s). |
| 02 | Test that NASA EVA Navigator software model objects include handrails, an arm reach that ranges from 4 ft. to 7ft., and a list of some object hazards that protrude from the structural surface.  Test that NASA EVA Navigator software UI features are simple, using drop-down lists and input fields.  Test that NASA EVA Navigator software hazards consist of a list of some objects that protrude from structural surface.  Test that “antenna” has about 1ft. volume around it and designated as a “Keep Out Zone”.  Test that NASA EVA Navigator software UI has an option to avoid sensitive hardware. | 1. Input Start Handrail and End Handrail values to use handrails. Click drop-down list and select the optional Middle Waypoint Handrails to use handrails (if available).  2. Input data range from 4ft. to 7ft. for arm reach.  3. Click drop-down list and select option Crew Hazards. Click drop-down list and select option Sensitive Hardware. |
| 03 | Test that NASA EVA Navigator software performance features accommodate a 3D model that determines a crewmembers particular location, navigates crewmembers, establishes a path(s) shortest distance, avoids a path(s) encounter with the least hazards, and determines a path(s) requirement for longer arm reach.  Test that 3D model informs the client how to navigate a crewmember.  Test that 3D model informs client which path is the shortest distance.  Test that 3D model informs client which path encounters the least hazards.  Test that NASA EVA Navigator software determines which path encounters the least hazards.  Test that NASA EVA Navigator software UI has an option to avoid crew hazards.  Test that NASA EVA Navigator software avoids crew hazards.  Test that NASA EVA Navigator software avoids hardware hazards. | 1. Input Start Handrail and End Handrail values.  2. Click drop-down list and select the optional Middle waypoint Handrails (if available).  3. Input integer values to determine wingspan. |
| 04 | Test that NASA EVA Navigator software features are available on GitHub (publicly). | 1. Access NASA EVA Navigator software http://lovetostrike.github.io/nasa-path-finder/demo.html. |
| 05 | Test that if NASA EVA Navigator software on GitHub is a passing build and allows access to the software and its included features, visit lovetostrike.github.io/nasa-path-finder. | 1. Access NASA EVA Navigator software https://lovetostrike.github.io/nasa-path-finder. |

# Testing

## Proposed Test Cases

Below are the results of all test cases.

## Test Case 01: Operating Environment

**Description:** Test that NASA EVA Navigator software features operate with Mac or PC systems with either Mac OS X (version 10.7.x or higher), Windows (version 7 or higher), or Ubuntu (14 or higher) with 3.4 GHz CPU or faster; 8 GB or more of RAM; 1 GB or more of GPU; and 10 GB or more of free disk space using a monitor, keyboard, and mouse over a TCP/IP network Internet connection or data connection with Chrome, Firefox, and Internet Explorer (IE) web browsers.

**Test Plan Requirements:** OE-1, OE-2, OE-3, OE-4, OE-5, OE-6, and OE-7

**Prerequisites:** None

**Steps:**

1. Download or visit NASA EVA Navigator software.

2. Start NASA EVA Navigator software.

3. Upload base model .stl file(s).

4. Upload handrail .stl file(s).

5. Upload position .str file(s).

6. Verify that default handrails and positions are replaced.

7. Input Start Handrail and End Handrail values.

8. Click drop-down list and select the optional Middle Waypoint Handrails. (if available)

9. Input integer values to determine wingspan.

10. Click find shortest path(s).

**Input:** Start handrail and end handrail values and integer values.

**Expected output:** NASA EVA Navigator software features operate with Mac or PC systems with either Mac OS X (version 10.7.x or higher), Windows (version 7 or higher), or Ubuntu (14 or higher) with 3.4 GHz CPU or faster; 8 GB or more of RAM; 1 GB or more of GPU; and 10 GB or more of free disk space using a monitor, keyboard, and mouse over a TCP/IP network Internet connection or data connection with Chrome, Firefox, and Internet Explorer (IE) web browsers.

**Assumptions:** NASA EVA Navigator software UI has features that include variables starting with Start Handrail, End Handrail, optional Middle Waypoint Handrails (if available), and Wingspan Integer Values and that the software’s performance uses a Web-based 3D model application.

**Results:** The input fields accepted the start and end handrail values from the dropdown list. There was the ability to enter a specific handrail name to find it quickly and if an entered value was not available a message was displayed to avoid running the path calculation with invalid handrail values.

For uploading, the upload was possible by both drag-and-drop as well as click. It was not clear that click to upload was available however. The upload processed without issue as long as the file was the specified file type (stl, str) and was formatted by the Python script (/bin/fixModelFile.py) to add line ending characters.

The uploaded handrail stl and str files does not replace the defaults, however, are added to the existing handrails in the model. This is to allow for adding additional handrails to the defaults since all handrails can be replaced by refreshing the browser page.

**Defects:**

1. **Minor.** Upload files prompt accepts drag/drop file uploads as well as click to upload. However adding an upload button or click to upload instruction may be clearer.
2. **Minor.** It was possible to select the same handrail as both the start and end.
3. **Major.** The Wingspan/arm reach slider had no effect on the path calculation.
4. **Major.** It was not possible to select decimal Wingspan values.
5. **Minor.** As an enhancement, allow options for replacing handrails or updating them on upload in addition to adding them.

## Test Case 02: Design and Implementation Constraints

**Description:** Test that NASA EVA Navigator software model objects include: handrails and arm reach.

**Requirements:** DC-1

**Prerequisites:** None

**Steps:**

1. Input Start Handrail and End Handrail values.

2. Click drop-down list and select the optional Middle Waypoint Handrails. (if available)

3. Input data range from 4ft. to 7ft. for arm reach.

4. Ensure path avoids Crew Hazards and Sensitive Hardware.

**Input:** Start handrail and end handrail values, integer values, and input range from 4ft. to 7ft.

**Expected output:** NASA EVA Navigator software model objects includes handrail, an arm reach that ranges from 4ft. to 7ft., and a list of some object hazards that protrude from the structural surface.

**Assumptions:** NASA EVA Navigator software UI has features that that are simple, using drop-down lists and input fields and has an option to avoid sensitive hardware; provides hazards that consist of a list of some objects that protrude from structural surface; and “antenna” has about 1ft. volume around it and designated as a “Keep Out Zone”.

**Results:** The input fields accepted the start and end handrail values from the dropdown list. There was the ability to enter a specific handrail name to find it quickly and if it an entered value was not available a message was displayed to avoid running the path calculation with invalid handrail values.

Hazards within the “Keep Out Zone” had to be identified by manual inspection of the calculated paths. However, it was possible to choose one of the alternate paths if the shortest path was too close to a hazard.

**Defects:**

1. **Minor (duplicate).** It was possible to select the same handrail as both the start and end.
2. **Major (duplicate).** The Wingspan/arm reach slider had no effect on the path calculation.
3. **Major (duplicate).** It was not possible to select decimal Wingspan values.
4. **Minor.** As an enhancement, update algorithm to automatically avoid “Keep Out Zone” around hazards without requiring manual inspection and alternate path selection.

## Test Case 03: Performance

**Description:** Test that NASA EVA Navigator software performance features accommodate a 3D model that determines a crewmember’s particular location, navigate crewmembers, establish a path(s) shortest distance, avoid a path(s) encounter with the least hazards and determine a path(s) requirement for longer arm reach.

**Test Plan Requirements:** PR-1, PR-1.1, PR-1.2, PR-1.3, PR-1.4, PR-1.5, PR-1.6, & PR-1.7

**Prerequisites:** None

**Steps:**

1. Input Start Handrail and End Handrail values.

2. Click drop-down list and select the optional Middle Waypoint Handrails (if available).

3. Input integer values to determine wingspan*.*

**Input:** Start handrail and end handrail values and integer values.

**Expected output:** The 3D model informs the client where a crewmember is located, how to navigate a crewmember, which path is the shortest distance, which path avoids encounters with the least hazards, and which paths determine requirements for longer arm reach. NASA EVA Navigator software accommodates a 3D model written in .stl format, either in binary or text format, calculates valid paths around the exterior of the ISS, and renders path(s) for user.

**Assumptions:** NASA EVA Navigator software UI has an option to avoid crew and hardware hazards.

**Results:** The application rendered and performed identically in all operating environments and target browsers. However, as expected with a 3D application, IE11 was the least performant of all browsers. Chrome and Firefox loaded the application in 4-6 seconds on average. IE11 took 16 seconds for the initial load. Once the application was initially loaded however, additional actions were performed at similar load times in all browsers.

In terms of overall performance the application takes the longest on initial load. This seems to be due to the large stl and str files being loaded into the DOM (over 42MB). This issue should be lessened when running the application locally instead of on a remote server. The average initial load times for each browser (in seconds) on a high-speed fiber broadband connection (100 Mbps) is below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Average** | 1st load | 2nd load | 3rd load | 4th load | 5th load |
| PC Chrome | **6.628** | 8.38 | 5.53 | 6.91 | 5.62 | 6.7 |
| PC Firefox | **6.142** | 6.12 | 4.57 | 6.95 | 5.9 | 7.17 |
| Mac Chrome | **4.452** | 4.89 | 4.38 | 4.42 | 4.34 | 4.23 |
| Mac Firefox | **5.282** | 5.93 | 5 | 5.26 | 5.17 | 5.05 |
| IE11 | **16.06** | 15.2 | 16 | 15.4 | 15.7 | 18 |

Once the application was loaded and all stl, str files were cached, all additional interactions such as calculating paths were performed instantaneously.

**Defects:**

1. **Minor.** IE11 performance on initial load lags well behind other browsers (16 seconds versus 4-6 seconds).

## Test Cases 04-05: Software Quality Attributes

**Description:** Test that NASA EVA Navigator software features are available on GitHub (publicly) and test that if NASA EVA Navigator on GitHub is a passing build and, that it allows access to the software and its included features.

**Test Plan Requirements:** Availability-1 & Robustness-1

**Prerequisites:** None

**Steps:**

1. Access NASA EVA Navigator software <http://lovetostrike.github.io/nasa-path-finder/demo.html>.

2. Access NASA EVA Navigator software <https://lovetostrike.github.io/nasa-path-finder>.

**Input:** URL address <http://lovetostrike.github.io/nasa-path-finder/demo.html> and <https://lovetostrike.github.io/nasa-path-finder>

**Expected output:** NASA EVA Navigator software features are available on GitHub (publicly) and if NASA EVA Navigator software on GitHub is a passing build, it allows access to the software and its included features.

**Assumptions:** NASA EVA Navigator software features will be available to Astronauts, Astronaut Trainers, Spacewalk Procedure Writers, and Application developers.

**Results:** The application is publicly available at the specified GitHub URL with a passing build as indicated on the repository landing page: <https://lovetostrike.github.io/nasa-path-finder>

It is possible to clone or download the application source code and instructions for running the application are in the README.md file.

Defects:

1. **Minor.** Since GitHub does not support running Java applications, the full backend application will only run on the local environment. On the GitHub link, the calculated path is loaded with sample data.