Software Verification of Orion Cockpit Displays

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Orion and its Cockpit Displays

• NASA’s Orion spacecraft is built to take humans to Mars effectively and safely

• To monitor spaceflight status and provide instructions to crew, cockpit has new software embedded digital displays to replace hundreds of pounds of paper documentations

• Digital displays have three glass screens to show graphical objects that are manipulated on screen using peripheral switches such as edge keys and knobs
Motivation

• Many physical man-hours go into monotonous and manual software verification of human spacecraft displays

• Need a more automated, robust and thorough verification method for Orion's cockpit displays to reduce human error
Goal

- Verify the display software using an automation tool such as EggPlant Functional
- Develop a framework to allow for repeatability and consistency of verification of different display items
What is EggPlant?

- Verification Software that utilizes image recognition
- Automation capabilities through simulation of user inputs
  - Clicks
  - Keyboard Keystrokes
- User-like testing method
  - Recognition of object on screen followed by a click or keystroke
- Thorough and long duration tests through automation
- Knowledge of background code or internal processes not needed
How Does EggPlant Work?

- EggPlant Functional works in a Controller – System Under Test Relationship
How Does EggPlant Work?
How Does EggPlant Work?

• Verifies nominal function by recognizing an image that appears at a specific instance during a test.
  • Images are captured prior to testing.
  • An example test on Windows OS would be recognizing an image of the Windows Start Menu after clicking on the Windows logo on the Windows Taskbar.

• Comes with a GUI to write test automation scripts for your System Under Test.

• Uses a language called SenseTalk for its scripts.

• Scripting is intuitive.
  • Code user interactions with simple EggPlant commands
How Does EggPlant Work?

Example Code:

```plaintext
Click(Image:"sample_image", waitfor:5)   // Click image
Typetext "Sample text."                   // Type "Sample text"

ImageFound(Image:"sample_image")        // Conditional Statement
                                        // Returns True or False
```
Display Software Verification

• Display Unit are split into:
  • Upper Left Quadrant
  • Upper Right Quadrant
  • Lower Left Quadrant
  • Lower Right Quadrant
  • Top Navigation Quadrant
  • Bottom Navigation Quadrant
# Framework Definitions

<table>
<thead>
<tr>
<th>Framework Description</th>
<th>Framework Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display Unit 1</td>
<td>DU1</td>
</tr>
<tr>
<td>Display Unit 2</td>
<td>DU2</td>
</tr>
<tr>
<td>Display Unit 3</td>
<td>DU3</td>
</tr>
<tr>
<td>Cursor Control Device 1</td>
<td>CCD1</td>
</tr>
<tr>
<td>Cursor Control Device 2</td>
<td>CCD2</td>
</tr>
<tr>
<td>Display Calls</td>
<td>DC</td>
</tr>
</tbody>
</table>
## Upper Left Quadrant

<table>
<thead>
<tr>
<th>Desired EdgeKey Function</th>
<th>Variable Name</th>
<th>DU1</th>
<th>DU2</th>
<th>DU3</th>
</tr>
</thead>
<tbody>
<tr>
<td>EK_Upper left click 1</td>
<td>ULC1</td>
<td>*30</td>
<td>.30</td>
<td>.30</td>
</tr>
<tr>
<td>EK_Upper left click 2</td>
<td>ULC2</td>
<td>*31</td>
<td>.31</td>
<td>.31</td>
</tr>
<tr>
<td>EK_Upper left click 3</td>
<td>ULC3</td>
<td>*32</td>
<td>.32</td>
<td>.32</td>
</tr>
<tr>
<td>EK_Upper left click 4</td>
<td>ULC4</td>
<td>*33</td>
<td>.33</td>
<td>.33</td>
</tr>
<tr>
<td>EK_Upper left click 5</td>
<td>ULC5</td>
<td>*34</td>
<td>.34</td>
<td>.34</td>
</tr>
<tr>
<td>EK_Upper left release 1</td>
<td>ULR1</td>
<td>‘30</td>
<td>;30</td>
<td>\30</td>
</tr>
<tr>
<td>EK_Upper left release 2</td>
<td>ULR2</td>
<td>‘31</td>
<td>;31</td>
<td>\31</td>
</tr>
<tr>
<td>EK_Upper left release 3</td>
<td>ULR3</td>
<td>‘32</td>
<td>;32</td>
<td>\32</td>
</tr>
<tr>
<td>EK_Upper left release 4</td>
<td>ULR4</td>
<td>‘33</td>
<td>;33</td>
<td>\33</td>
</tr>
<tr>
<td>EK_Upper left release 5</td>
<td>ULR5</td>
<td>‘34</td>
<td>;34</td>
<td>\34</td>
</tr>
</tbody>
</table>
Schematic of the main Edge Keys with their assigned variable names.
Display Software Verification

Schematic of the miscellaneous Edge Keys with their assigned variable names.
Display Software Verification

Example Code:

```plaintext
put “C:\Users\user\Desktop\DisplayUnit_KeyStroke_Framework.suite\Scripts\DU1” into DU1

//Navigates to MPS Display
put DU1.Flt_MPS

//Click and release 2 edge key buttons
put DU1.URCR1
put DU2.LRCR3
```
Conclusions and Future Work

- A display test script run multiple times on EggPlant Functional proved verification was carried out successfully.

- EggPlant Functional and SenseTalk proved to be highly useful tools for automating the testing of the Orion cockpit display simulators.

- The Edge Key framework and Common EggPlant Function scripts enabled to write modular and re-usable code to apply to different displays and their items:
  - popup types
  - enumerations.

- Common Eggplant Functions can be used repeatedly in tests of other displays, and such iterative testing will help validate reliability and consistency of simulation of Orion cockpit display software.
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Thank You!