

# 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



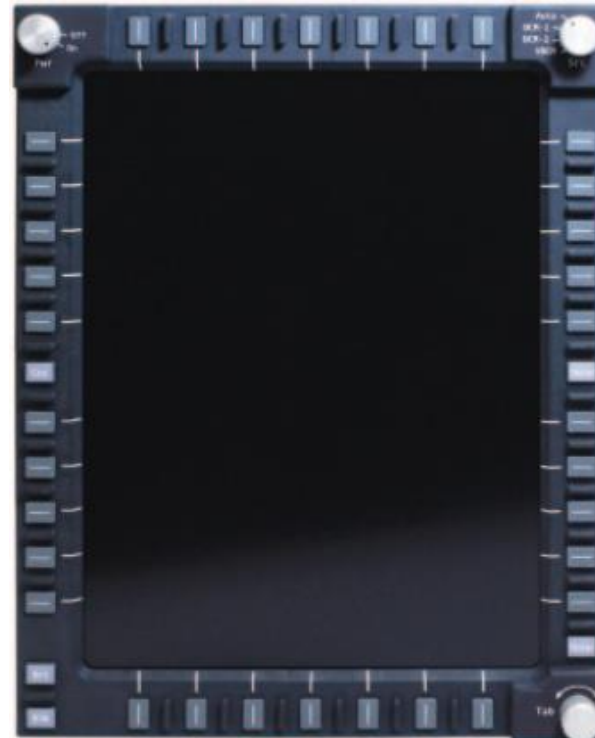
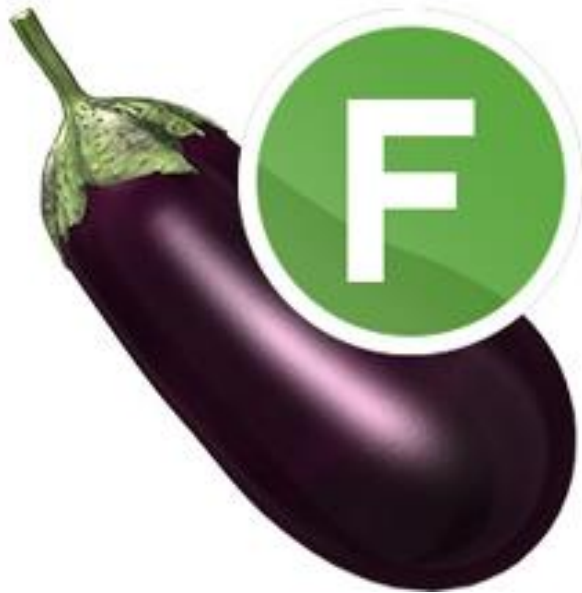
# Motivation

- 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

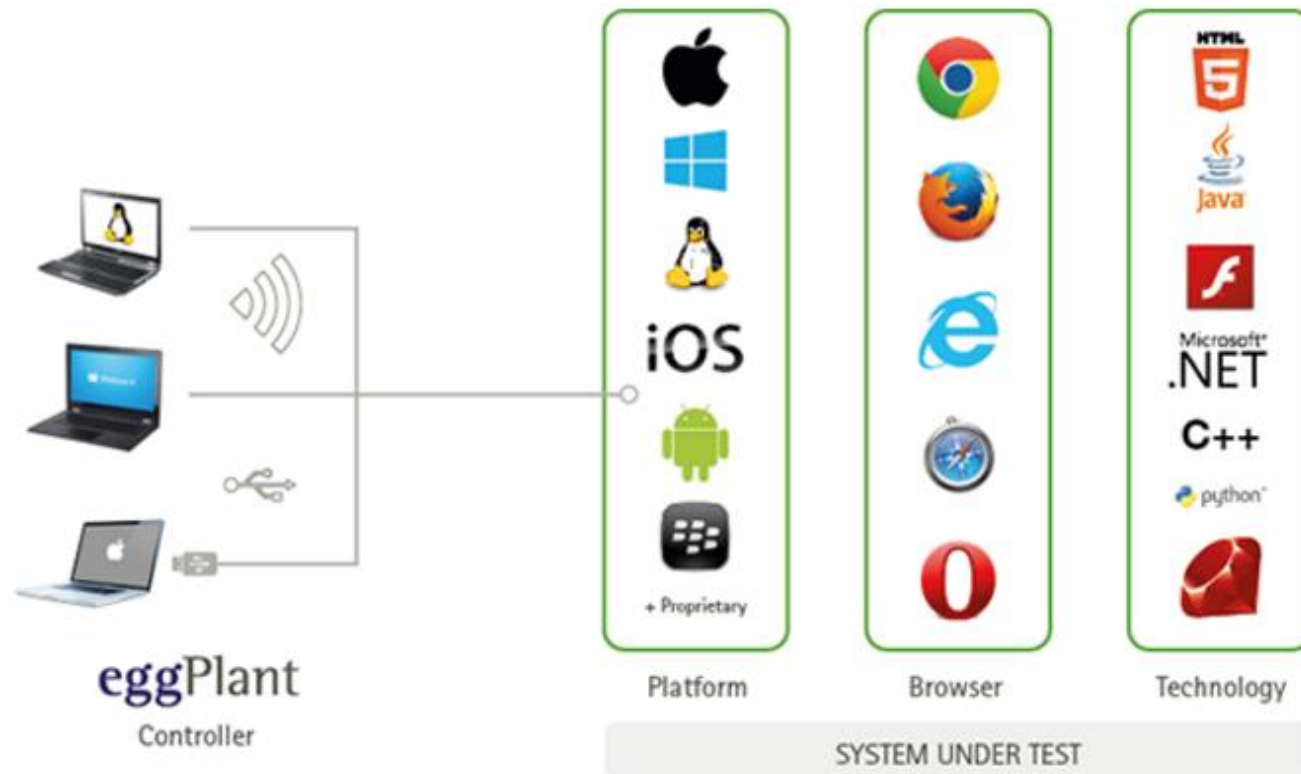


# What is EggPlant?

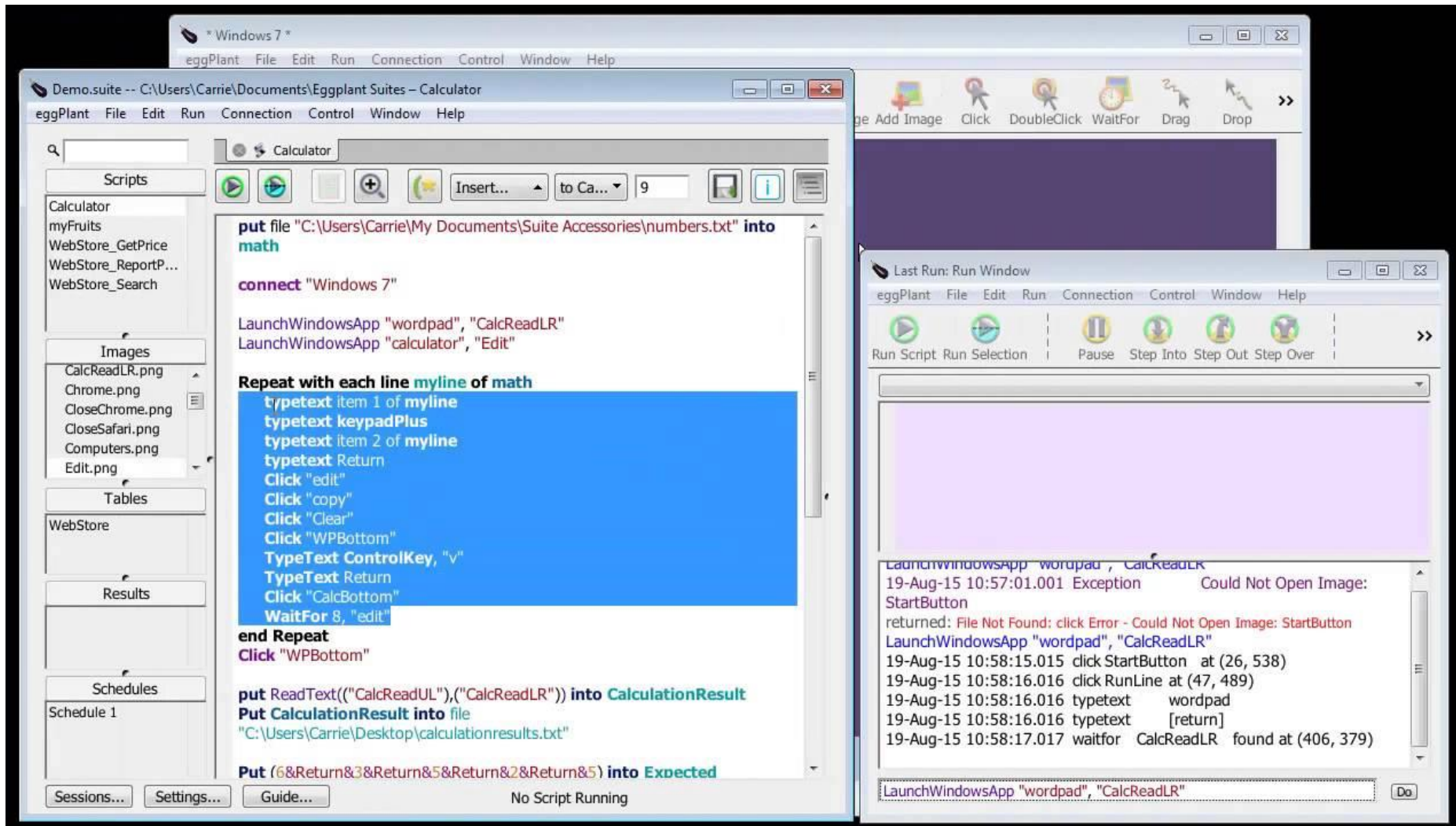
- Verification Software that utilizes image recognition
- Automation capabilities through simulation of user inputs
  - Clicks
  - Keyboard Keystrokes
- User-like testing method
  - Recognition of object on screen followed by a click or keystroke
- Thorough and long duration tests through automation
- 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



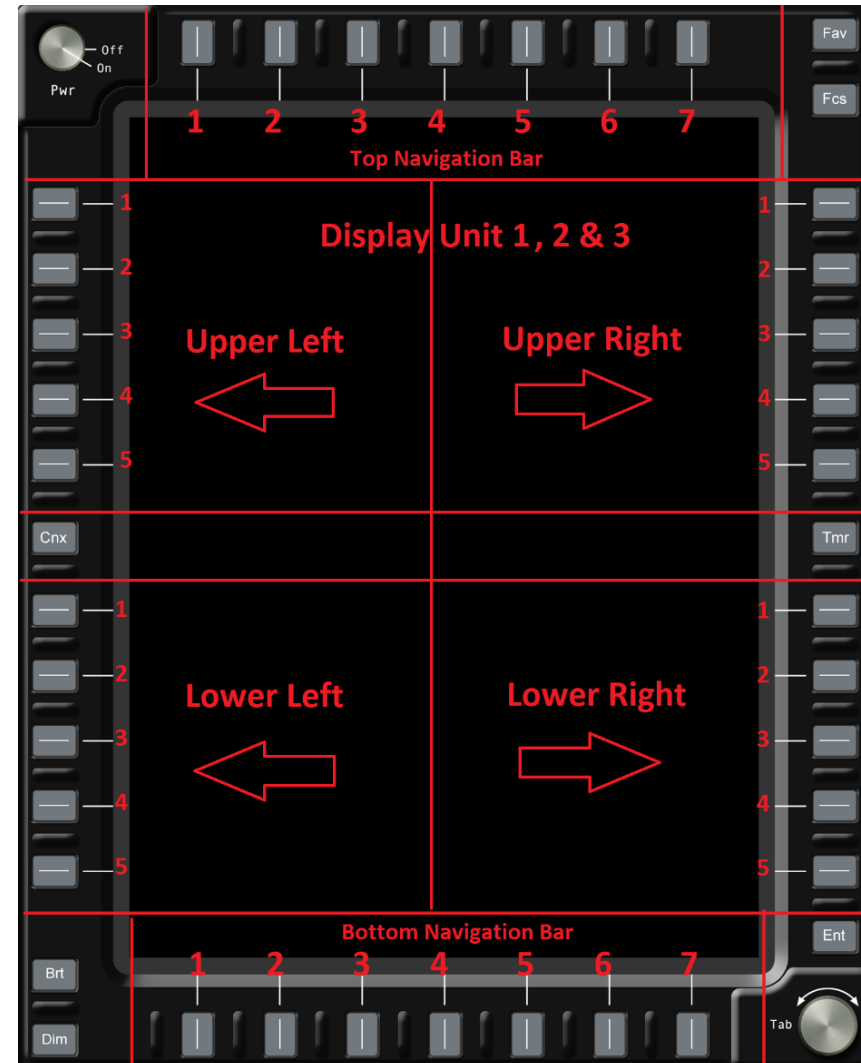
# How Does EggPlant Work?

Example Code:

```
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

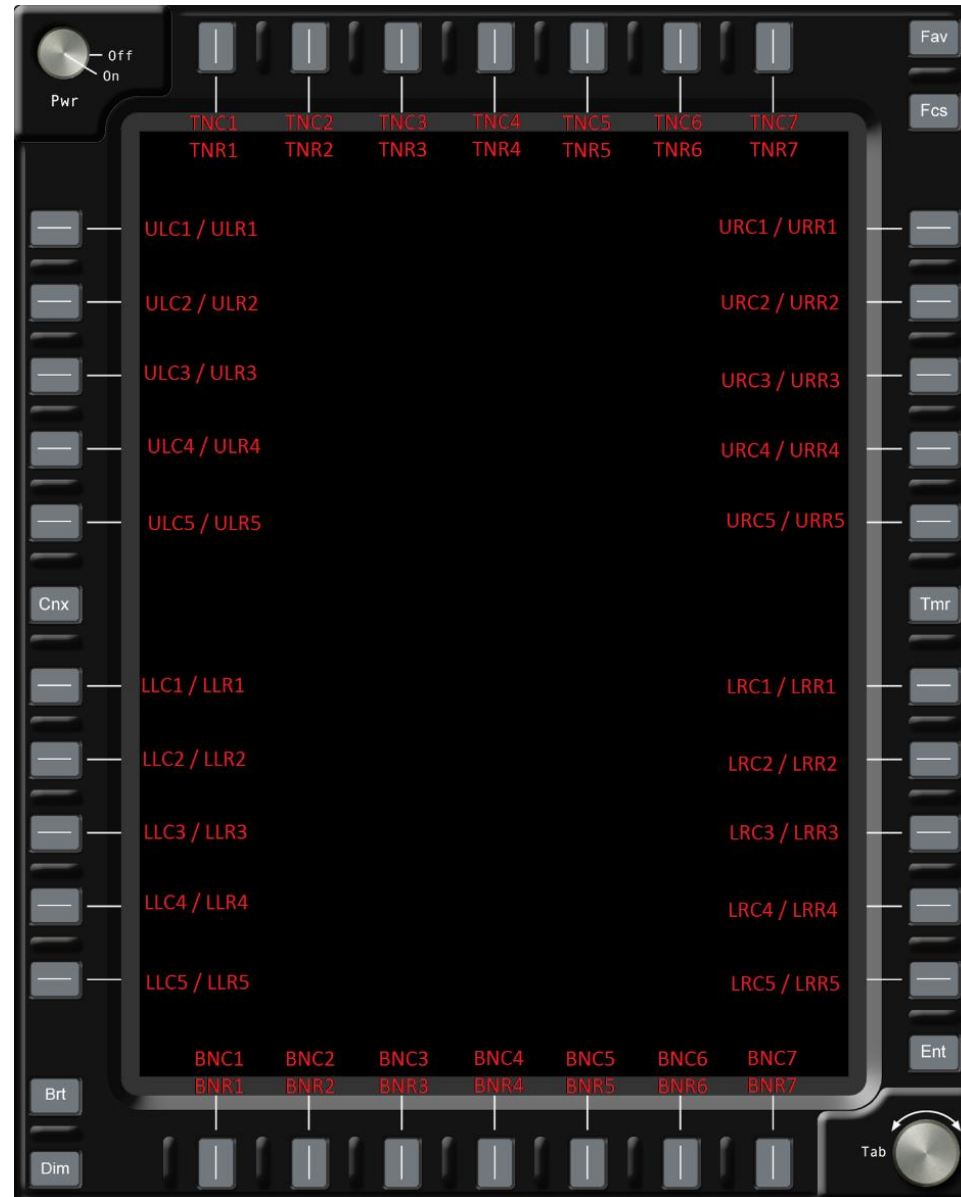
Framework Description	Framework Name
Display Unit 1	DU1
Display Unit 2	DU2
Display Unit 3	DU3
Cursor Control Device 1	CCD1
Cursor Control Device 2	CCD2
Display Calls	DC

# Upper Left Quadrant

<u>Desired EdgeKey Function</u>	<u>Variable Name</u>	<u>DU1</u>	<u>DU2</u>	<u>DU3</u>
EK_Upper left click 1	ULC1	*30	,30	.30
EK_Upper left click 2	ULC2	*31	,31	.31
EK_Upper left click 3	ULC3	*32	,32	.32
EK_Upper left click 4	ULC4	*33	,33	.33
EK_Upper left click 5	ULC5	*34	,34	.34
EK_Upper left release 1	ULR1	'30	;30	\30
EK_Upper left release 2	ULR2	'31	;31	\31
EK_Upper left release 3	ULR3	'32	;32	\32
EK_Upper left release 4	ULR4	'33	;33	\33
EK_Upper left release 5	ULR5	'34	;34	\34

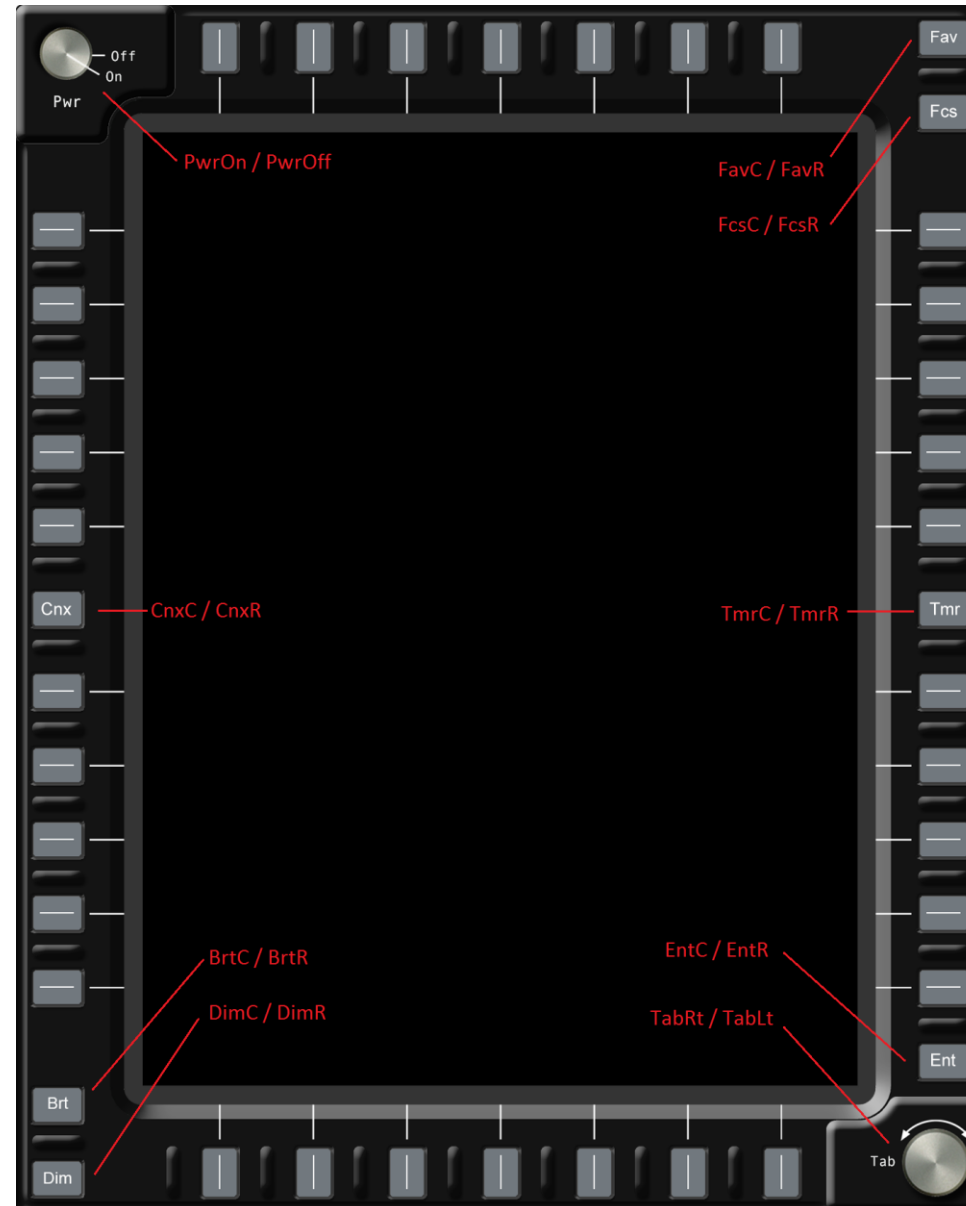
# Display Software Verification

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:

```
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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