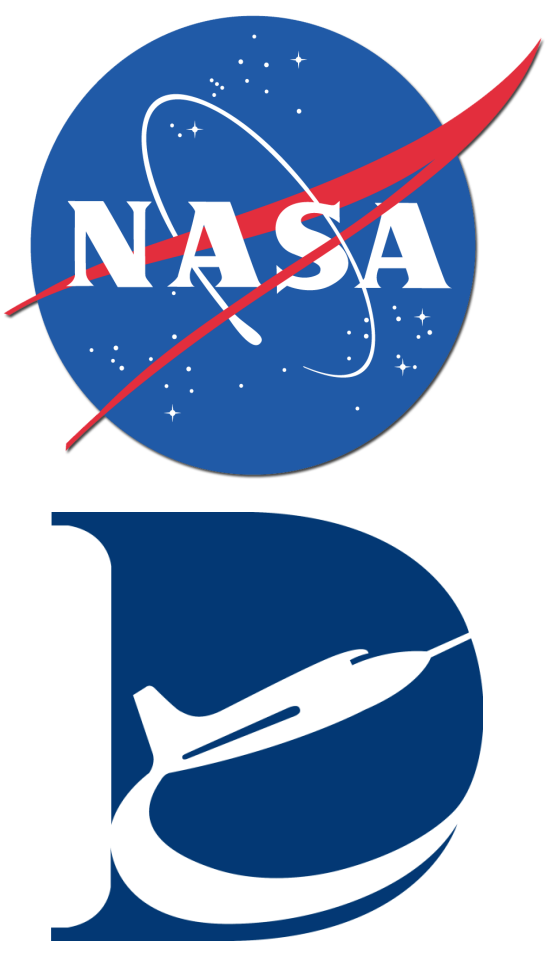


# Abstract

One of the pilot-machine interfaces (the forward viewing camera display) for an Unmanned Aerial Vehicle called the DROID (Dryden Remotely Operated Integrated Drone) will be analyzed for optimization. The goal is to create a visual display for the pilot that as closely resembles an out-the-window view as possible. There are currently no standard guidelines for designing pilot-machine interfaces for UAVs. Typically, UAV camera views have a narrow field, which limits the situational awareness (SA) of the pilot. Also, at this time, pilot-UAV interfaces often use displays that have a diagonal length of around 20". Using a small display may result in a distorted and disproportional view for UAV pilots. Making use of a larger display and a camera lens with a wider field of view may minimize the occurrences of pilot error associated with the inability to see "out the window" as in a manned airplane. It is predicted that the pilot will have a less distorted view of the DROID's surroundings, quicker response times and more stable vehicle control. If the experimental results validate this concept, other UAV pilot-machine interfaces will be improved with this design methodology.



# Sitting in the Pilot's Seat; Optimizing Human-Systems Interfaces for Unmanned Aerial Vehicles



S. D. BECHTEL, JR.  
FOUNDATION  
STEPHEN BECHTEL FUND

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## Human-Systems Interfaces

Piloting an UAV is difficult because a remotely located pilot has reduced sensory perception of the state of the aircraft. Trying to pilot an UAV with a display that gives a distorted image of the UAV's surroundings makes a difficult task even more complicated.



Ikhana (UAV)\*

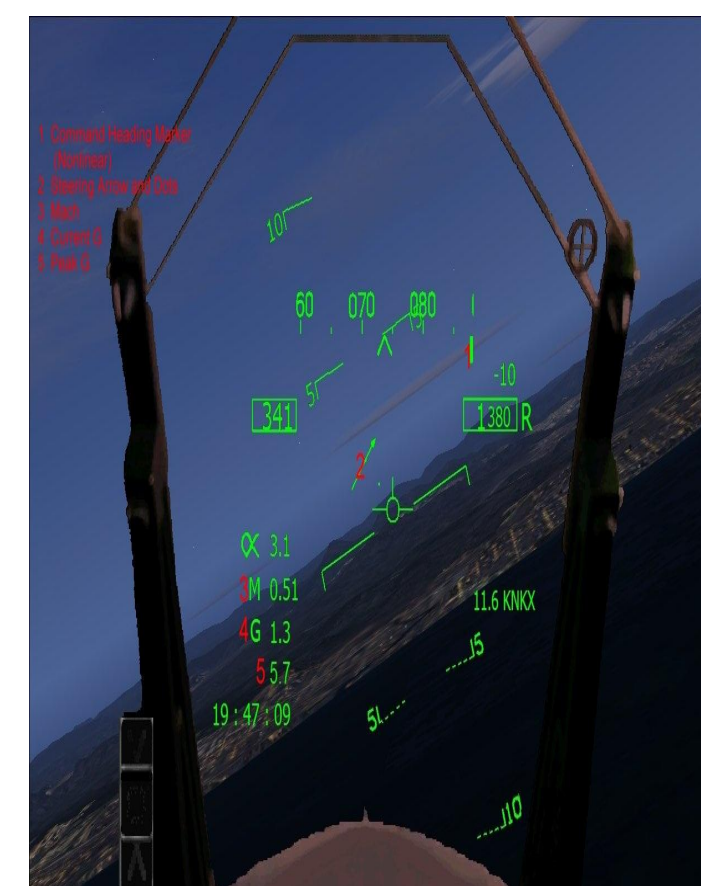


Pilot-UAV interface of Ikhana\*

There are currently no standard guidelines for designing pilot-machine interfaces for UAVs. Typically, UAV camera views have a narrow field, which limits the situational awareness (SA) of the pilot. Also, at this time, pilot-UAV interfaces often use displays that have a diagonal length of around 20". Using a small display may result in a distorted and disproportional view for UAV pilots. Making use of a larger display and a camera lens with a wider field of view (FOV) may minimize the occurrences of pilot error associated with the inability to see "out the window" as in a manned airplane. It is predicted that the pilot will have a less distorted view of the DROID's surroundings, quicker response times and more stable vehicle control. If the experimental results validate this concept, other UAV pilot-machine interfaces will be improved with this design methodology.



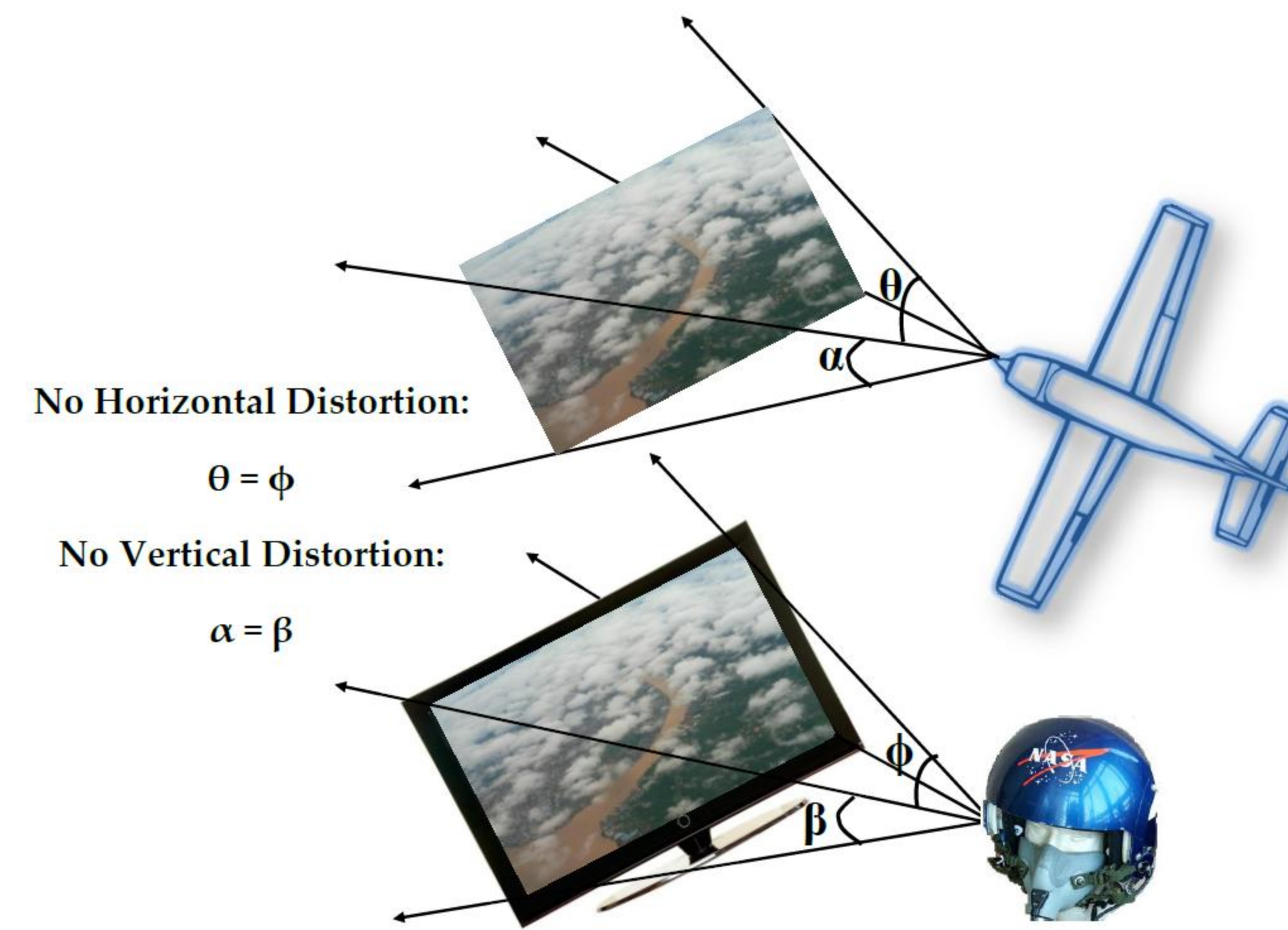
Undistorted simulated image (25° tilted horizon)\*



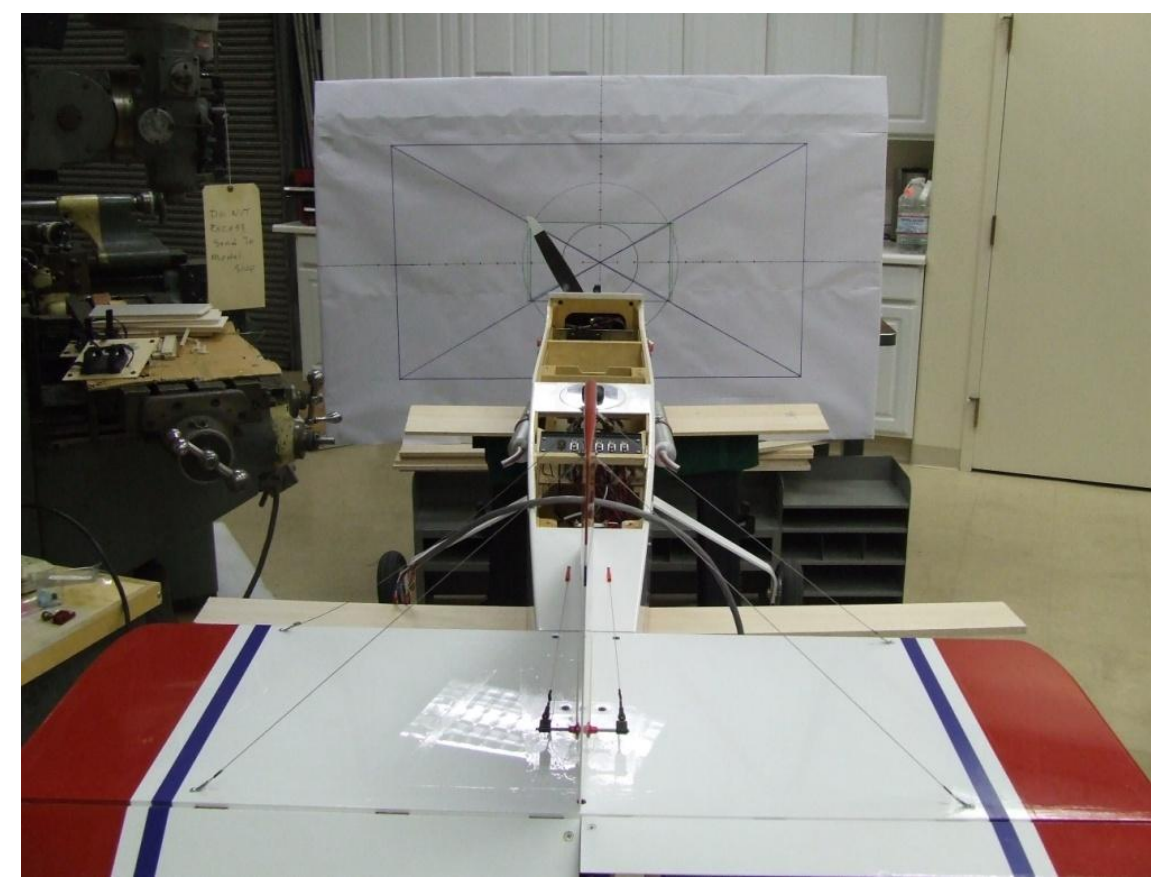
Distorted by display configuration, apparently 45° bank angle\*

## Methods

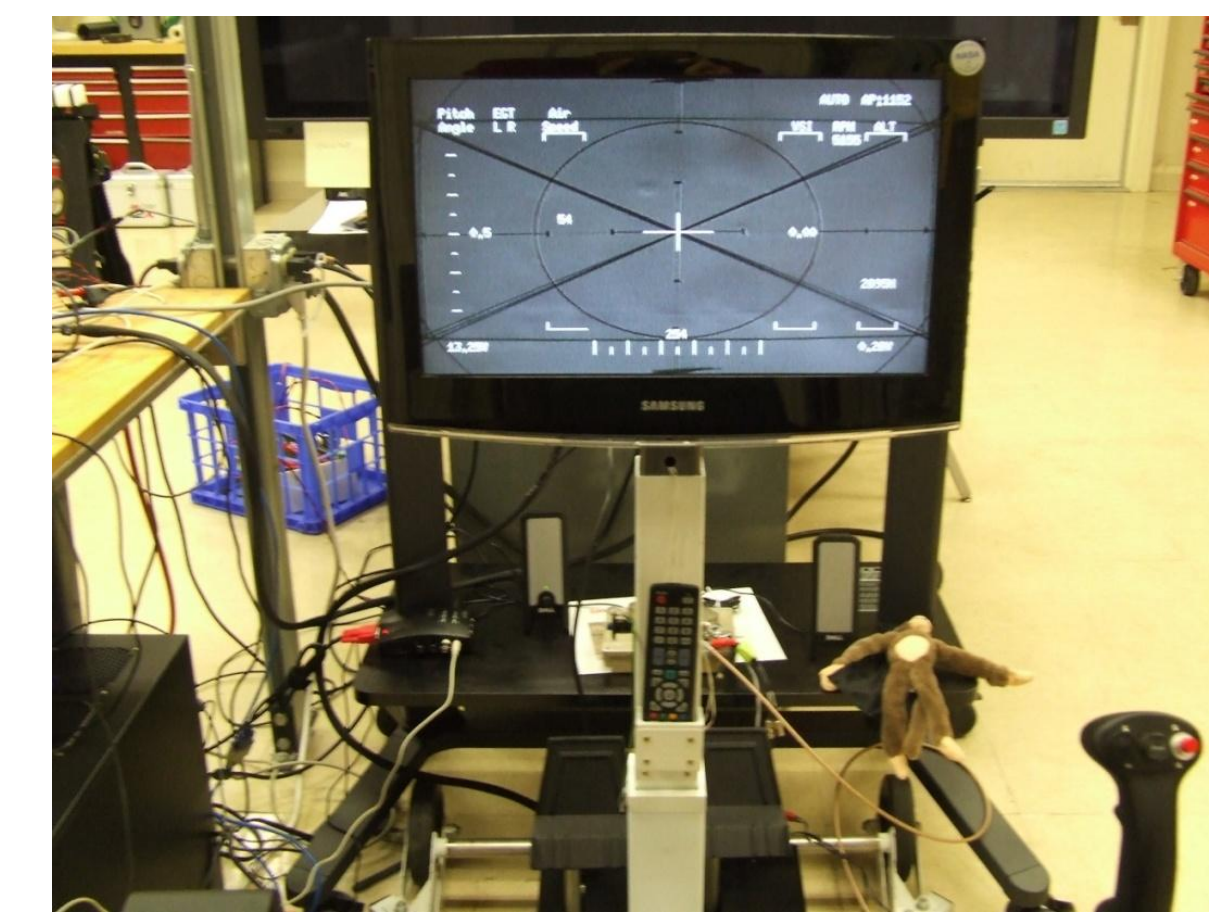
An ideal display screen will portray the UAV's surroundings so that the pilot sees what he would see if he were actually sitting in the cockpit and looking out the window. The goal is to create a visual display for the pilot that as closely resembles an "out-the-window" view as possible.



- 1) Measure distortion levels of current and new setups for comparison. Determine which setup has minimal distortion.

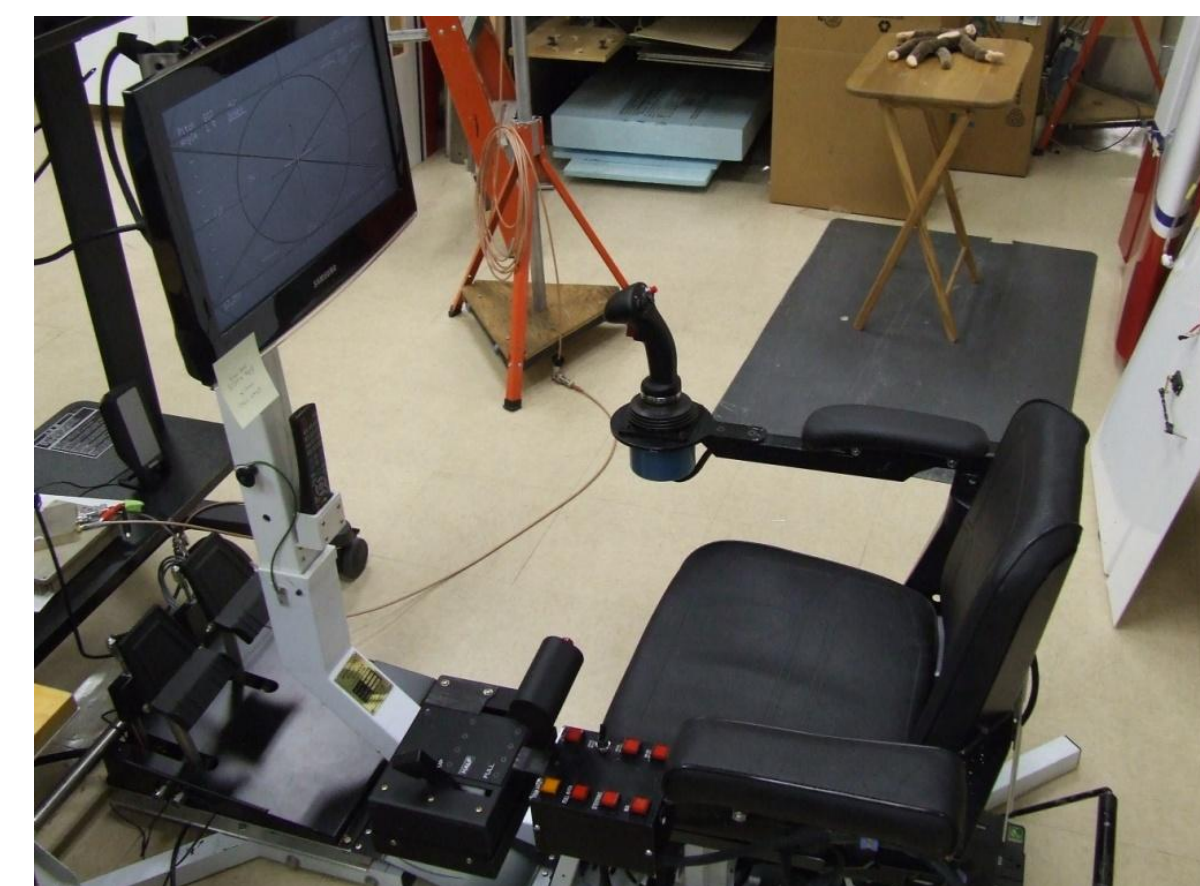


DROID with test board in front\*\*



Screen with test board displayed\*\*

- 2) Conduct flight tests using current setup, setup with minimal distortion and setup with 86 degree field of view. Test for controllability, stability, and situational awareness.



Current setup\*\*



DROID in flight\*

## Results

	Aspect Ratio
Small Display (19")	1.781:1 (Full)/ 1.333:1 (4:3 Mode)
Large Display (55")	1.772:1 (Full)/ 1.333:1 (4:3 Mode)
5.5mm Lens (44.9° FOV)	1.343:1
3mm Lens (86° FOV)	1.411:1

It was found that the setup with the least distortion was the 5.5mm lens and large display in 4:3 aspect ratio mode. This minimal distortion setup was found by matching the aspect ratios as close as possible. The 3mm lens (wide FOV) produced a "fisheye" look by distorting the image along the edges. Future attempts to implement a wide FOV should require the use of a lens that reduces distortion. It is possible that reducing the level of visual distortion may hurt the pilot's ability to fly because he may have become accustomed to the current level of distortion.

## Future Work

At this time, flight tests have yet to be conducted. Flight tests will produce measurable data that will quantify difference in controllability, stability, and situational awareness of the pilot. Analysis of the data should either support a recommendation for modifying the pilot-UAV display or show that the pilot is unaffected by the levels of visual distortion and field of view that are currently standard design practice.

## Acknowledgements

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\*Photos available on internet

\*\* Photos taken at Dryden Flight Research Center