

Aug 14th, 3:00 PM - 4:15 PM

## Augmented and Virtual Reality for In-Flight Simulator Aircraft

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Ruben DeValois

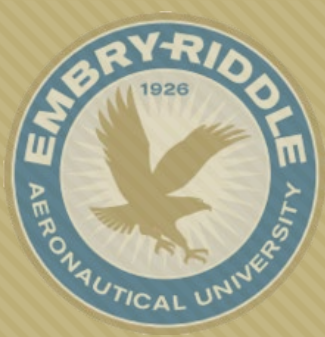
*Flight Level Engineering*, rubendevalois@gmail.com

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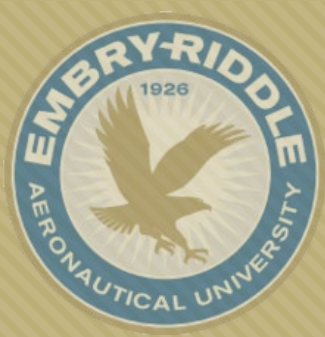
Martos, Borja Ph.D. and DeValois, Ruben, "Augmented and Virtual Reality for In-Flight Simulator Aircraft" (2017). *National Training Aircraft Symposium (NTAS)*. 16.  
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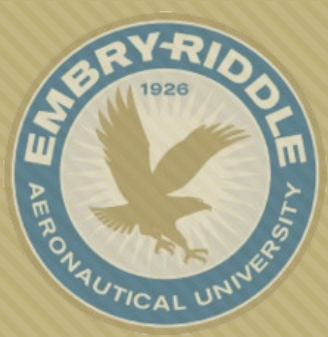
# Low-Cost Wearable HUD for Light General Aviation

By Pavan K. Chinta; Dr. Borja Martos



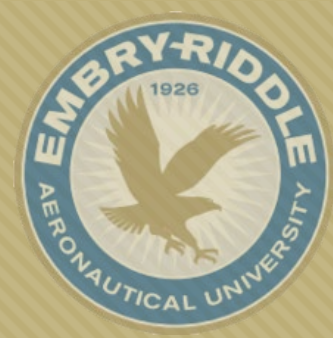
# Overview

- Motivation
- Hypothesis
- Areas of Focus
- Equipment
- Challenges
- Results
- Conclusion



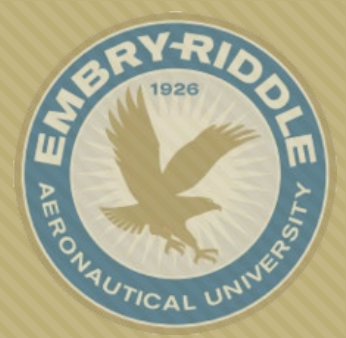
# Motivation

- "... the HGT could have likely prevented a significant portion of loss of control (LOC) accidents..."
- "...96% of all aviation accidents, 97% of fatal aviation accidents, and 96% of all fatalities... 51% of the estimated total flight time..."
- "... in 2016 the Federal Aviation Administration (FAA) overhauled the airworthiness standards for small GA airplanes..."
- "...with the release of Google glass in 2014, there is a growing trend of wearable AR..."



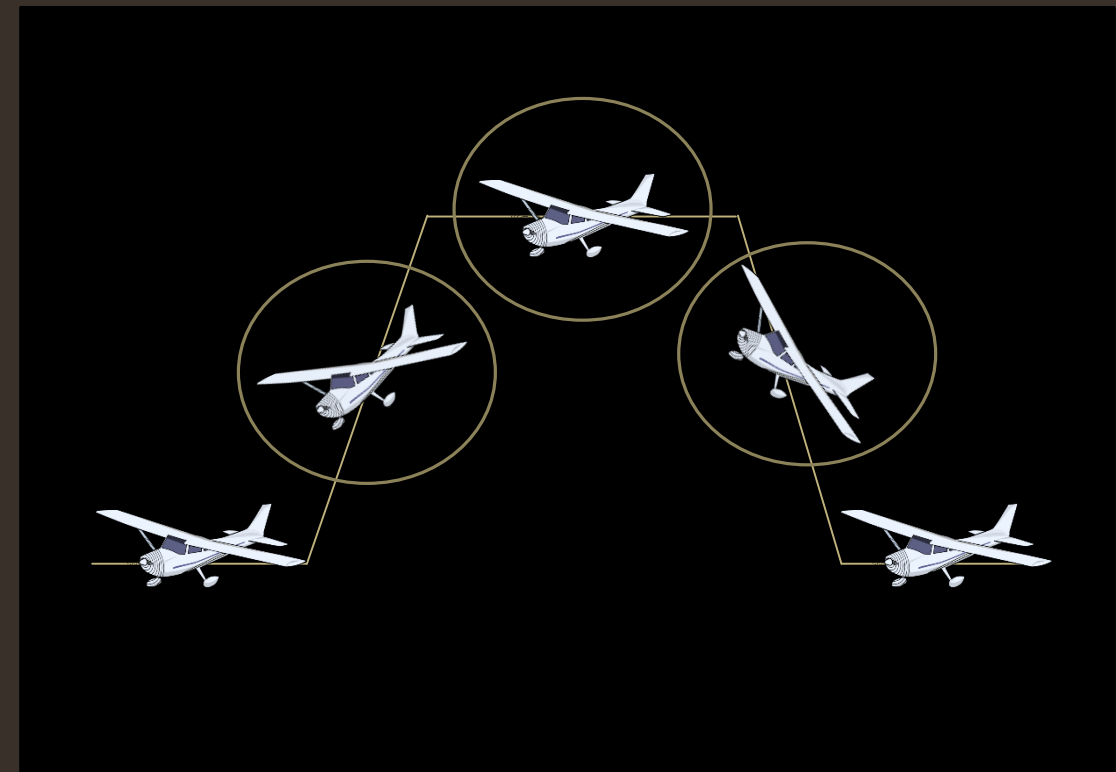
# Research Hypothesis

$$\underbrace{V + h + \beta + \theta + \psi + \theta}_{\text{traditional cockpit}} + \underbrace{(\alpha + \gamma)}_{\text{EFRC HUD}} = \textit{intuitive flying}$$

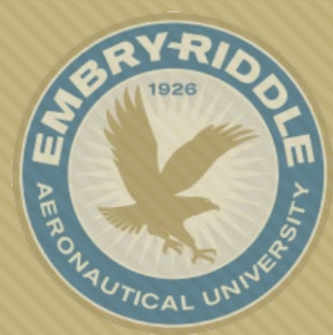


# Areas of Focus

- Flight-Phase Performance
  - Climb
  - Cruise
  - Landing



# Equipment



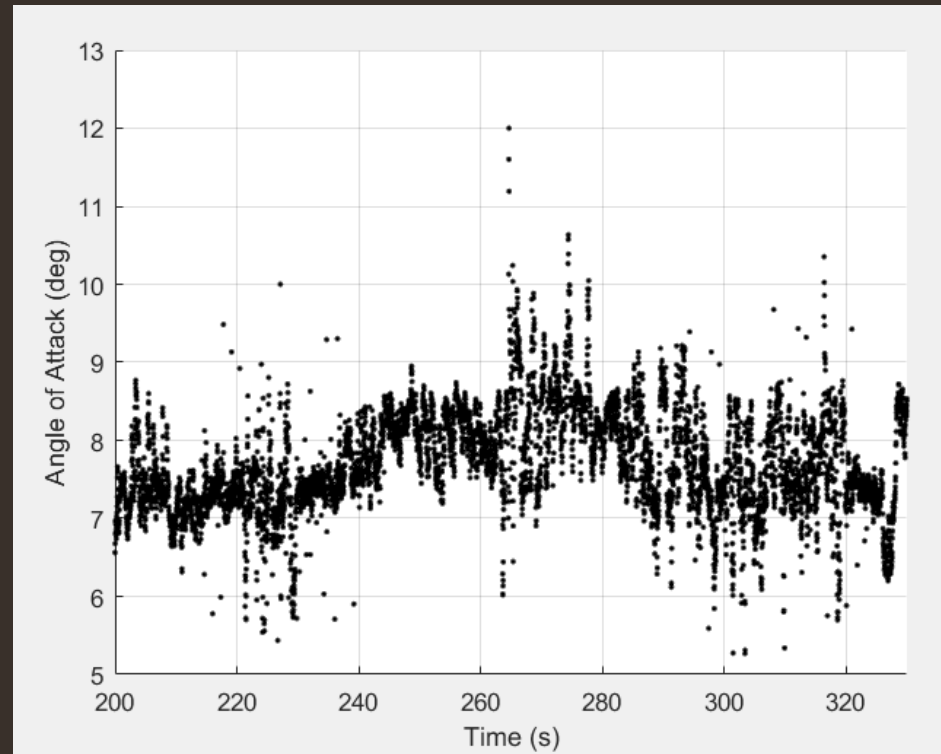
- Air Data Probe
  - $\alpha/\beta$  mechanical vanes
  - swivel head pitot-static system
- Honeywell HG1700 IMU
- ProPak-V3 GPS



- Epson BT-200

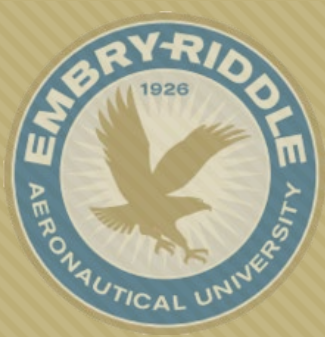
# Challenges

- Atmospheric Turbulence



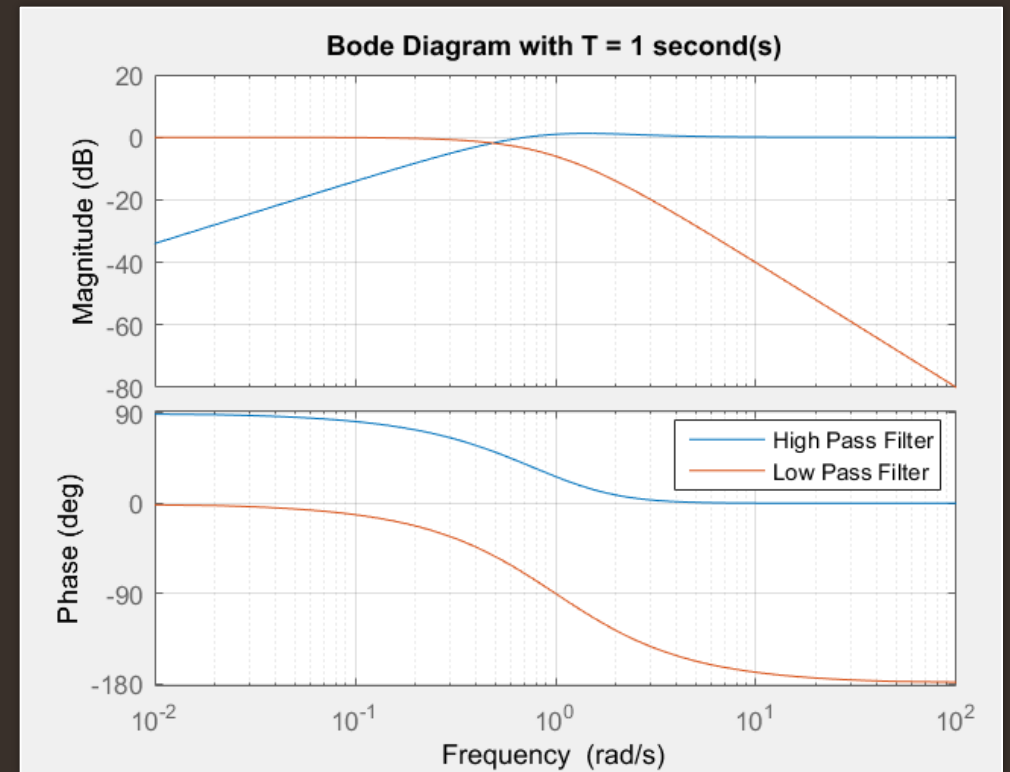
Straight and level flight at 4500 feet with high atmospheric turbulence.

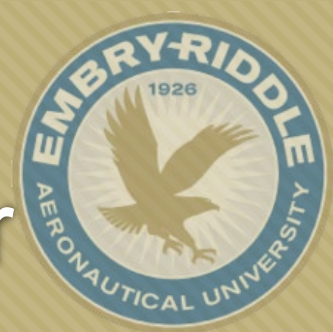




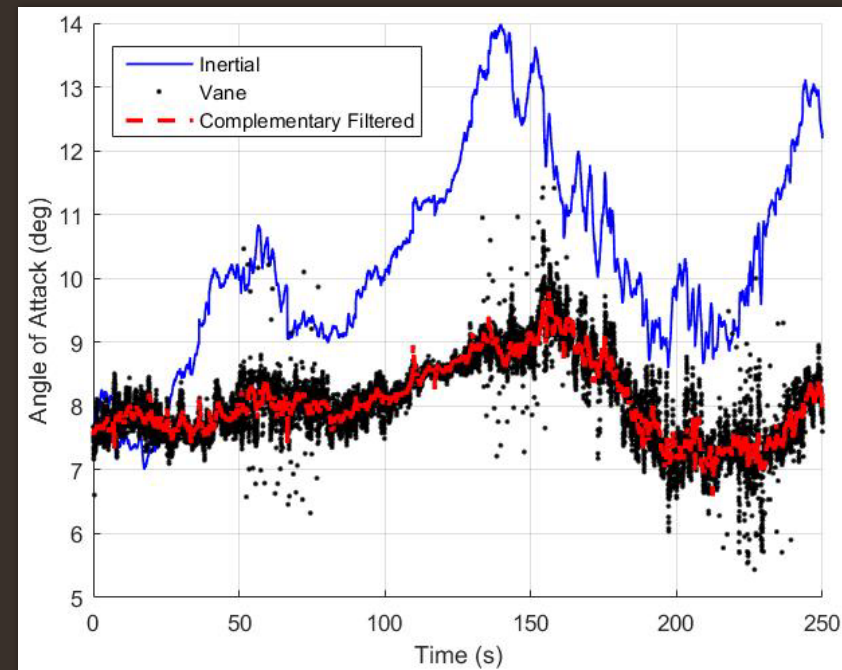
# Complementary Filter

$$\alpha_f = f_l(\alpha_i + \alpha_g) + f_h\left(\int \dot{\alpha}_i dt\right)$$

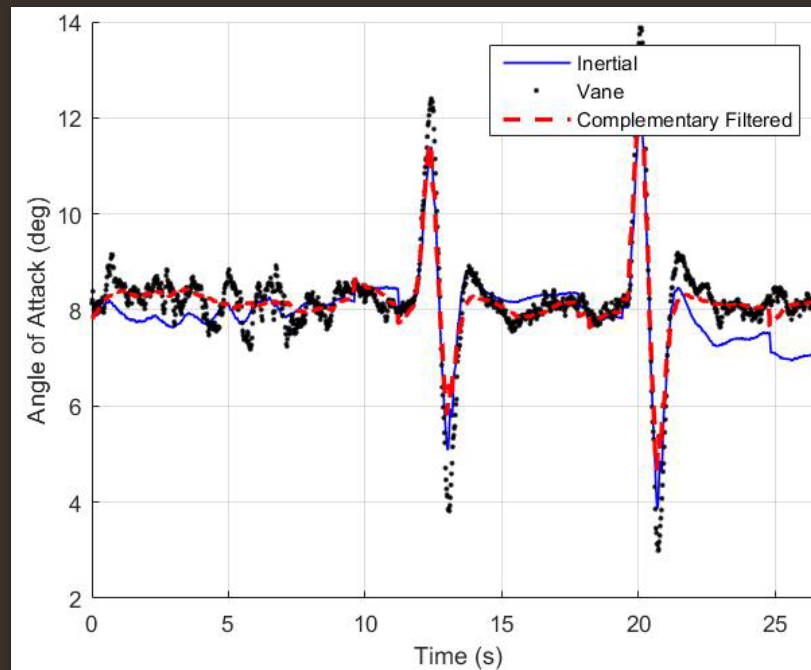




# Flight Test Results: Complementary Filter

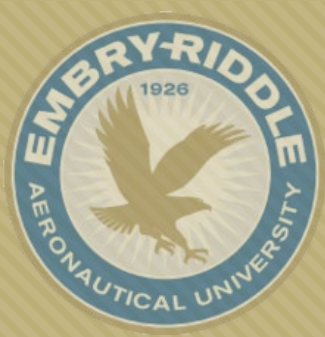


Straight & Level in High Turbulence



Short Period in Light Turbulence

EXAMPLES

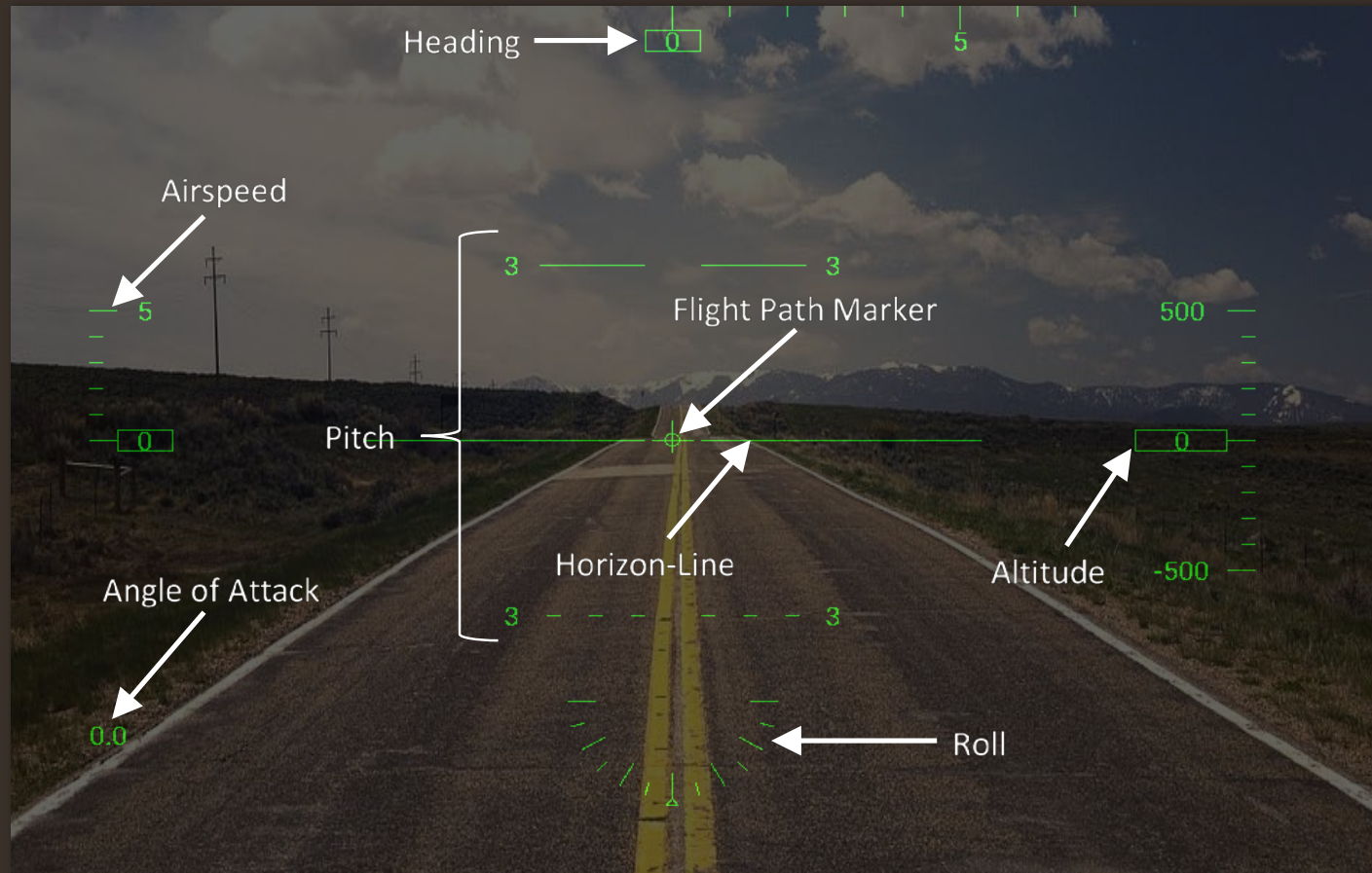


# More Challenges

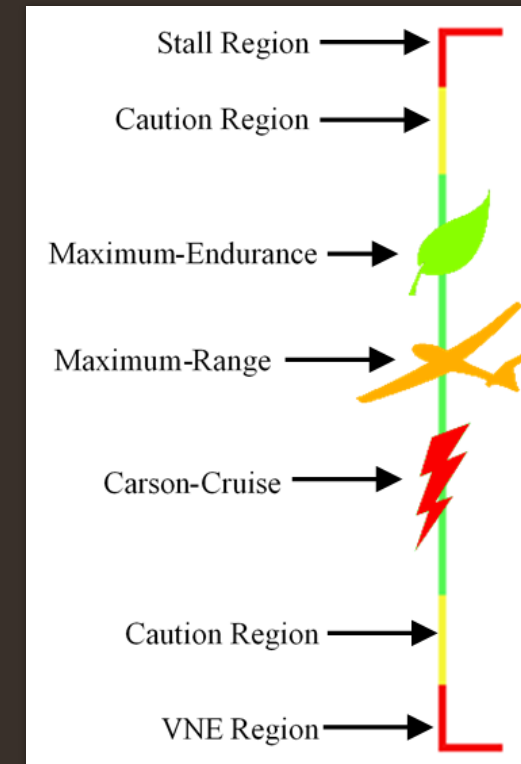
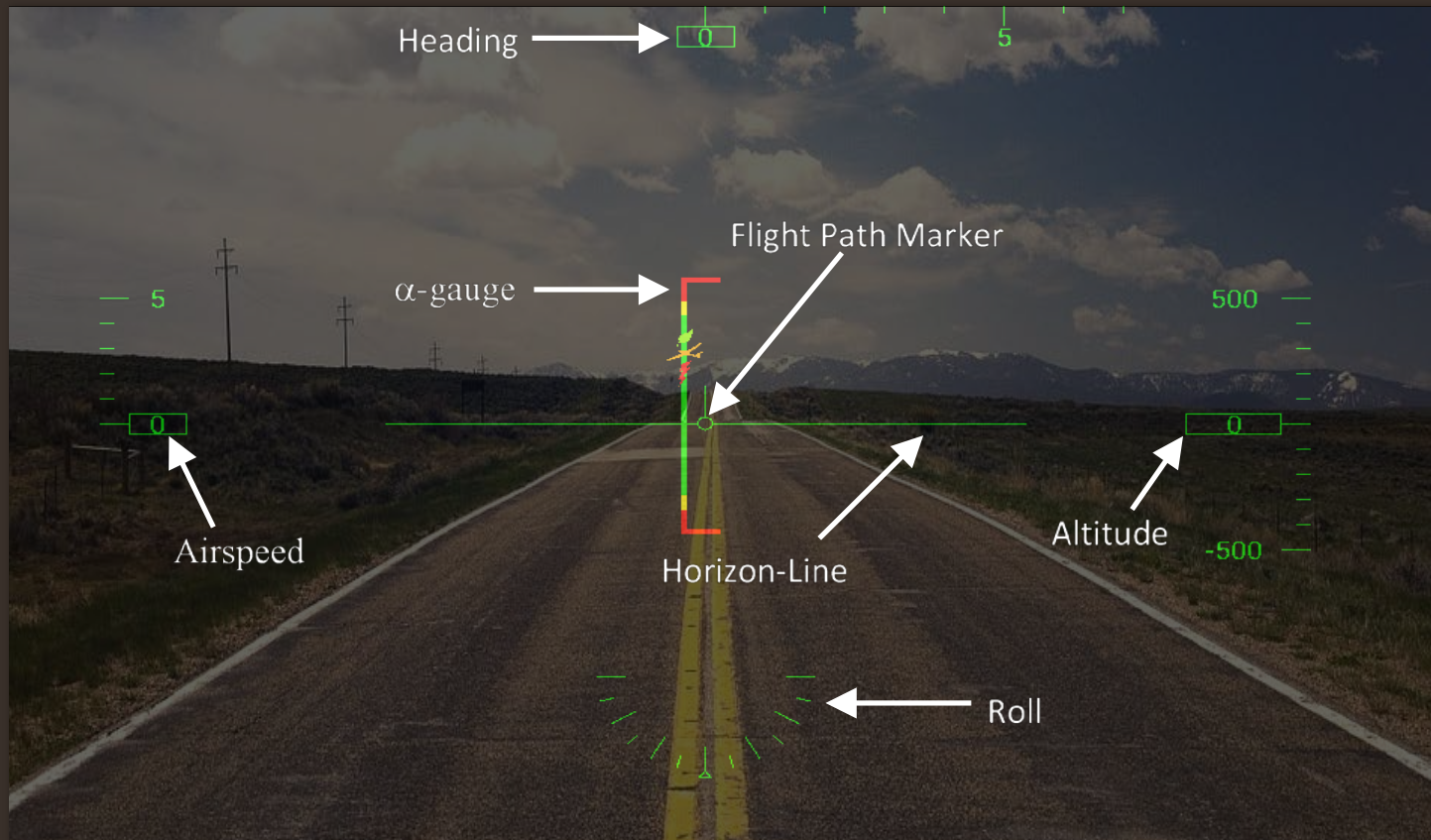
- Air Referenced vs Inertial Flight Path Angle
- Head Worn vs Fixed Mounted
  - Gradient Descent Orientation Filter
    - DIY Drone World
    - Single Tuning Parameter

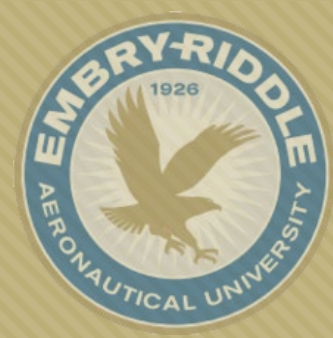


# HUD Modes: Climb



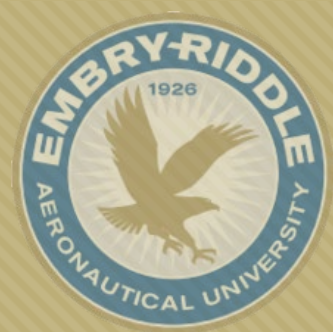
# HUD Modes: Landing





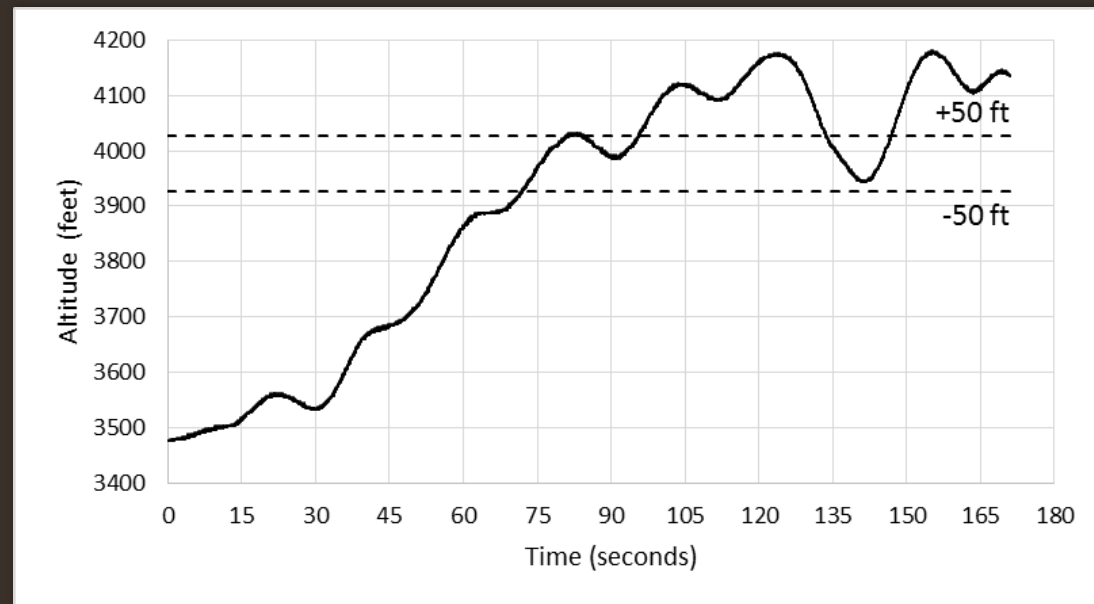
# Flight Test Matrix

Task	Assistance	Acceptable Tolerance
Climb and Level-Off	None	+/- Δ50 feet
Climb and Level-Off	EFRC HUD	+/- Δ50 feet
Touch Target on Runway	None	+/- Δ100 feet
Touch Target on Runway	EFRC HUD	+/- Δ100 feet

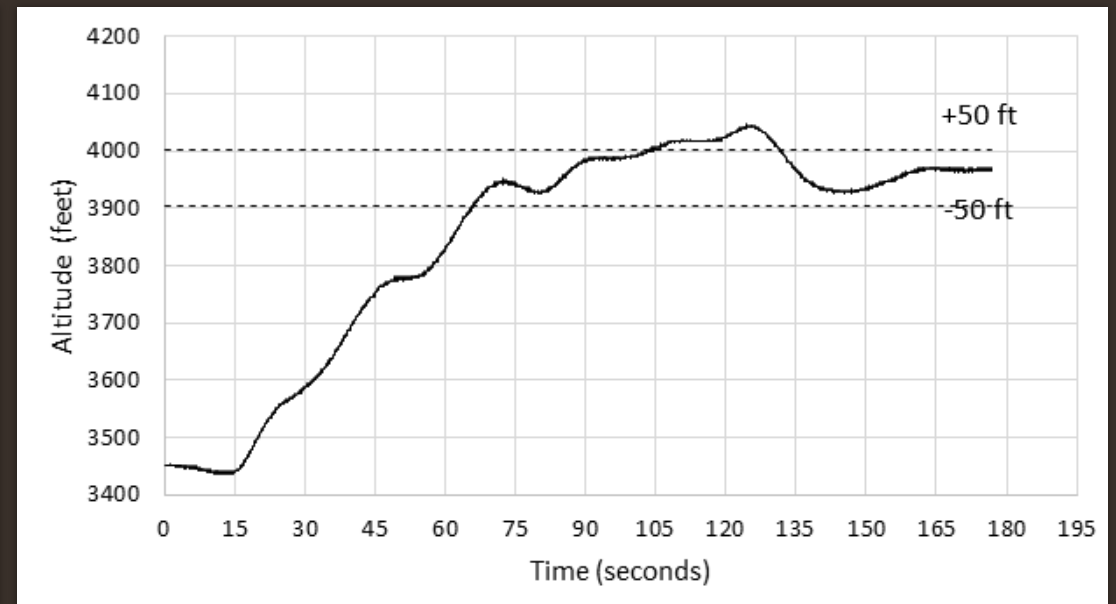


# Flight Test Results: Climb and Level-Off

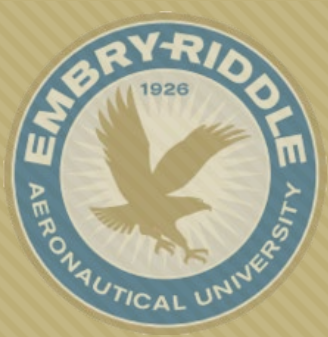
Without any assistance



With Assistance from EFRC HUD

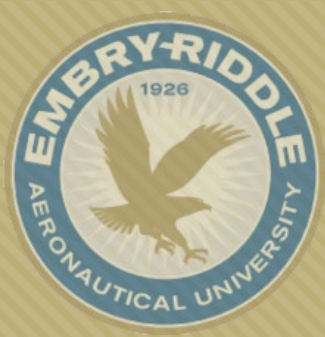


# Climb and Level-Off: Without Assistance



- Key Points
  - Last few seconds of the task
  - Only used altimeter and VSI
  - Note the small movements
  - Note the lag in the instrument
- [View Media 1](#)

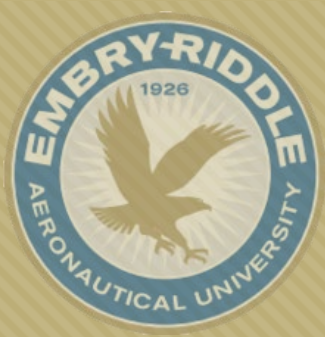




# Climb and Level-Off: With Assistance

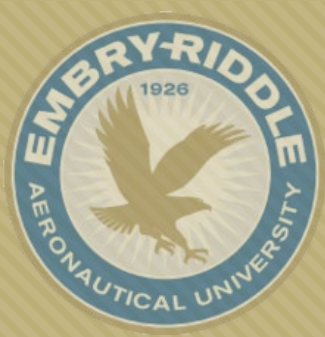
[View Media 2](#)

# Touch Target on Runway: Without Assistance

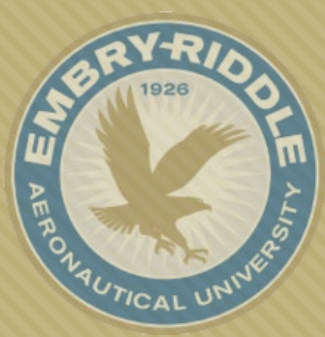


- Key Points
  - Last few seconds of the task
  - Visual approach
  - Input-observe-adjust
- [View Media 3](#)

# Touch Target on Runway: With Assistance

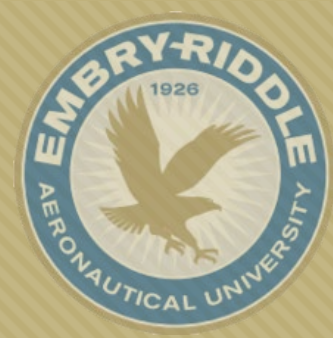


○ [View Media 4](#)



# Conclusion

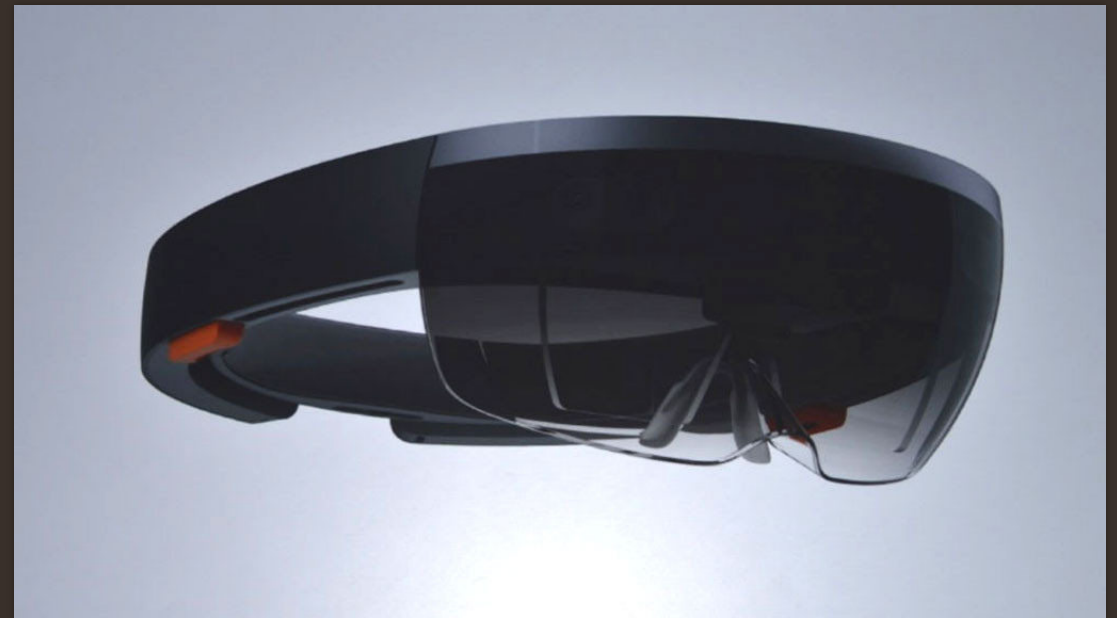
- Effective technique to deal with Turbulence
- Clear advantage in climb phase
- Beneficial in holding constant glide slope

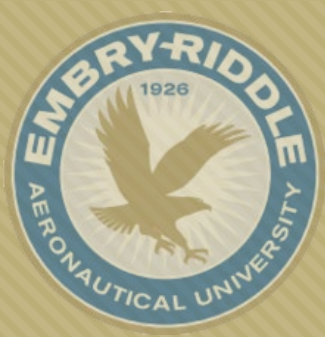


# Action Plan

1. Flight Path Quickening (Maneuvering)
2. IMC conditions and night flying
3. Determine which training scenarios would most benefit from this concept
4. Incorporate angle of attack (L/D, Carson Cruise, etc.) and flight path marker into educational materials.
5. Determine how to best leverage existing/new angle of attack sensors.
6. Incorporate angle of attack and flight path into simulator and full flight scenarios.
7. Carry out simulator and flight scenarios with a small group of pilots
8. Present results and disseminate to interested parties as a supplement to existing flight / simulator training

## New Technologies





**THE END**