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Augmented and Virtual Reality for In-Flight Simulator Aircraft

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Low-Cost Wearable HUD for Light General Aviation

By Pavan K. Chinta; Dr. Borja Martos

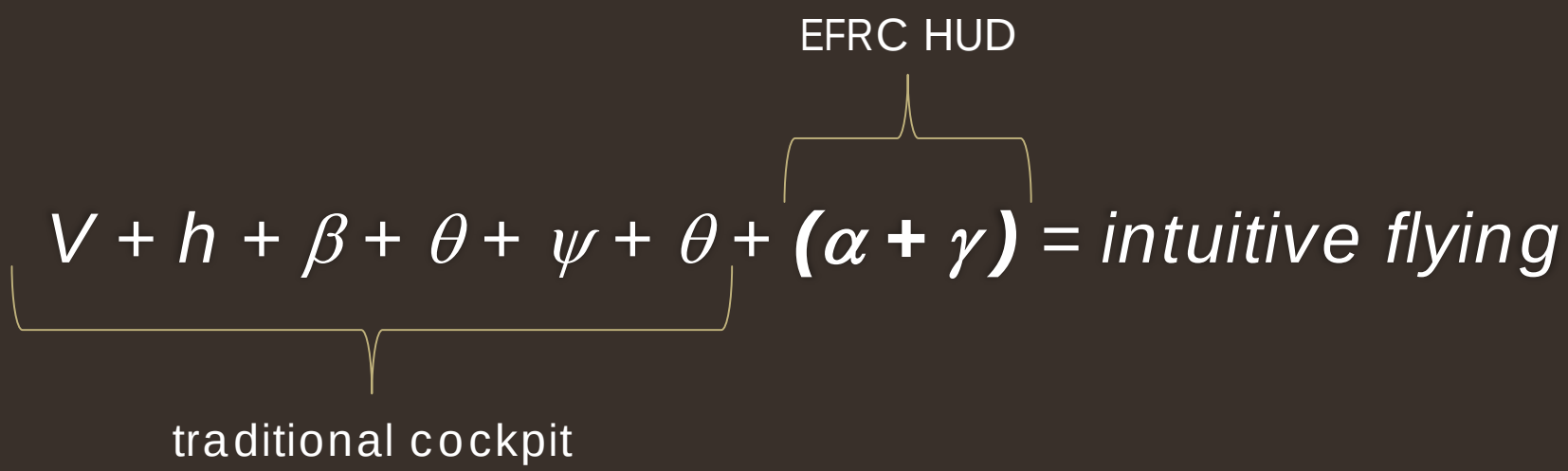
Overview

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

Motivation

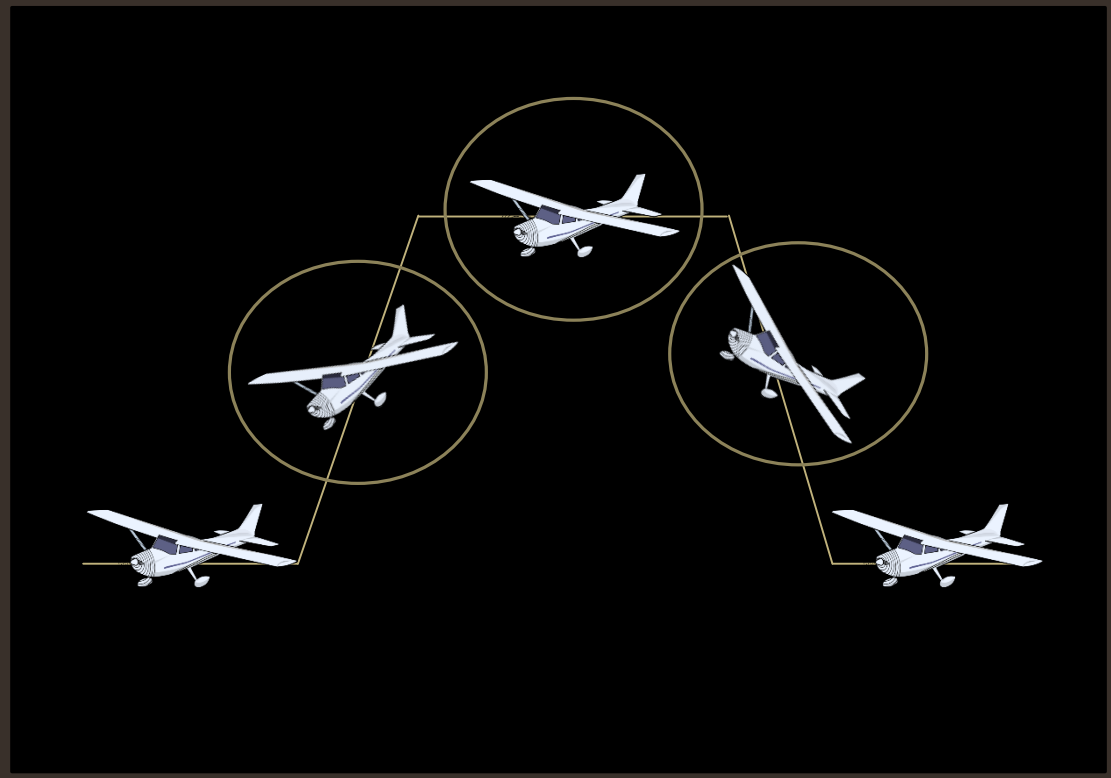
- “… the HGT could have likely prevented a significant portion of loss of control (LOC) accidents…”
- “…96% of all aviation accidents, 97% of fatal aviation accidents, and 96% of all fatalities… 51% of the estimated total flight time…”
- “… in 2016 the Federal Aviation Administration (FAA) overhauled 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



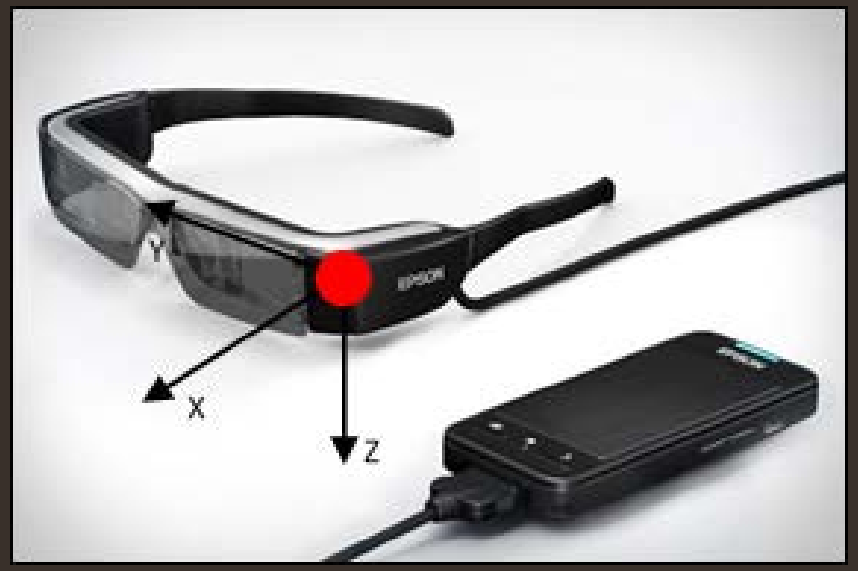
Areas of Focus

- Flight-Phase Performance
  - Climb
  - Cruise
  - Landing



Equipment

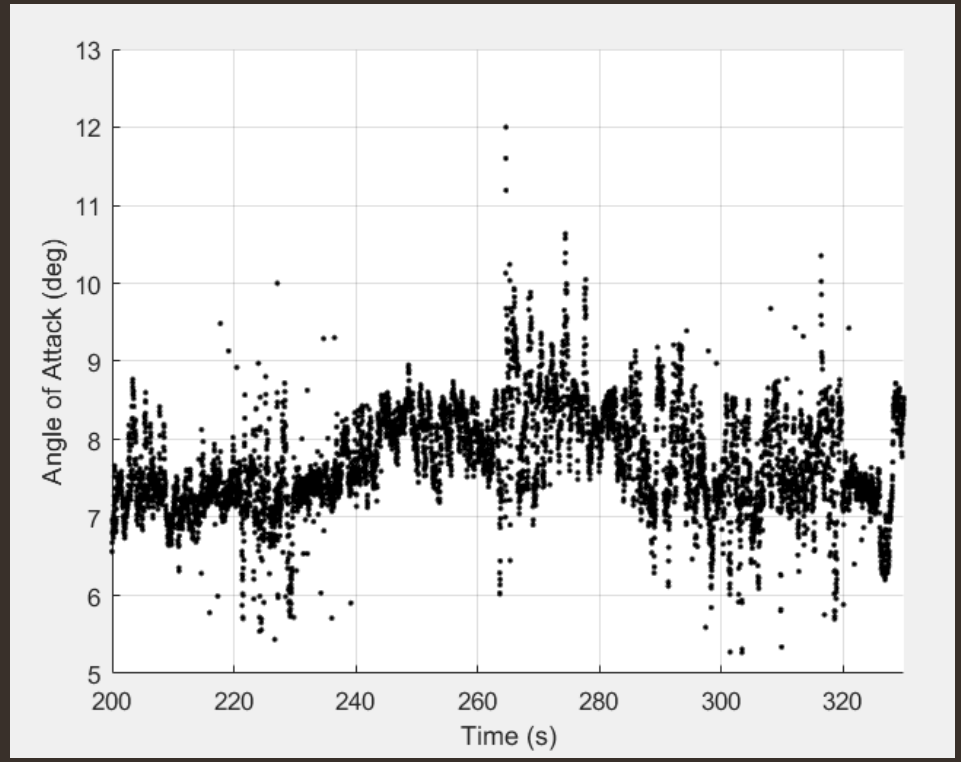
- Air Data Probe
  - α/β mechanical vanes
  - swivel head pitot-static system
- Honeywell HG1700 IMU
- ProPak-V3 GPS



- Epson BT-200

Challenges

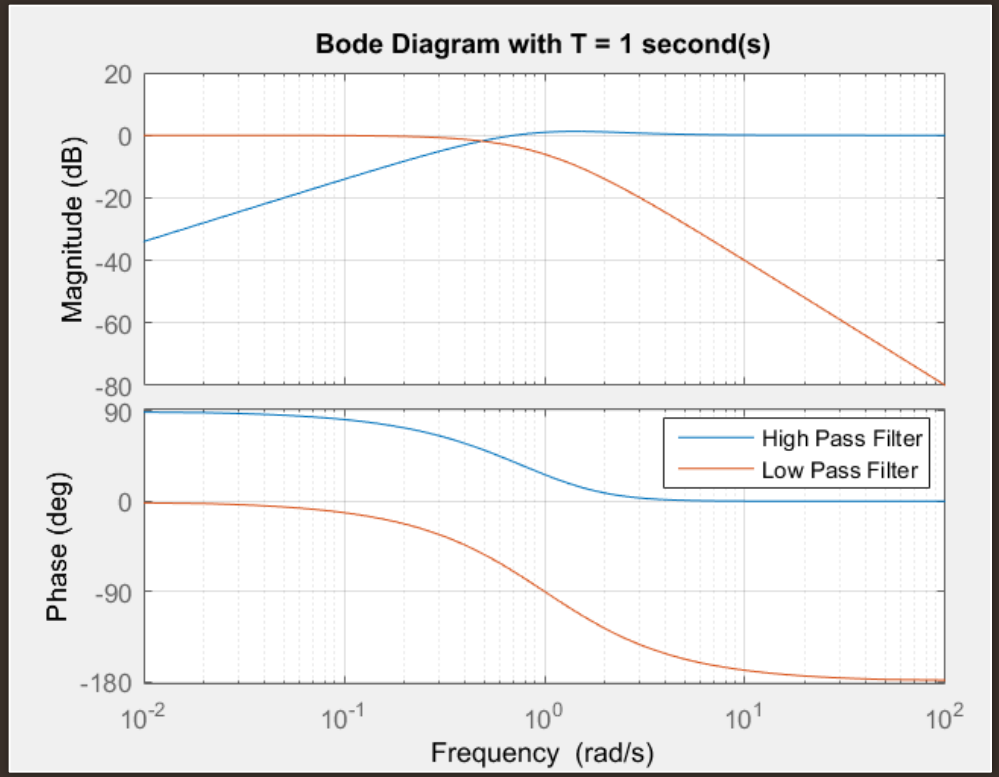
- Atmospheric Turbulence



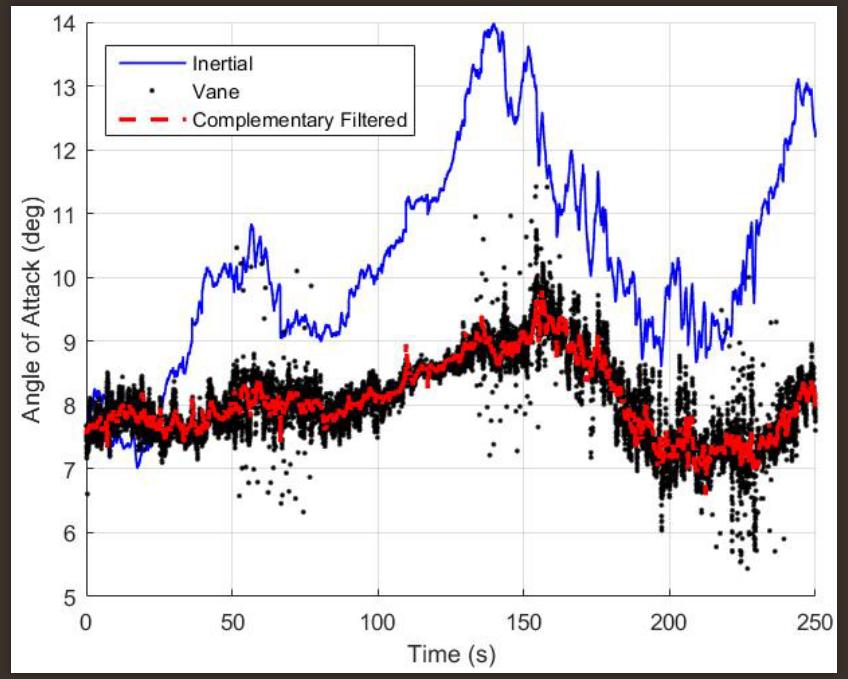
Straight and level flight at 4500 feet with high atmospheric turbulence.

Complementary Filter

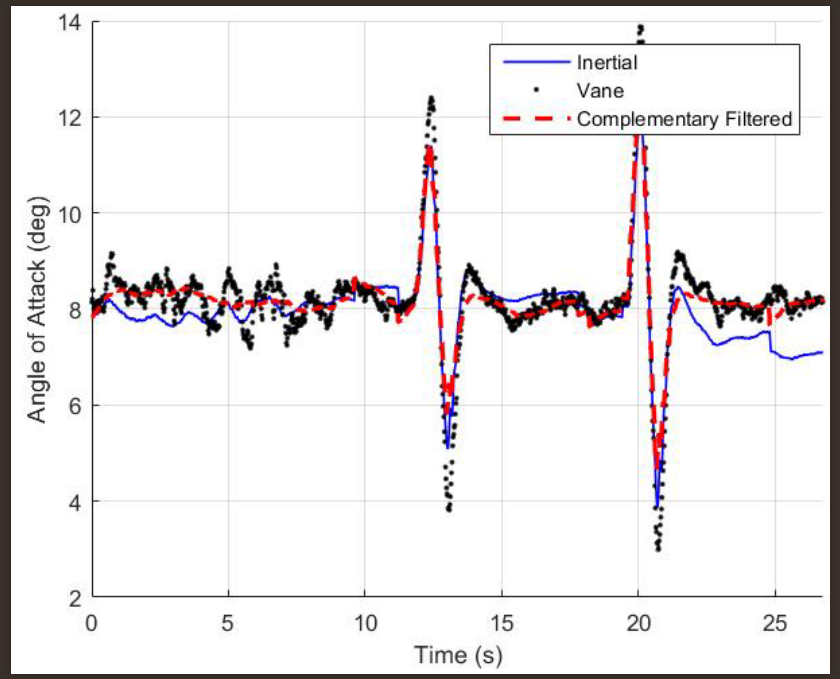
$$\alpha_f = f_l(\alpha_i + \alpha_g) + f_h(\int \dot{\alpha}_i \, dt)$$



Flight Test Results: Complementary Filter



Straight & Level in
High Turbulence



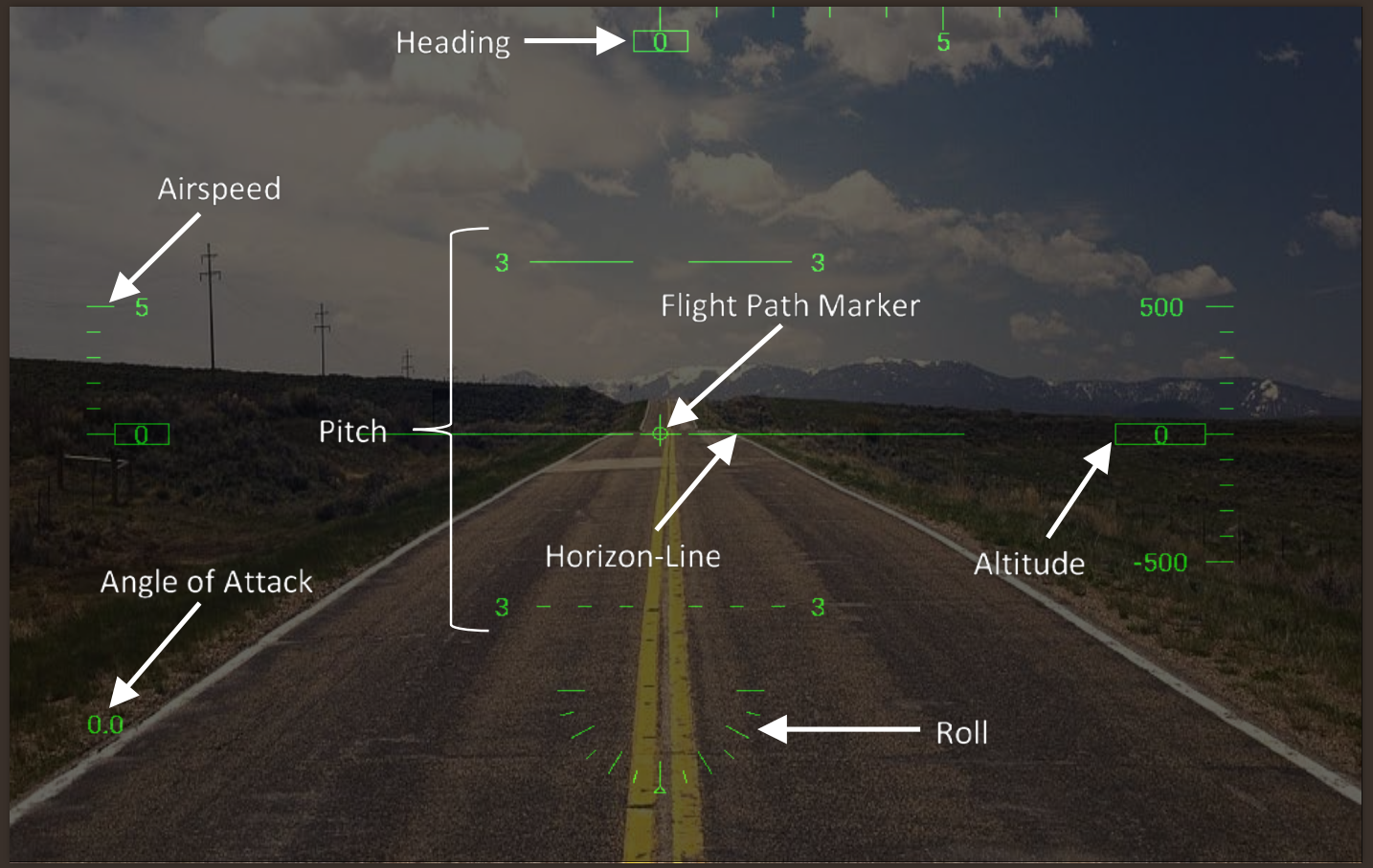
Short Period in
Light Turbulence

EXAMPLES

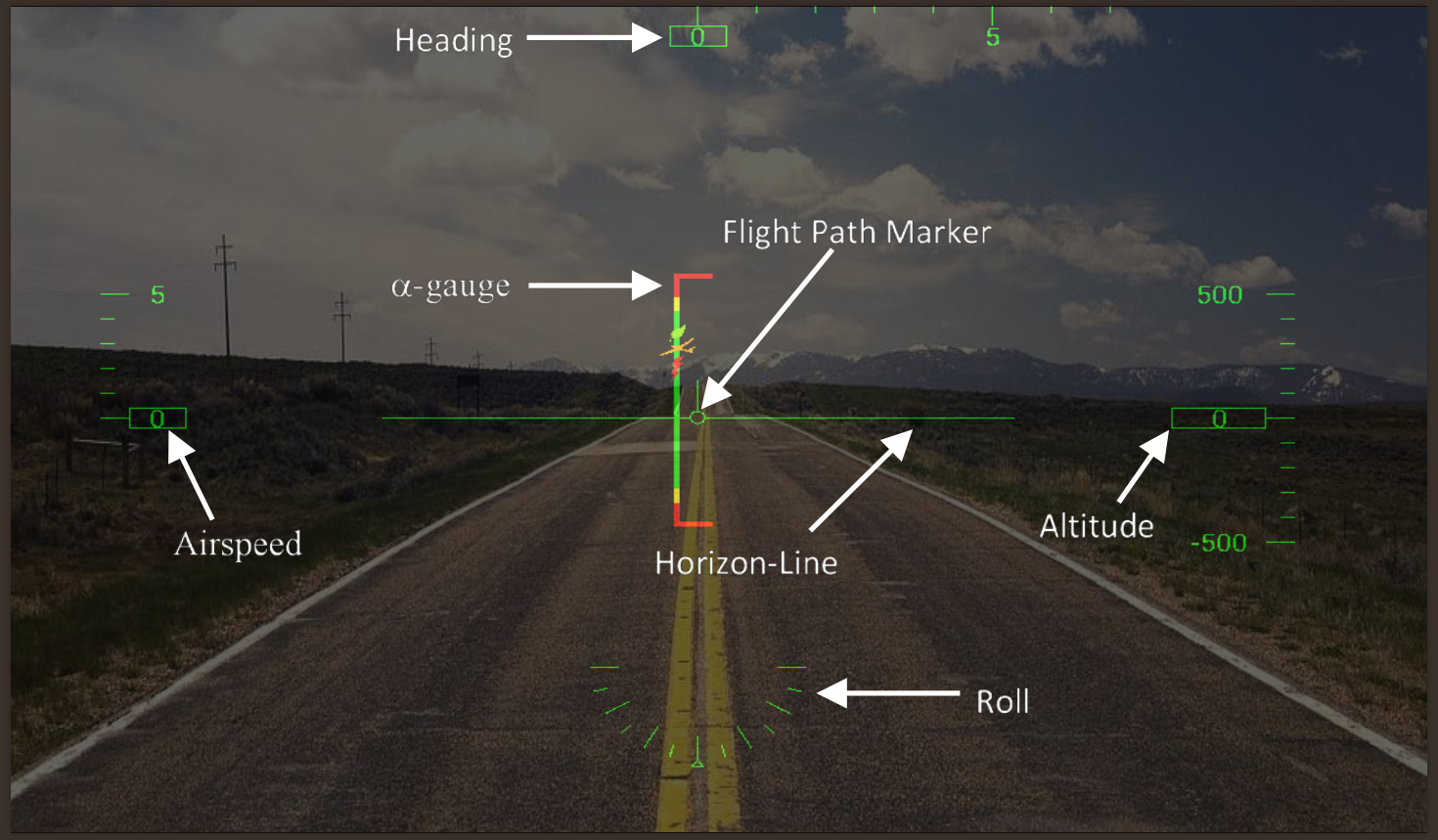
More Challenges

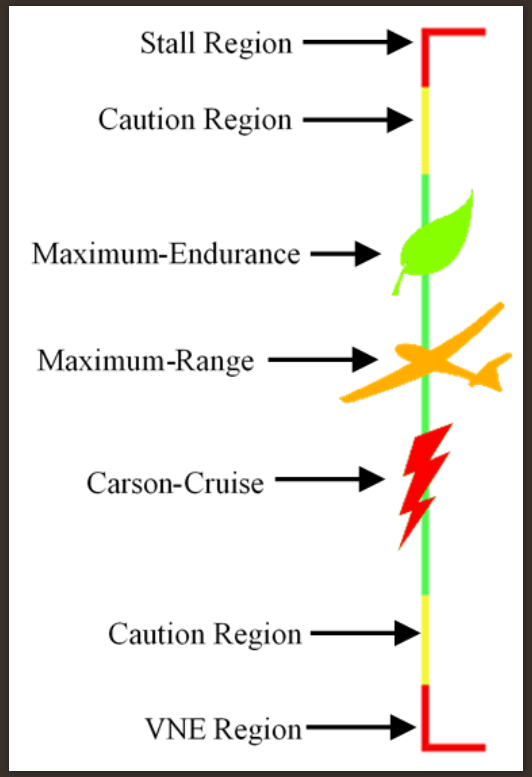
- Air Referenced vs Inertial Flight Path Angle
- Head Worn vs Fixed Mounted
  - Gradient Descent Orientation Filter
    - DIY Drone World
    - Single Tuning Parameter

HUD Modes: Climb



HUD Modes: Landing



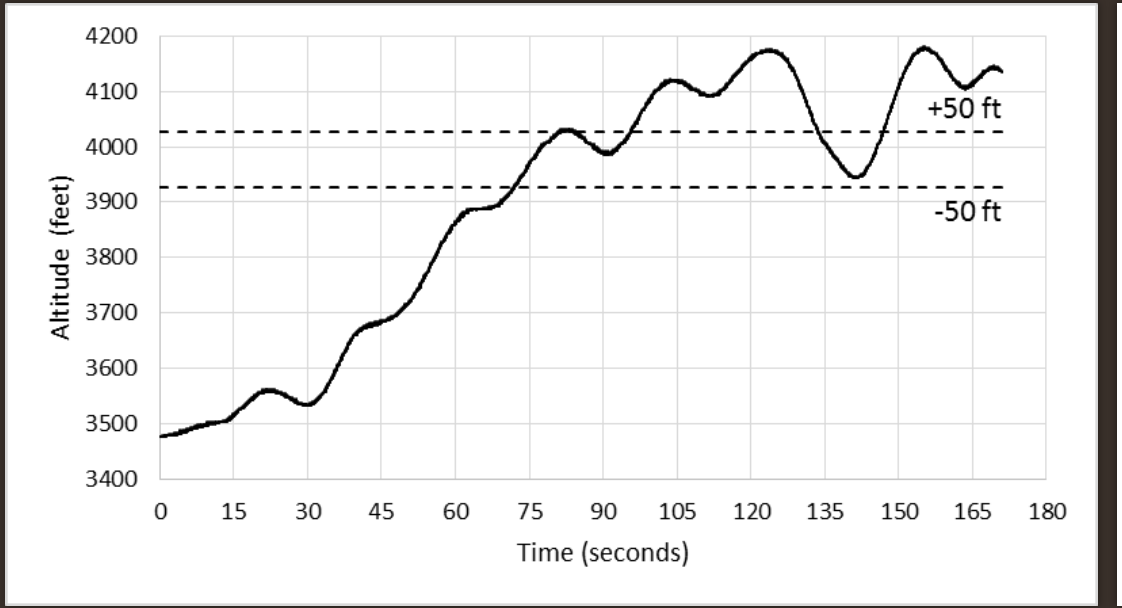


Flight Test Matrix

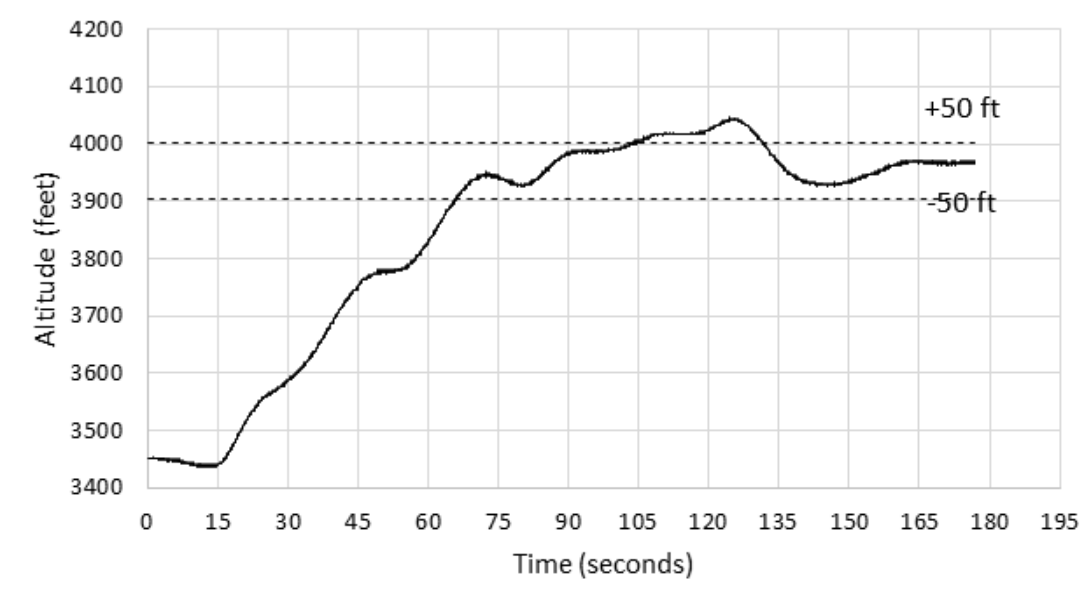
Task	Assistance	Acceptable Tolerance
Climb and Level-Off	None	+/- Δ50 feet
Climb and Level-Off	EFRC HUD	+/- Δ50 feet
Touch Target on Runway	None	+/- Δ100 feet
Touch Target on Runway	EFRC HUD	+/- Δ100 feet

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

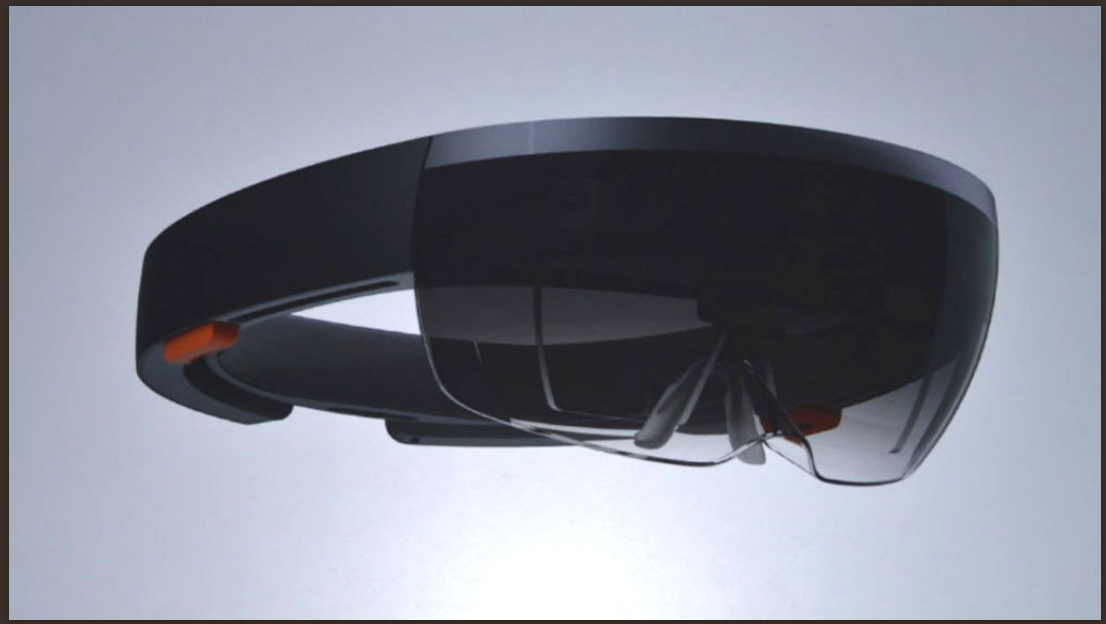
Conclusion

- 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



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