Aerospace technology Congress - FT 2019

GESTURE-BASED INTERFACE FOR FLIGHT CONTROL

Preliminary Simulation Tests

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Where I come from…

- The city of São José dos Campos in Brazil

Aircraft control interface in the last 100 years…

Breguet 14 (1916)

By Gautherie – fr.wikipedia, Public domain, https://commons.wikimedia.org/w/index.php?curid=1664178
https://www.airliners.net/photo/Thailand-Air-Force/Breguet-14-B2/4930371

Northrop B-2 (1989)

https://aeromagazine.uol.com.br/artigo/o-aviao-mais-caro-da-historia_2013.html
https://www.boldmethod.com/blog/lists/2015/08/21-facts-about-the-b-2-spirit-stealth-bomber/

Sukhoi SU-57 (2010)

By ReaL-FrienD - https://www.flickr.com/photos/realfriend/67875175/, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=2725070
https://www.airplaneupdate.com/2019/04/sukhoi-su-57.html

Can we design more intuitive pilot aircraft interfaces?

Project BrainFlight

Institute of Flight System Dynamics

Technische Universität München

https://www.tum.de/nc/en/about-tum/news/press-releases/details/31531/

Uses of neurons signals emitted from the brain to control the aircraft

Our Purpose

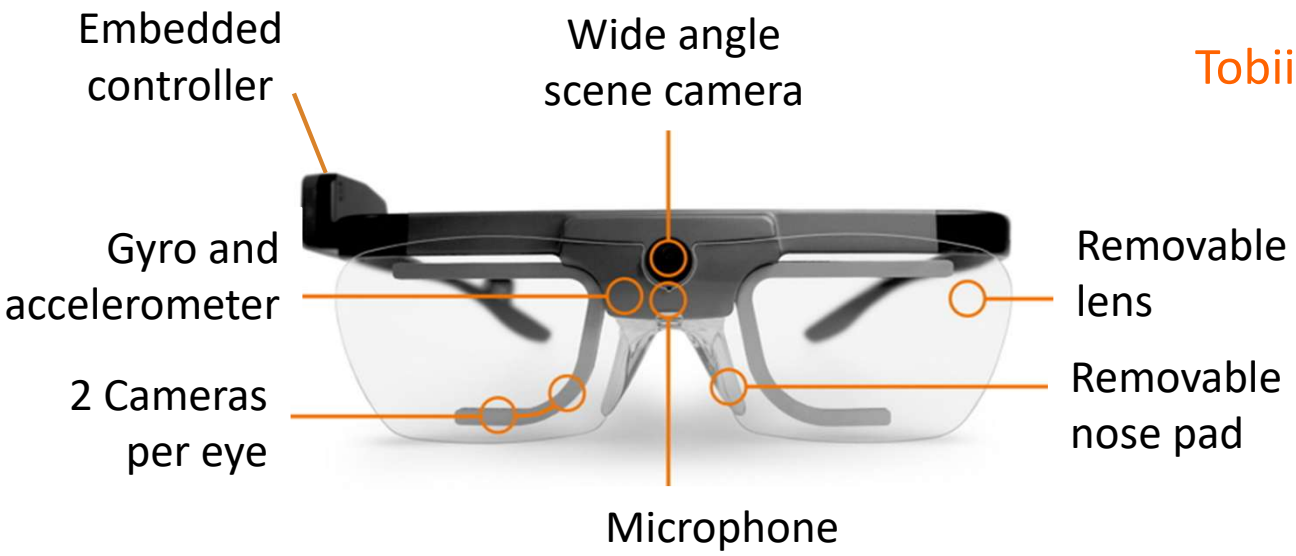
Development of aircraft control interfaces that do not require yokes, sticks or pedals for inputs on the aircraft roll, pitch, yaw and thrust controls.

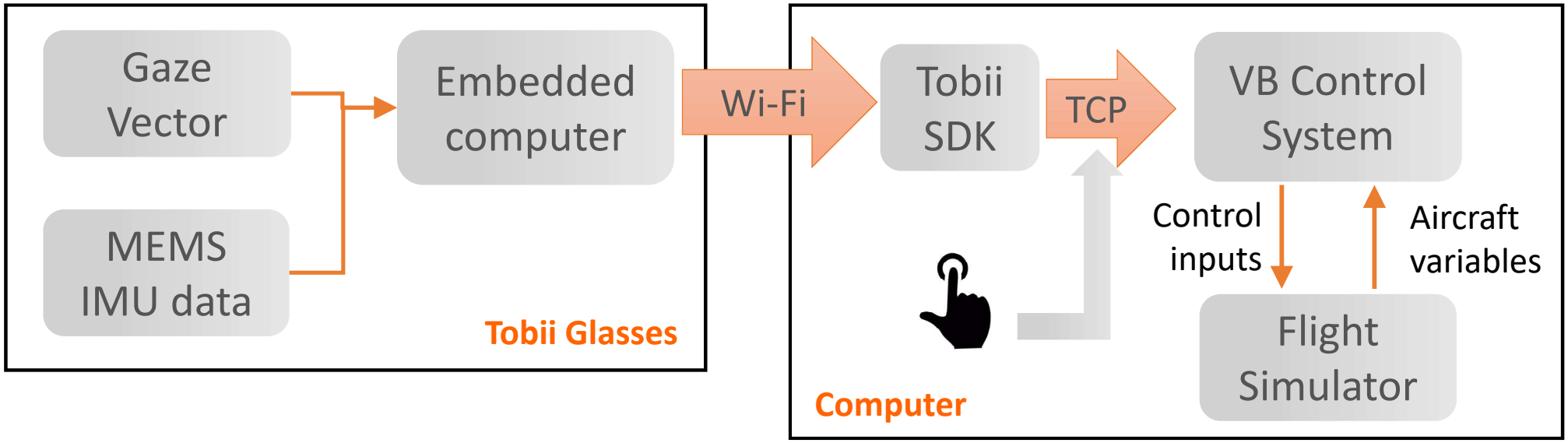
Use of body motion and visual focus direction.

Body tracking devices

Eye tracking glass

Using the Visual Focus





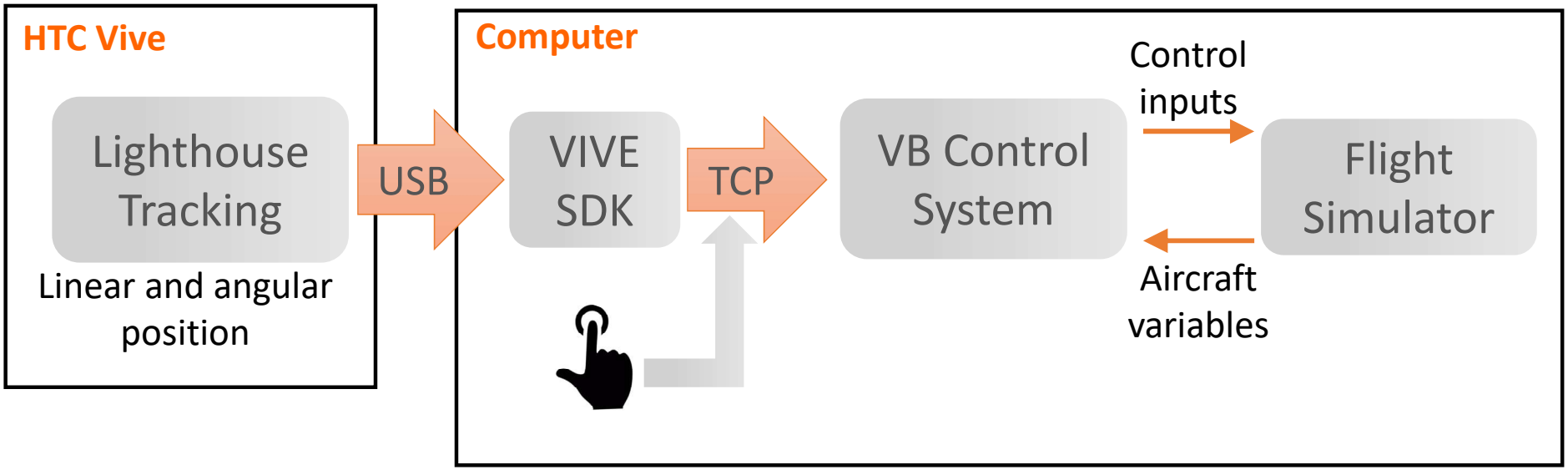
Using Body Motion

HTV Vive VR Kit

Hand trackers

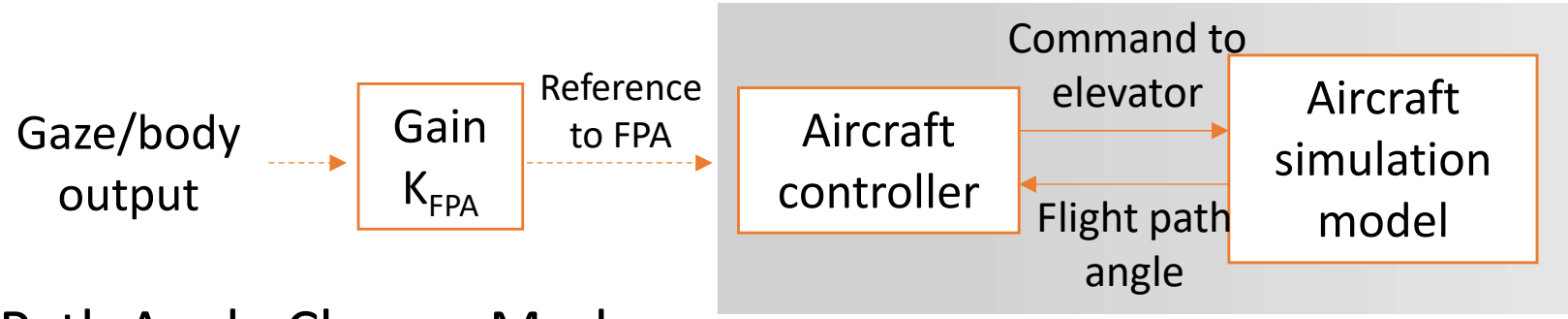
Lighthouse tracking system

Hand, arm, leg trackers

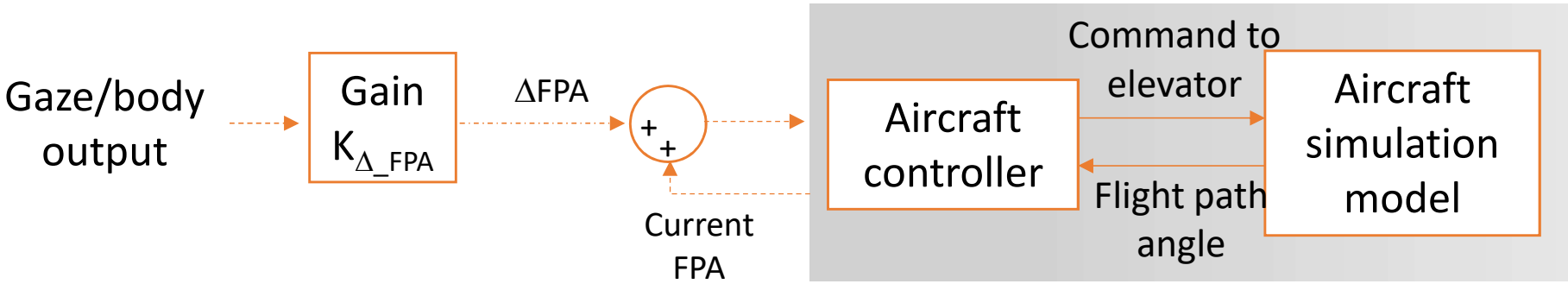


Vertical Control Modes

- Flight Path Angle Mode
  - The Flight Path Angle (FPA) or Flight Path Trajectory is proportional to the output from gaze or body tracking system.

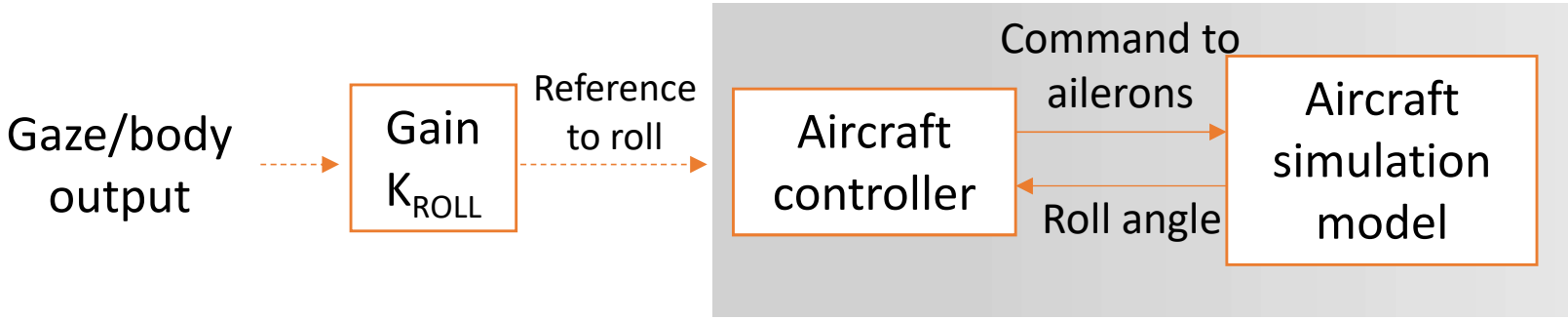


- Flight Path Angle Change Mode
  - An increment proportional to the gaze/body output is added to the current value of the Flight Path Angle (FPA).

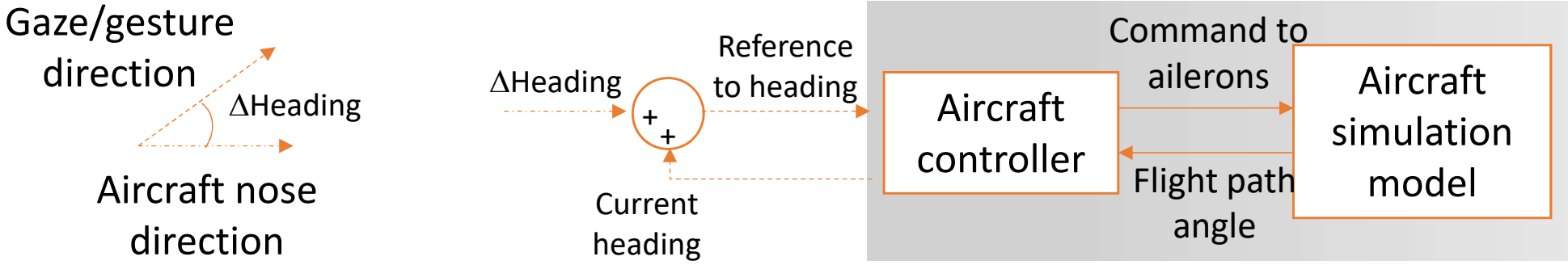


Horizontal Control Modes

- Roll Angle Mode
  - The roll angle is proportional to the output from gaze or body tracking system.

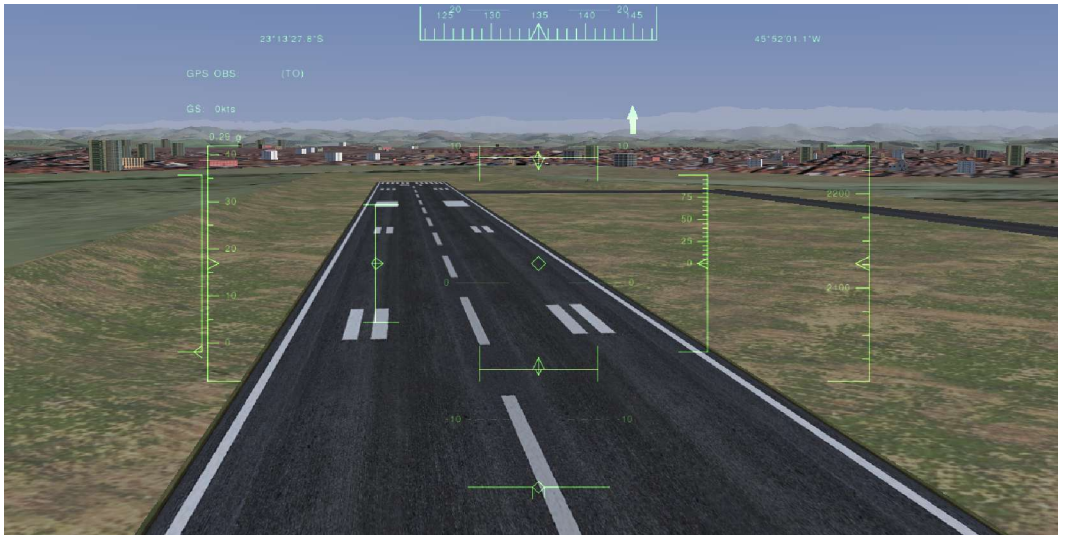


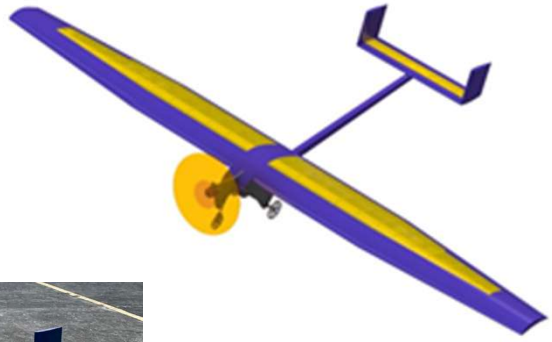
- Heading Change Mode
  - The pilot look or point in a direction to either side of the aircraft's nose and set a new heading.

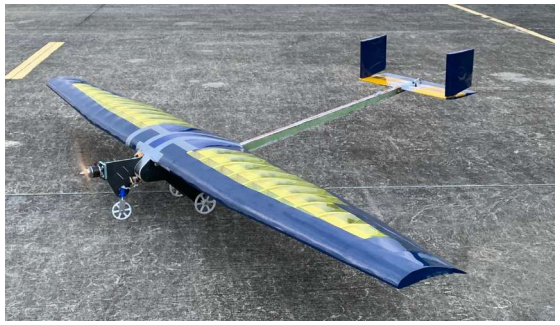


Experimental Evaluation

- Aircraft: light cargo UAV
  - Aerodynamic model based on wind tunnel and flight test data;
  - Electric propulsion;
  - Mass of 15 kg;
  - Wingspan of 3.2 m.

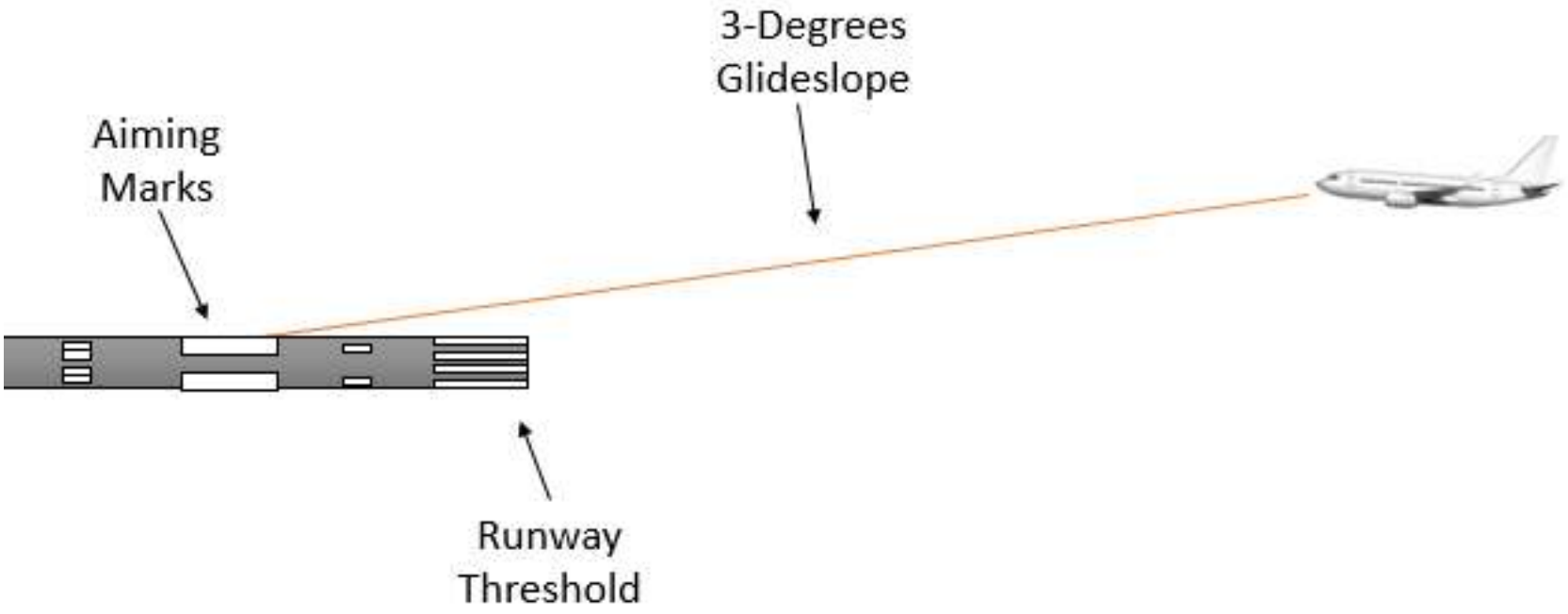






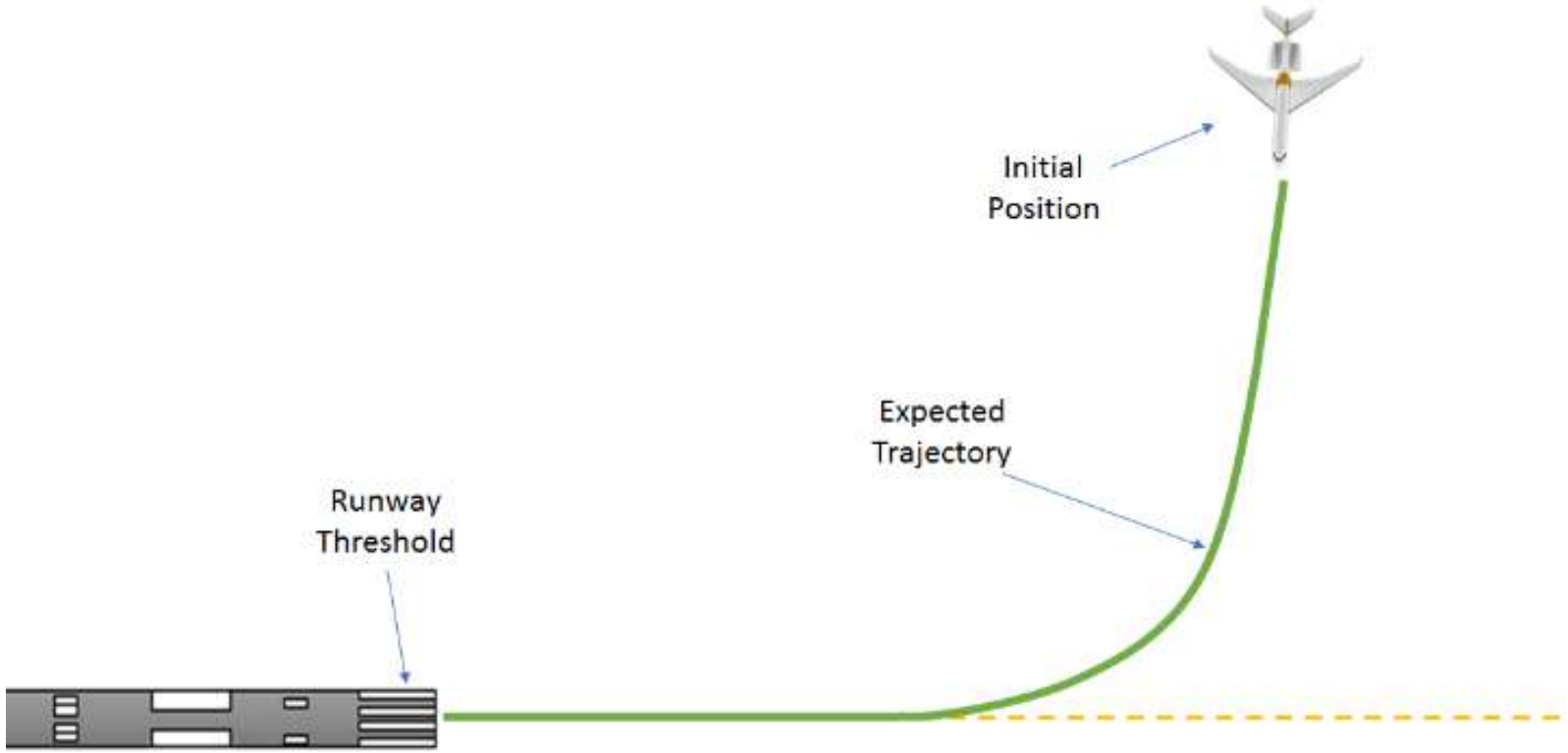
Simulation Scenario

- Vertical Guidance
  - Task: **adjust the descent rate to land at the runway**;
  - Reference of 3-degrees glideslope;
  - Performance metrics:
    - Cumulative deviation from reference glideslope;
    - Distance between real touch down position and touch down reference.



Simulation Scenario

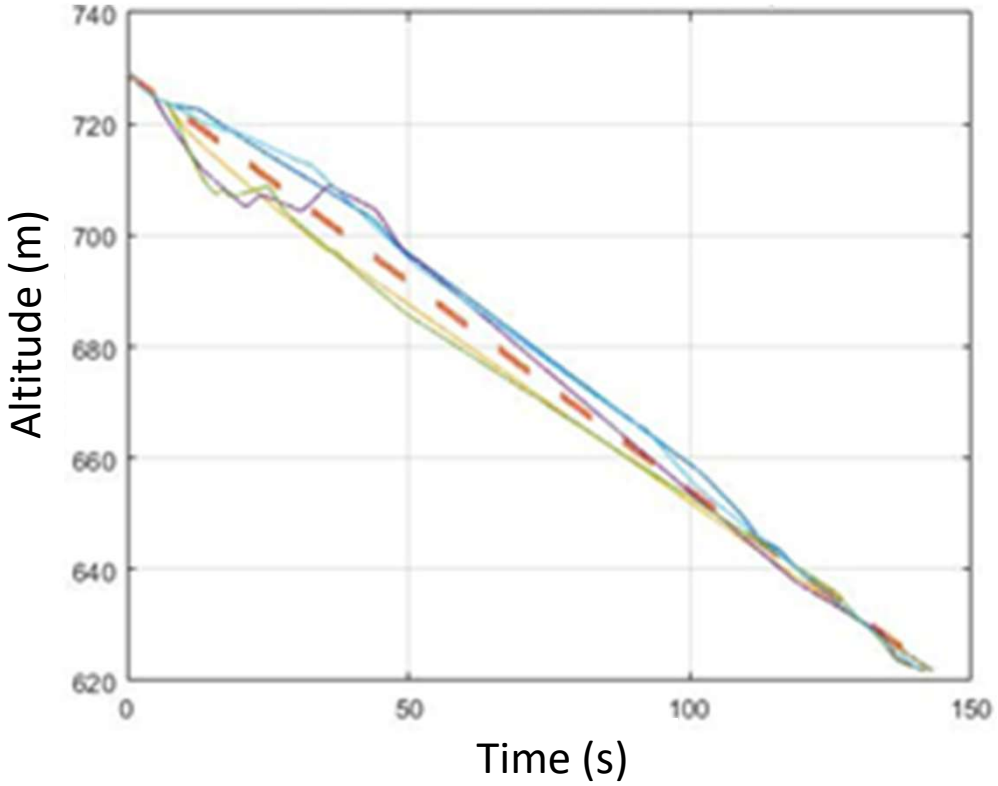
- Horizontal Guidance
  - Task: **align aircraft with the runaway to land, altitude is adjust by autopilot**;
  - Performance metrics:
    - Heading error related to runway at the moment of touchdown;
    - Distance between real touch down position and touch down reference.



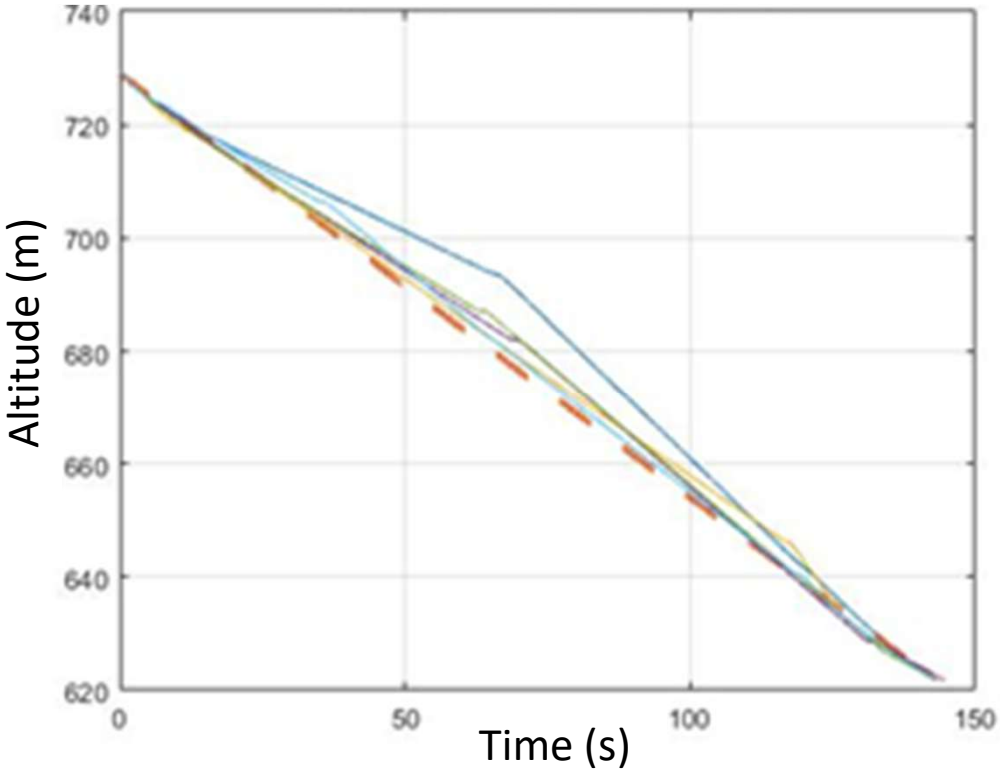
Results – Vertical Guidance

- 5 repetitions of each flight.

Gaze Configuration

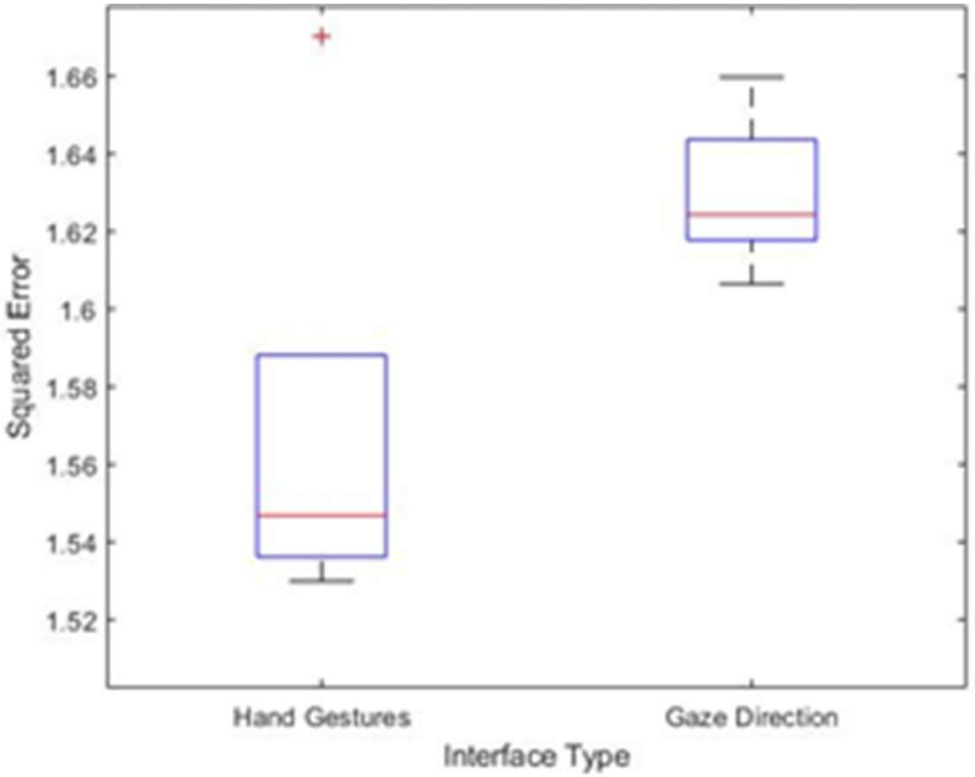


Hand Configuration



Results – Vertical Guidance

Cumulative Glideslope Deviation



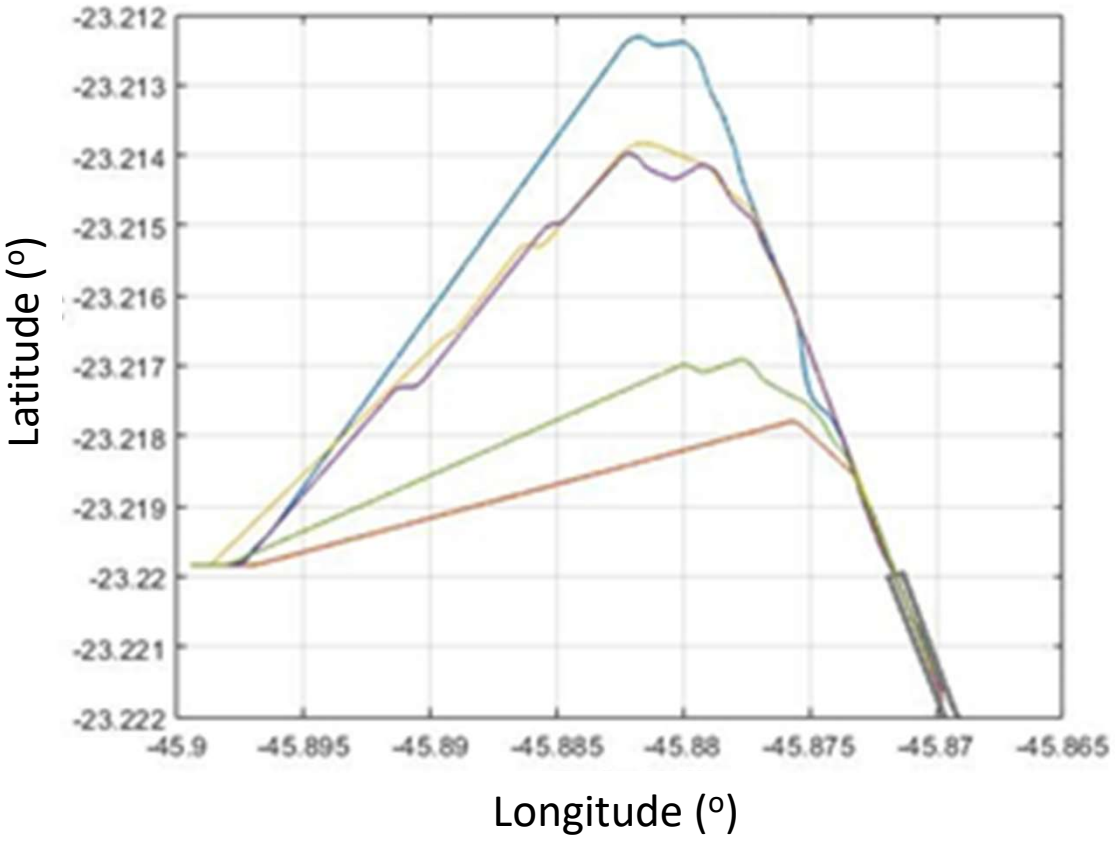
Hand gesture resulted in a smaller deviation error.

Results – Horizontal Guidance

- 5 repetitions of each flight.

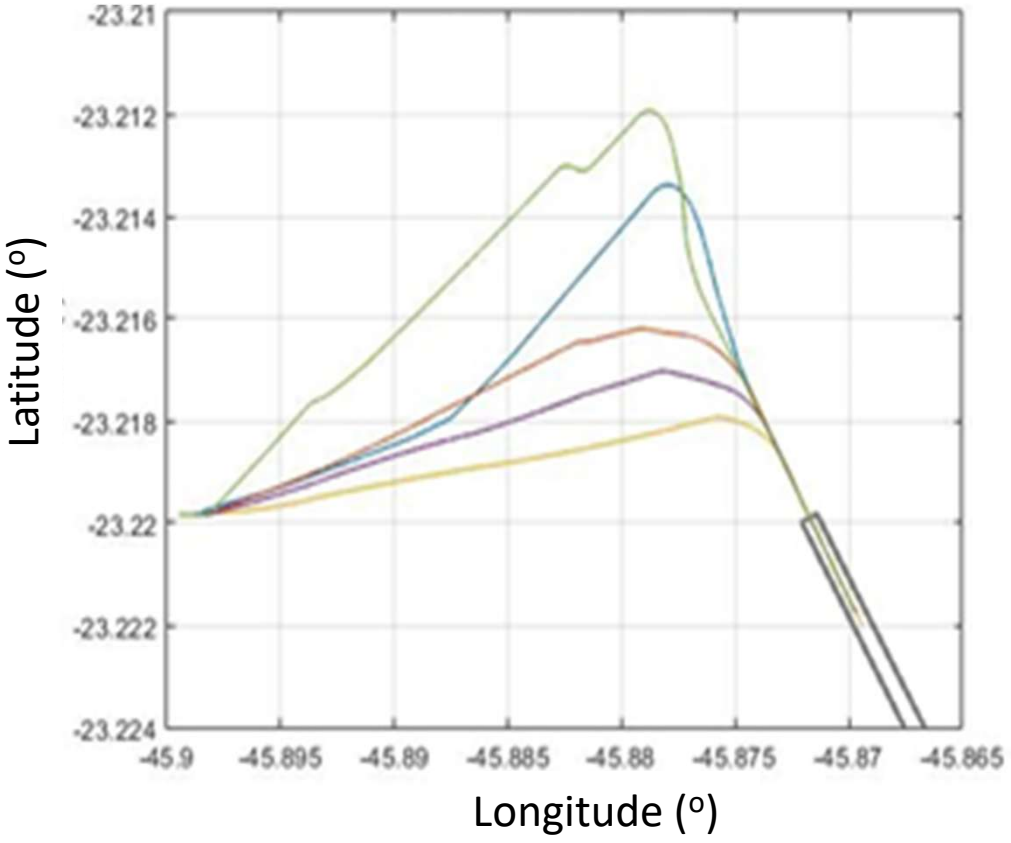
Gaze Configuration

Geographic position in time



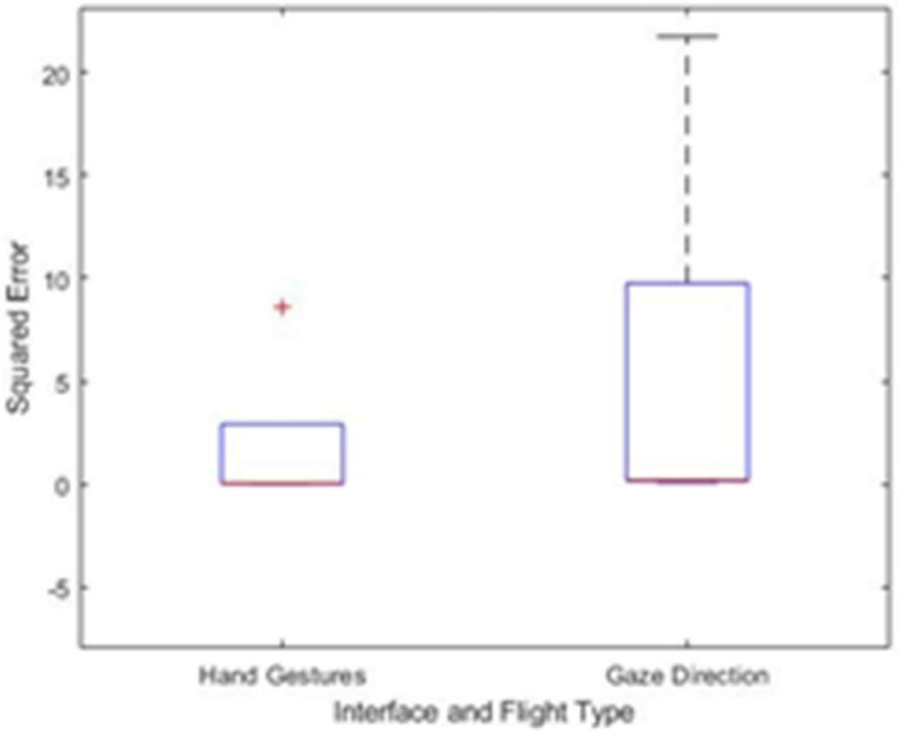
Hand Configuration

Geographic position in time



Results – Horizontal Guidance

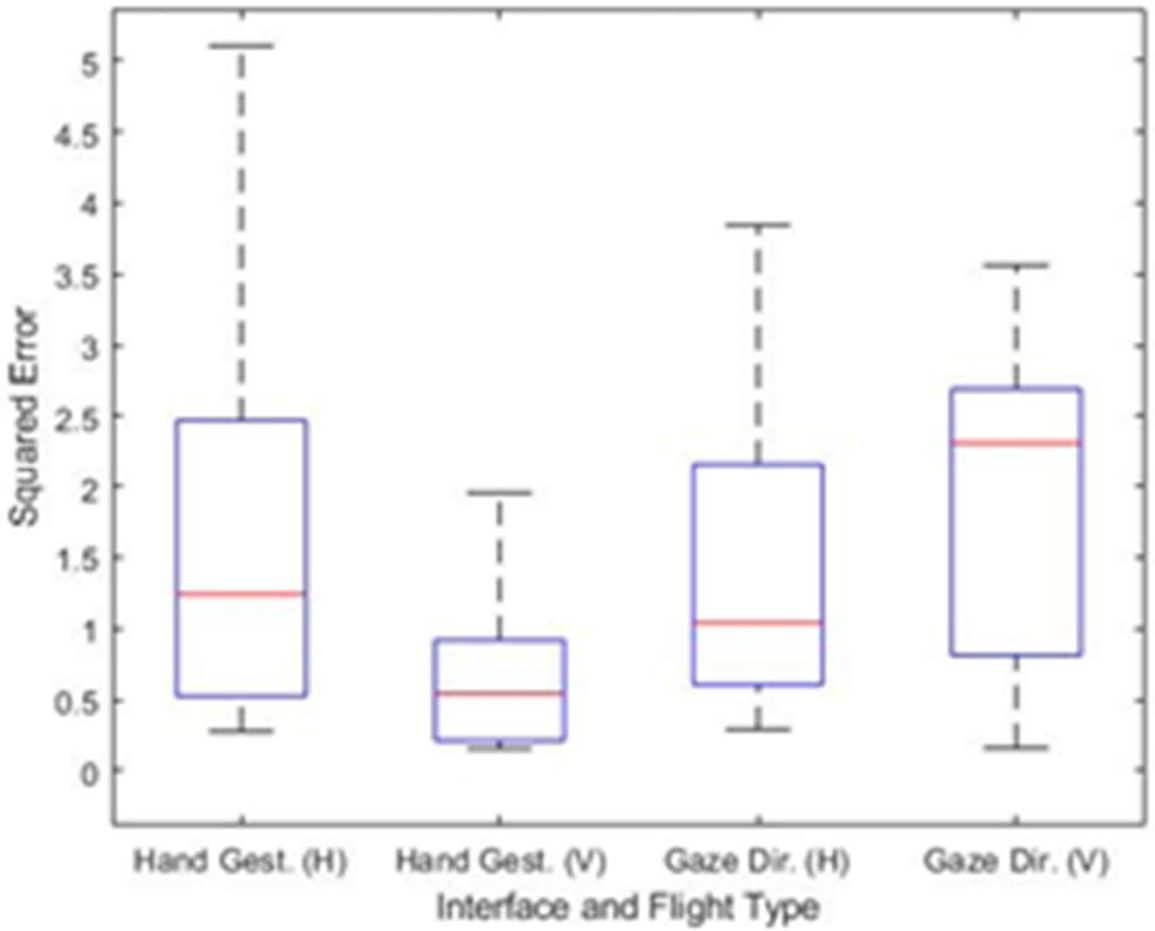
Heading Error at Touchdown



Hand gesture resulted in a smaller error.

Results – Vertical and Horizontal Guidance

Touchdown position error for all configurations



Hand gesture resulted in a smaller error for vertical guidance.

Conclusions and Future Work

Can we use body motion and visual focus direction for aircraft guidance?

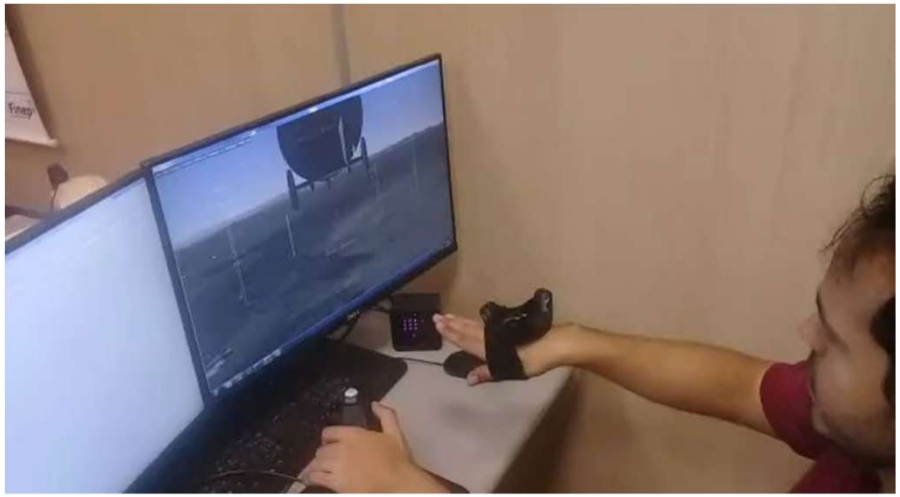
Preliminary results indicate feasibility.

Future Works

- Improve the system calibration;
- Test in a widescreen environment;
- Compare with conventional control;
- Define high level functions to use gesture and gaze.

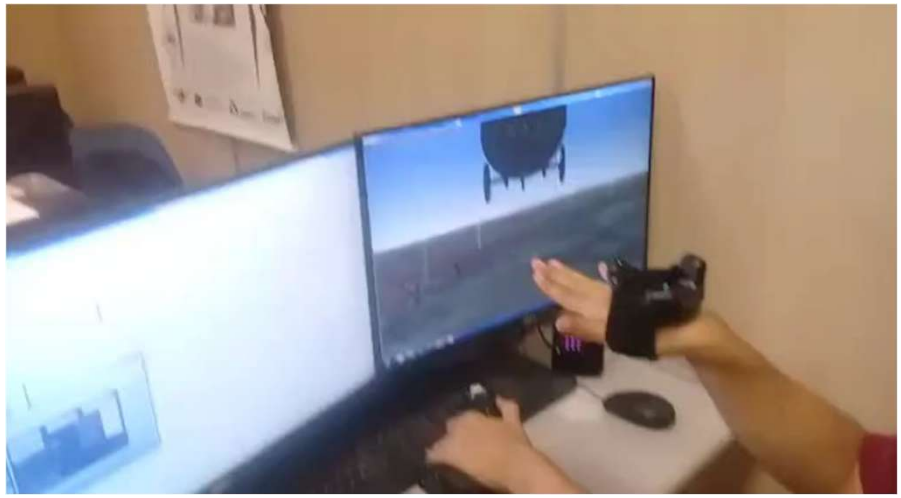
Demonstration

Gaze - Horizontal



Hand - Horizontal

Gaze - Vertical



Hand - Vertical

CENTRO DE
COMPETÊNCIA
EM MANUFATURA

Thank You

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