Using eye-tracking for adaptive human-machine interfaces for pilots: A literature review and sample cases

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A few words about us…

tory

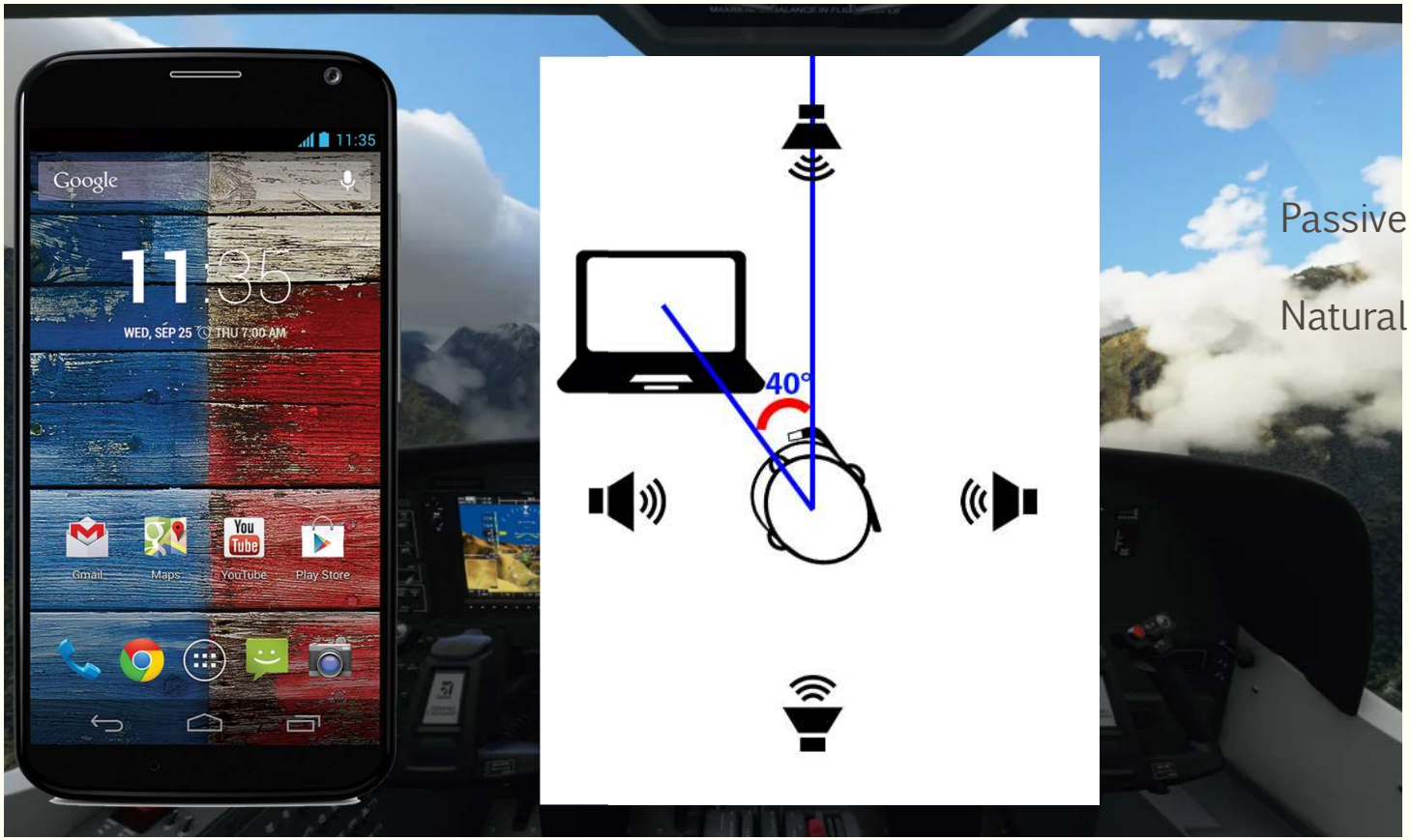
EPIIC

Enhanced Pilot Interfaces & Interactions for fighter Cockpit

A FEW IMPORTANT TERMS

Adaptive HMI, Eye-tracking

Adaptive Human-Machine Interfaces?

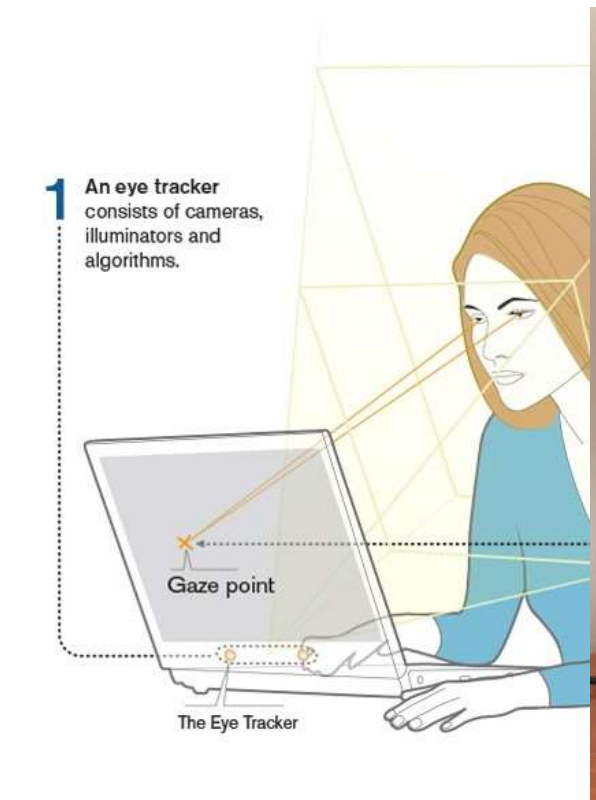


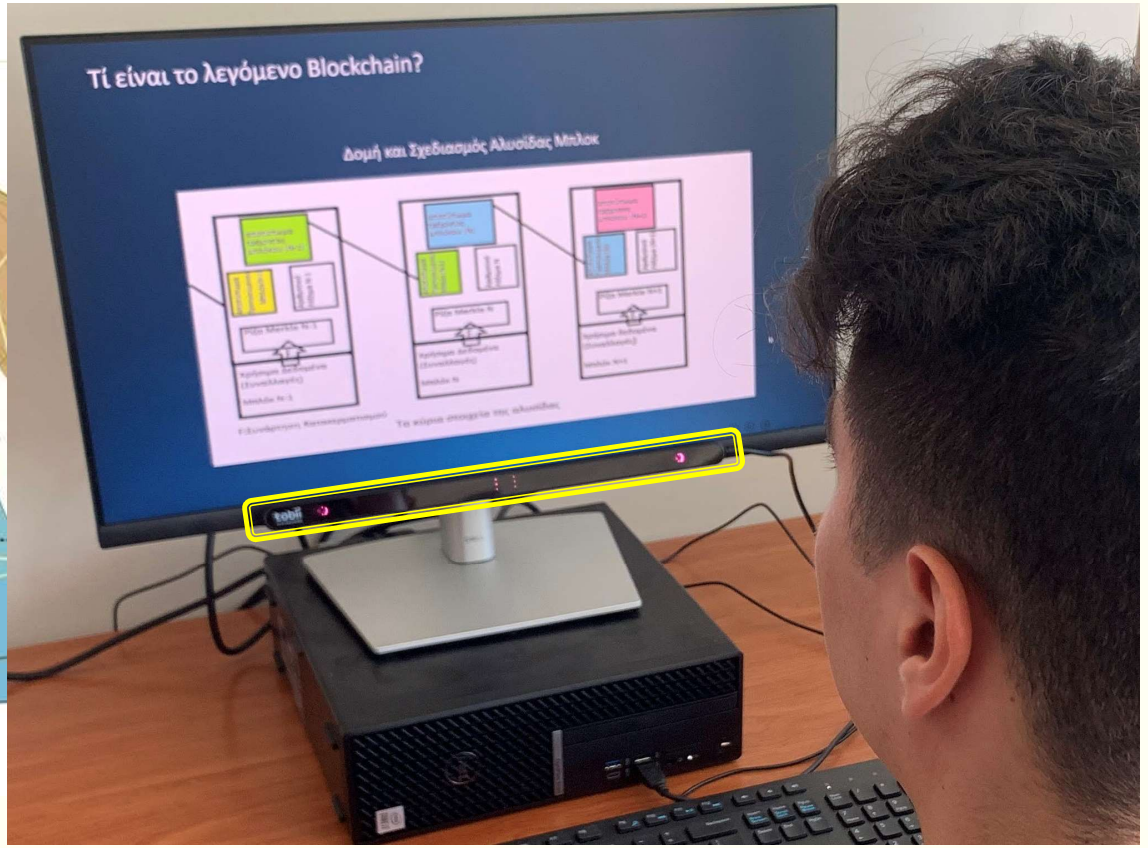
User Initiated

Passive

Natural

Eye-tracking?





Eye-tracking?

LITERATURE REVIEW

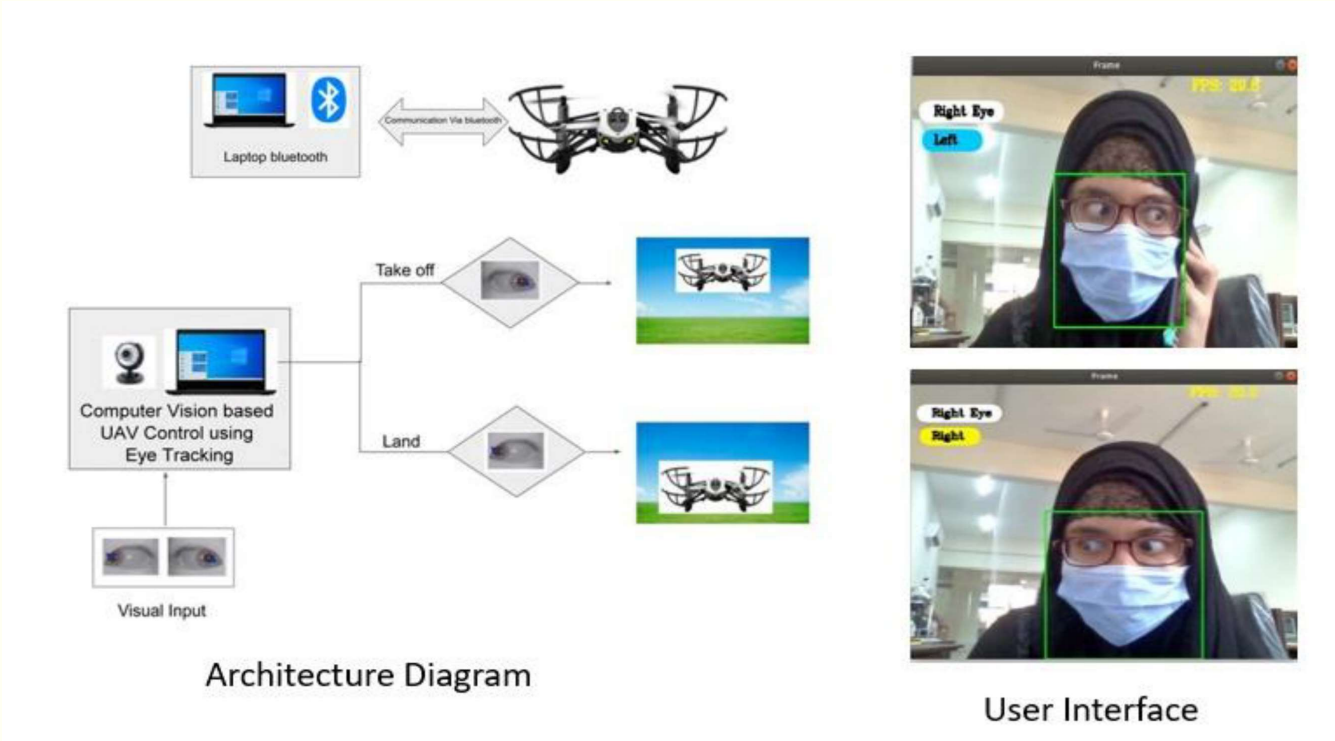
Flight simulator games, UAV, Aviation

Literature Review

- Flight simulator games

Literature Review

- UAV pilots



Munir Z, Siddiqui MA, Ullah G, Khan MJ, Hong K-S, Naseer N. Unmanned Aerial Vehicle Control by Eye-Tracking using Computer Vision and Machine Learning. 2022 13th Asian Control Conference (ASCC), 2022, p. 1–5

Literature Review

- Aviation

Haslbeck A, Schubert E, Gontar P, Bengler K. The relationship between pilots' manual flying skills and their visual behavior: a flight simulator study using eye tracking. Advances in Human Aspects of Aviation 2012:561–8
Korek WT, Mendez A, Asad HU, Li W-C, Lone M. Understanding Human Behaviour in Flight Operation Using Eye-Tracking Technology. In: Harris D, Li W-C, editors. Engineering Psychology and Cognitive Ergonomics. Cognition and Design, Cham: Springer International Publishing; 2020, p. 304–20.

OUR SAMPLE CASES

UAV Simulations, UAV Flights

Research Methodology

1
- Experiment protocol
- Research questions
- Piloting
- Calibration

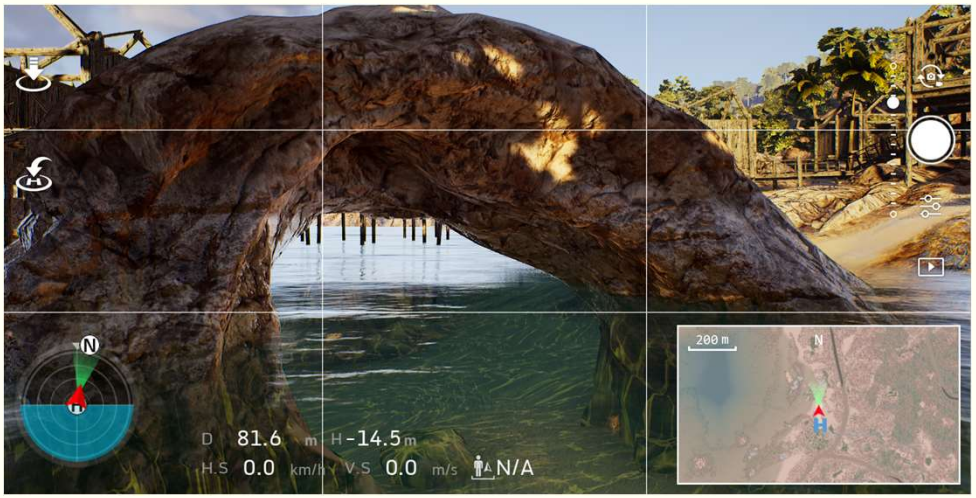
2
- UAV Simulations
- Eye tracking data
- Analysis

3
- UAV flights
- Eye tracking data

4
- Data analysis
- Conclusions

Sample Case 1 - UAV Simulations

- Fly under demanding conditions
- Examined the pilots' fixation points
- Discern discrepancies between experienced and novice ones
- Areas suitable for adaptation from the HMI



Sample Case 1 - UAV Simulations

Inexperienced pilot

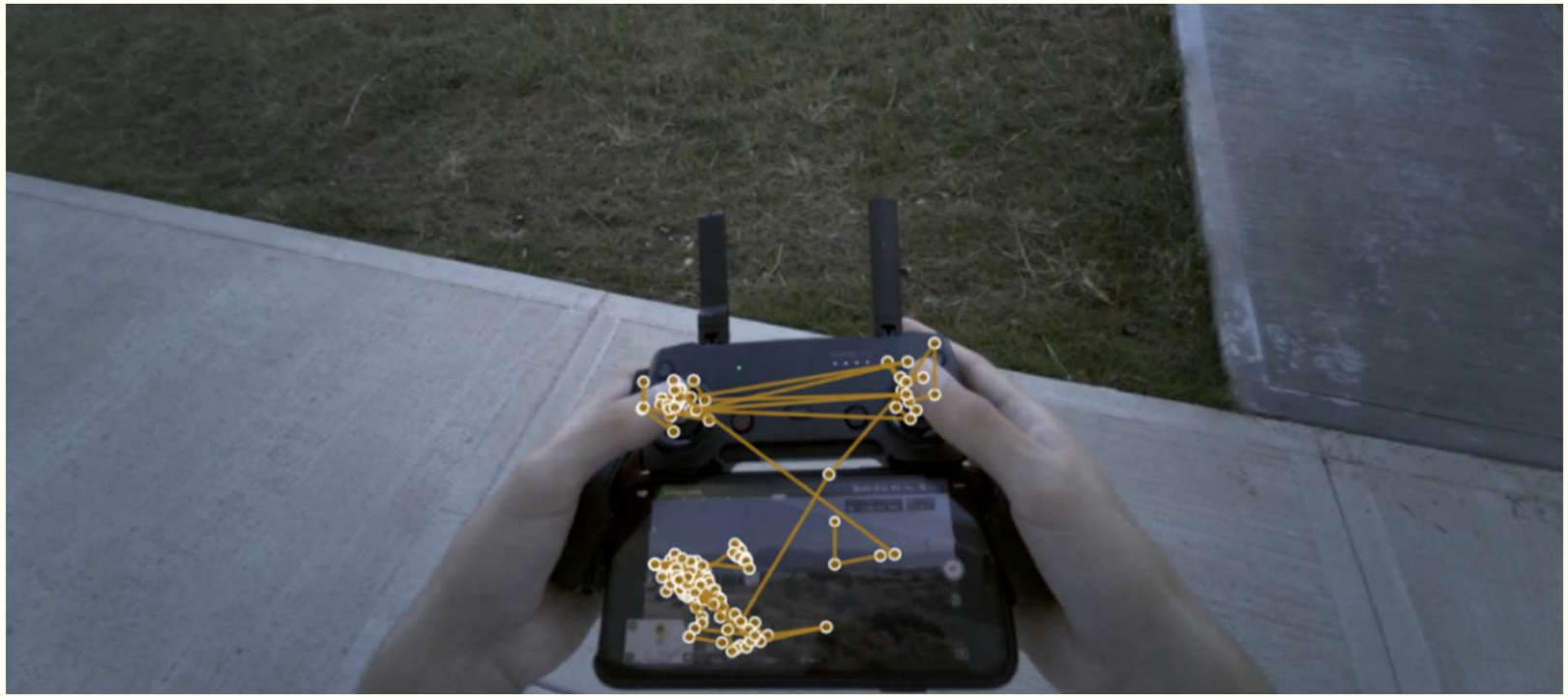
Experienced pilot

Sample Case 2 - Real Drone Flights

- Transitioning from visual line of sight (VLOS) to beyond visual line of sight (BVLOS) operations.
- During the BVLOS phase of the flight, they encountered signal interruptions and, in some instances, complete signal loss.

Sample Case 2 - Real Drone Flights

Sample Case 2 - Real Drone Flights



RESULTS

Takeaway, Acknowledgment

Results

- Using eye-tracking data for real time adapting HMI is both feasible and cost-effective
- Adapting HMI for:
  - Assist the pilot in maintaining a sense of spatial orientation
  - Alleviate the cognitive burden associated with monitoring multiple information sources simultaneously
  - Assist the pilot when unsuccessful searches for information
  - Emphasizing the sought-after data
  - Identifying missing important visual information from the screen
  - Minimize eye gaze beyond the screen area
  - Change when something critical occurred (e.g., signal loss from the camera)

Takeaway Message

These (early) findings highlight the potential for adaptive interfaces to assist pilots in critical decision-making, improve situational awareness, and enhance overall flight safety.

THANK YOU

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