

HF003: CHARACTERIZATION AND APPLICATION OF AIR TRAFFIC CONTROLLERS VISUAL SEARCH PATTERNS AND CONTROL STRATEGIES FOR EFFICIENT AND EFFECTIVE TRAINING

PROJECT AT-A-GLANCE

- UNIVERSITY: University of Oklahoma
- PRINCIPAL INVESTIGATOR(S): Ziho Kang, John Dyer.
- STUDENT:

RELEVANCE TO TECHNICAL TRAINING AND HUMAN PERFORMANCE

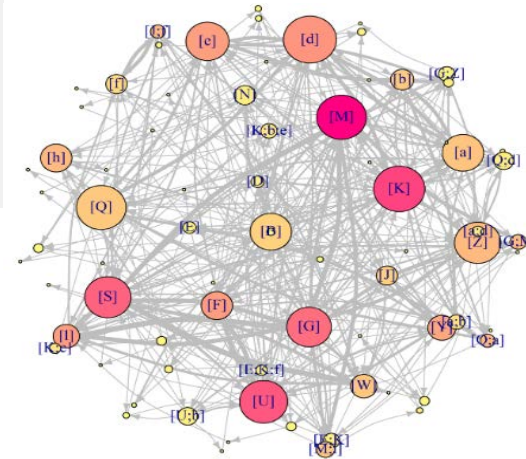
- This proposed project aims to characterize and classify the visual scanning patterns and control strategies of expert air traffic control operators (ATCOs) in order to support the efficient and effective training of air traffic control candidates.
- We will collect eye movement data and aircraft control commands from multiple expert ATCOs, and develop designs to better provide the characterized and classified visual search and control strategies. The research focus is on enroute air traffic control.

STATEMENT OF WORK

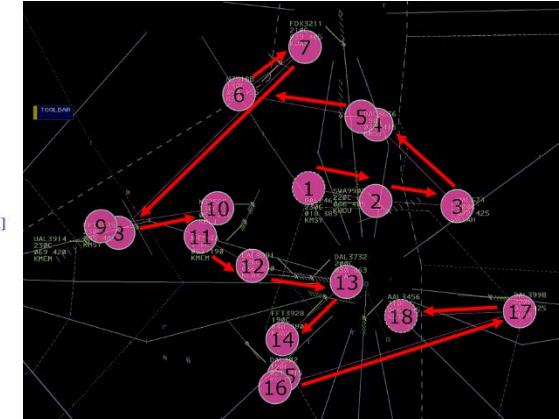
- Conduct requirement analysis for collecting ATCO's eye movements, retrospective verbal inputs, and mitigation commands.
- Perform experiments on retired expert ATCOs: Record eye movements and verbal commands. Analyze visual scanning patterns and conduct retrospective verbal protocol analysis..
- Characterize and classify expert ATCO's visual search patterns and control strategies.
- Develop designs to provide visualization and classification results.

April 16-17, 2019
The Ohio State University

Examples of visual scan characteristics



Overall visual scan characteristics



Example of spiral visual scan

STATUS

- Project completed in Q1 of 2018.
- Final briefing completed in Q2 of 2018.
- All milestones complete: Discovered different types of visual scans and conflict mitigation strategies using high fidelity scenarios.

FUTURE WORK

- Phase II (i.e. next phase) research is to start shortly: (1) implementing the results into a gamified software and (2) evaluating the learning effectiveness.
- Development of algorithms (e.g. machine learning) to automatically classify visual scans.
- Development of real-time eye tracking analysis algorithms.

HF003: CHARACTERIZATION AND APPLICATION OF AIR TRAFFIC CONTROLLERS VISUAL SEARCH PATTERNS AND CONTROL STRATEGIES FOR EFFICIENT AND EFFECTIVE TRAINING

Publications, Presentations & Awards

Publications

- **Journal paper:** Mandal, S. and Kang, Z (2018). Using eye movement data visualization to enhance training of air traffic controllers: A dynamic network approach. *Journal of Eye Movement Research*. 11(4), 1-20.
- **Conference paper:** Fraga, R. P., Kang, Z., and Mandal, S. (2018). Characterization of air traffic controllers' visual search patterns and control strategies, In *Proceedings of the 2018 ICSTEM The International Society of Engineering and Researchers*, Jun. 18-19, Seoul, South Korea.
- **Conference paper:** Kang, Z., Mandal, S., Alhashim, A., and Dyer, J. (2017). Data visualization approaches in eye tracking to support the learning of air traffic control operations, In *Proceedings of the 2017 National Training Aircraft Symposium*, Aug. 13 - 17, Daytona Beach, FL.
- **Conference paper:** Kang, Z. (2017). Real Time Eye Movement Analysis Framework. In *Proceedings of the 2nd International Conference on Bio-engineering for Smart Technologies*, Aug. 30 - Sep. 1, Paris, France.
- Kang, Z, Fraga, R. P., and Mandal, S. Mixed methods approach of visual scanning and verbal protocol analysis. (under preparation)

Presentations

- Kang, Z. (2018, October): Advancements of eye movement analysis methodologies for a dynamic task: Applications in air traffic control operations and other domains. *Invited Tech Talk at the Air Force Research Laboratory*, Department of Defense, Oct. 18, Austin, TX.
- Kang, Z. (2018, June). Characterization of air traffic controllers' visual search patterns and control strategies, In *Proceedings of the 2018 ICSTEM The International Society of Engineering and Researchers*, Jun. 18-19, Seoul, South Korea.
- Kang, Z. (2018, June): Human factors research roadmap (invited panel). *Center of Excellence For Technical Training and Human Performance Workshop*, Jun. 5-6, Norman, OK.
- Kang, Z. (2018, May): Human systems integration: Eye tracking for training. *Human Systems Integration Summit* (invited talk). Mike Monroney Aeronautical Center, Federal Aviation Administration, May 22, OKC, OK.
- Kang, Z. (2018, April): Improving the mission readiness of employees and safety of the NAS (invited panel). *FAA SOAR Q4 meeting*, Apr. 4, Philadelphia, PA.

HF003: CHARACTERIZATION AND APPLICATION OF AIR TRAFFIC CONTROLLERS VISUAL SEARCH PATTERNS AND CONTROL STRATEGIES FOR EFFICIENT AND EFFECTIVE TRAINING

Publications, Presentations & Awards

Presentations (continued)

- Kang, Z. (2017, August). Real Time Eye Movement Analysis Framework: Objective-Based Systematic Approach. In *Proceedings of the 2nd International Conference on Bio-engineering for Smart Technologies (BioSmart)*, Aug. 30 - Sep. 1, Paris, France.
- Kang, Z. (2017, August). Data visualization approaches in eye tracking to support the learning of air traffic control operations, In *Proceedings of the 2017 National Training Aircraft Symposium*, Aug. 13 - 17, Daytona Beach, FL.
- Kang, Z. (2017, June). Characterization of visual scanning patterns and aircraft control strategies for training. *FAA SOAR Q4 meeting*, Jun. 13-15, FAA Headquarters, Washington D.C.
- Kang, Z. (2017, June): Data visualizations in eye tracking research, *Tobii Pro Research Spotlight Seminar Series* (Invited talk). Invited talk for Tobii Pro North America. Jun. 1, Norman, OK.
- Kang, Z. (2017, March). Characterization of visual scanning patterns and aircraft control strategies for training. *FAA SOAR Q3 meeting*, Feb. 28 - Mar. 1, Daytona Beach, FL.
- Kang, Z. (2017, November). Characterization of visual scanning patterns and aircraft control strategies for training. *FAA SOAR Q2 meeting*, Nov. 30 - Dec. 1, Norman, OK.

Recognitions/Awards

- Kang was nominated for the **Dr. Hamed K. Eldin Outstanding Early Career IE in Academia Award** at the Instituted of Industrial and Systems Engineering in 2018.
- Kang was the **Keynote Speaker** at the IEEE BioSmart conference in 2017.
- Kang received the **Best Presentation Award** at the IEEE BioSmart conference in September in 2107.
- Kang received the **Andrew P. Sage Best Transactions Paper Award** in 2016.
- Mandal received the **Best Student Paper Award** from the Aerospace TG within the Human Factors and Ergonomics Society in 2016.