Abstract

There is a critical gap in attempting to predict aviation system and human performance on taxiways. Large-scale computer simulations and human-in-the-loop experiments have historically been used to provide higher levels of performance. However, testing these algorithms is challenging due to the lack of a validated computational cognitive model to parallel human performance.

The present study attempts to bridge this gap by constructing and validating a computational cognitive model of taxiing, using ACT-R. The model has been validated against taxi position data recorded by real pilots at DFW airport and simulations of a C-17 at DFW airport (SODAA data). Preliminary comparisons already useful, but more comparisons needed.

Motivation

Surface traffic management is a critical concern for NextGen. Large-scale computer simulations can provide insight into sequencing, conflict resolution, and human-in-the-loop experiments. However, testing these algorithms is challenging because of the lack of a validated computational cognitive model to parallel human performance.

Approach

Construct computational cognitive models of pilots taxiing.

Methodology. Two phases:

I. Analyze and pilot prototypical data.

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- Correlate with metrics.
- Analyze chart to see human error.
- What is the “expected” performance on these metrics?
- What is the “predicted” performance on these metrics?
- “Surprise” the human with results from the model performance?
- Evaluate capability and brief.

II. Validate the model.

- Validate the model against taxi position data recorded by real pilots at DFW airport and simulations of a C-17 at DFW airport (SODAA data).
- Preliminary comparisons already useful, but more comparisons needed.

Task Analysis

- Testability: if the model is used to be a “Turing test” for the model.

- Will use a second validation approach.

- Validate: SODAA Data

- Validation: SODAA Data

- Preliminary comparisons already useful.

- What criteria for those metrics?

- Do not know which trajectories are errors.

- Significant volume of data.

- Data for validation is frequently sparse.

- Not HITL simulation data, thus limiting fidelity concerns.

- Perhaps eventually, participate in large-scale NASA/FAA fast-track tests to validate the model.

- Inform database of pilot response time distributions.

- Replace human “pseudopilots” in HITL simulations of ground control.

- Possibly expand to other team members.

- Widen range of taxi tasks.

- More complete knowledge for off-nominal situations.

- Natural language communications with ground control.

- Better performance for off-nominal situations.

- More complete knowledge for off-nominal situations.

Future Directions and Applications

- Validate model

- Online taxi task complexity.

- Natural language communications with ground control.

- Full and all of the above.

- Different environment (e.g., LAX)

- Test in real time

- Test in real time

- Assist controllers

- Areal human taxi “autopilot” in HITL simulations of ground control

- Evaluate impact of changes in displays or other output format

- Cloud-based simulations

- Initial environments

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In preparation for next year's project, we plan to develop and validate a new model of taxiing.

A Human Performance Model of Commercial Jetliner Taxiing

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