



Development and Evaluation of an Eye Gaze Interactive Air Traffic Control Workstation

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Training, human factors and cockpit operations

Content

Eye Gaze Interaction

Integration of eye gaze interaction in ATC workstation

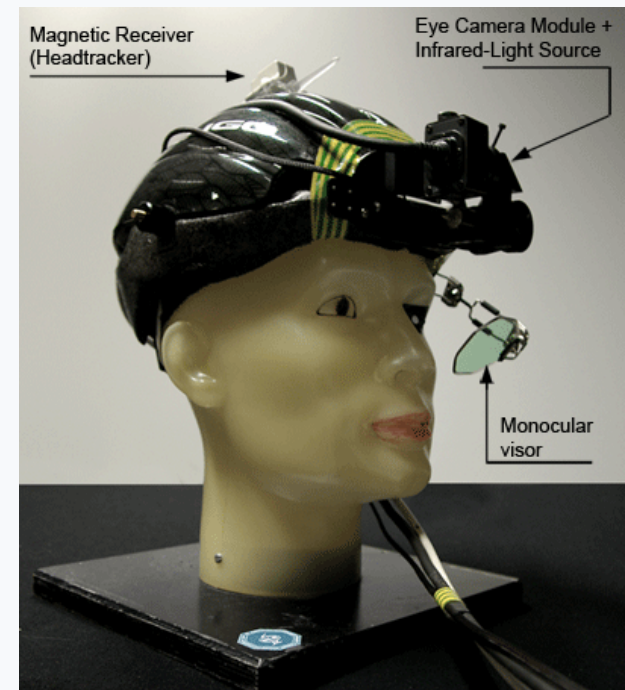
Usability Testing

Conclusion

Discussion

Objective

1. Design Eye Gaze Interaction for an *ATC workstation* interface
2. Evaluate the proposed design in a usability study



Eye Gaze Interaction

What is Eye Gaze Interaction?

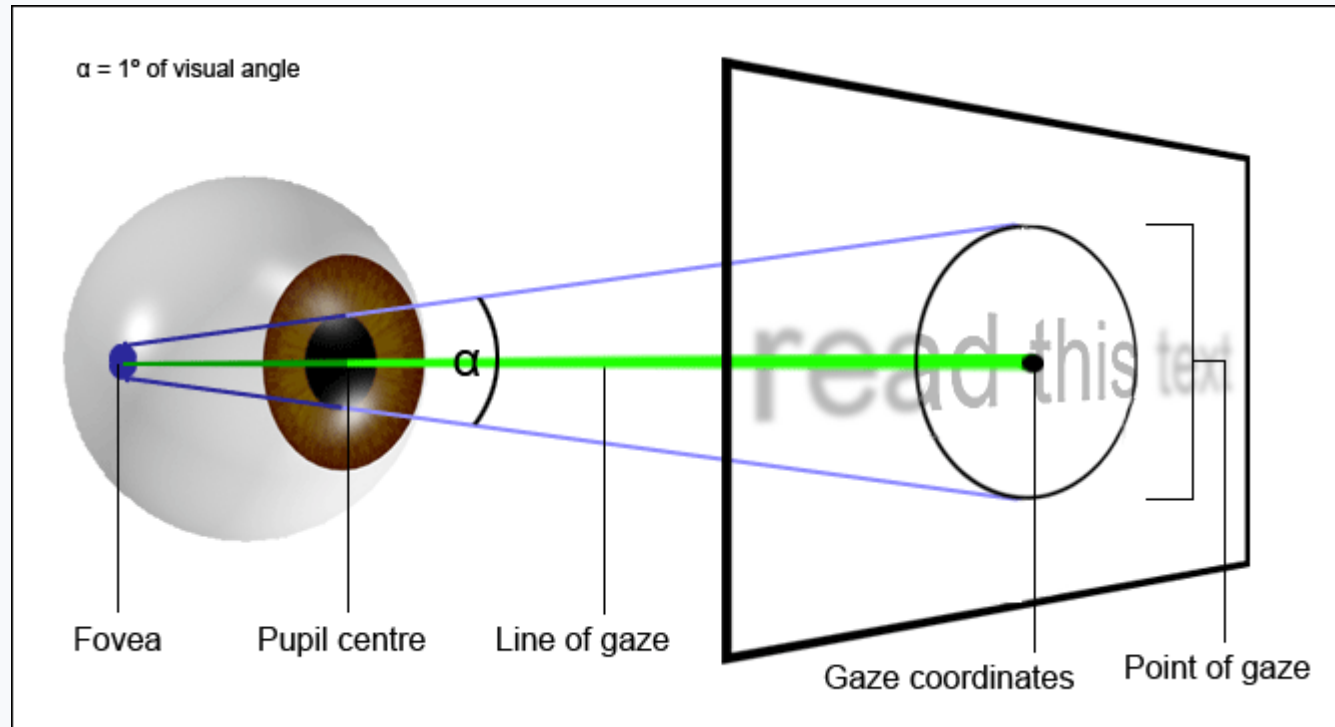
Use Point of Gaze as input to a computer

The user points at objects on the screen by looking at them

Advantages: speed, ease of use, intuitiveness, low cognitive load

Problem: eye movement is non-intentional and unconscious

Eye Tracking Hardware



Eye Gaze Interaction in ATC workstation interface

Example interface used:

AAA Workstation – in use at area control located at Schiphol Airport Amsterdam

Entering commands in the workstation to be expedited.

Method of analysis: CPM-GOMS

Objectives:

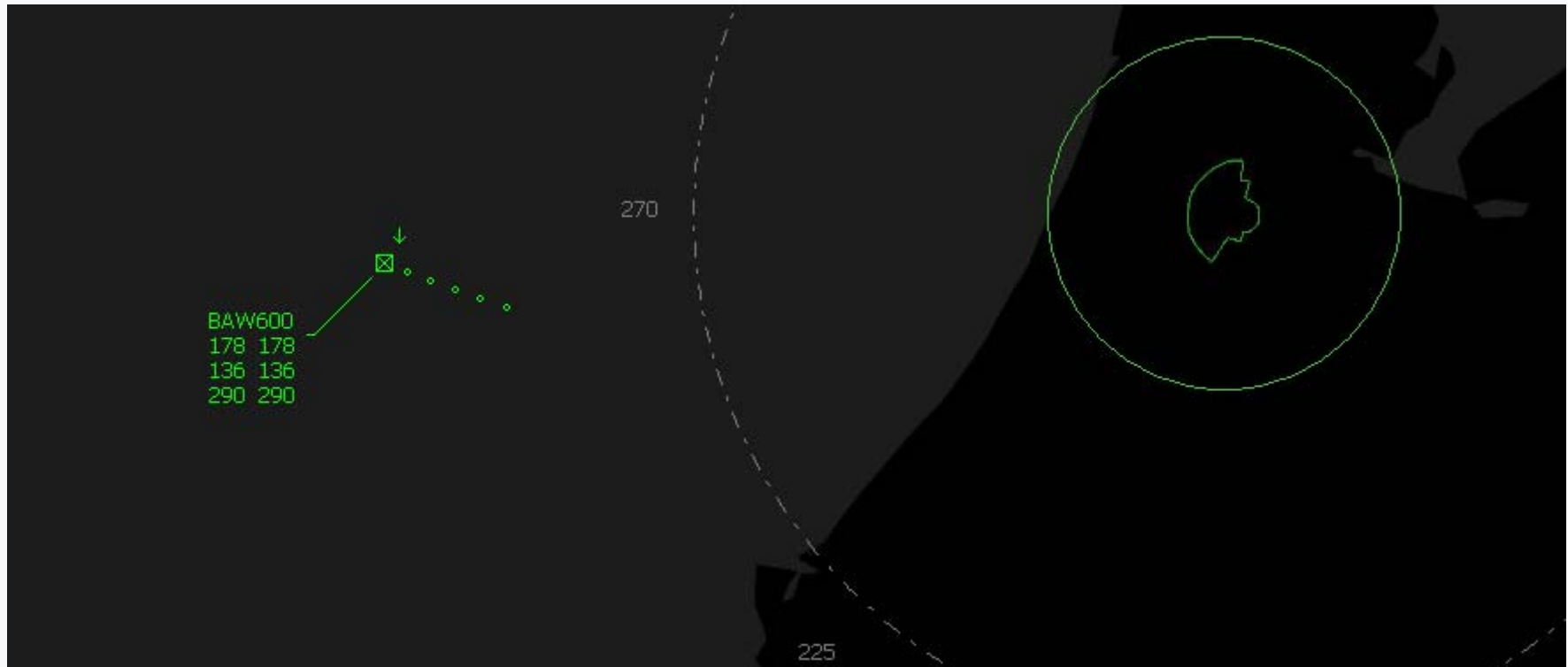
a. Speed up the process

→ Reduce workload → Increase performance

b. Maintain consistency

Entering commands using eye gaze

Step 1 of 4: Point / look at the aircraft



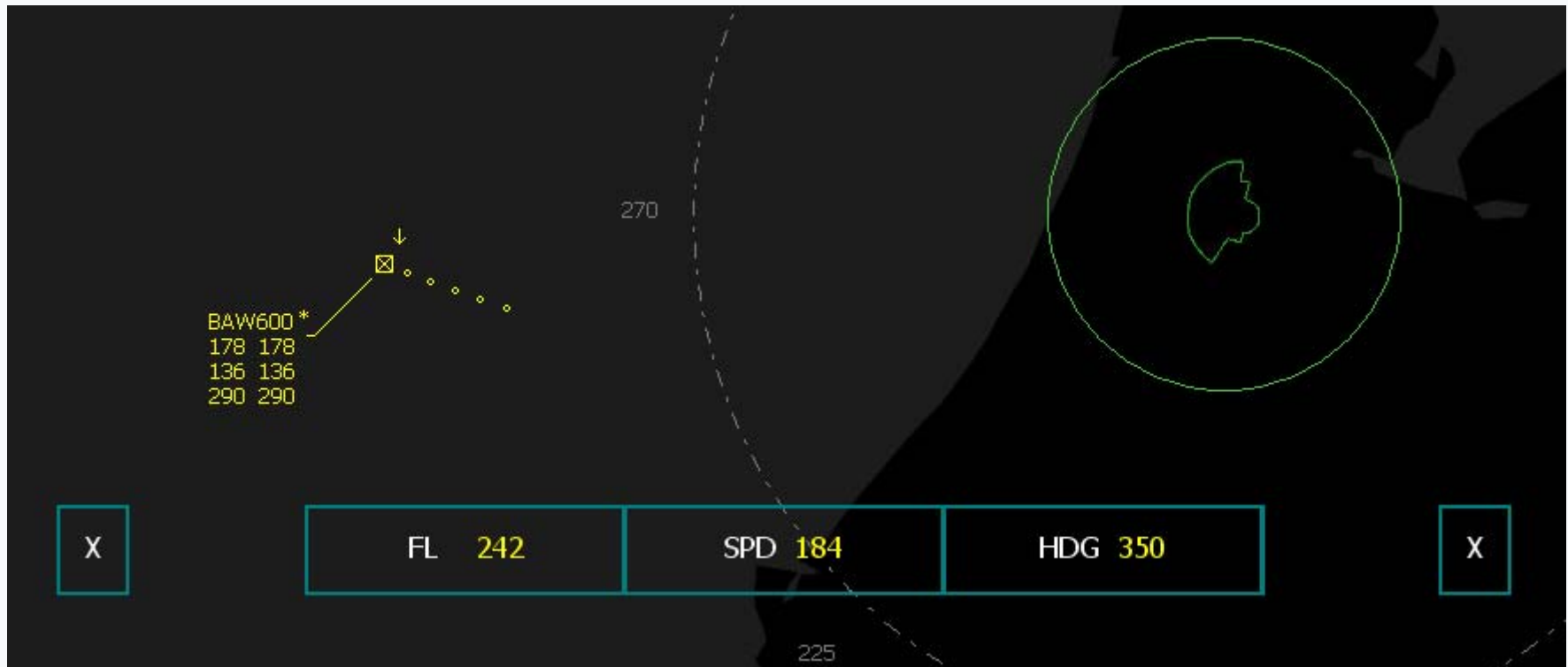
Entering commands using eye gaze

Step 1 of 4: Asterisk appears



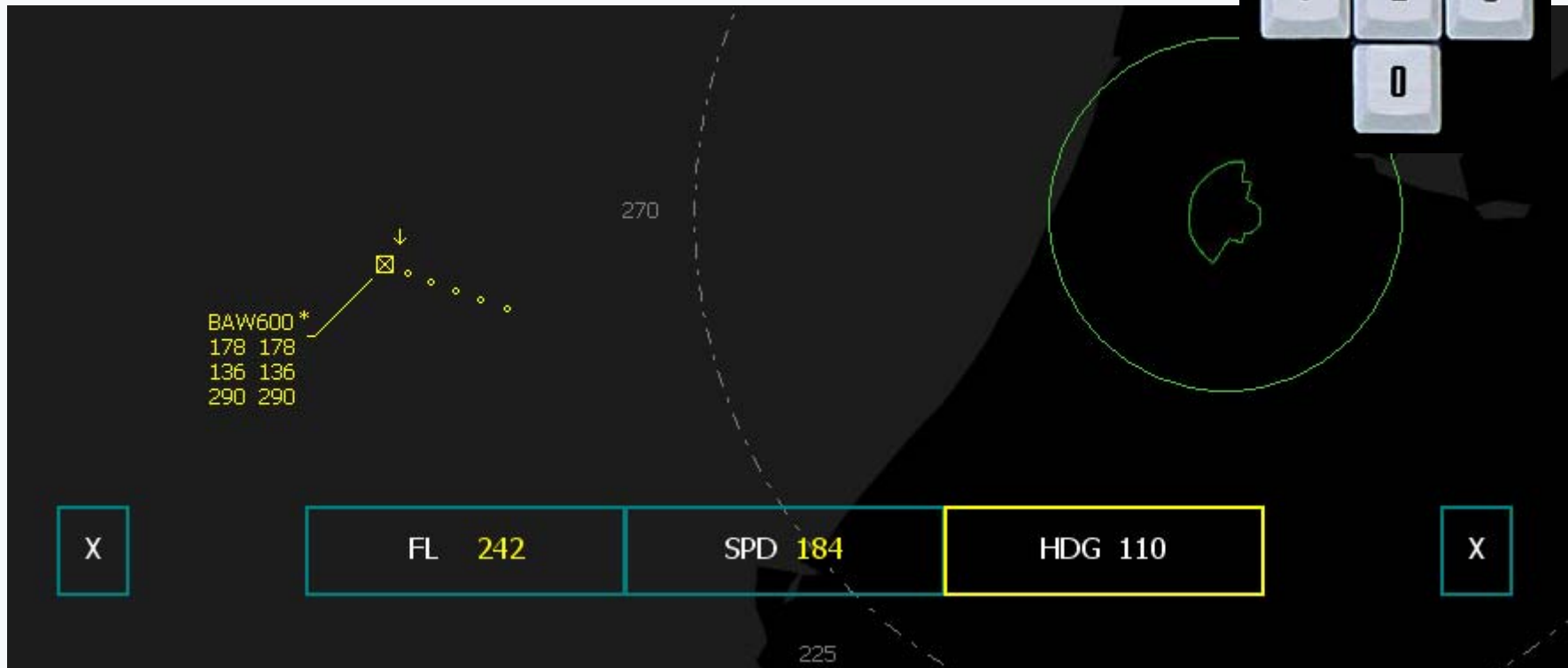
Entering commands using eye gaze

Step 2 of 4: Pressing SEL – SCREENMENU appears



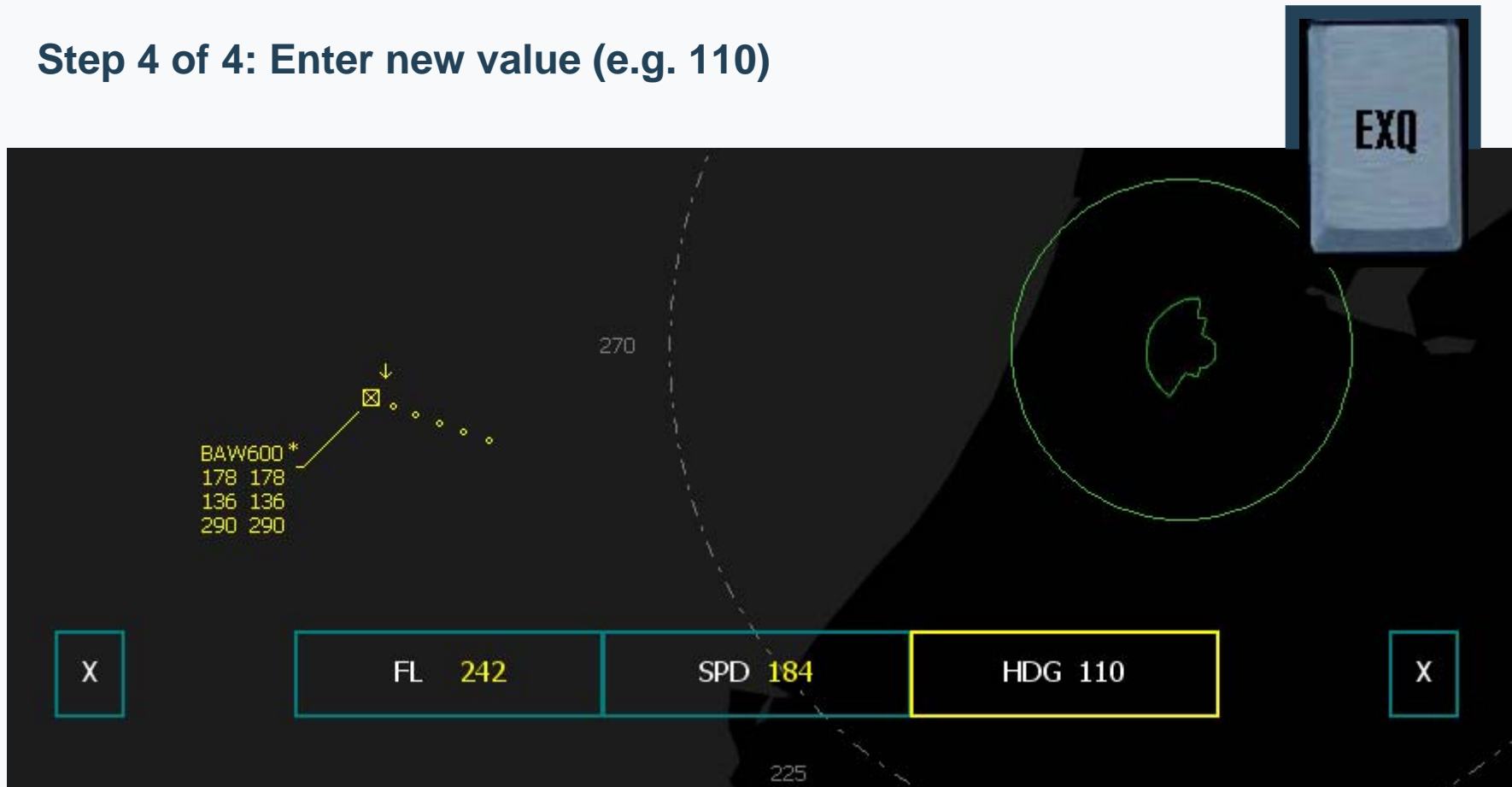
Entering commands using eye gaze

Step 4 of 4: Enter new value (e.g. 110)



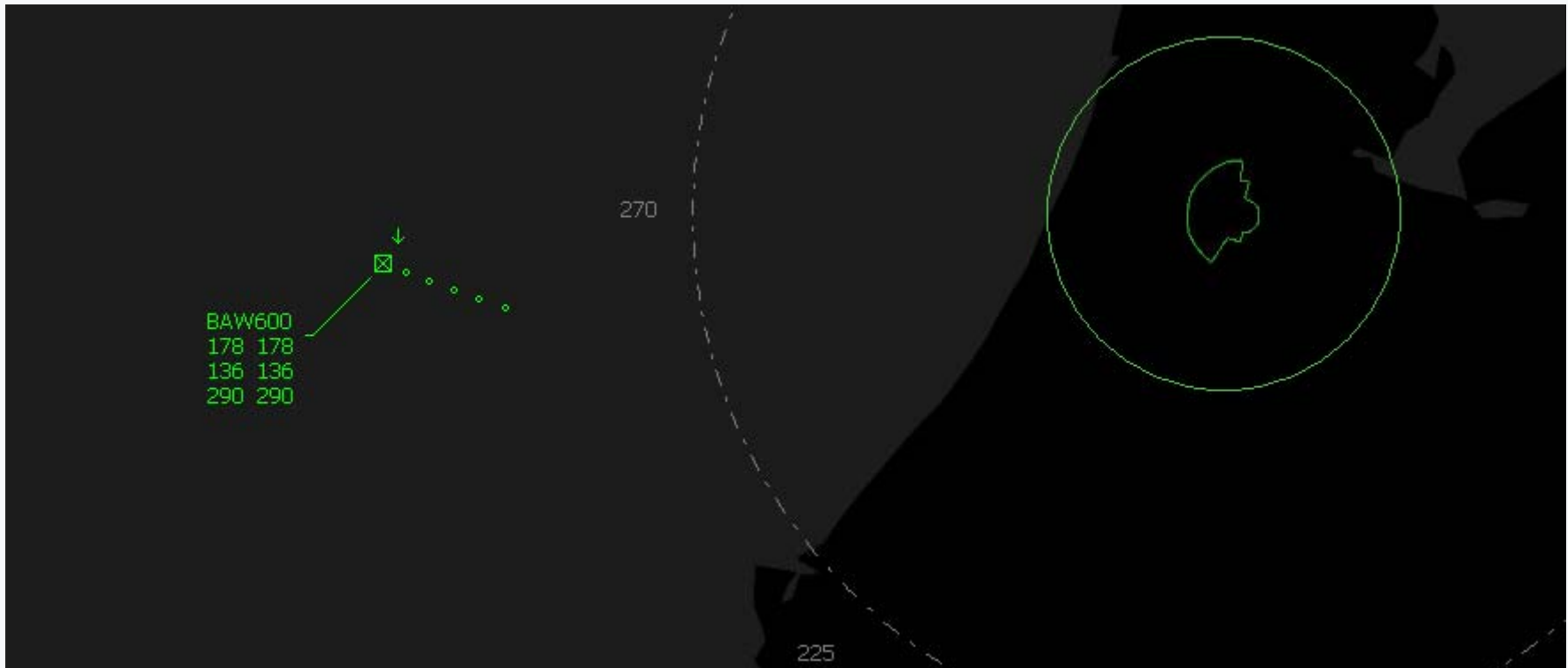
Entering commands using eye gaze

Step 4 of 4: Enter new value (e.g. 110)



Entering commands using eye gaze

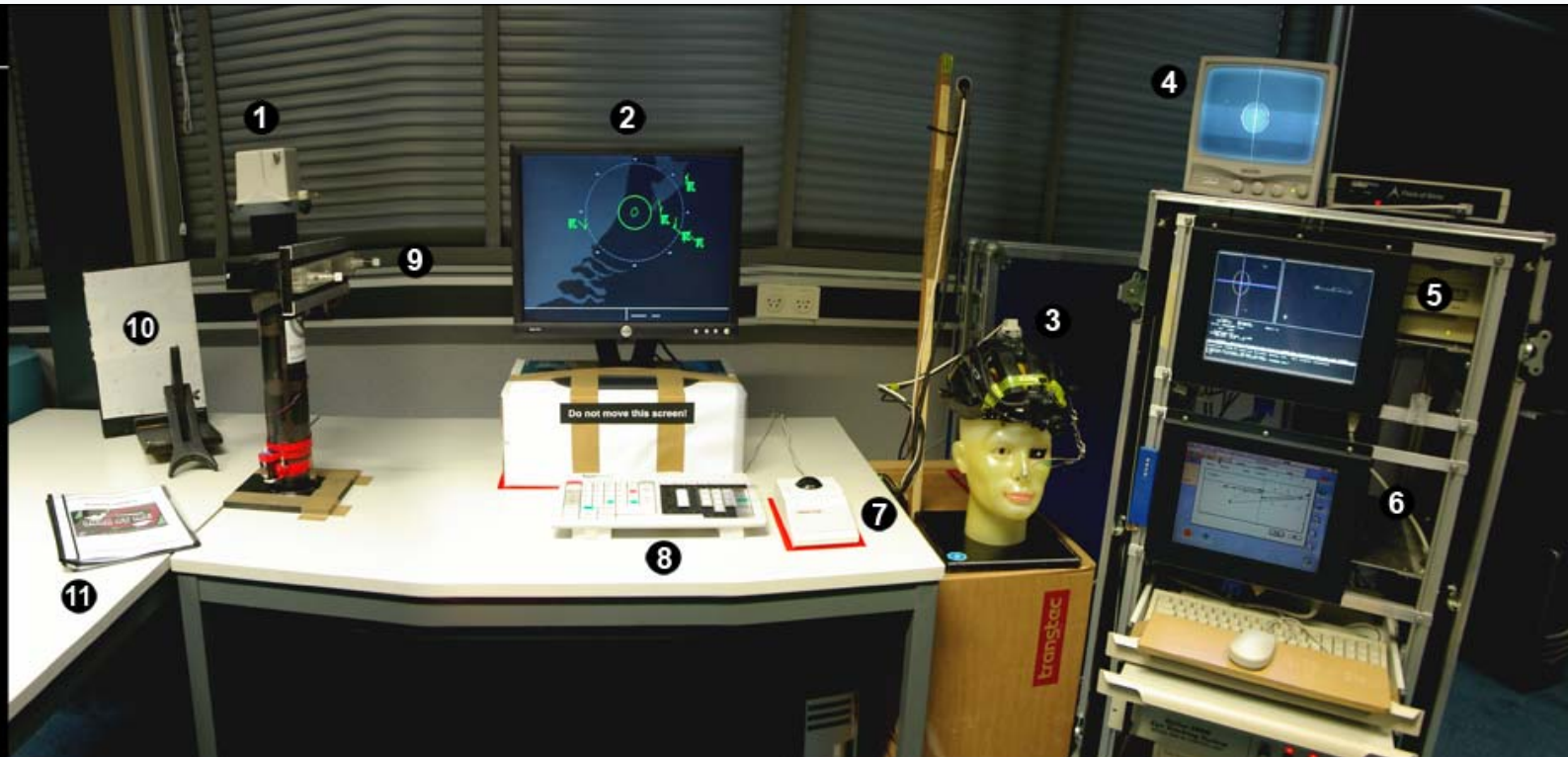
Step 4 of 4: Press execute button – screenmenu disappears



Simulation environment

Workstation Set Up

- 1 Magnetic transmitter
- 2 Radar screen
- 3 Helmet assembly
- 4 Eye monitor
- 5 GazeTracker PC
- 6 GazeTracker Macintosh
- 7 Rollball unit
- 8 Typematrix Keyboard
- 9 Line of Gaze calibration aid
- 10 Chinrest
- 11 Training syllabus



Usability testing

- a. Selecting aircraft (rollball vs. eyegaze)
- b. Entering a command (keyboard vs. screenmenu)

Dependent variables

Reaction times

Error rate

Workload

Performance

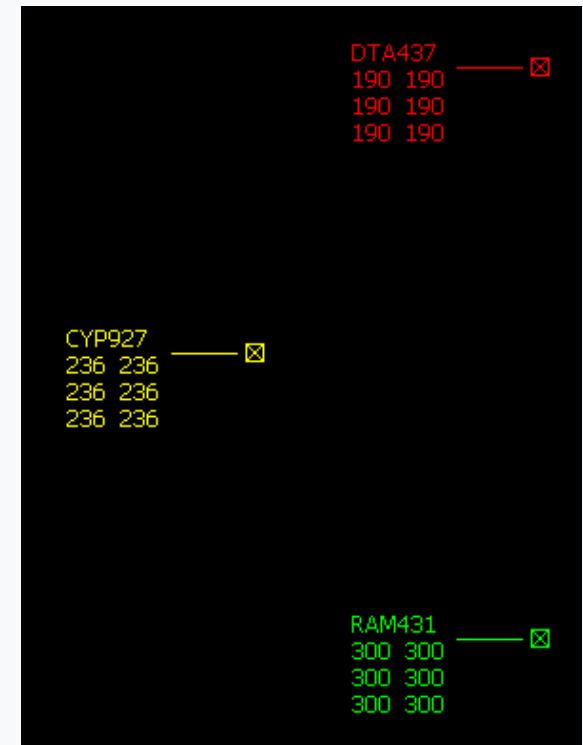
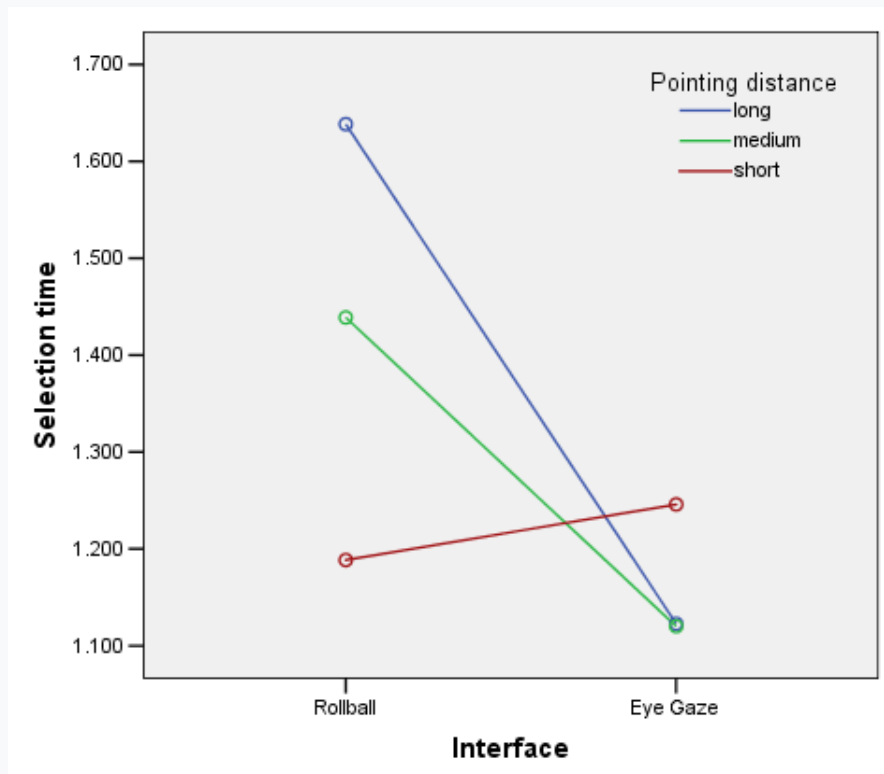
User satisfaction

Experimental Design: **Within-Subjects (N = 12)**

Usability testing

1. Selecting aircraft

“Select aircraft as fast as possible!”



Usability testing

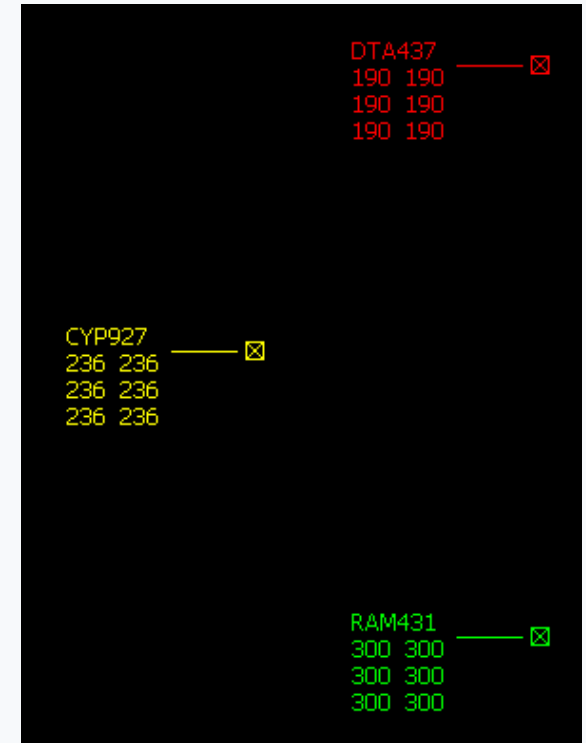
1. Selecting aircraft

“Select aircraft as fast as possible!”

Error rate:

Rollball: 7.44%

Eyegaze: 3.97%



Usability testing

1. Selecting aircraft

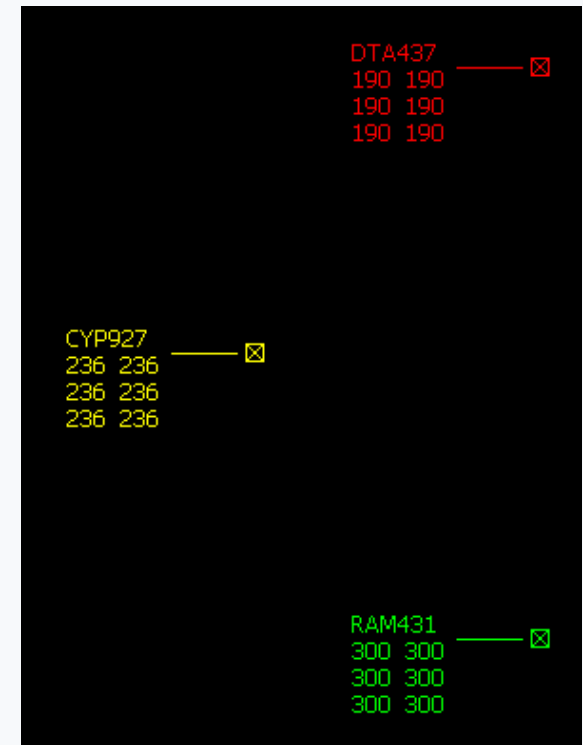
“Select aircraft as fast as possible!”

Satisfaction:

“If I had to do this exercise again, I would prefer to use ... “

Rollball: 0%

Eyegaze: 100%



Usability testing

2. Entering commands

“Enter commands as fast as possible!”

Reaction times:

Keyboard: 6096 ms

Screenmenu: 7435 ms

Difference is significant at $\alpha = 0.01$.



Usability testing

2. Entering commands

“Enter commands as fast as possible!”

Error rate:

Keyboard: 0.03% (1 error on 3780 trials)

Screenmenu: 0.40% (15 errors on 3780 trials)

Difference is significant at $\alpha = 0.05$.



Usability testing

2. Entering commands

“Enter commands as fast as possible!”

User satisfaction:

“If I had to do this exercise again, I would prefer ...”

Keyboard: 50%

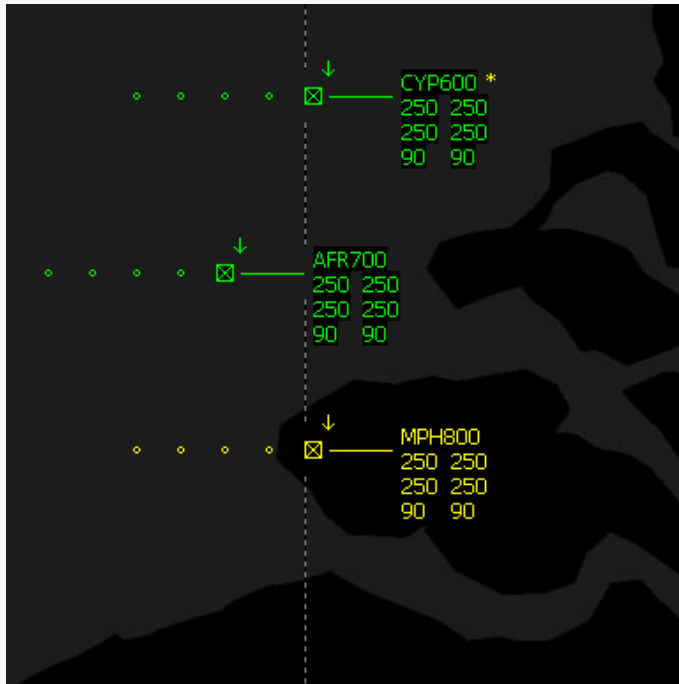
Screenmenu: 50%



Usability testing

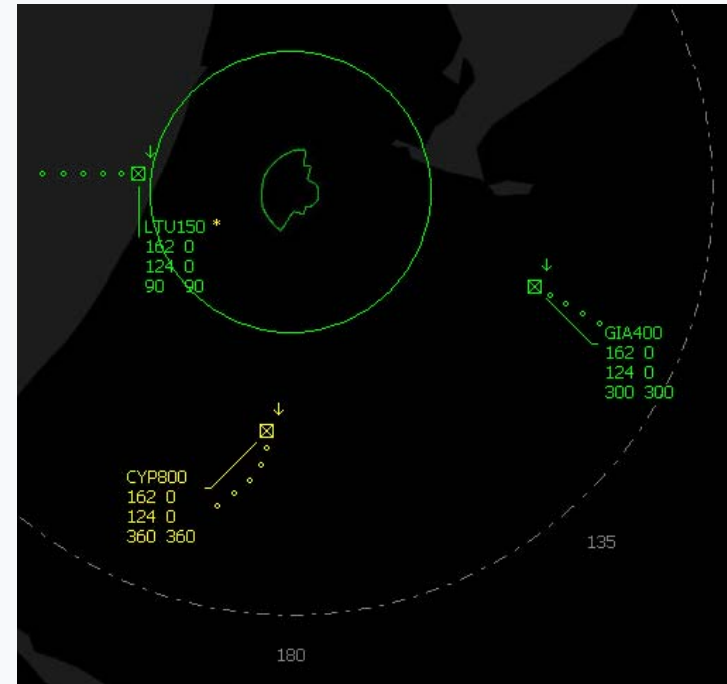
3. Speeding

“Line up aircraft on a line!”



4. Approach

“Send aircraft to the airport!”



Usability testing

3. Speeding

“Line up aircraft on a line!”

Workload (measured by NASA TLX rating)

Lower workload with rollball / keyboard

Own performance & frustration level**

** significant at alpha = 0.05.*

4. Approach

“Send aircraft to the airport!”

Lower workload with rollball / keyboard

No dimensions differed significantly

Usability testing

3. Speeding

“Line up aircraft on a line!”

Performance

Rollball / keyboard: 123.4
Eyegaze / screenmenu: 217.9

Significant at alpha = 0.05.

4. Approach

“Send aircraft to the airport!”

Rollball / keyboard: 222.6
Eyegaze / screenmenu: 283.2

No significance.

Conclusions

Reaction times

Selecting aircraft: eyegaze faster than rollball

Entering commands: screenmenu slower than keyboard

Error rate

Selecting aircraft: less errors with eyegaze

Entering commands: more errors with eyegaze

Workload

higher workload with eyegaze

Performance

lower performance with the eyegaze

Discussion

High Workload / low performance using screenmenu

High performance for selection of aircraft

Intuitiveness of eye gaze interaction for a specific task

Eye pointing is very fast and unrelated to pointing distance, offering benefits for big screens or multiple screen environments.

Training might increase users' confidence with eye gaze interaction.

Remote/ less intrusive eye tracking systems

Questions?

Thank you for your attention

Tanja Bos

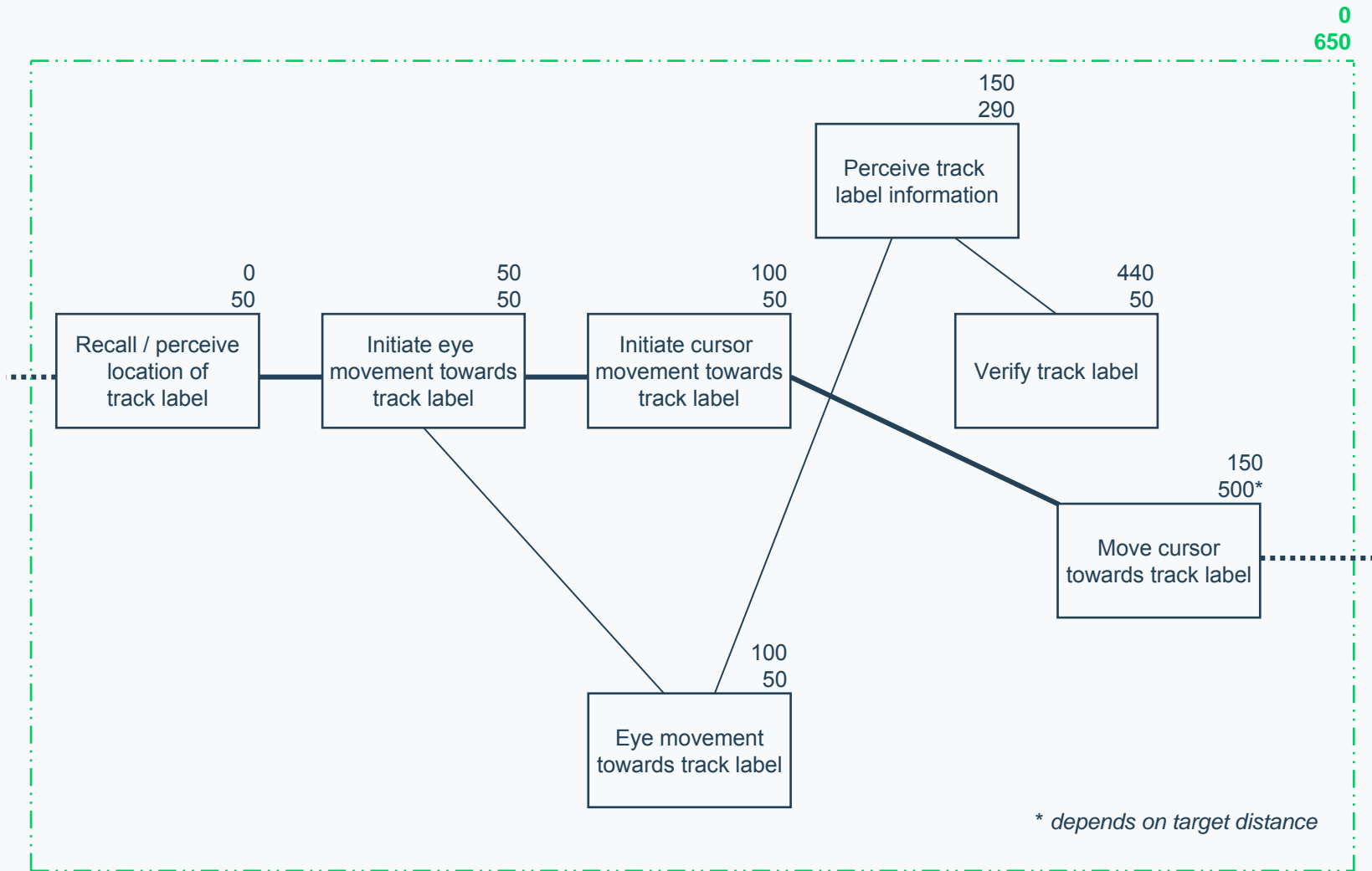
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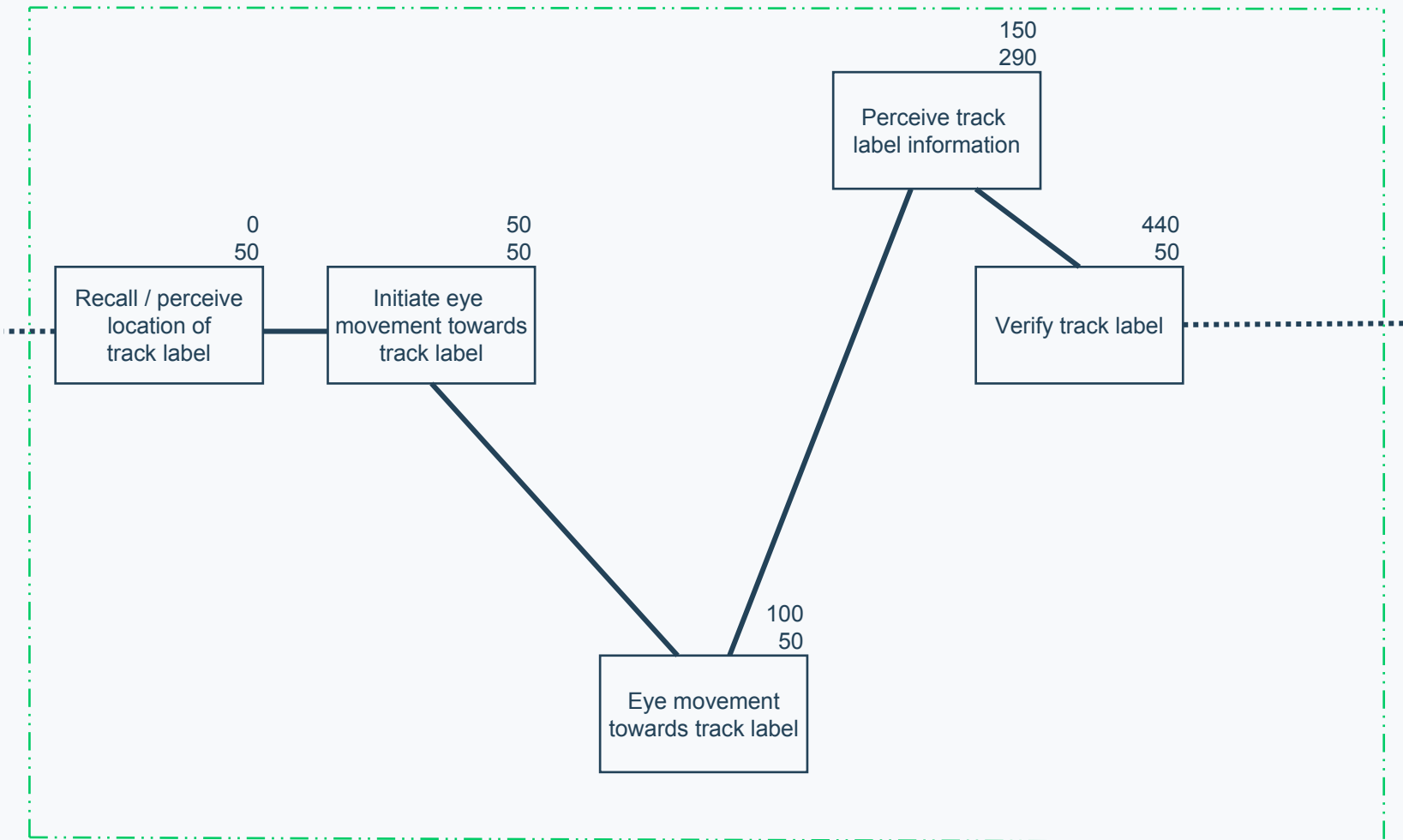
CPM-GOMS Analysis – brief example



subgoal 1: point at aircraft

CPM-GOMS Analysis – brief example

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subgoal 1: point at aircraft