

Interactive and Immersive 3D Visualization for ATC

Matt Cooper

Norrköping Visualization and Interaction Studio

University of Linköping, Sweden

Background

- Fundamentals:
 - Air traffic expected to increase
 - Saturation of ATC anticipated in ~15 years
- So, something needs to change...
 - New approaches to ATC
 - New ways of working
- ...to increase capacity without impacting safety

Our approach

- To construct an interactive, immersive 3D visualization system for ATC
- To use it as a test-bed:
 - For flight and data visualization methods
 - For navigation and interaction methods
- To evaluate the features and explore new possibilities.

3D Visualization for ATM

- Display flights in 3D
 - Show waypoints
 - Show trajectories (flight plans)
- Display Terrain in 3D
- Use 3D models to show flights
- Target (Semi-)Immersive displays
 - Workbench
 - VR Theatre ('Reality Centre')

Stereoscopic display

- Separate images for each eye giving full stereo vision.
- Enhances 3D display giving very strong sense of distance (depth-cueing)
- Requires fast graphics but today easily achieved using high-end PC graphics
- Allows a truly immersive environment

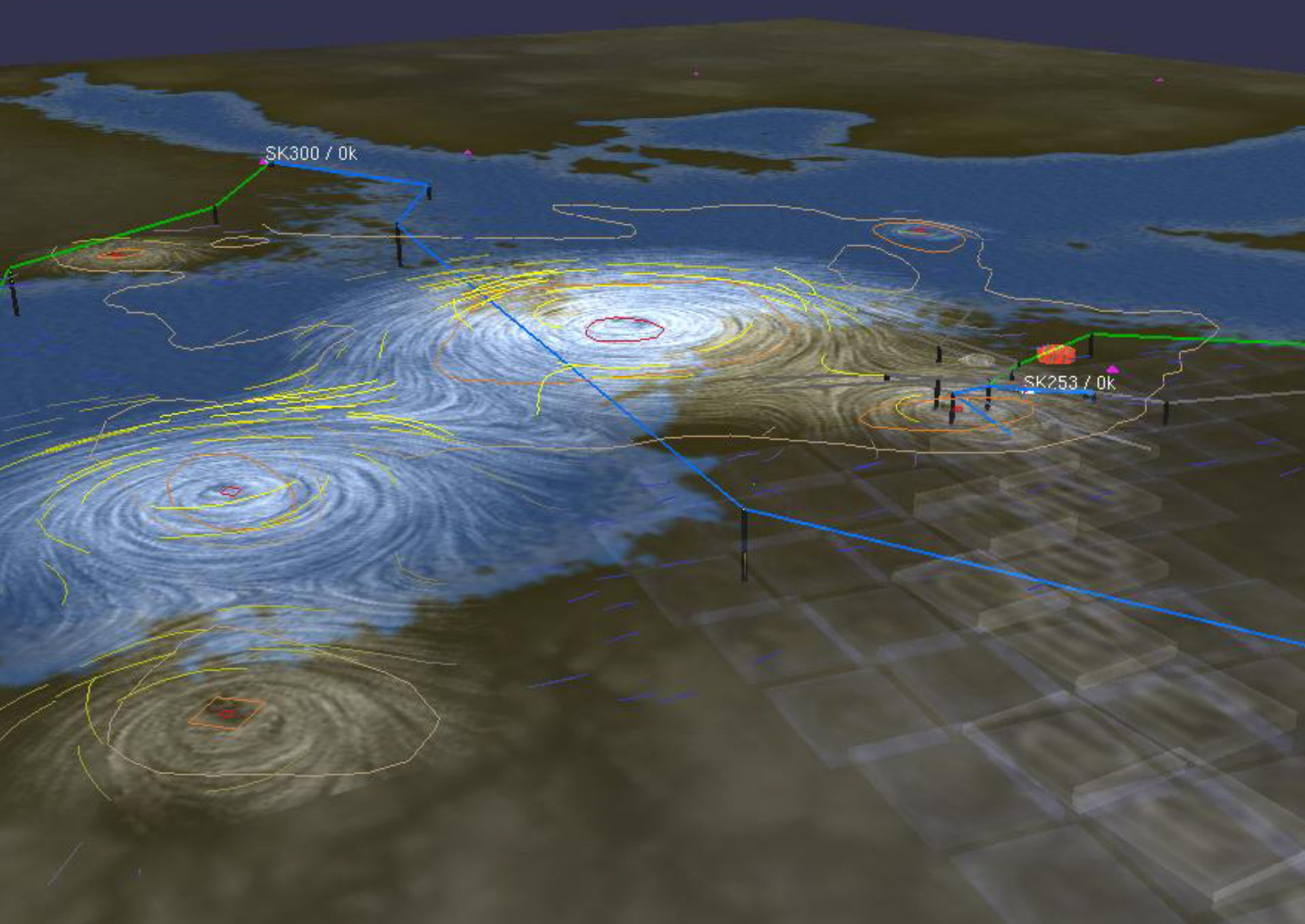
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3D Data for ATM

- Other information is also 3D
 - Not the flight information
- Aircraft have to be navigated around 3D obstacles:
 - Exclusion zones
 - Weather features
 - 'Chop reports'
 - Storms and localized features



Immersive interaction

- Sense of immersion destroyed by reliance on external controls
 - User is removed from the scene
 - Loses orientation and situational awareness
- Immersive interaction approaches are required:
 - 3D interaction (wands and gloves)
 - Voice recognition control and feedback
 - Positional audio

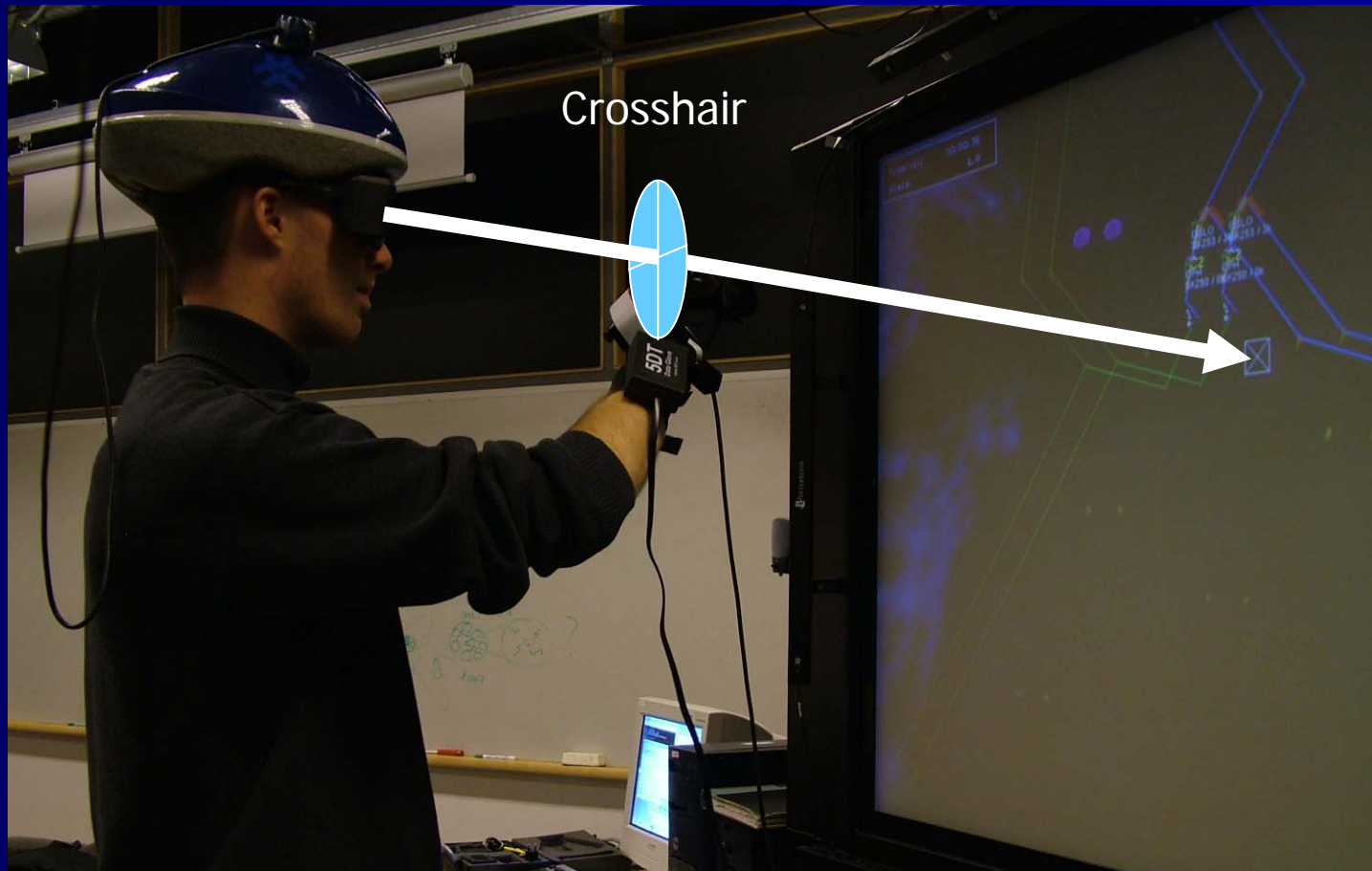
3D interaction

- 3D tracked devices give 5/6 degrees of freedom
- Used to create a 'wand' or 'beam' pointer
 - Can point at objects in the scene and select
- Also carry out navigation by 'flying'

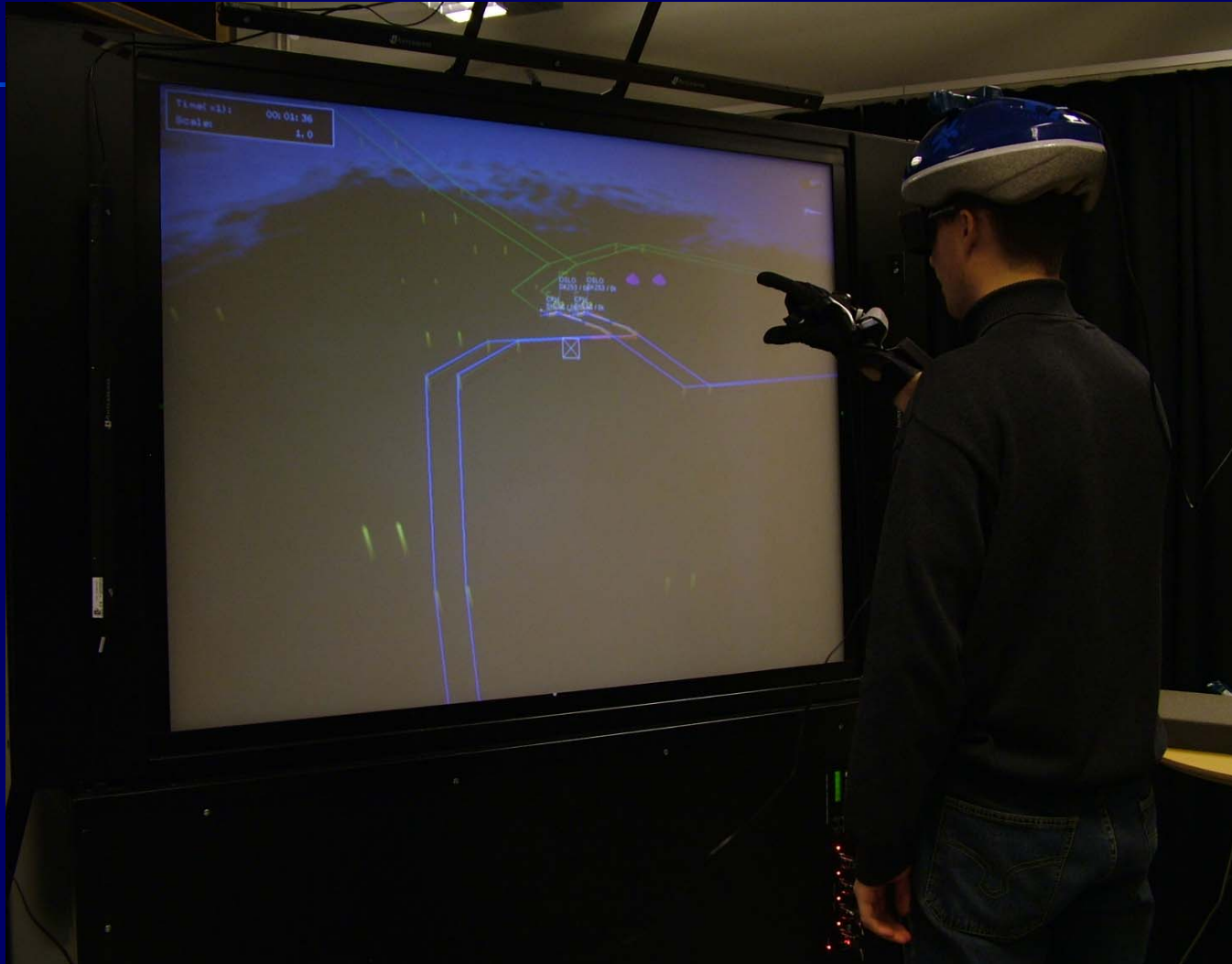
Tracked data-glove

- Data glove has been used to provide gesture-based interaction
- The combined hand-eye interaction approach allows for a more sophisticated selection mechanism
 - Use co-ordinated selection to give user a natural selection process
 - Picking with your hand

Picking using hand and dominant eye



Glove-based picking



Speech commands

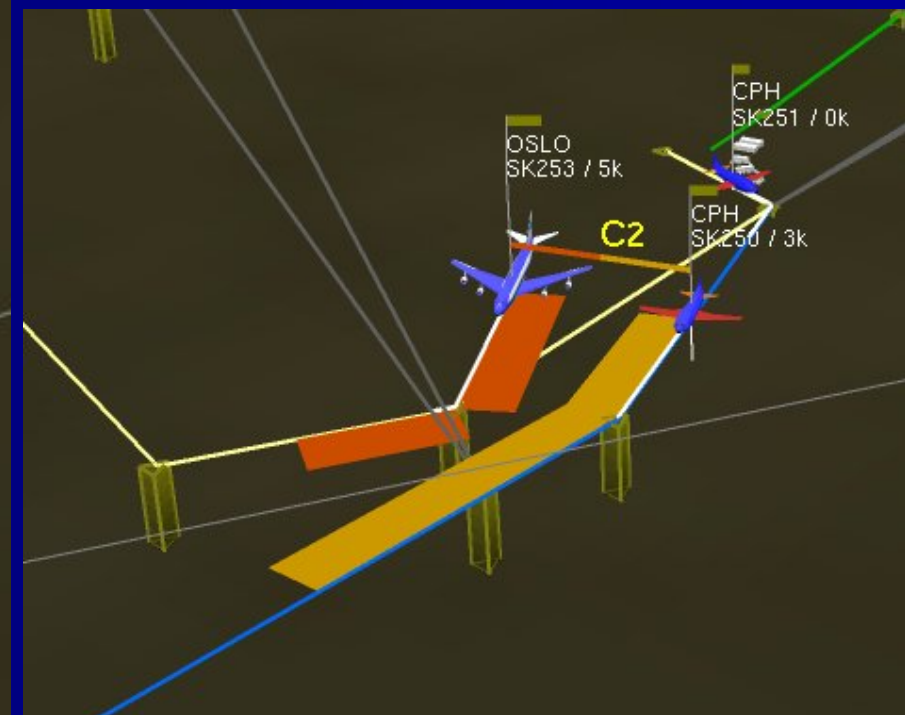
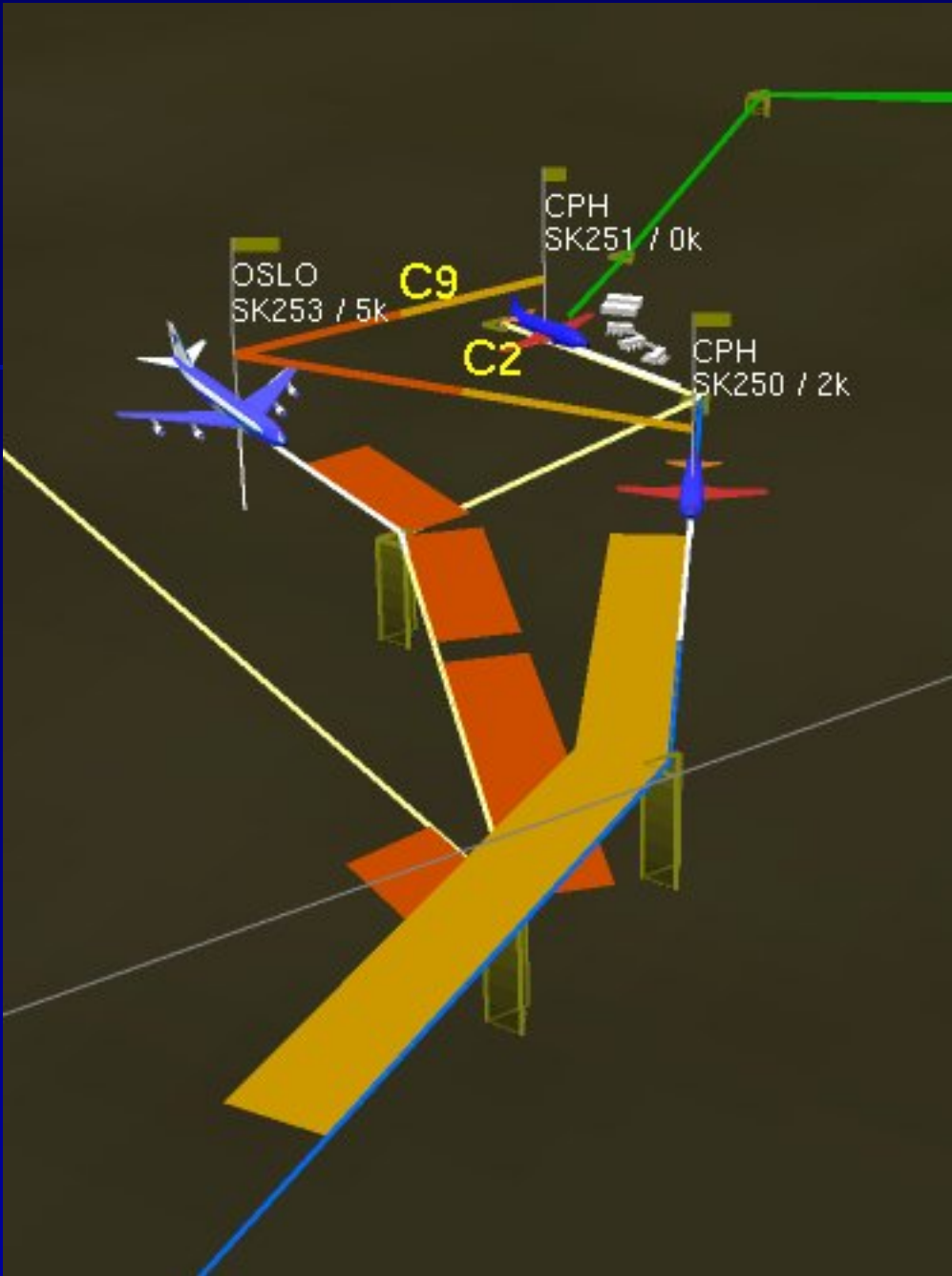
- Use voice control
 - to provide access to complex features
 - Use in any environment
 - Stay immersed
- Use Voice feedback for confirmation
 - Also warnings and other information

Audio feedback system

- Sound alerts using speech to provide information
- Placed in the user's work environment using 'positional sound' based on
 - Amplitude modulation
 - Phase delays
- Very realistic positional effect drawing user's attention to the correct view location

Conflict detection

- Depends on searching for the intersections of the volumes described by each flight's exclusion zone.
- Search 10 minutes or more into the future.
- Brute force approach but cheap enough to use interactively.
 - Allows real-time conflict resolution



Evaluation

- Evaluation is a parallel process in this project
 - Collaboration with LFV and many demonstrations to interest-groups.
 - Systems delivered to Eurocontrol INO group for evaluation:
 - by HMI experts.
 - by experienced controllers.

Evaluation

- Evaluation of the overall system is qualitative
 - Examining overall usability and getting feedback from controllers
- Quantitative 'feature-based' evaluation carried out at ERC

Future work

- Evaluation and feedback
- More realistic trajectories
 - Flight corridors
 - Couple the system with real simulation
 - Allows for more realistic flight path changes
- Improved voice control
 - This year moved from discrete to continuous
 - Need to move to more complex grammar
 - Can then use this to select and control

More future work

- Better approaches to weather information
 - Improvements this year - more possibilities
- Approaches to specific environments
 - Global and mid-range view, airport environment
 - Specializations in the type and means of information presentation
 - Use map better and more:
 - guide user in various operations

Even more future work

- Data Reduction methods
 - ‘Information overload’ is becoming a problem
 - Many features and many data representations
- Looking at reduction approaches:
 - Feature extraction and highlighting
 - Moded displays for task-based visualization

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