TriControl
A Multimodal Air Traffic Controller Working Position

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Oliver Ohneiser, Malte Jauer
German Aerospace Center (DLR)
Institute of Flight Guidance
Controller Assistance
Braunschweig, Germany
Motivation and Concept

Controller Communication (Current):

- Potential communication bottleneck
- Suitability of current modalities?

Controller Communication (TriControl):

- Principles of inter-human communication
- Goal: quicker and more intuitive interaction

Fall-back: Radio Telephony
Previous Work

• Today many different interaction modalities available in various domains

• Investigations (see references in paper)
  • Technology screening (SESAR 10.10.02)
  • Multi-touch (SESAR 10.10.02)
  • Eye tracking (internal)
  • Speech recognition (AcListant® project)

• Development of unimodal prototypes and performance assessment (internal)
  • Mouse
  • Multi-touch
  • Speech recognition
Previous Work – Eye Tracking

• ATC usage possibilities
  • Mental workload and fatigue assessment
  • Input device
    • **Hands-free** interaction (manipulation of radar labels or electronic flight strips)
    • **Fast and natural** (e.g. compared to mouse)
    • Efficient pointing device

• Development of research prototype
  • Eye tracking device (Tobii)
  • Evaluated as suitable for callsign selection
Previous Work – Speech Recognition

- Automatic speech recognition (ASR) of controller-pilot communication
- DLR Development of an Active Listening Assistant in cooperation with Saarland University
- With context knowledge ➔ **Command error rate < 2%**
- Reducing controller workload by automating flight strip management
  - **Flight strips are integrated** into radar labels
  - Controller commands are **automatically inserted**
  - Time reduction for radar label maintenance **by a factor of 3**
Previous Work – Multi-Touch

• Unimodal prototype development in SESAR 10.10.02 (DLR, DFS)
• Investigation of usability
• Direct multi-touch manipulation of aircraft on radar screen
• Gestures
  • Altitude (vertical)
  • Speed (horizontal)
  • Headings (rotational)
  • Distance measuring (two fingers)
• Evaluation with 14 air traffic controllers:
  • Fast and efficient
  • Conceivable at CWPs
  • Error tolerant
  • Not a show-stopper due to safety issues
## TriControl – Idea

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLH001</td>
<td>DESCEND</td>
<td>FL 70</td>
</tr>
</tbody>
</table>

- Aircraft identifier selected by eye gaze
- Command type selected via multi-touch gestures
- Command value is spoken
- Insertion of elements consecutively or simultaneously
TriControl – Set-up

- Standard display for radar and flight strip information
- Headset with “push-to-talk” via foot switch
- Contactless eye-tracking device
- Multi-touch device for gesture input
- No "head-down" time required
TriControl – Workflow

Automatic Speech Recognition

Eye Tracking Device

Multi-touch Display

Command

DLH001
descend
FL 70
TriControl – Gestures

- Operated intuitively and blindly
- Additional gestures for zooming, panning
TriControl – „RadarVision“ Flight Strip Integration

- Five grey cells in label
  - Command types

<table>
<thead>
<tr>
<th>DLR001 (H)</th>
<th>FL</th>
<th>Altitude</th>
<th>KT</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heading / Waypoint</td>
<td>Rate of Descent</td>
<td>Miscellaneous</td>
<td></td>
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</tbody>
</table>

- Empty Commands

<table>
<thead>
<tr>
<th>DLR001 (H)</th>
<th>F121</th>
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<th>29</th>
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TriControl – „RadarVision“ Flight Strip Integration

• Cancel command with single touch → white old value

• Newly inserted commands → yellow value

• Correction always possible → insert new command

• Acknowledge command with single touch → white new value
Preliminary Evaluation

- Structured feedback (12 people, many ATCOs) at World ATM Congress 2016
- System Usability Scale questionnaire (SUS)

- Average SUS score: 79 → Good usability of whole multimodal CWP
- “Frequent Use” only rated 2.9 → Eye tracking issues (glasses, contact lenses)?
- Simplicity rated best (3.3) → Clarity and intuitiveness of multimodal concept
- All other item ratings between 3.0 and 3.3 → Good usability of different aspects
Demonstration

Eye-Tracking

Multi-Touch

Speech Recognition

BER8411
A41  40  20  19
200  ----  ----
180  F100
Conclusion and Future Work

• **TriControl**: first multimodal air traffic CWP prototype with potential benefits:
  • Natural, intuitive, and efficient interaction to reduce mental workload
  • Speed gain through three parallel modalities (comparing conventional systems)

• **Other combinations** of interaction modalities / other devices (to be compared)

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</table>

• User should choose **individually preferred modality**

• Implement contextual correction, automatically correct implausible commands

• Studies on operational feasibility, suitability, user acceptance, usability, operational improvements, capacity, and safety
Thank you for your attention!

Oliver Ohneiser, Malte Jauer
DLR, Institute of Flight Guidance
Controller Assistance

Oliver.Ohneiser@DLR.de
Phone: +49 531 295-2566

Malte-Levin.Jauer@DLR.de
Phone: +49 531 295-3021