Wear to Work: SESAR Augmented Reality Technology for Enhancing Air Traffic Operations in Airport Control Towers. RETINA Project

Sara Bagassi, University of Bologna
sara.bagassi@unibo.it

AVARS Conference
6 June 2018, Geneve
RETINA (Resilient Synthetic Vision for Advanced Control Tower Air Navigation Service Provision) is the concept of enhancing human sight capabilities and situation awareness in the control tower by means of synthetic vision.
In the RETINA concept, controllers are no longer limited by what the human eye can physically see out of the tower windows. As trust in digital data will continue to grow, RETINA’s concept allows the controller to have a head-up view of the airport traffic even in low visibility conditions similar to the synthetic vision currently used in the cockpit.

RETINA builds upon the technologies developed in SESAR, such as remote tower, safety nets, SWIM, to provide augmented reality tools for the tower controller.
RETINA concept: motivation

Image: Washington International Airport (1962)

Image: Liverpool International Airport (nowadays)
Low Visibility Procedures

*Normal Visibility Conditions

> 12 nm
RETINA concept
RETINA HMD
SEE-THROUGH HEAD-MOUNTED DISPLAY

OUTSIDE VIEW
AR OVERLAY
COMBINED VIEW
RETINA HMD

SEE-THROUGH HEAD-MOUNTED DISPLAY
RETINA SD
SEE-THROUGH SPATIAL DISPLAY

SENSORS
DATASETS
4D MODEL
AR INTERFACE
AIR TRAFFIC CONTROLLER

OUTSIDE VIEW
AR OVERLAY
COMBINED VIEW
RETINA SD

SEE-THROUGH SPATIAL DISPLAY
Validation Platform
Validation Platform

ATCO
OOT
AR App
HDE

4D model

VOICE COMM.

Pseudo-Pilot

PP App
Visibility Conditions
Baseline – Spatial Display – Head Mounted Display

BASELINE EQUIPMENT  RETINA SPATIAL DISPLAY EQUIPMENT  RETINA HEAD MOUNTED DISPLAY EQUIPMENT
## Experimental Plan

<table>
<thead>
<tr>
<th>Batch</th>
<th>CONDIVIS</th>
<th>EQUIPMENT</th>
<th>BASELINE</th>
<th>HMD</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch 1</td>
<td>CONDIVIS 1</td>
<td>EXE1</td>
<td>MEDIUM-HIGH TRAFFIC</td>
<td>EXE2</td>
<td>MEDIUM-HIGH TRAFFIC</td>
</tr>
<tr>
<td>Batch 2</td>
<td>CONDIVIS 2</td>
<td>EXE4</td>
<td>MEDIUM TRAFFIC</td>
<td>EXE5</td>
<td>MEDIUM TRAFFIC</td>
</tr>
<tr>
<td>Batch 3</td>
<td>CONDIVIS 3</td>
<td>EXE8</td>
<td>MEDIUM TRAFFIC</td>
<td>EXE9</td>
<td>MEDIUM TRAFFIC</td>
</tr>
<tr>
<td>Batch 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EXE11</td>
</tr>
</tbody>
</table>

### Validation Exercise 1-10

**Subjective Measurements**
- Questionnaires: to assess workload, performance and information accessibility.
- Debriefs: to record the opinions and feelings of participants with respect to the operational concept.

**Objective Measurements**
- Head down time
- Head up time
- Number of switches head-down/head-up
- Throughput
Results: Head-Down vs Head-Up Time

- RETINA Solutions Provide a Dramatic Reduction of Head-Down Time

- The effect is maximized by HMD solution
Results: Number of Switches

- RETINA Solutions Provide a Dramatic Reduction of the No. of Switches Head Down-Head Up
- The effect is maximized by HMD solution
Results: Throughput

- RETINA Solutions Provide an overall increase in the throughput
Results: Workload and Performance

- RETINA Solution SD provides a significant reduction of all workload components
- RETINA Solution HMD provides an overall increase in performance, but it also increases physical workload
Results: Information Accessibility

- RETINA Solutions provide an increase in information accessibility
Conclusions

• The RETINA concept has a clear effect in stimulating the ATCO to work in a head-up position more than in a head-down position.

• The ATCO is provided with a unique conformal representation of all the needed information that is currently provided by means of several visual inputs.

• When using SD and HMD solution, all workload components are reduced or maintained except Physical Workload and/or Frustration, slightly increased compared to the one obtained with baseline equipment.

• When low visibility conditions apply, the use of RETINA tools provides the ATCO with a head-up conformal view of all needed information, leading to the reduction of current restrictions due to LVP.
Thank you very much for your attention!