Virtual Tower Control
- From research prototypes to industrial deployment -

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The Vision

- Virtual Tower Control -

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What is the core of this idea?

- **Cost Savings!**
  - Cost efficient allocation of personell by relatively small investment

- **Safety!**
  - Infrared Camera
  - Augmented Vision
  - Tracking

➡️ **Sustainability of cost efficient air traffic control**
Where remote control can be a solution?

1. RTO Center for 1+n small or medium sized airports
2. RTO Center for 1+n big airports
3. Remote Control of view restricted Apron oder Runways
4. Contingency
How did DLR contribute to the development of remote Tower?

RApTOr 2005-2008

VICTOR 2008-2012

RAiCe 2008-2012

RTC DFS Auftrag 2012

SESAR 2012-2015
DLR Research Prototype at Braunschweig Airport (2006)

- Video system for panorama and image processing
- Gbit/s - Fibre optic LAN
- Experimental Augmented Vision HMI

Height 20 m

Wind 6 kt 310°

LH089
BA236
Technical Data

Cameras:
4 x (1600x1200), 14bit/pixel,
25 frames/s
PTZ: f = 3.6 – 82.8 mm, 23 fold
PTZ-IR
3 Fields of View (2°, 7° and 21°)
4-5μm MWIR, 640x512pixel,

Panorama:
Wide angle tiled projection with
4x2 SXGA (1280 x 1024)
2 arc min / pixel

Data Transfer:
GBit Ethernet, typically 100 MBit/s,
MJPEG compressed
Focus of our Research

• Operational and technical proof of feasibility:

  • Operational & Performance Requirements
  • Situational Awareness
  • Usability
  • Acceptance
  • Safety Risk Assessment
  • Workload
  • Eye Point of Regard Measurements
RAiCe (2010)
- first 1 to 2 Multiple Remote Simulation -
RAiCon (2010 - 2012)

- DFS-DLR-Collaboration
- Planning, Development, Set up, implementation and validation of a RTO prototype systems at Airport Erfurt
Field Test Plattform Erfurt

200° - Camera System:
5 x (1920x1080), 200° x 66°
12bit/pixel, 30 frames/s

Pan-Tilt-Zoom (PTZ) - Camera:
VGA-Resolution
continuous Rotation
23x Zoom, 1,7° - 40° Field of View

Panorama Wall:
5 HD-LCD – Monitors
2 Wacom – Displays
Visual Resolution 30cm/500m (2 arc min)
Set up of Research Prototype Platform at Erfurt Tower, 2012

Cameras on top of the Tower Erfurt

WAN-broadcast
50Mbit/sec

Technical Test Station Braunschweig

Rack room of Tower Erfurt

Remote Position Erfurt Tower
Panoramic View and PTZ
Comparison of Perception

VCR Position Tower Erfurt

Remote Position Tower Erfurt

Experimental Set up, Erfurt Tower, June 2012
Gear Down - Mean Plot for Correct Answer with Standard Error (n = 27)

Correct Answers in %

- CWP-remote
- CWP-tower

Distance (NM)

H1 (0.5)  H2 (1.0)  H3 (1.5)
Gear Down - Used Sources of Information for Position CWP-tower (only correct answers)

- **H1 (0.5)**
  - Panorama: 30
  - Magnification: 10
  - Panorama and Magnification: 5
  - Radar: 0

- **H2 (1.0)**
  - Panorama: 25
  - Magnification: 15
  - Panorama and Magnification: 10
  - Radar: 0

- **H3 (1.5)**
  - Panorama: 20
  - Magnification: 15
  - Panorama and Magnification: 10
  - Radar: 0

Gear Down - Used Sources of Information for CWP-remote (only correct answers)

- **H1 (0.5)**
  - Panorama: 30
  - Magnification: 0
  - Panorama and Magnification: 0
  - Radar: 0

- **H2 (1.0)**
  - Panorama: 25
  - Magnification: 0
  - Panorama and Magnification: 0
  - Radar: 0

- **H3 (1.5)**
  - Panorama: 20
  - Magnification: 0
  - Panorama and Magnification: 0
  - Radar: 0
Static Objects - Used Sources of Information for Position CWP-tower (only correct answers)

Distance

250m | 500m | 1000m

Frequency

Panorama
Magnification
Panorama and Magnification

Static Objects - Used Sources of Information for CWP-remote (only correct answers)

Distance

250m | 500m | 1000m

Frequency

Panorama
Magnification
Panorama and Magnification
DFS Human Factors Studie 1:1 Multiple Remote Concept

Feasibility Studie & Safety Assessment

Is a controller able to handle traffic via different airports safe and efficiently?
Average workload and traffic load over the time
1:2 Multiple Remote Tower Center Simulation (SESAR, 2013)

Is a controller able to handle traffic simultaneously at two airports safe and efficiently?
% aller Starts und Landungen beobachtet:

Multiple Remote: 82,7%

Single Remote: 93,2%
Mean Dwellfixes (N=16)

- Out the window
- e-strips
- Radar
- other

%
Important Results of our Research

• Operational and technical proof of feasibility:

  • Operational & Performance Requirements
  • Situational Awareness
  • Usability
  • Acceptance
  • Safety Risk Assessment
  • Workload
  • Eye Point of Regard Measurements

→ Feasibility proven!

DLR Remote Field-Test-Plattform, Research Airport Braunschweig
Remote Tower Community

- Inventor & Patent holder
- Research and Develop.
- Communicator

- System Provider

- ANSPs
- Airports

- Additional Support

WORKSHOPS
Publications
Conferences
Technology Transfers

European Institutions

Manufacturer

User

R&D
New Features: Ultra-HD Resolution for Remote Apron Control

Hi-Res-Camera:
1920 x 2880 pixel in use
17mm lens with lens shift
1“/pix resolution (human eye)
35° x 50° Field of View/camera

Display Wall System (42 displays)
255° x 50°- panorama view (hor. x vert.) with 7 cameras

Hi-Res-Display-Wall with SquareTile-Displays:
6 x 960x960 pixel/Camera
-> 1920 x 2880 pixel
Ultra narrow bezel design
What is still to be done?

- Concept Design
- Decision Support Tools
- Certification and Standardisation
- Best HMI Design
- Fusion with additional sensors
Where are we today?

A Vision has become Reality

Most recent Field-Test-Platform, DLR Braunschweig