

# **Validation of an innovative experimental safety assessment for virtual control tower HMI designs**

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- Introduction to the Virtual Tower Control Project and hazards in the HMI design
- Problem definition
- Approach to assess design configurations
- Experimental setup
- Results
- Outlook



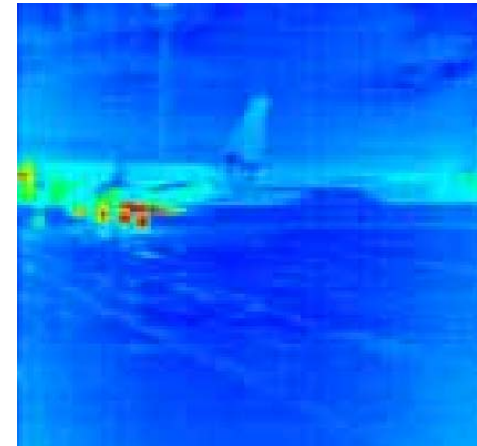
- VICTOR (DFS)
- Raice, Raptor (DLR)
- Advanced Remote Tower (Saab)

**Main function is to  
substitute visual information**

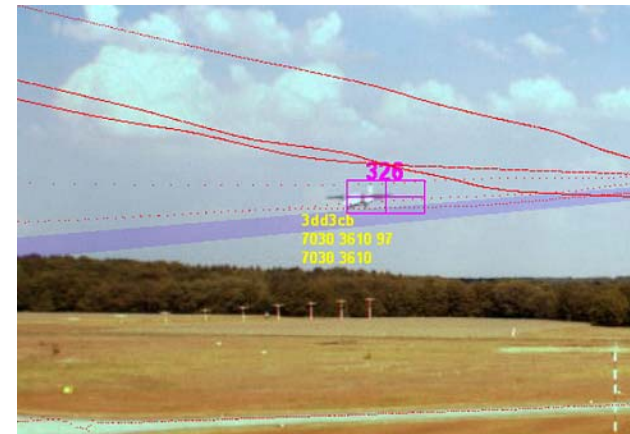


## Systems for HMI design

- Video camera
  - Pan tilt camera
  - Panorama view
- Infrared camera
- Radar (primary and secondary)
- Tracking functions on the video screen
- Airport status monitor
- Weather monitor

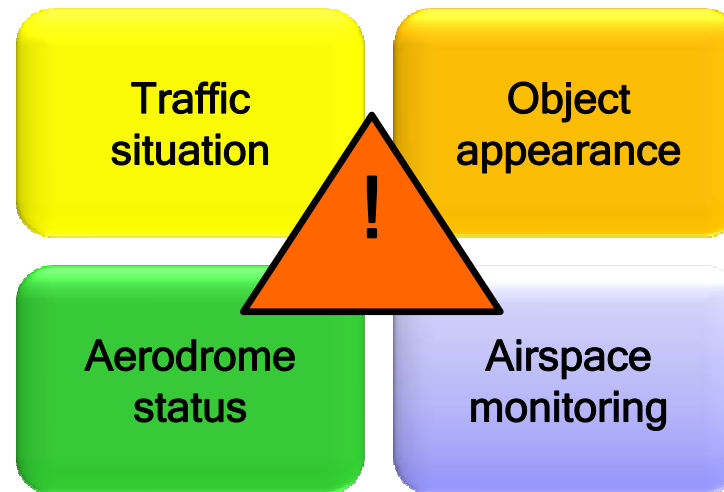


Source: DLR



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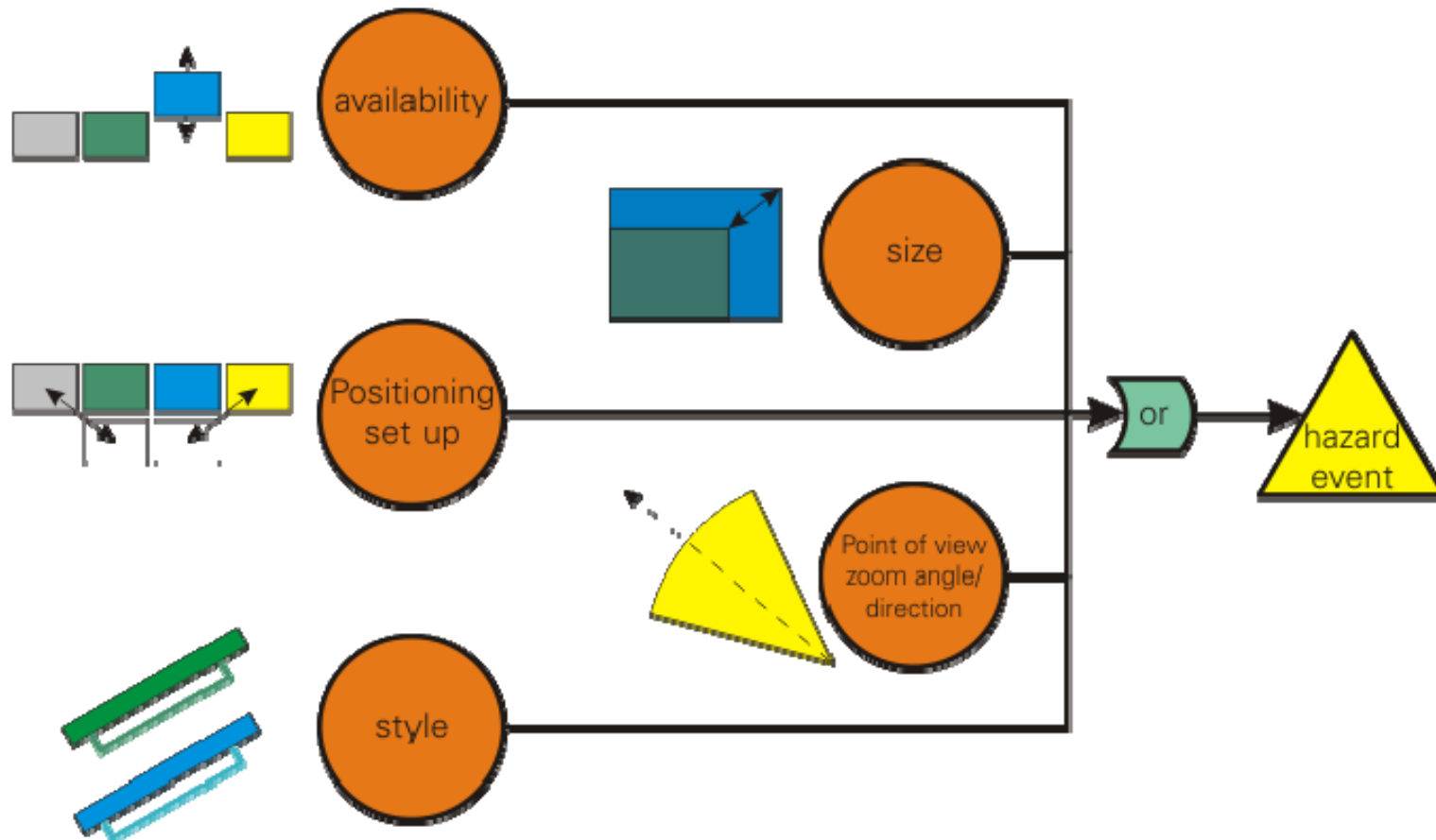
- A hazard is a corrupted or incomplete perception of visual information in the context of ATCOs tasks
- 27 hazards were identified by 5 ATCOs in a workshop
- 13 with severity class A (Accident)
- Proposed hazard classification



### Inability to

- detect objects on RWY when checking RWY occupancy for giving a landing clearance (wildlife, a/c, ground vehicles, pedestrian)
- detect weather conditions (wind shearing)
- check a/c for abnormal appearance (protection of Pitot-sensors not removed, engine failure and smoke generation)
- check gears in the case of a low pass tower
- detect unauthorized movements in the area of responsibility
- to immediately detect go arounds of a/c

A complete overview will be published soon.



## Which design parameters contribute most to mitigate risk?

### Assumptions

- A set of configuration setups of the HMI are available
- Boundary conditions are determined
  - Weather
  - Traffic volume / density
  - Airport layout
  - Concept of operations

### Concept

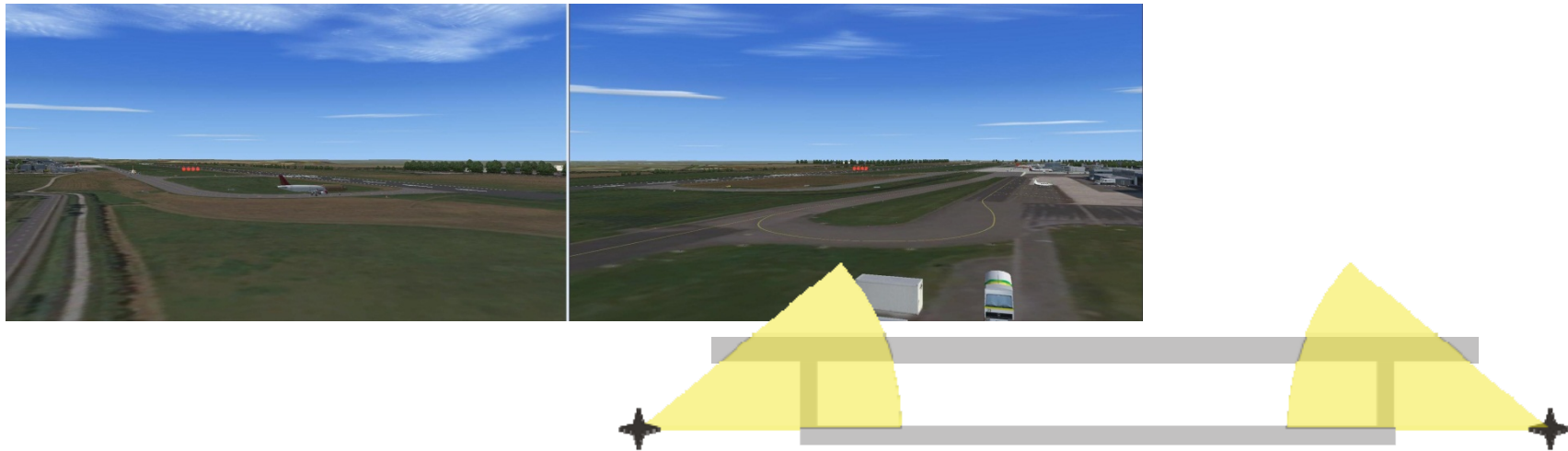
- Provoke hazard occurrence by performing experiments (HIL) with threat appearance
- Varying design parameters (assumed as independent input variable)
- Assess HMI setups by resulting frequency of occurrence



- Video system
- Secondary ground surveillance
- Secondary airborne Surveillance Radar (SSR)
- Keystrokes for clearance indication
- Keystrokes to indicate successfully detected threat appearances

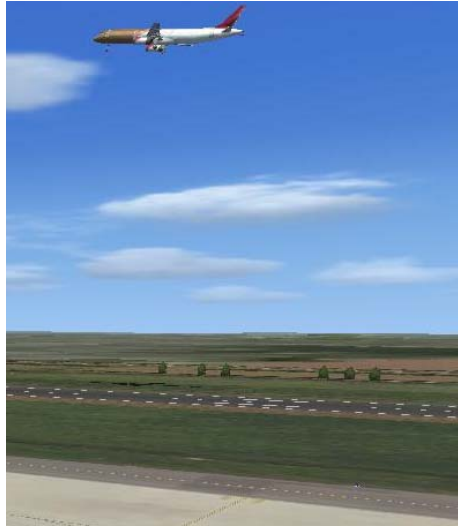


## Crossing view (pointed angle to RWY)



## Panoramic view (180°)





**Go around**



**Unauthorized overrun of lineup stop bars by a/c  
and ground vehicle**

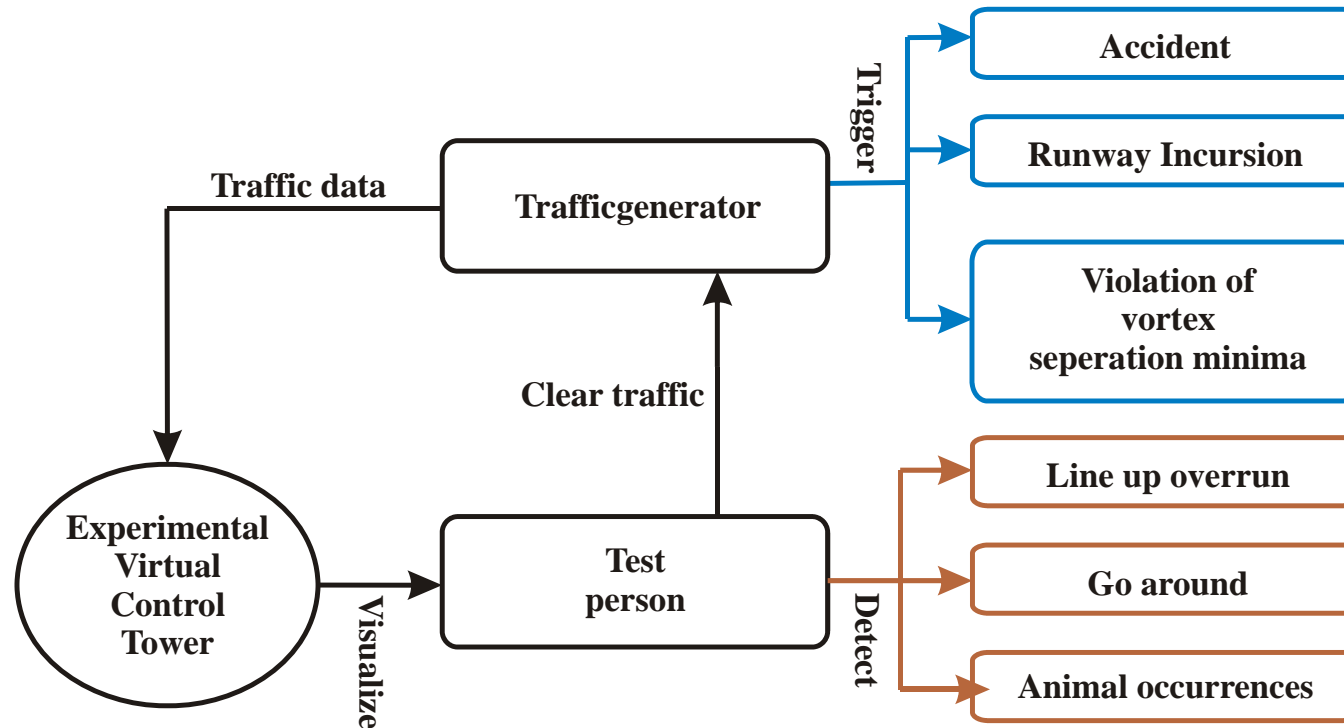


**Animal appearance**

Configuration	Point of view	Secondary Ground Surveillance
A	Panoramic	Available
B	Panoramic	Not available
C	Crossing	Available

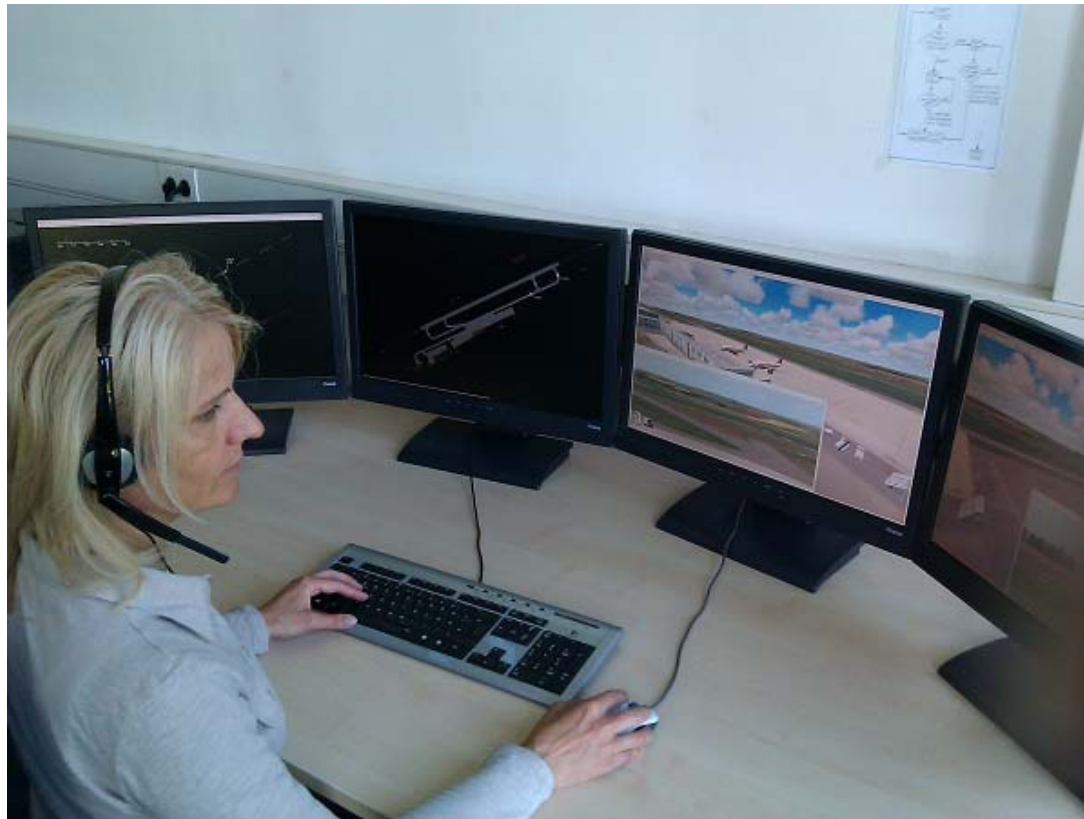
- Baseline A
- B and C each including one variation of A

- Operational scenario includes
  - Inbound traffic (automated landing clearances)
  - Outbound traffic (automated push back and taxi clearance)
  - Hazard appearances
  - Airport (single runway layout)
- Primary Task
  - Clear for lineup
  - Clear for take off
- Secondary Task
  - Detect threat events

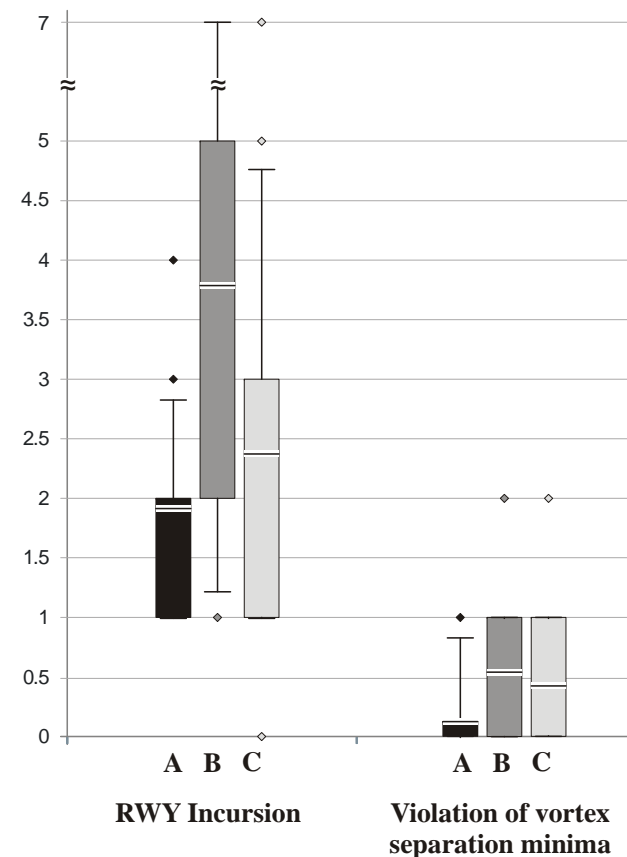


- Traffic inbound (go around): 12 (4)
- Traffic outbound (overrun): 13 (3)
- Friction test vehicles (overrun): 4 (2)
- Animal appearance: 4
- Endurance of one run: 34 minutes

- 13 test persons performed the execution
- Varying sequence of configuration A,B and C



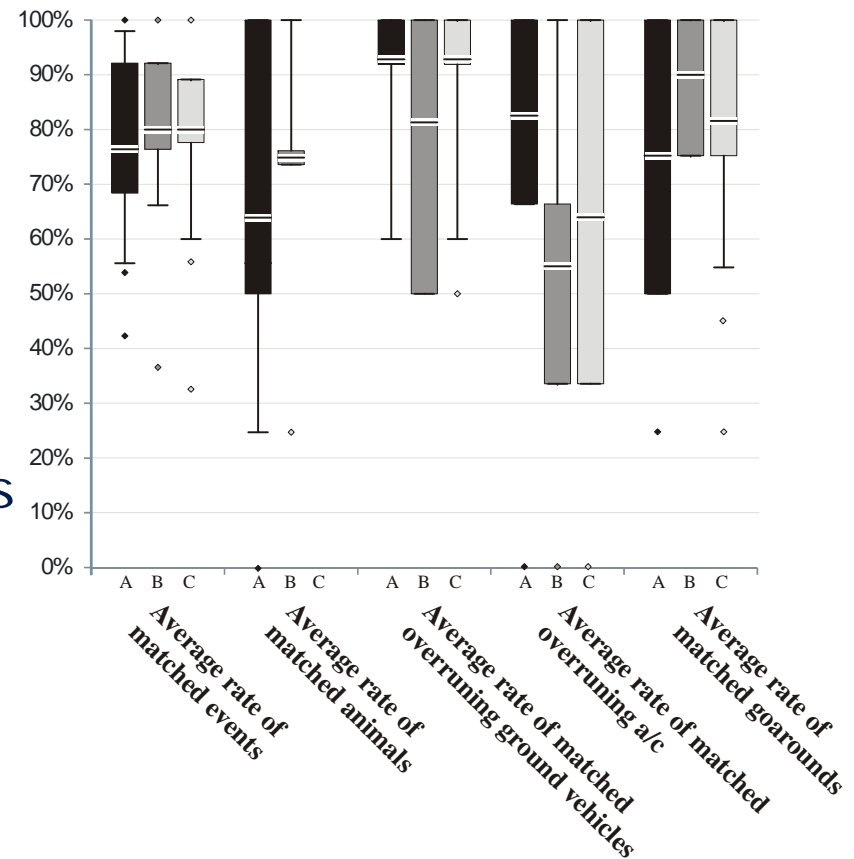
- The missing ground surveillance (B) contributes most to the frequency of RWY incursion and violation of vortex separation minima.
- The panoramic view/ground surveillance availability (A) contributes least.





- The missing ground surveillance (B) contributes most to successfully detect animals and go arrounds
- The missing ground surveillance (B) contributes most to not detect overrunning events of a/c and ground vehicles
- The crossing view (C) contributes little to the frequency to detect go around events compared to (A)

Detection rate

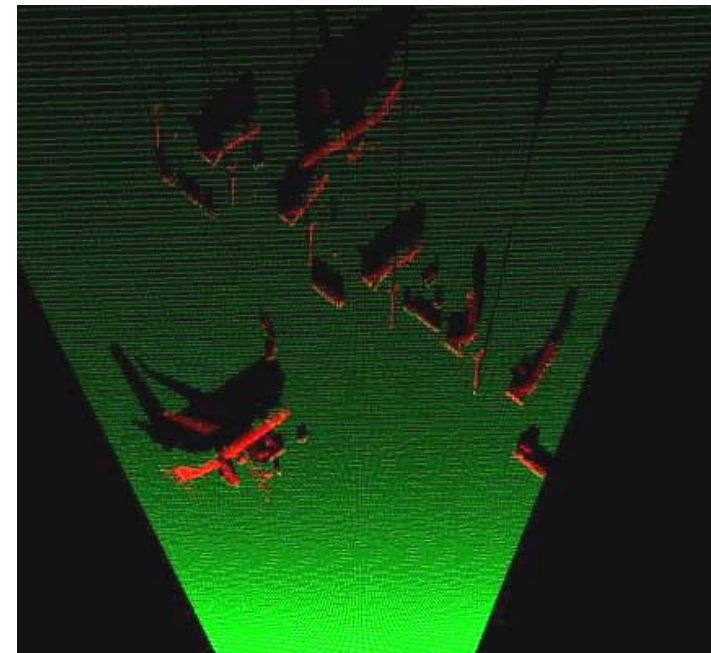


- An assessment of HMI setups has been performed that points out contributing effects on the probability of hazard occurrence.
- The assessment identifies safety relevant design parameters.
- The development of safety requirements may take into account identified safety relevant design parameters.



- Multiple Airport Control: Assess new concepts of operation
- Varying input variable: maximum number of controlled movements at a time

- LiDAR-supported detection (high contrast)
- (A) Separated views (Video + LiDAR)
- (B) Merged view Video-LiDAR



Thank you.

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