ENHANCEMENTS FOR REMOTE TOWER

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Remote tower - background

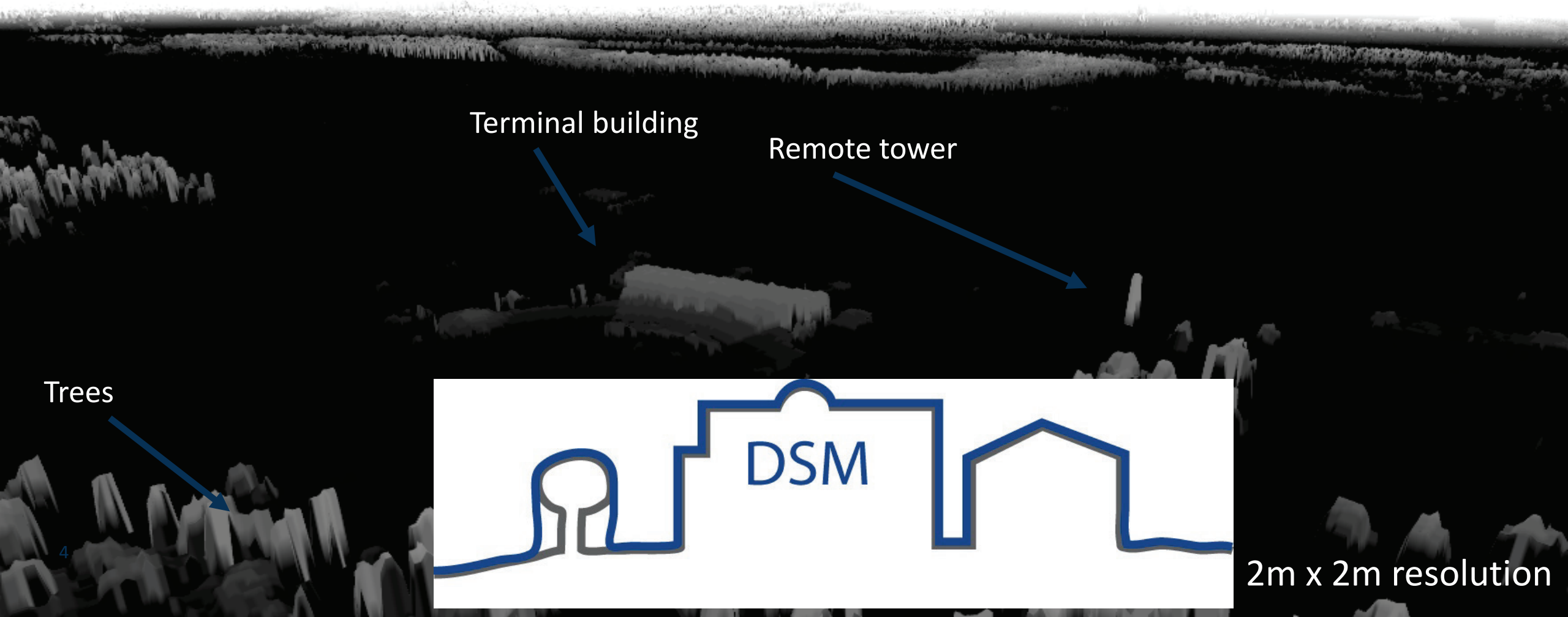
- Remote tower concept: replacing physical presence of controllers and towers with digital solutions.
- Cost of providing air traffic control (ATC) is high
- Remote tower can also support increased safety and security.
- Status:
  - "Single" RT deployed and operational since 2014.
  - SESAR 2020 PJ.05 "Remote Tower for Multiple Airports"

Our role in SESAR 2020 PJ.05

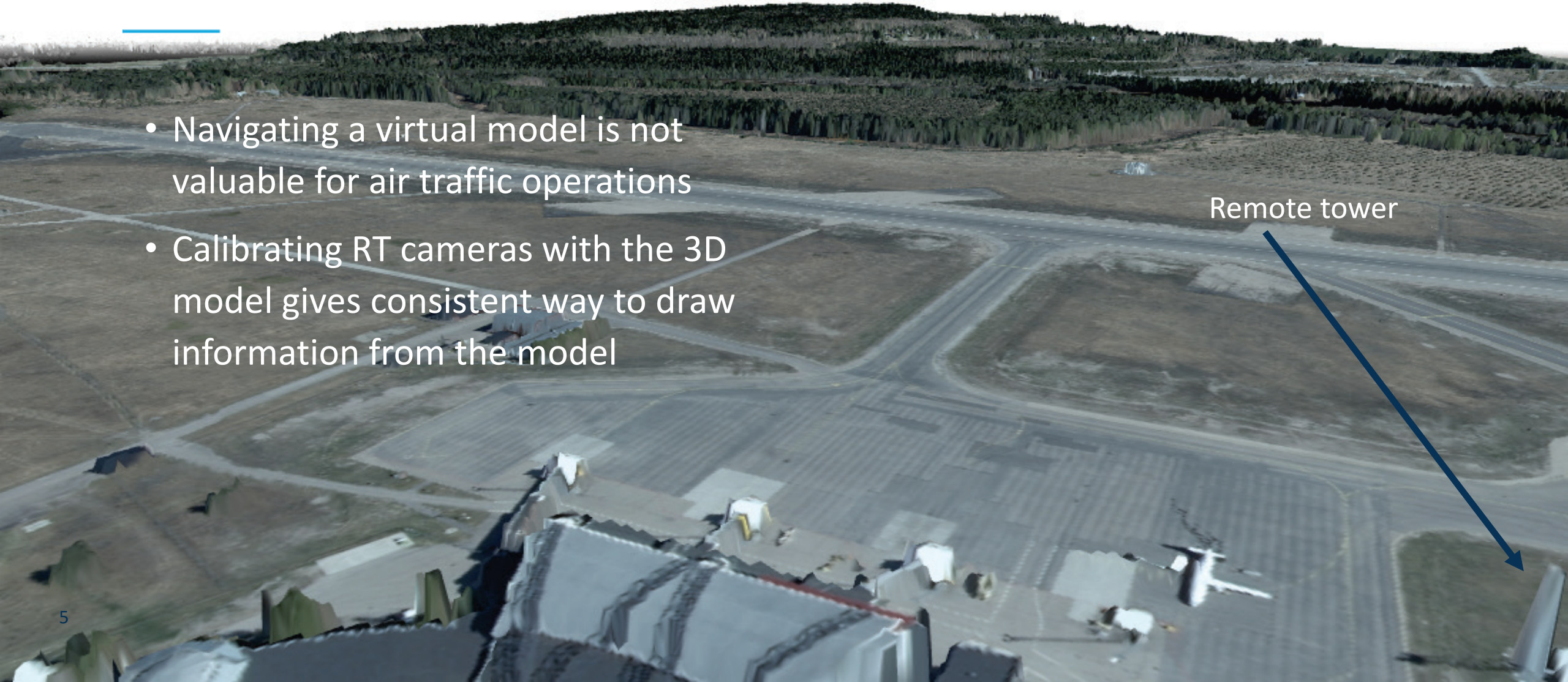
- Enhancements to remote tower based on 3D modelling
- Machine learning for tracking surface movements

3D elevation data

- Hi-res data purchased from Metria AB
- Low-res data is available from "ALOS World 3D – 30m (AW3D30) ©JAXA" provided by JAXA



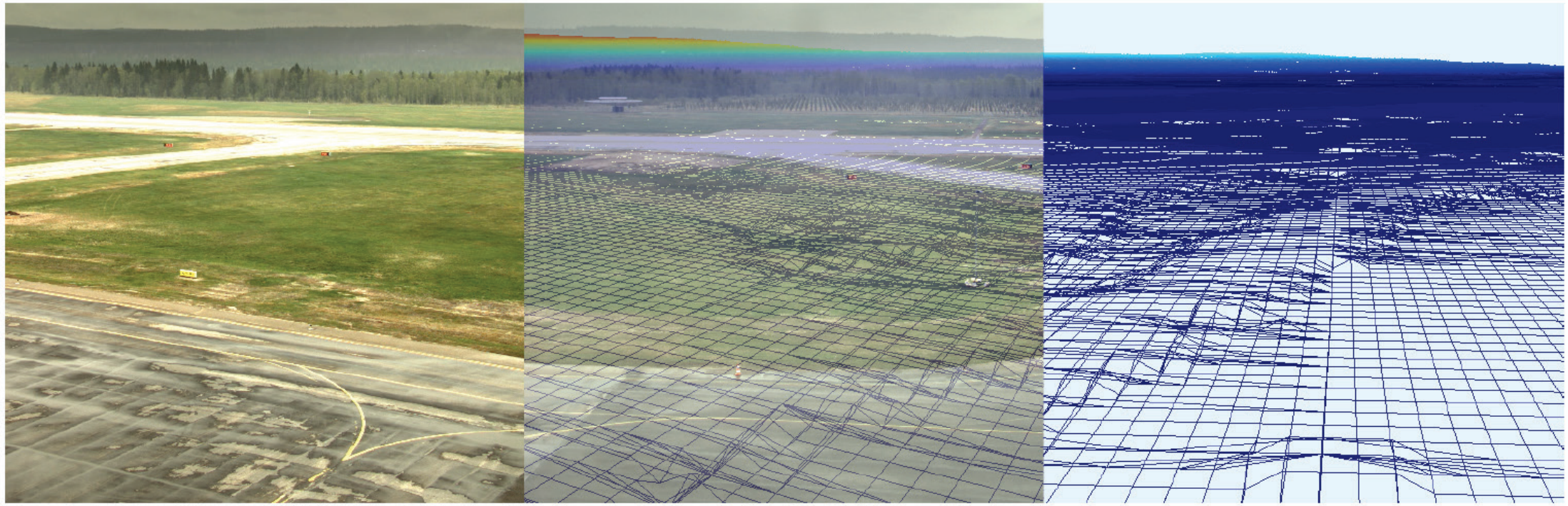
How to make use of 3D model in RT



- Navigating a virtual model is not valuable for air traffic operations
- Calibrating RT cameras with the 3D model gives consistent way to draw information from the model

Calibrating 3D with OTW view

3D model view with calibrated virtual cameras



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Camera calibration

- Interactive application for manoeuvring the 3D model and specifying known parameters in a GUI to best align with the video.

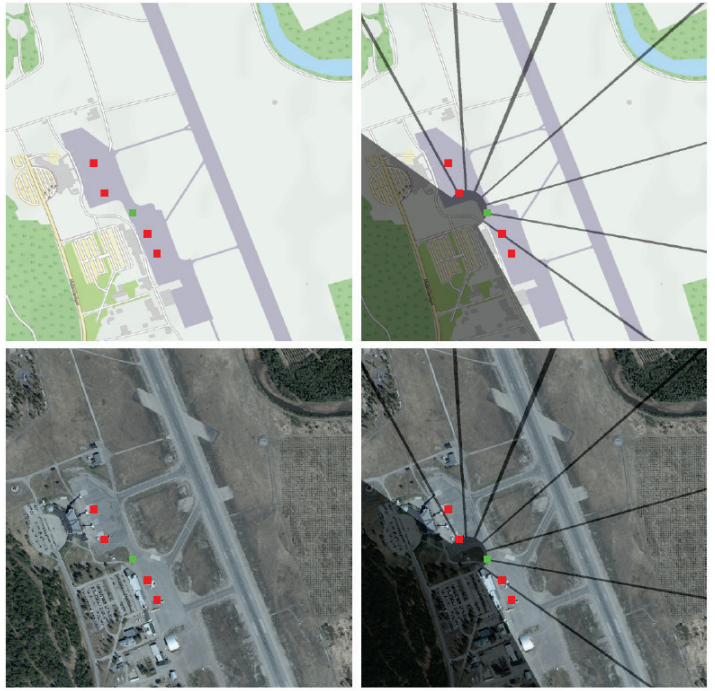
Known parameters	Unknown parameters
Position Aspect ratio "Up" vector	Direction Field of view

Three main applications

- **Distance picking** – for any two points on the visible terrain compute an accurate distance between the points.
- **Map integration** – for any mouse position in the visible terrain, show the corresponding position in a map view.
- **Surface movement tracking** – use 2D tracking of pixel movements/objects in the video to determine the 3D position of those objects.

Demonstration

- Depth values for providing a sense of depth
- Global coordinates for positioning events
- Integrated map view with active camera overlays



VIDEO EXPOSURE CORRECTION

Video Exposure Correction

- Performed every frame operating on three separate colour channels
- Image is split into horizontal bands for improved performance
- Correction functions are determined by comparing narrow bands of pixels along the adjacent edges
- Allowing a correction for half of the image, decreasing from the edge to the middle
- Moving objects pose a challenge

Video Exposure Correction

TRACKING

Detection, classification, localization & tracking

Detection: There is an object in this image

Classification: The object is an aircraft

Localization: It is inside this bounding box

Tracking: It is an instance of aircraft #1

Attention mechanisms: where to look?

On start-up (expensive)

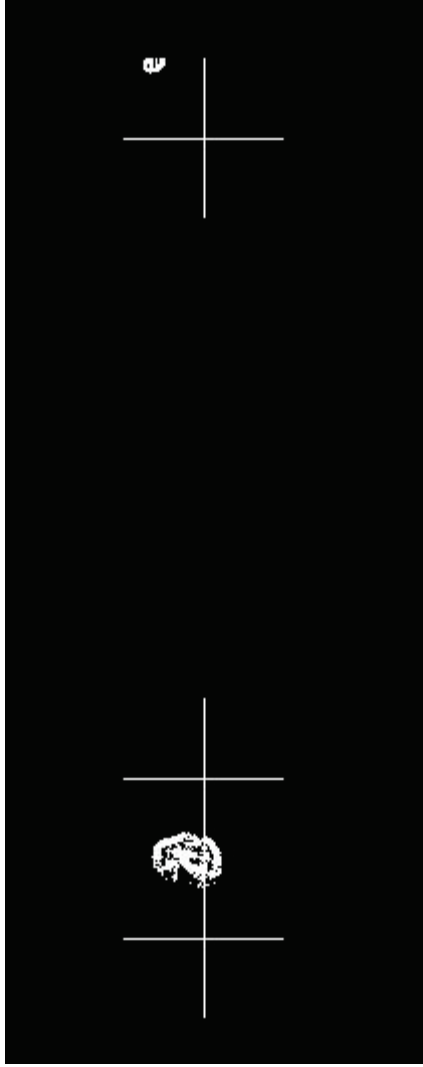
- Run detection on all the cameras, using sliding windows of various sizes.

On each frame (cheap)

- *What has changed?*
  Pixelwise difference between consecutive frames + thresholding.
- *Where can we expect an object?*
  Use previous predictions to decide where you expect an object to be.

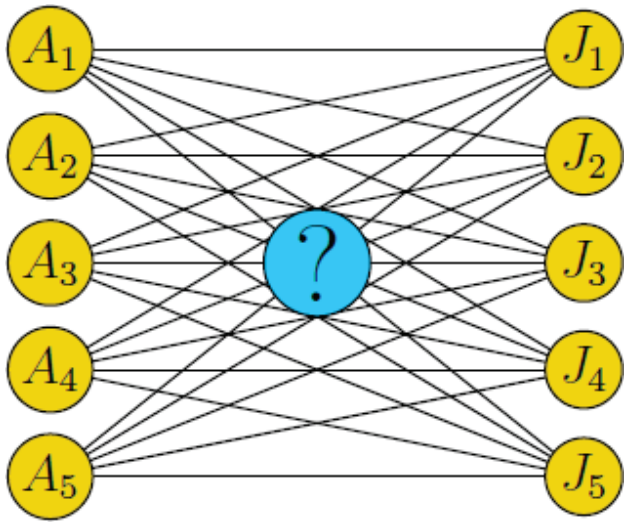
Challenges

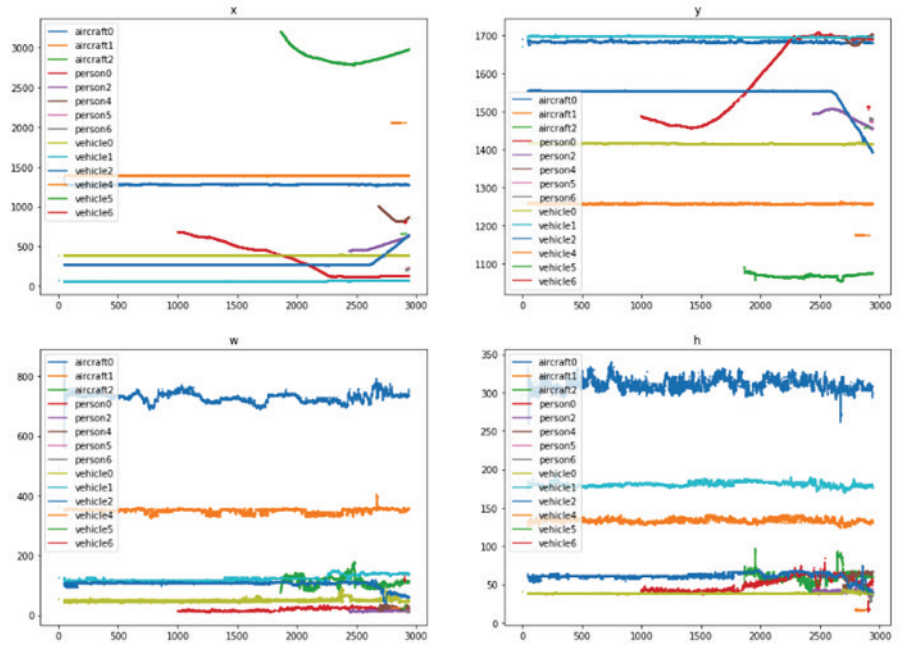
- Video compression artifacts can cause changes everywhere.
- Tolerances need to be chosen carefully.



Tracking = …

- … connecting the dots.
- Mathematically solving an assignment problem





- Hard part: machines lack common sense stabilisation of the consolidated predictions!

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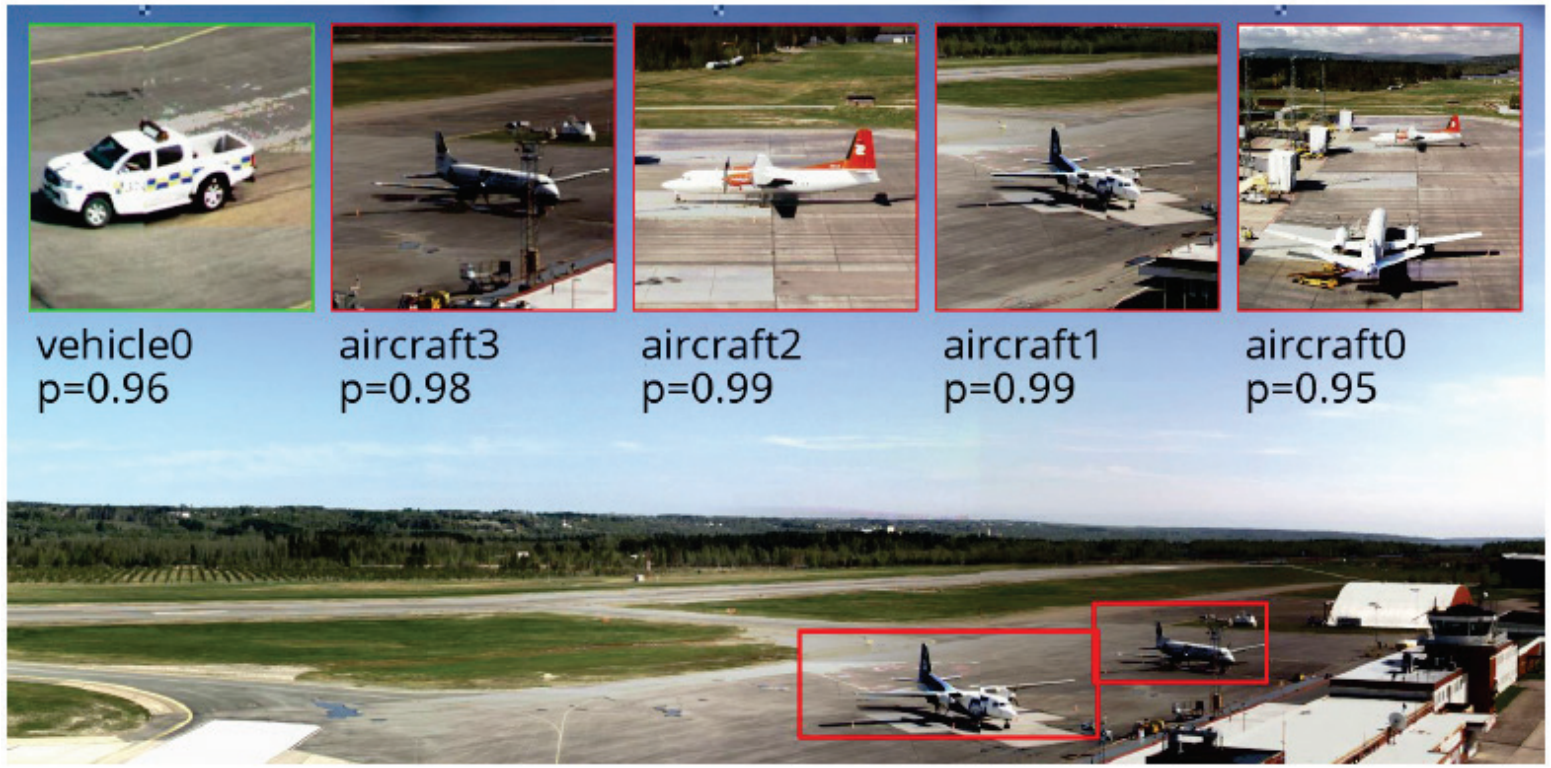
Demonstration: 3D integrated tracking



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