

WP4: Control and navigation of a single PAV

Vision-based navigation in GPS restricted environments

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<http://www.mycopter.eu>

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Navigation of PAVs in GPS Restricted Environments

- Control and automation for PAVs relies on accurate state information
- Cameras are used as main sensors
 - Localization of the PAV
→ control
→ support for untrained pilot
- Modeling of the environment
→ collision prevention

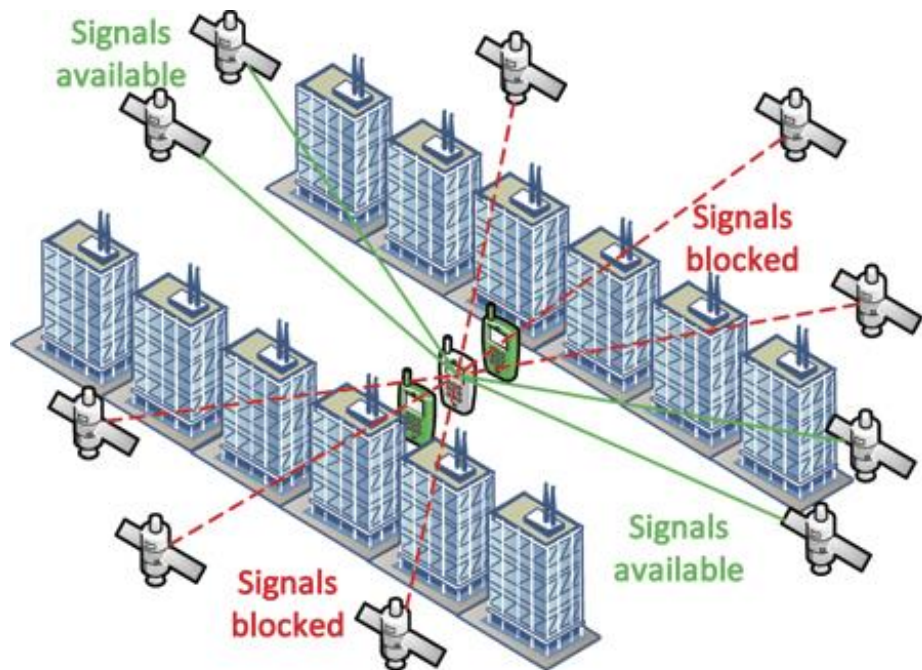


illustration: www.gpsworld.com

Unmanned Aerial Vehicles (UAVs) and PAVs

- Multi-rotor helicopters
- All rotors aligned in a plane
- Rotor axes perpendicular to that plane
- Take off weight ≈ 1.5 kg



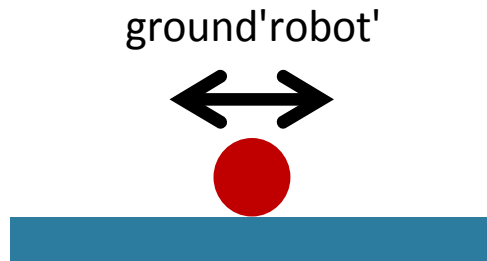
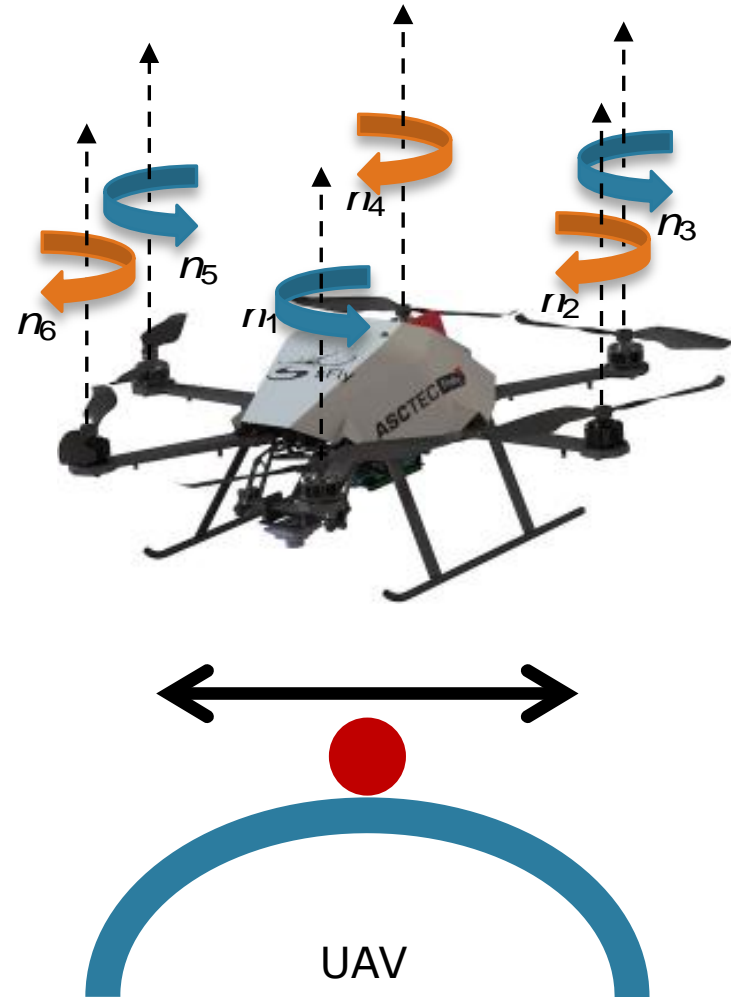
Illustration: Gareth Padfield



Image: e-volo GmbH

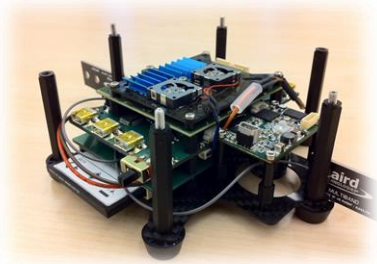
Challenges for UAVs

- Degrees of freedom
- Coupled and fast dynamics
- Constant motion and inherent instability

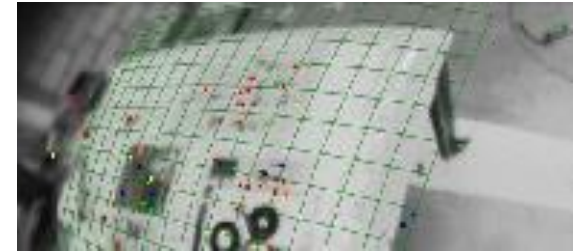


- → “Cannot simply stop”

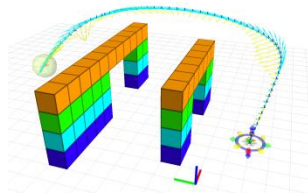
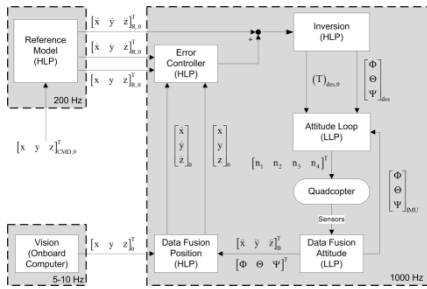
What do we Need for Autonomous UAVs ?



Processing Hardware



Localization

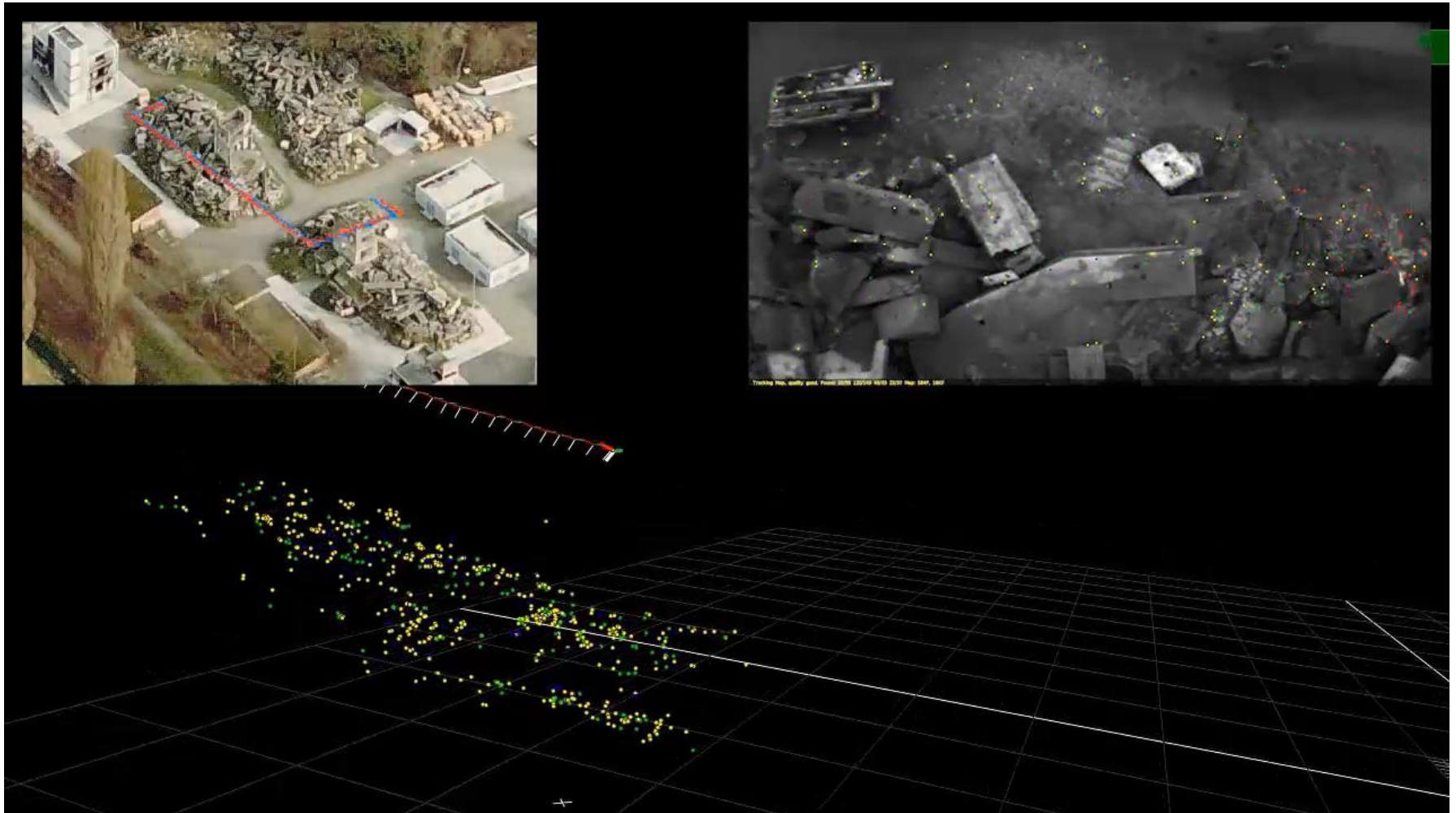


Control / Planning / Obstacle Avoidance

$$\begin{pmatrix} \dot{p} \\ \dot{v} \\ \dot{b} \end{pmatrix}_O = \begin{bmatrix} 0 & I & 0 \\ 0 & 0 & R_{OB} \\ 0 & 0 & 0 \end{bmatrix} \begin{pmatrix} p \\ v \\ b \end{pmatrix}_O + \begin{bmatrix} L_p \\ L_v \\ R_{BO} \cdot L_b \end{bmatrix} \cdot ((p)_O - (\hat{p})_O) + \begin{bmatrix} 0 \\ R_{OB} \\ 0 \end{bmatrix} \cdot (a)_B$$

State Estimation /
Data Fusion

Computer-Vision Based Localization



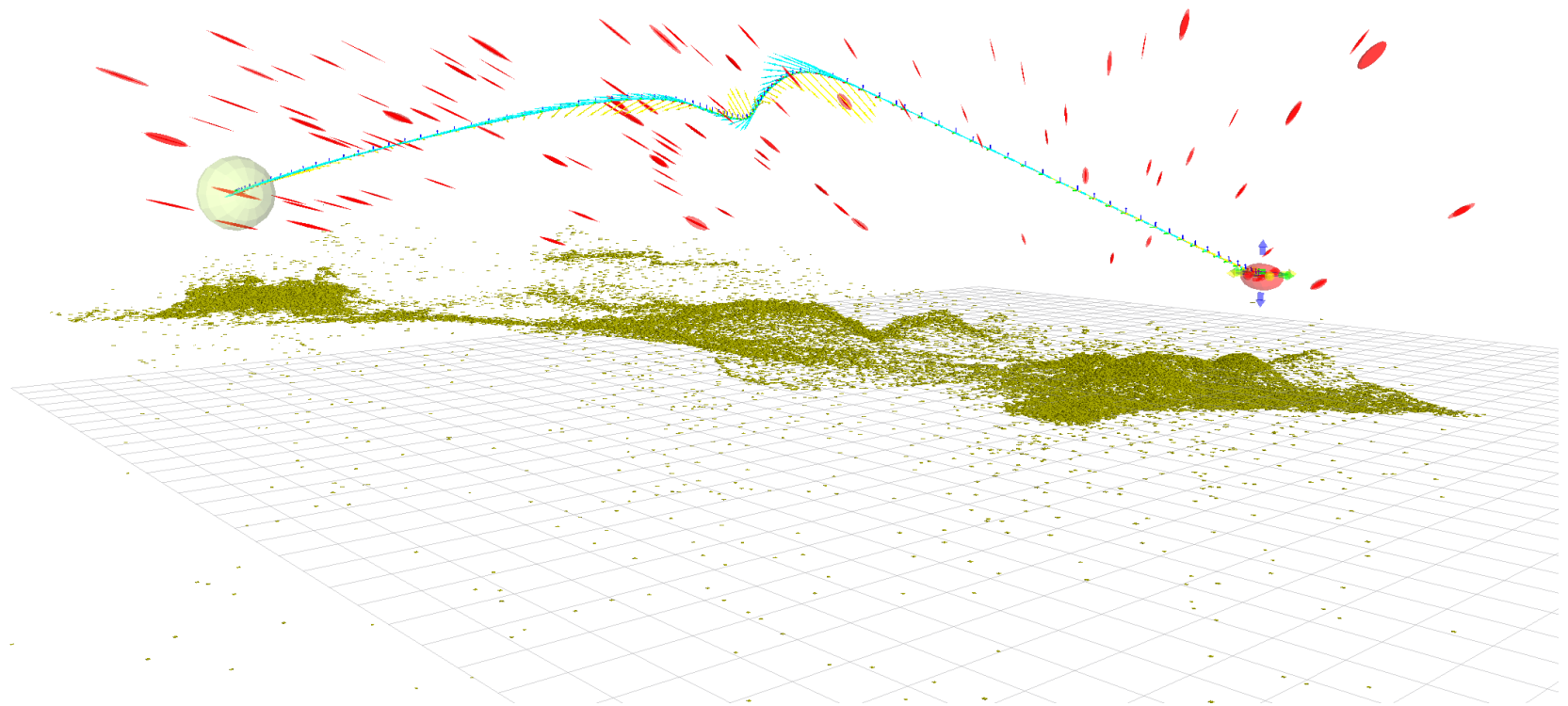
Robustness to Disturbances



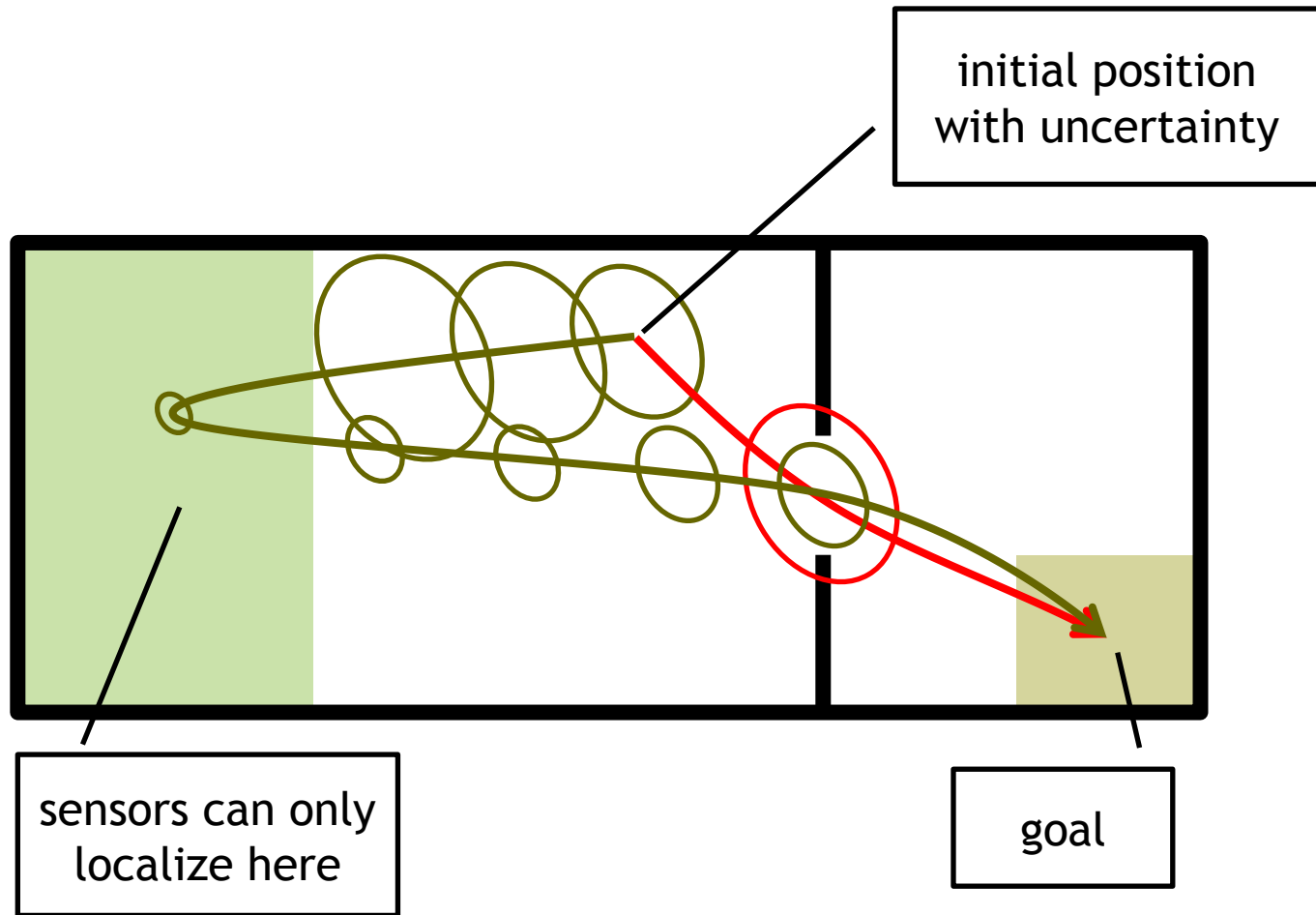
Take-off and Landing Scenarios



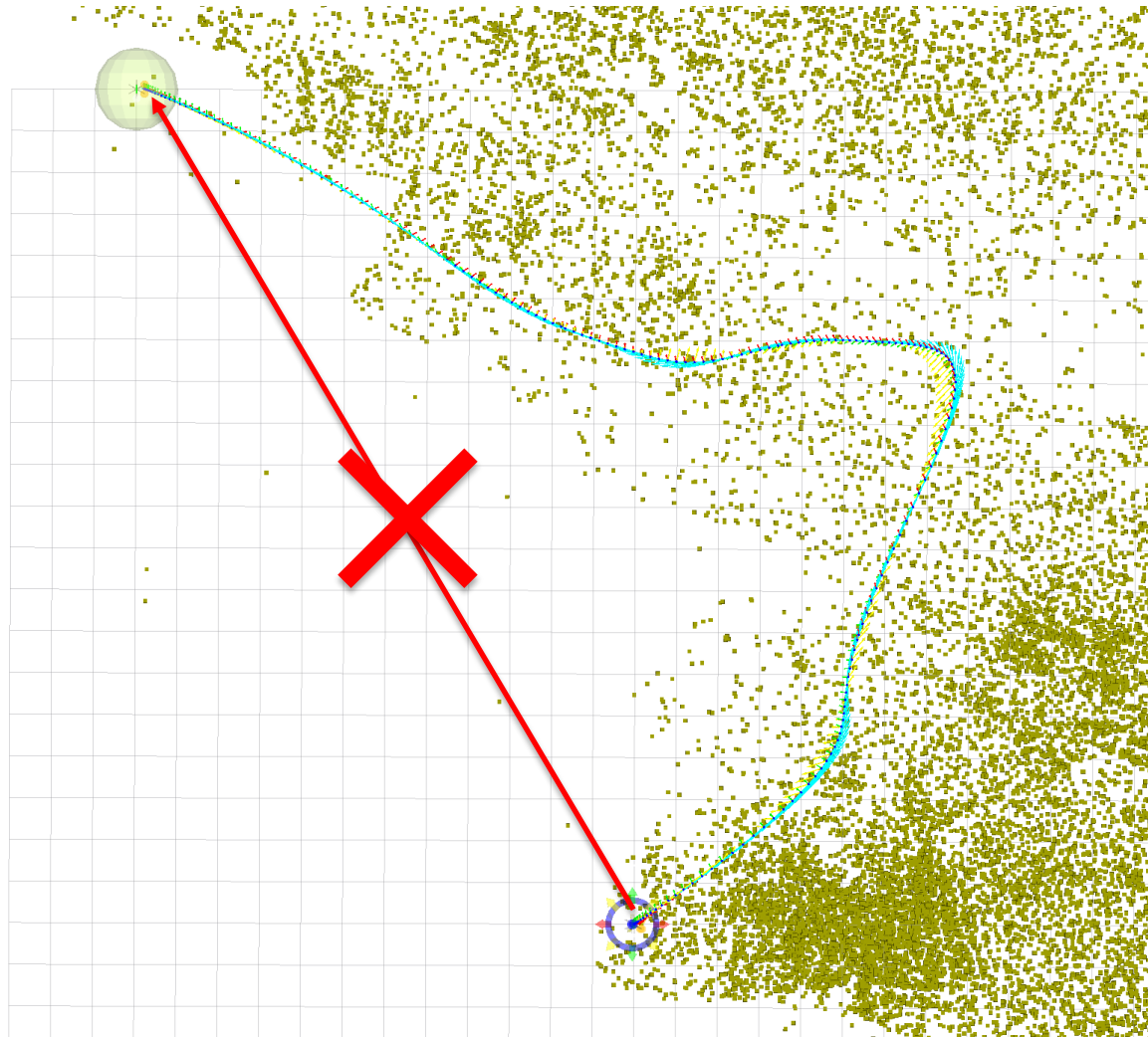
Motion and Uncertainty Aware Path Planning



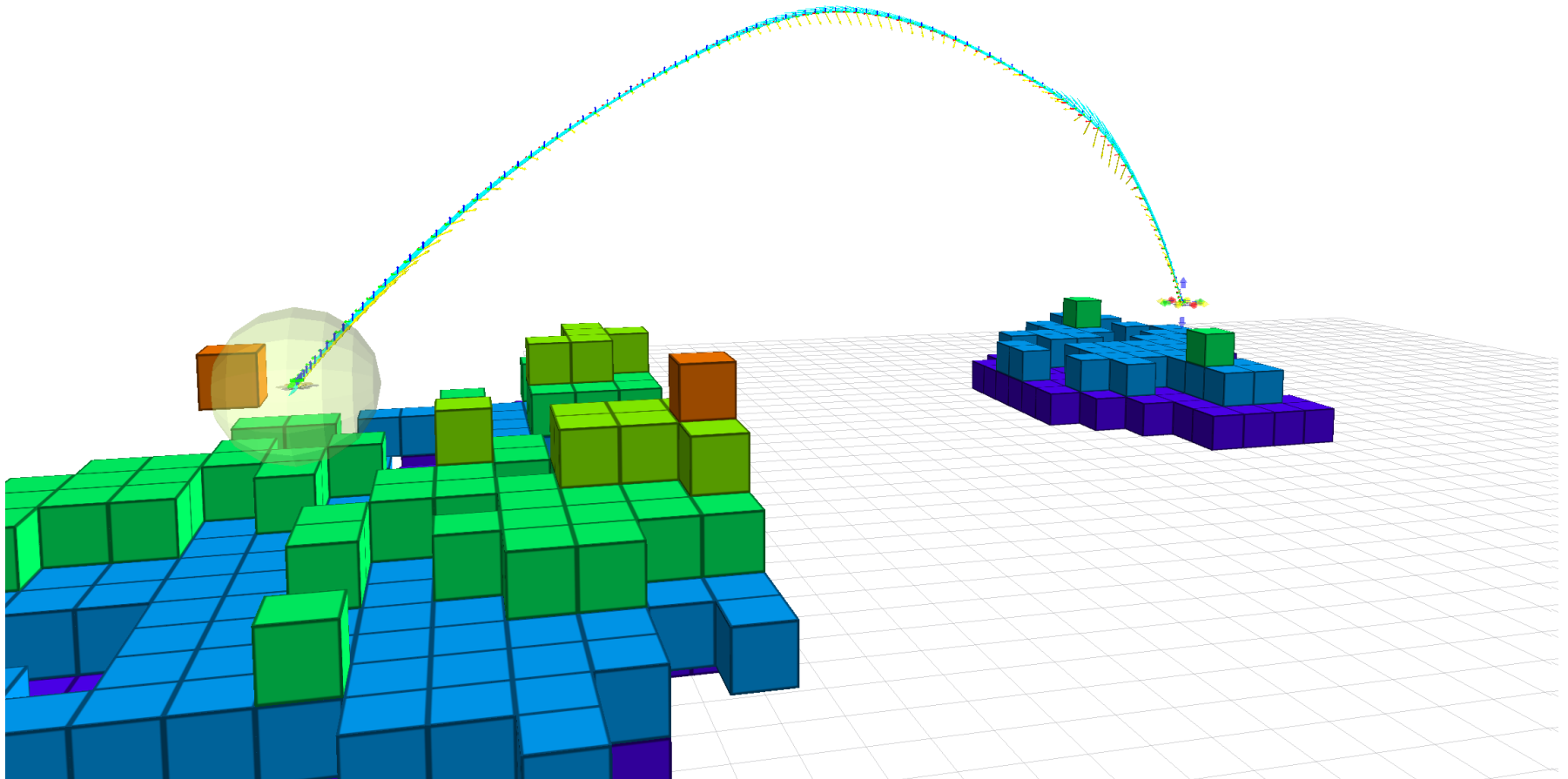
Path Planning, Including Localization Uncertainty



Uncertainty Aware Path Planning

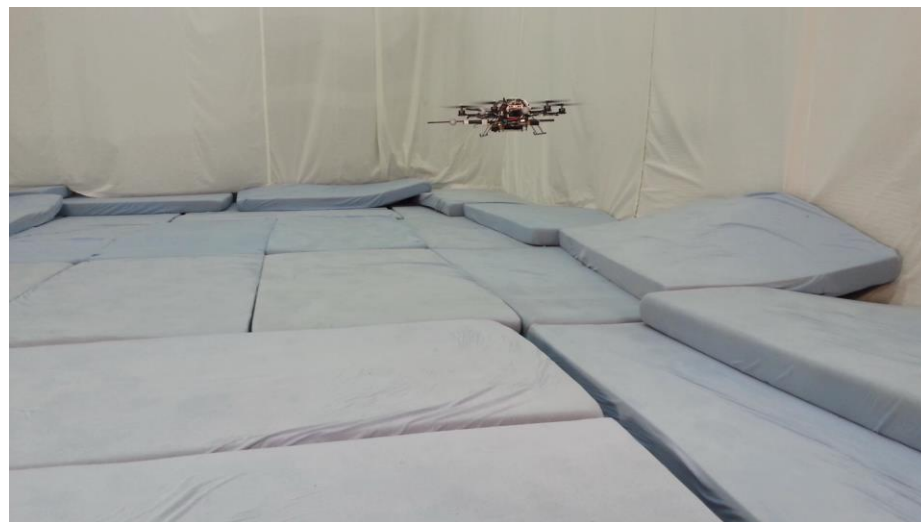


Uncertainty Aware Path Planning



Conclusions

- Efficient position and trajectory control.
- Robust vision based localization
- Modular multi-sensor fusion framework.
- Path planning framework, planning safe paths that provide sufficient motion.



Thank you for your attention!

- Live UAV Demo this afternoon

