BEIHANG UNIVERSITY

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Indoor Localization for Quadrotors using Invisible Projected Tags

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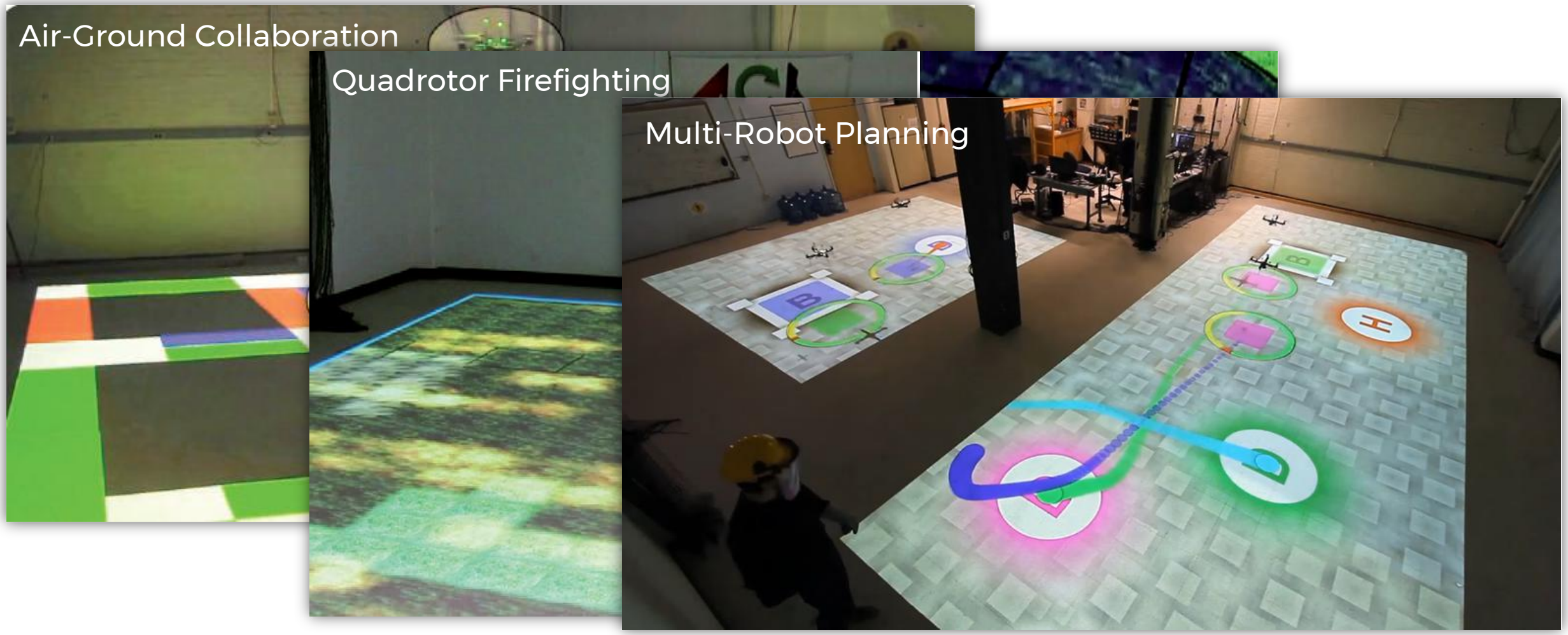
Augmented Reality (AR) + Robotics



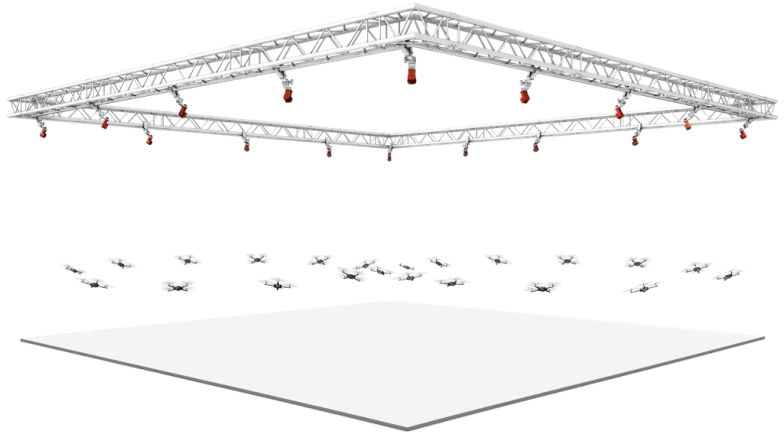
- Omidshafiei, Shayegan, et al. *Control Systems Magazine, 2016*.

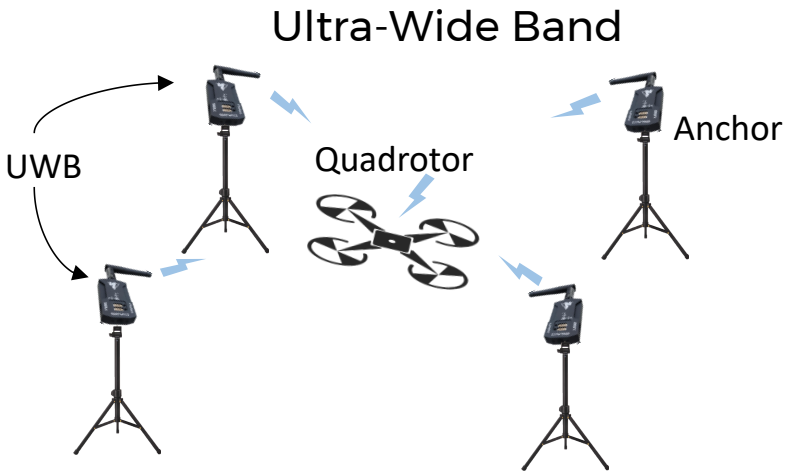
Challenges for Indoor Localization

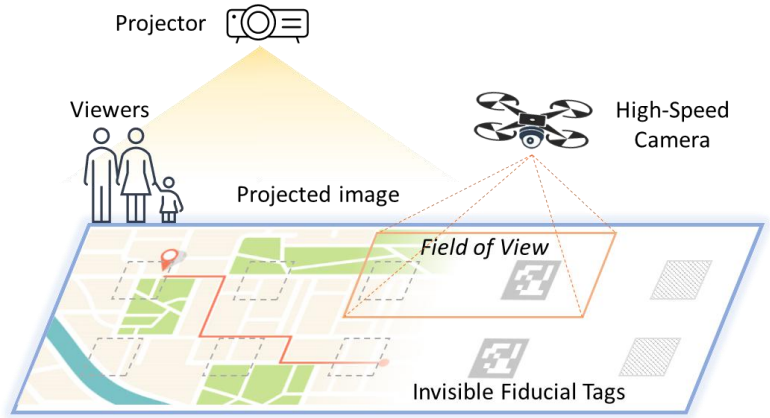
	OptiTrack	UWB	IPT
Price[1]	CNY 190,000	CNY 35,000	**CNY 30,000**
Position Accuracy	sub-mm level	cm level	cm level
Orientation Info	YES	NO	**YES**
Anti-Interference	YES	NO	**YES**
No Calibration	NO	NO	**YES**

Goal

- **Indoor localization**
- Low-cost
- Centimeter-level
- Orientation info
- Real-time
- No coordinates alignment



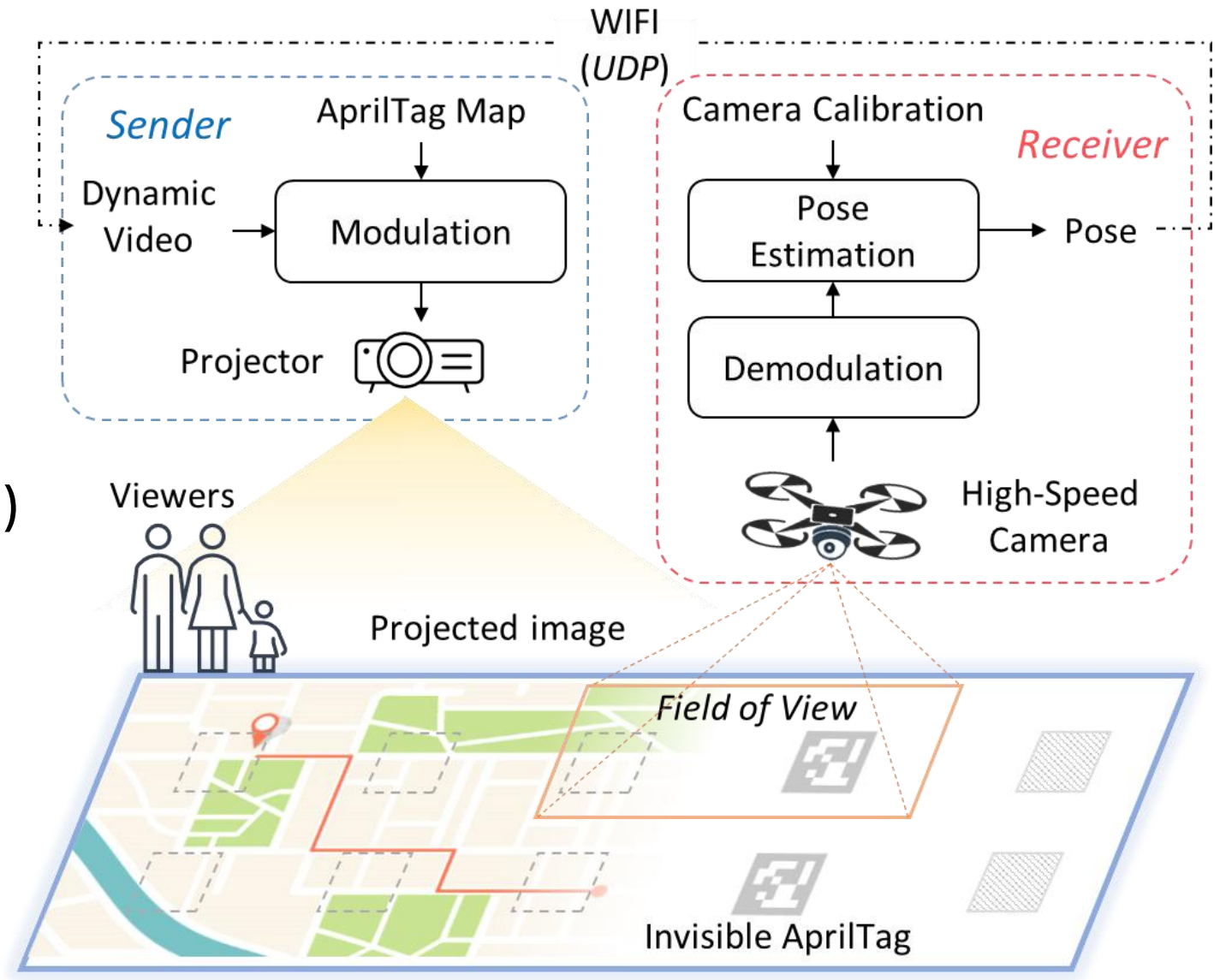




[1]This price consists of devices for both localization and visualization but no personal computers and robots.

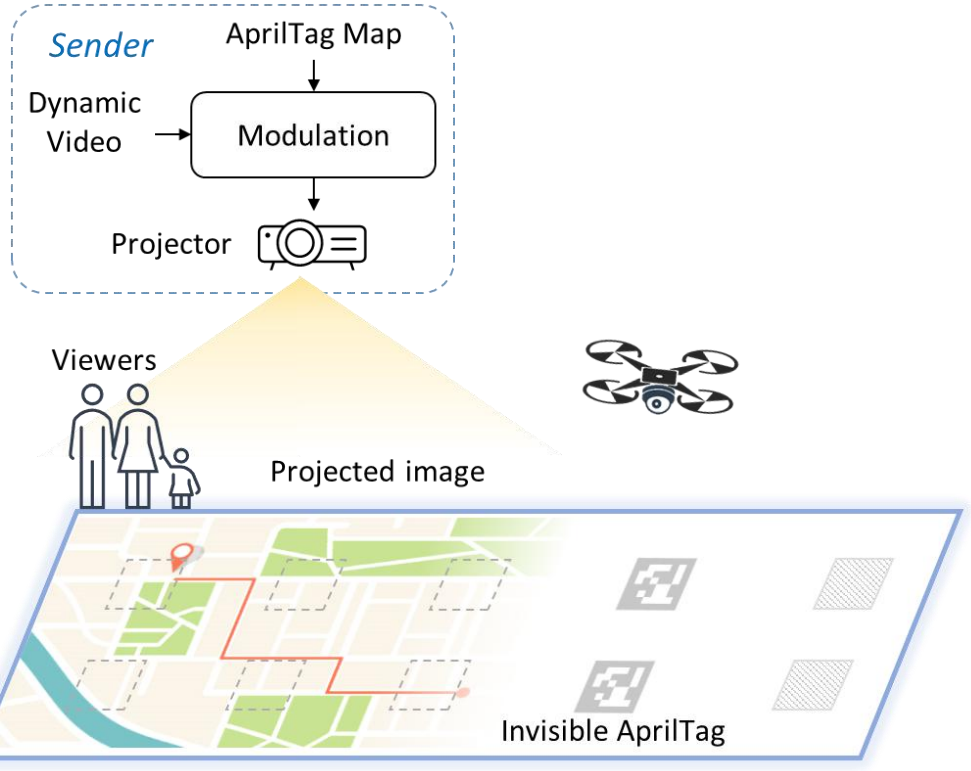
IPT

(Invisible Projected fiducial Tag)



Method - Sender

Flicker-Fusion Property



AprilTag 36h11 series

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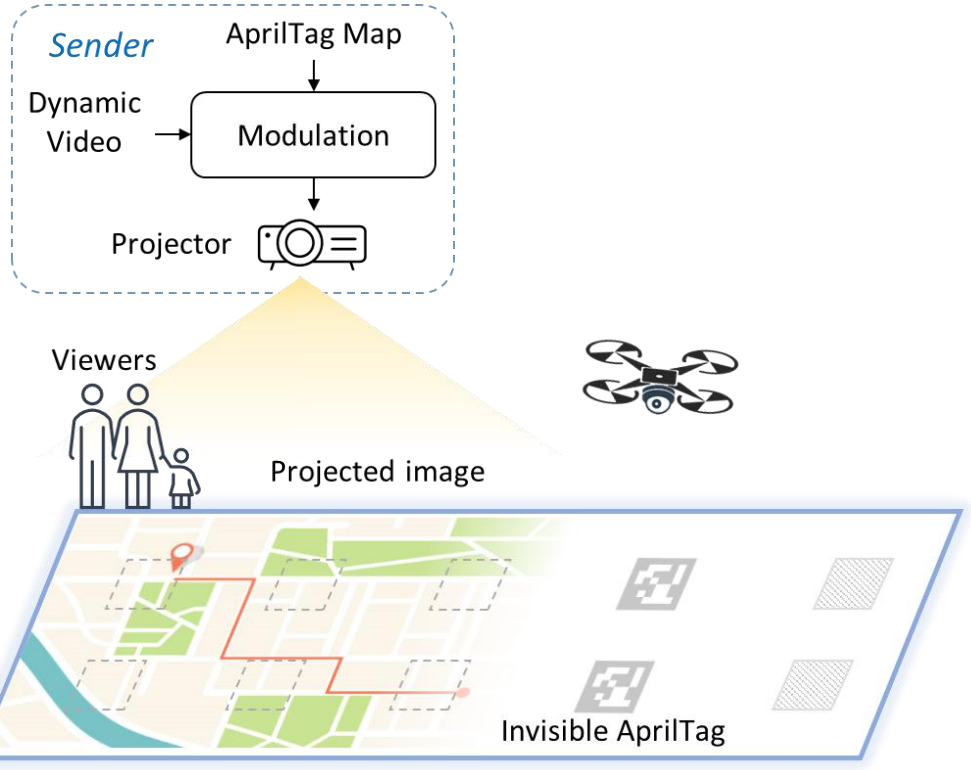
Method - Sender

Flicker-Fusion Property



AprilTag 36h11 series

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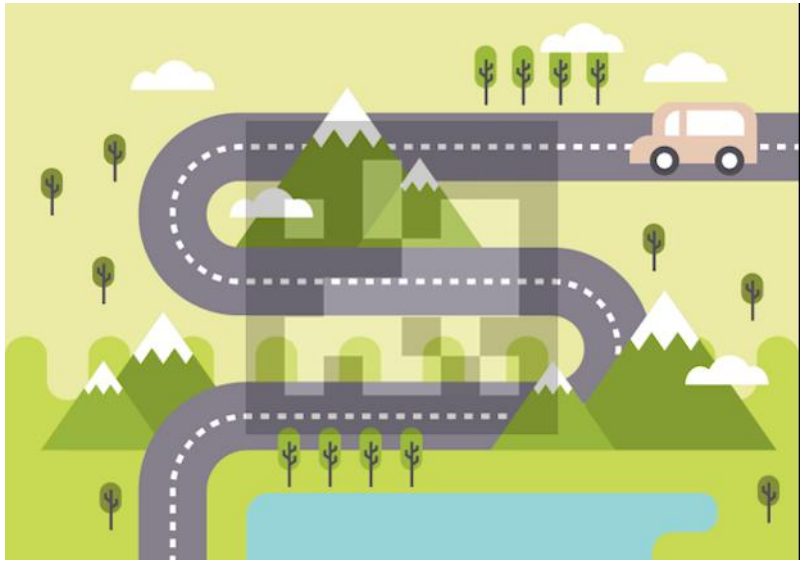
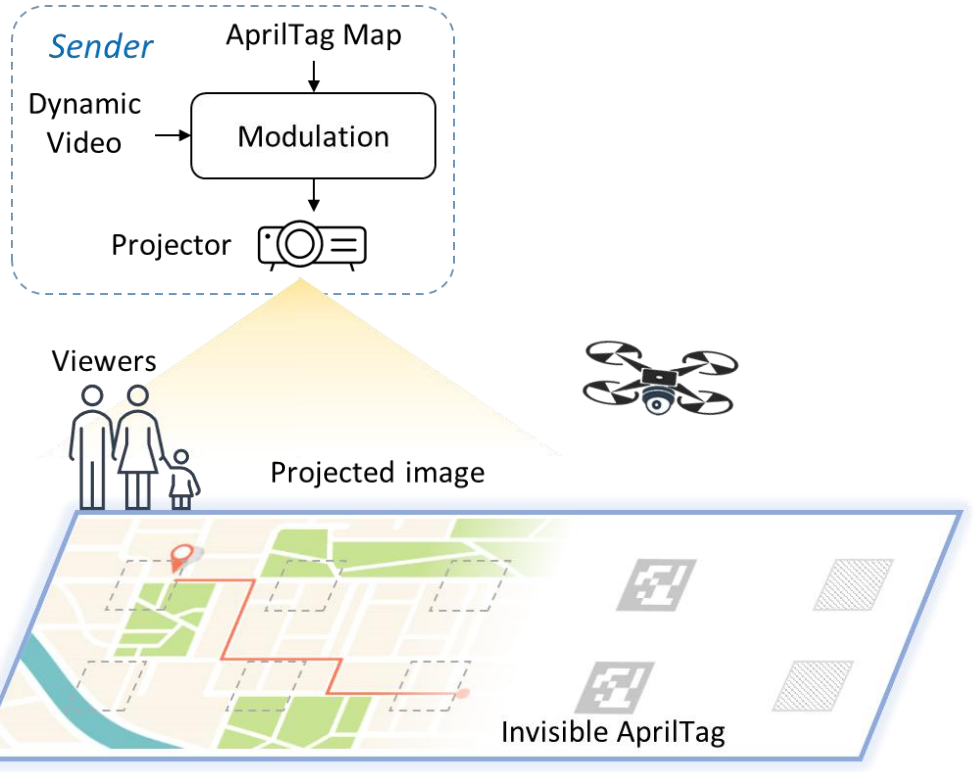


Method - Sender

Flicker-Fusion Property



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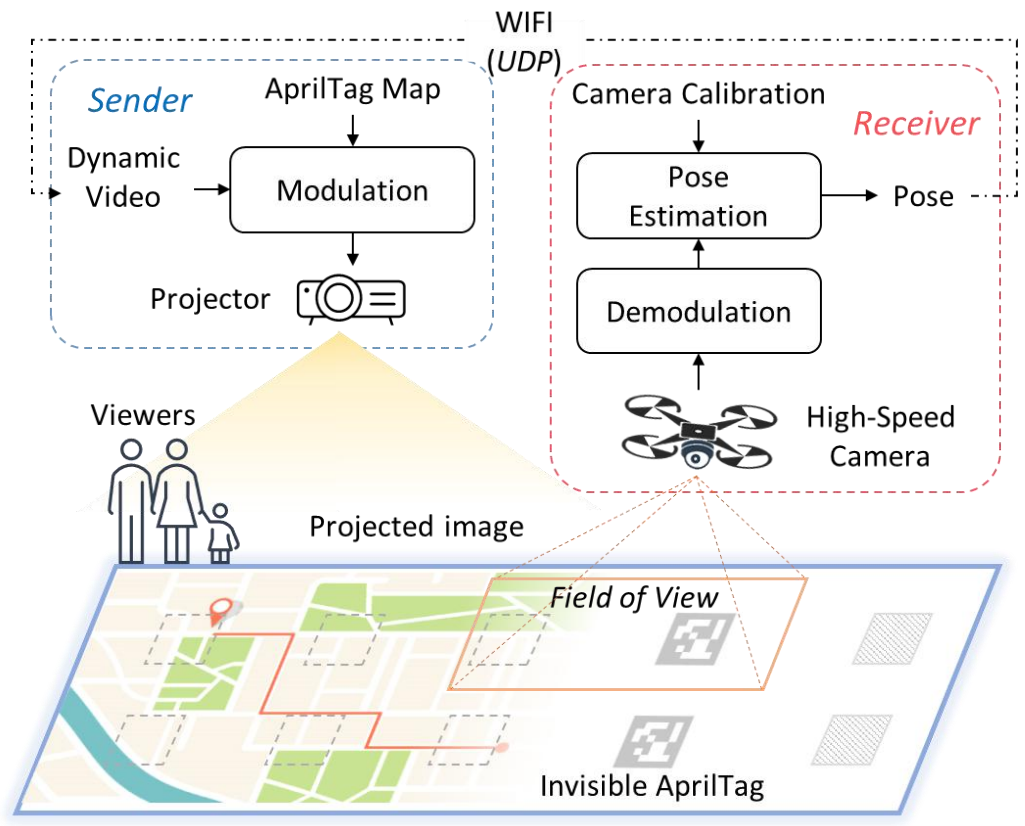
Method - Receiver

Demodulation Process



Two successive frames

Subtract in lightness channel

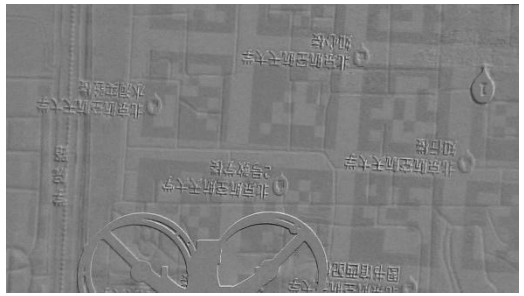
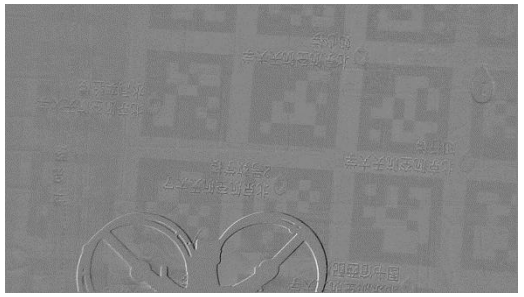
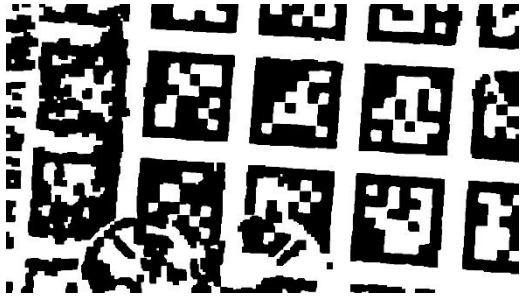


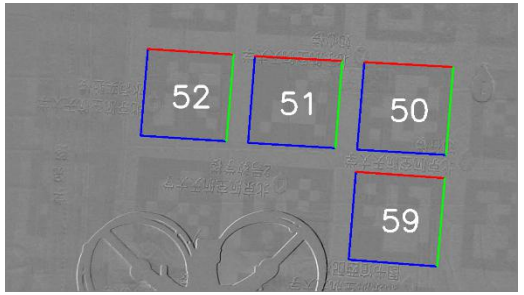
Image alignment



Preprocessing



Tag detection

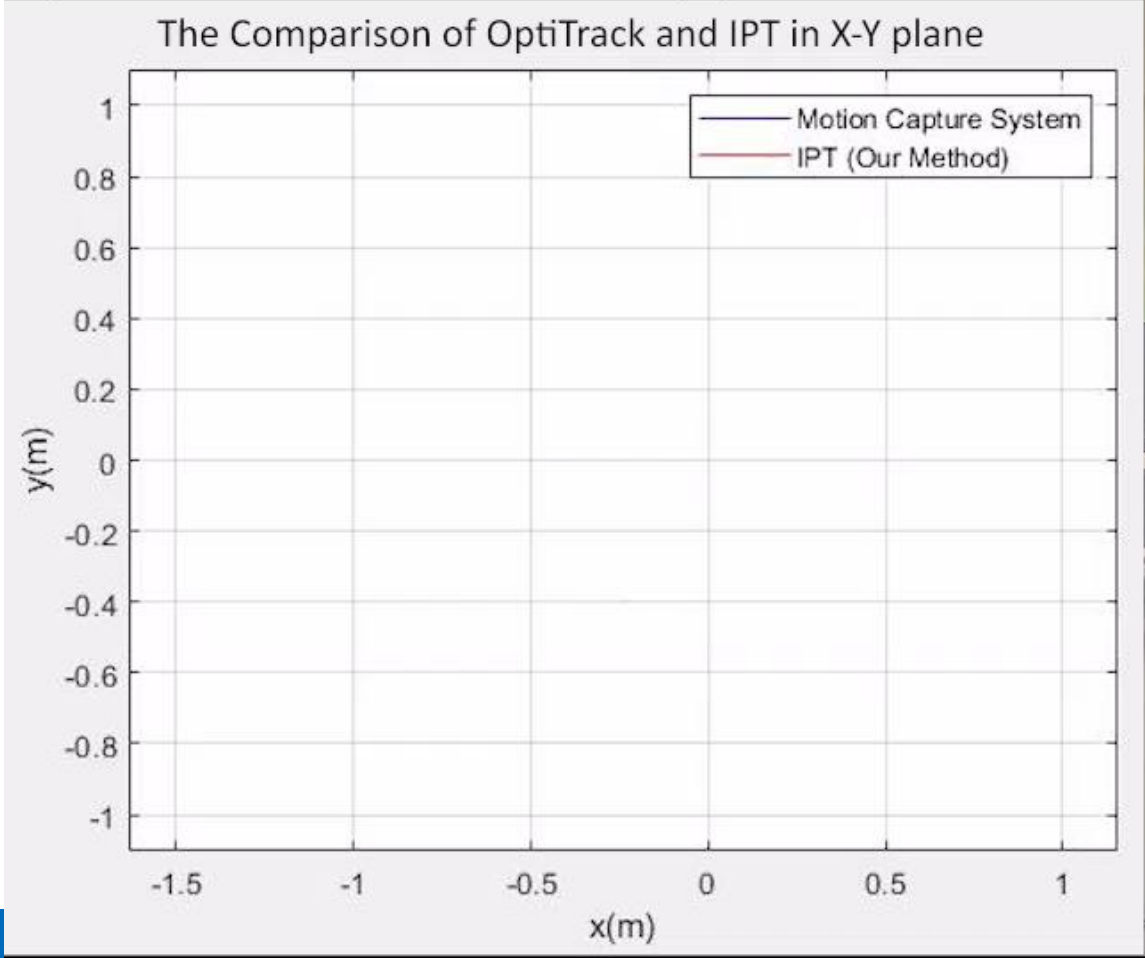


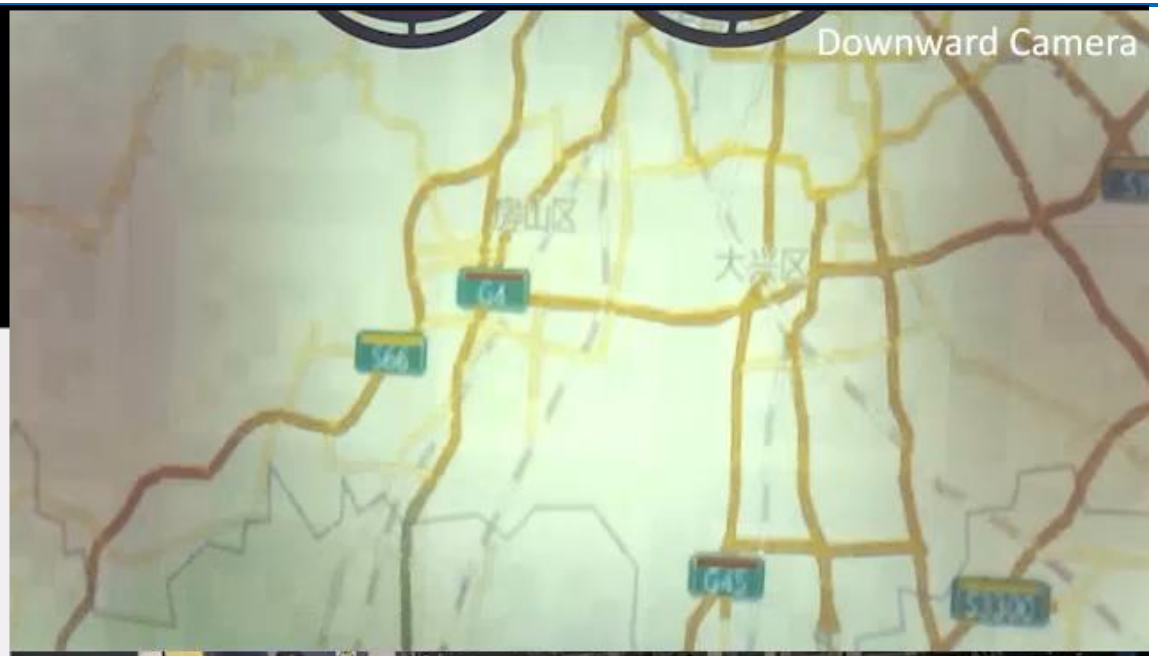
Pose Estimation

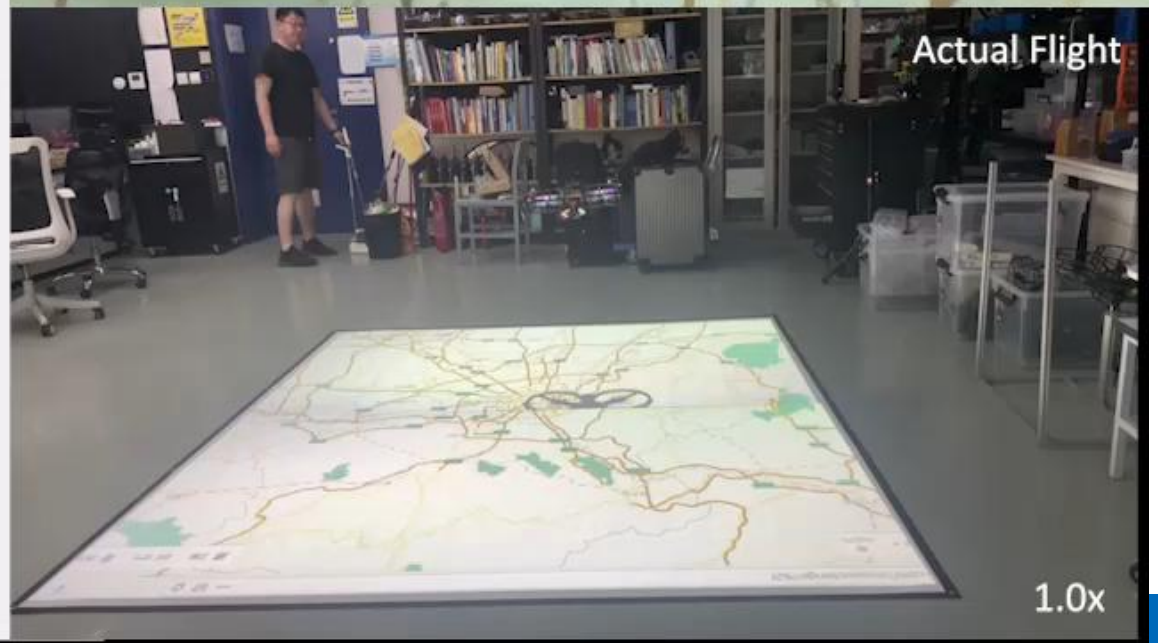
Experiments

Accuracy experiment:

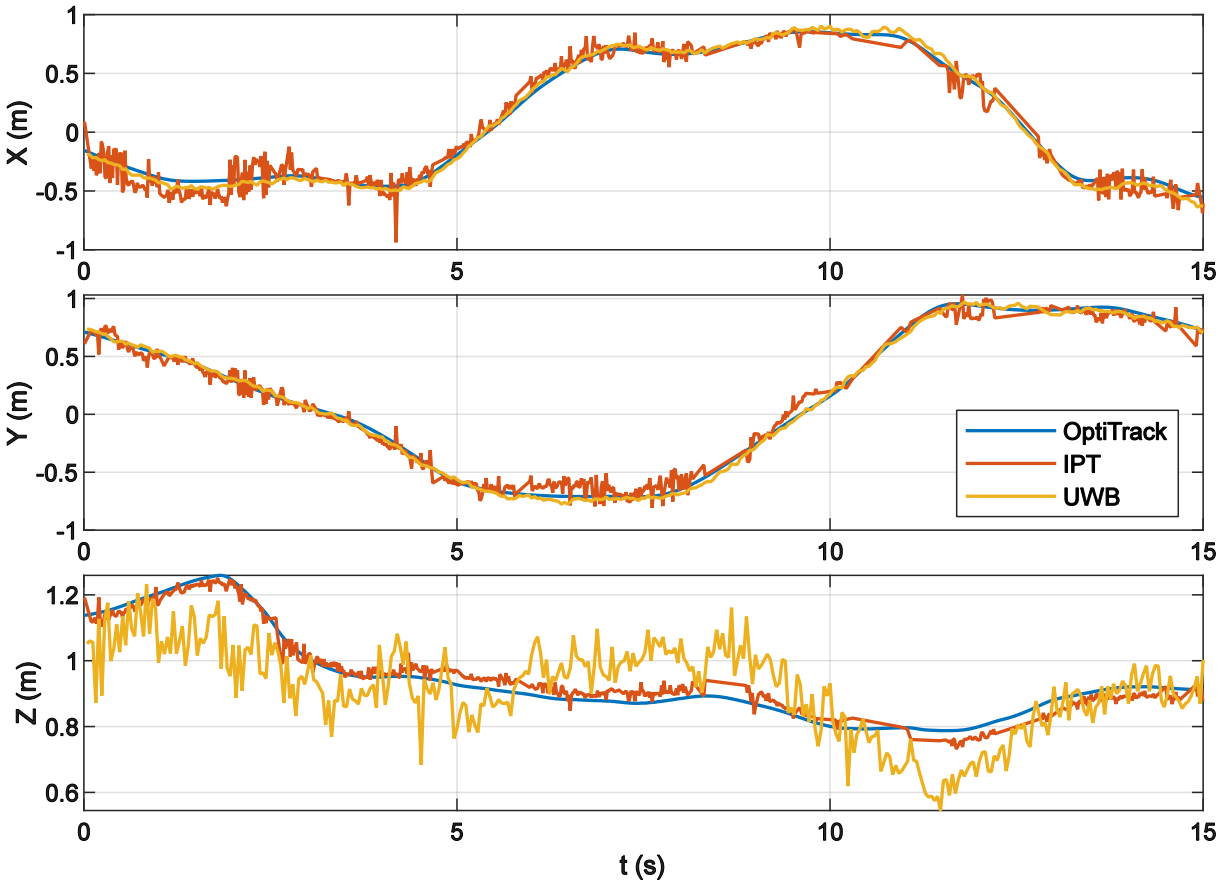
*Note that this result comes directly from OpenCV function SolvePnP(). The final result can be obtained after inversely coordinate transformation, which is significantly affected by orientation measurements. Read paper for details.



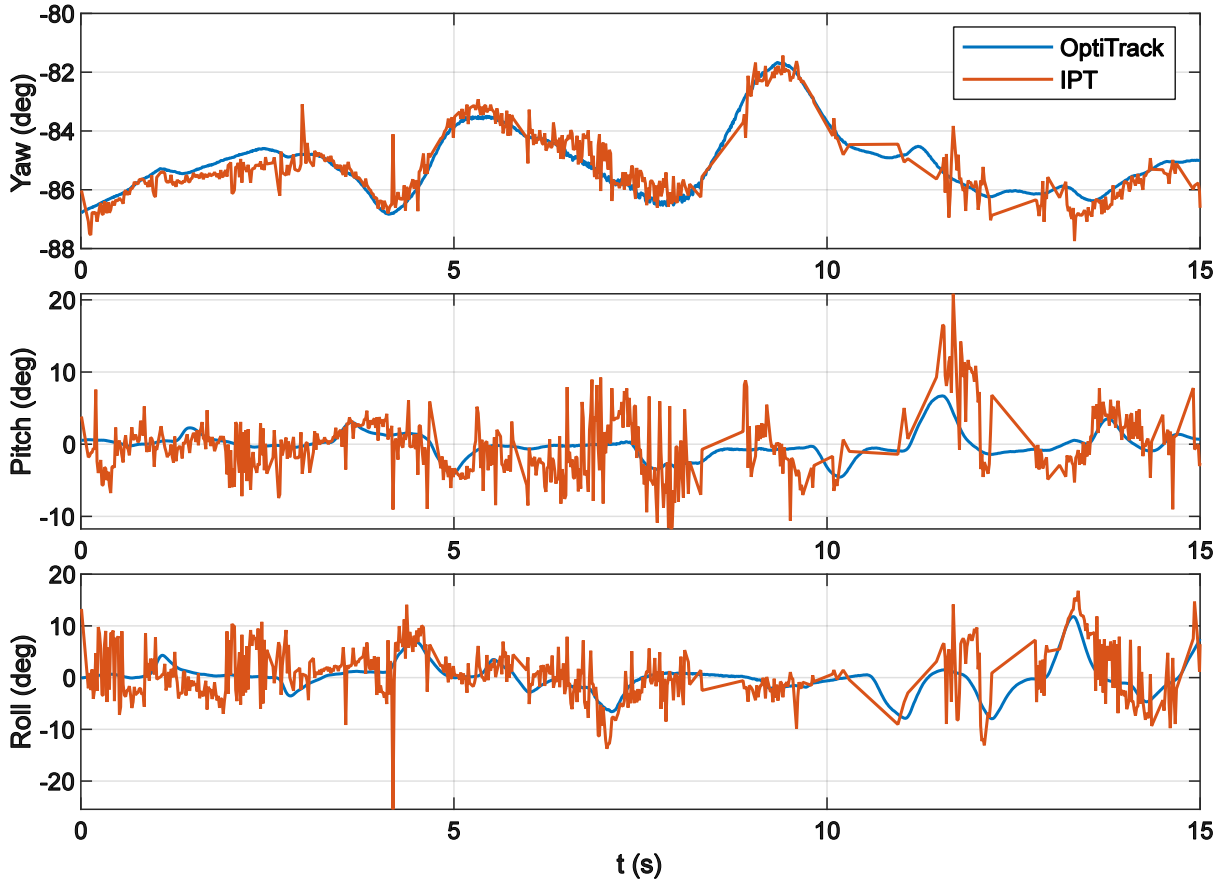




Experiments



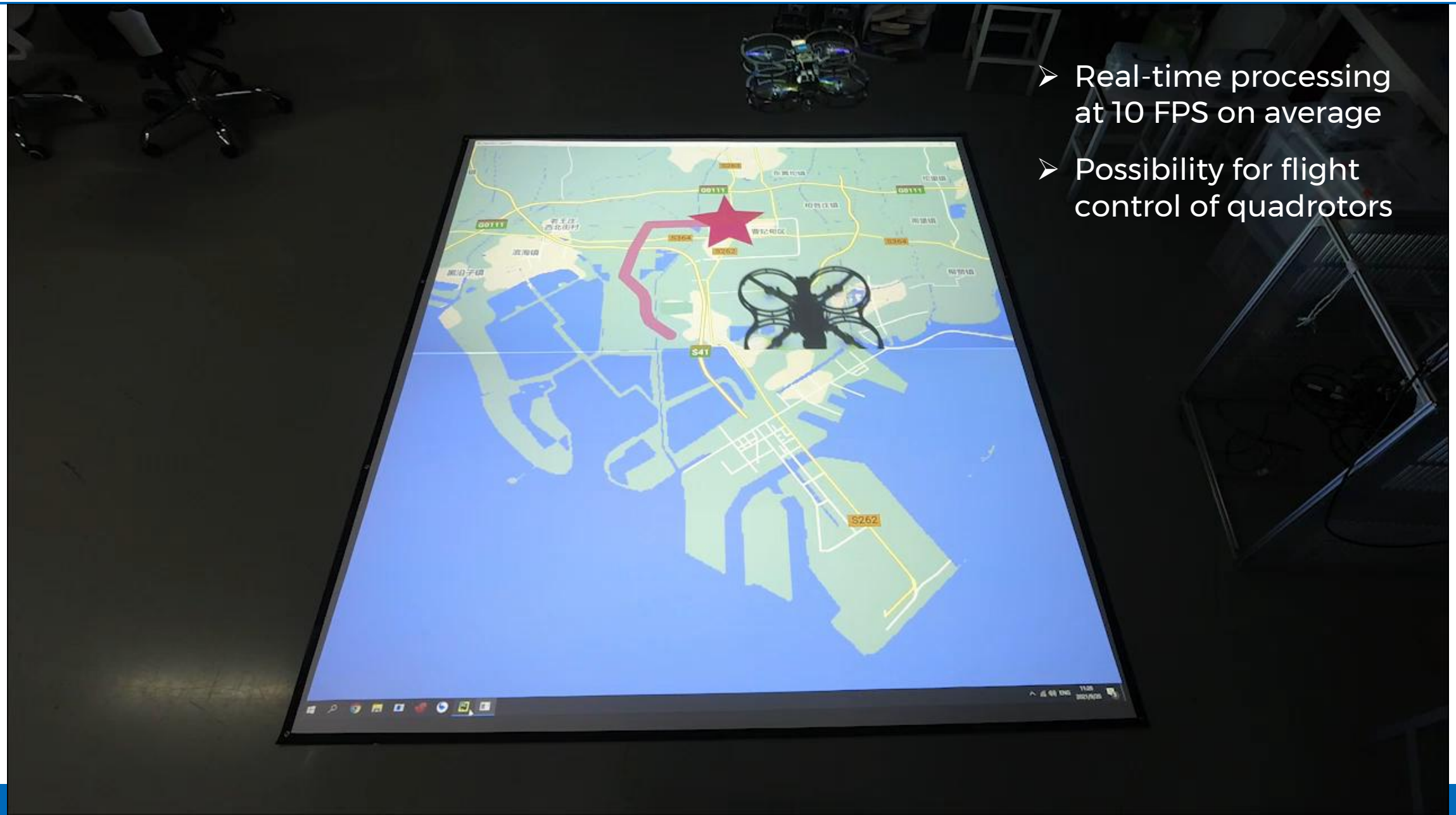
a. Position (no filtering)



b. Orientation (no filtering)

- Centimeter-level positional accuracy
- Oscillating orientation, better in yaw

Experiments



- Real-time processing at 10 FPS on average
- Possibility for flight control of quadrotors

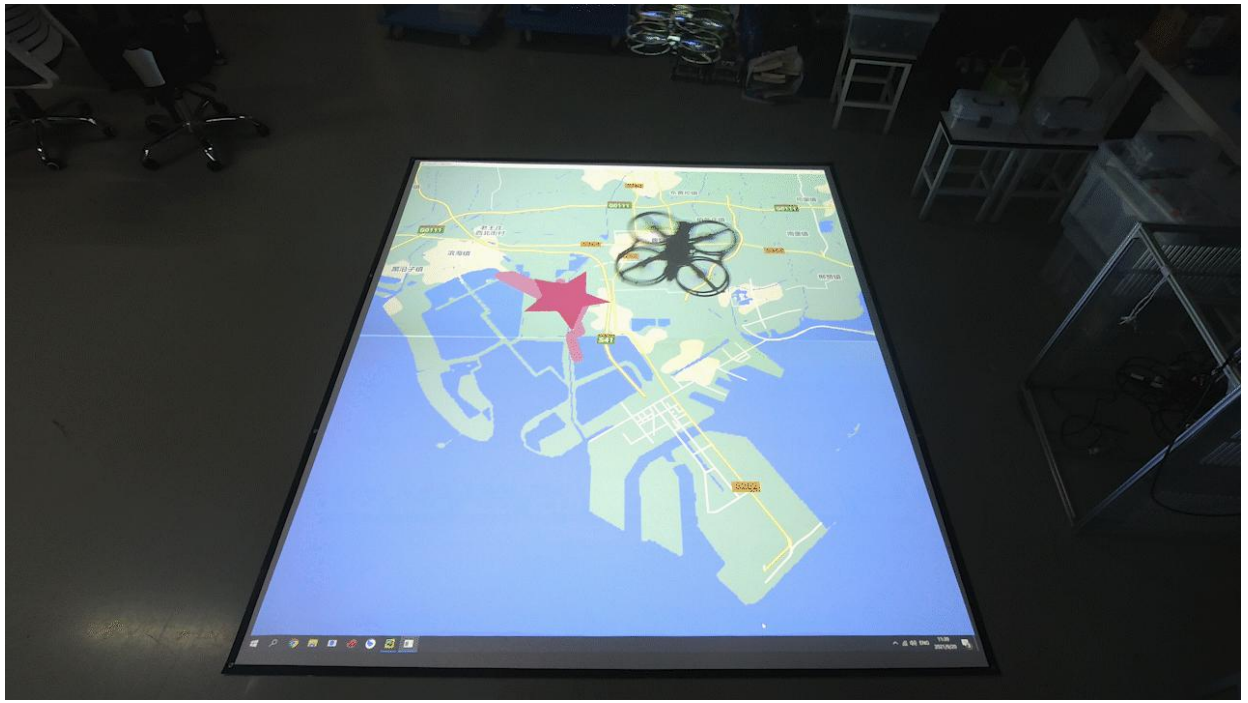
IPT

- An indoor localization method based on human-invisible projected tags
- The first time screen-camera communication is utilized for AR robot localization

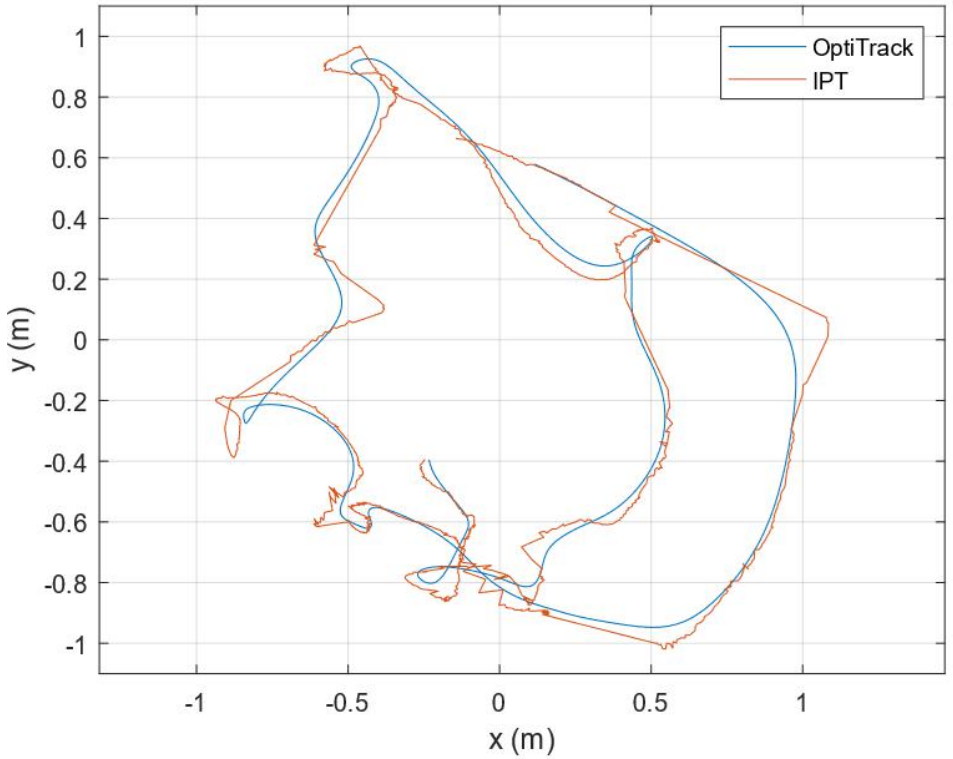
Future work

- Integrate with IMU
- Multi-agent scenario
- More complex videos
- More vigorous robot movements.

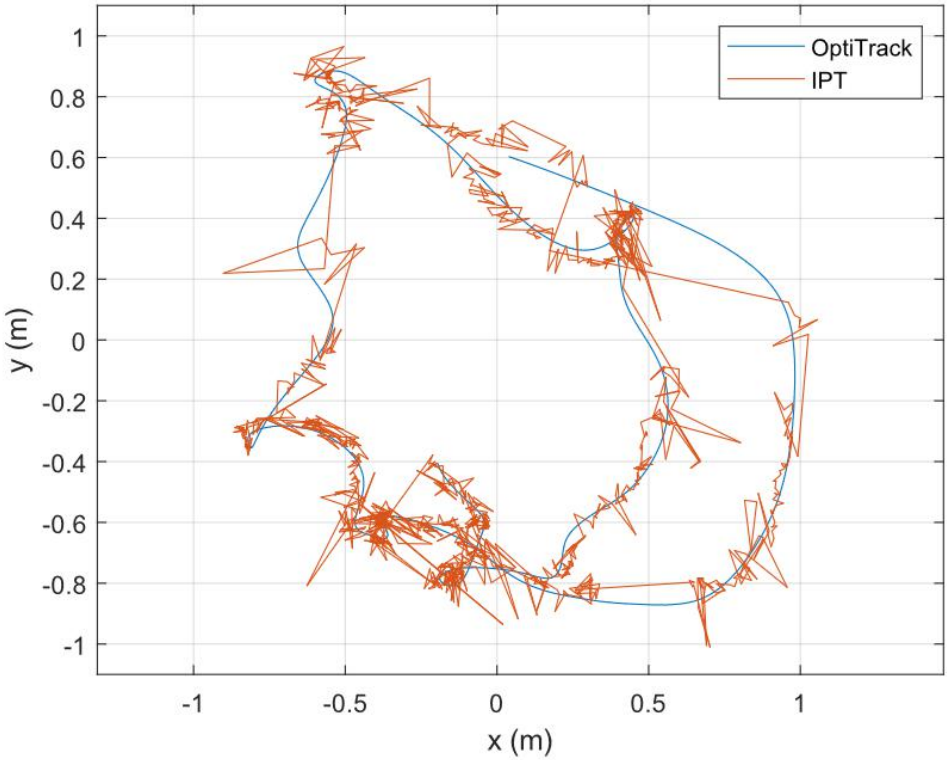
Thanks for Watching



Experiments



(a) Result from the SolvePnP() function in OpenCV



(a) Result after coordinate transformation

$$\left[\begin{array}{c|c} {}^{w}_{c}R & {}^{w}\vec{T} \end{array} \right] = \left[\begin{array}{c|c} R^T & -R^T \cdot \vec{T} \end{array} \right]$$

- Integrated with better orientation sensor → higher positional accuracy