

Crazyflie and positioning

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BAM days
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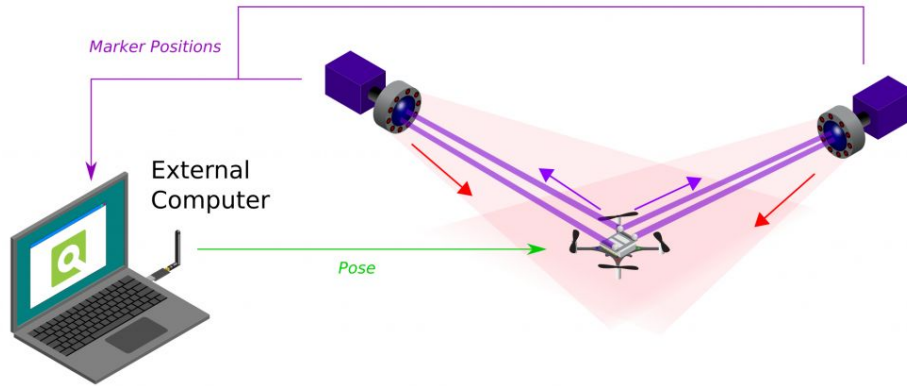


Why position and different ways of doing it



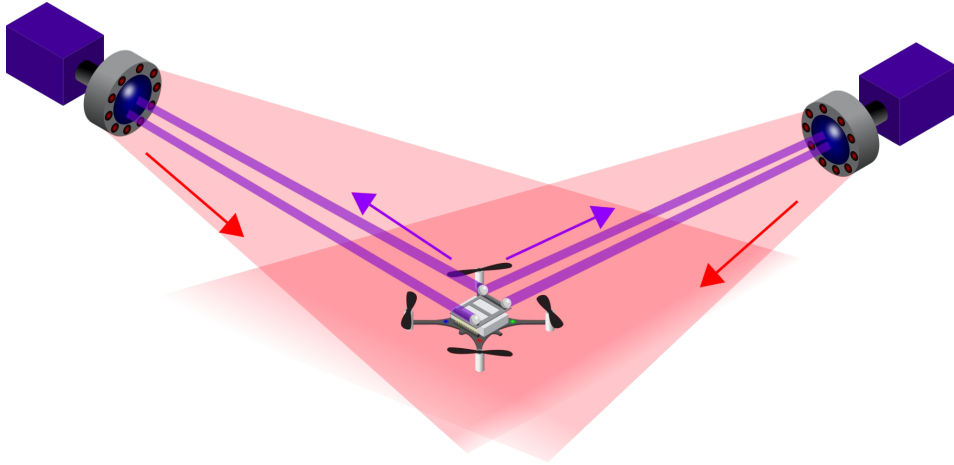
- Why?
 - Avoid drift
 - Swarming
 - Autonomy
 - Ground truth
- How?
 - Relative vs absolute positioning
 - Off-board vs on-board position / pose estimation
- Additional systems supported by decks

Off-board absolute positioning



- + Knowledge of all positions
- + Can integrate with any positioning system:
Send either position or pose to Crazyflie
- Higher latency
- No on-board autonomy

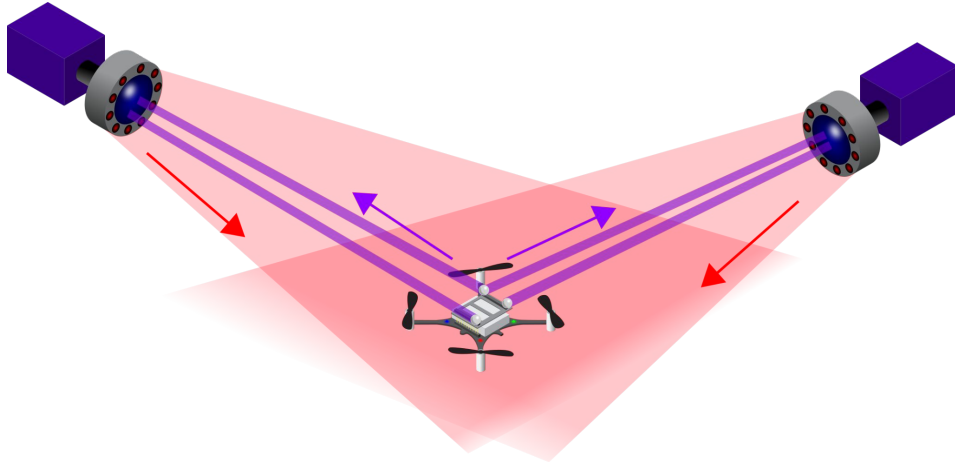
Motion capture systems (1/2)



- Absolute positioning / off-board pose estimation
- Markers
 - Body identification
 - Active vs passive
- Qualisys support in examples
- CrazySwarm

- Our lab has a 6 camera Qualisys system that's 7x6x3 meters

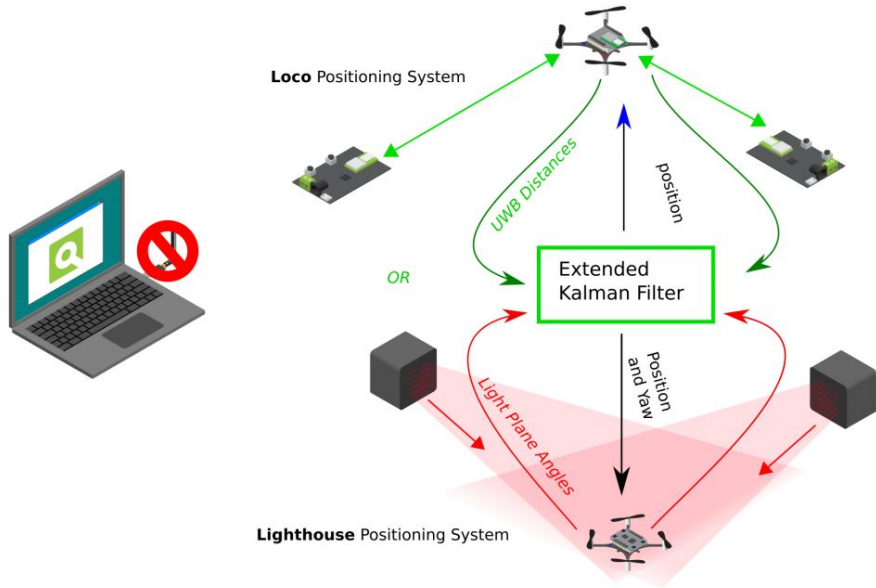
Motion capture systems (2/2)



- + Very high accuracy
- + Good scalability
- + De Facto standard

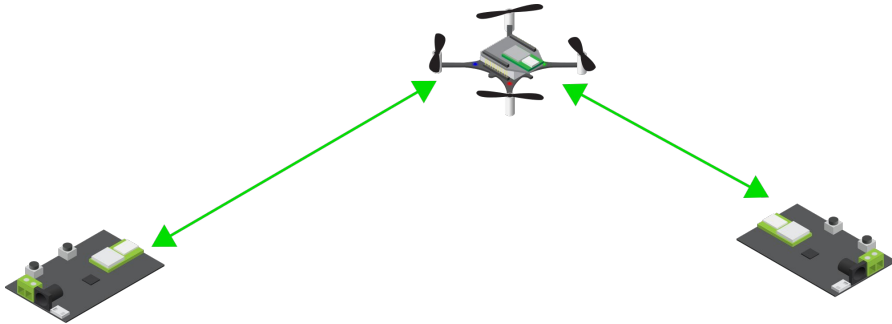
- High price
- Complex

On-board absolute positioning



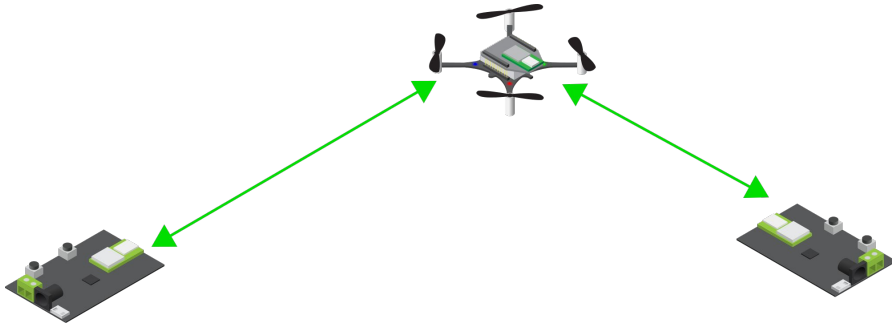
- + Support on-board autonomy
- + Update on partial updates
- + Low latency
- No central knowledge of all positions

Loco positioning (1/2)



- Absolute positioning / on-board position estimation
- Based on radio (Ultra Wide Band)
- Different algorithms
 - TWR
 - TDoA (2 and 3)
- Our lab has a 8 anchor system that's 7x6x3 meters (TDoA3)

Loco positioning (2/2)

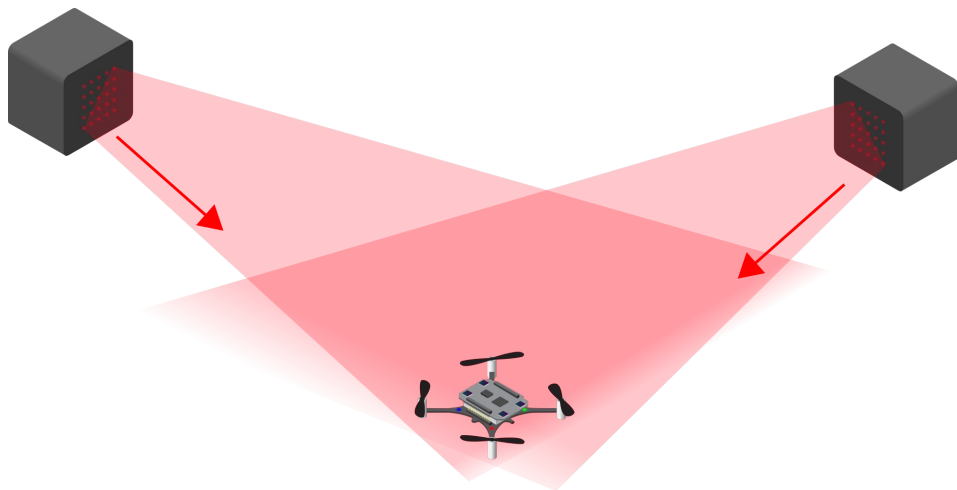


- + Large tracking volume
- + Graceful degradation
- + Non-line of sight (depending on material)
- + Not sensitive to sunlight

- Manual system geometry
- Some scaling, but could be better

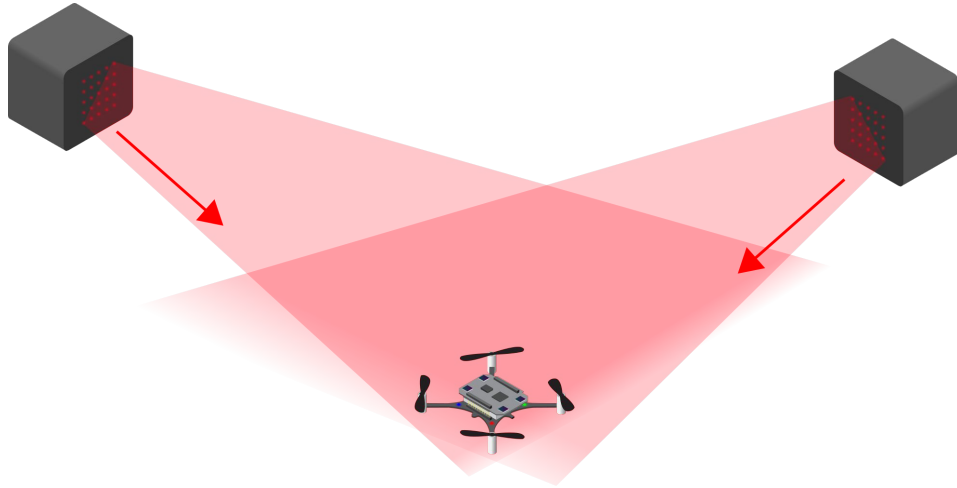
- +/- More noise (GPS emulation)

Lighthouse (1/2)



- Absolute positioning / on-board position/yaw estimation
- Uses SteamVR base stations
- Lighthouse Positioning System: Dataset, Accuracy, and Precision for UAV Research (<https://arxiv.org/pdf/2104.11523.pdf>)
- Our lab has Lighthouse V1/2 (2 of each) that's 4x4x3 meters

Lighthouse (2/2)

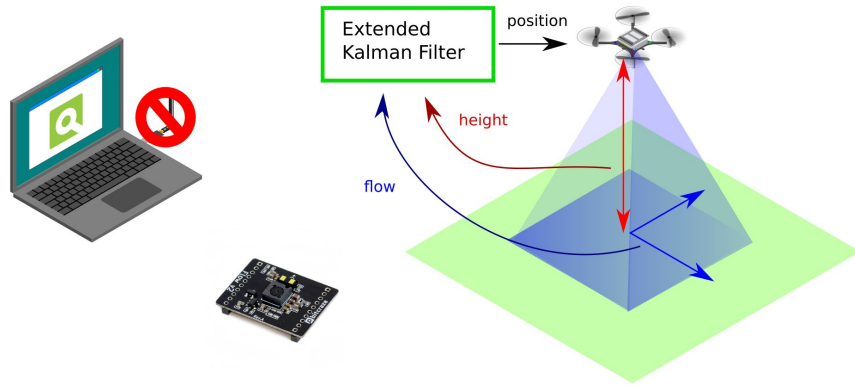


- + Quick and easy set-up
- + Automatic system geometry
- + Good mobility
- + Great value
- + Good accuracy

- Currently does not scale well
- Sensitive to reflections
- More work on performance needed

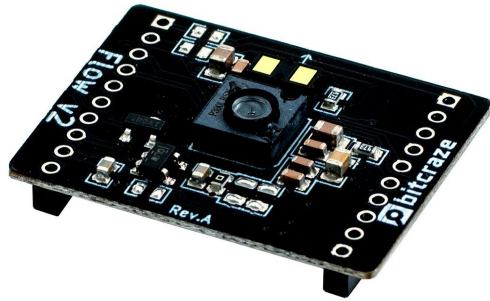
On-board relative positioning

- + Quick setup, no external systems
- + Lower cost



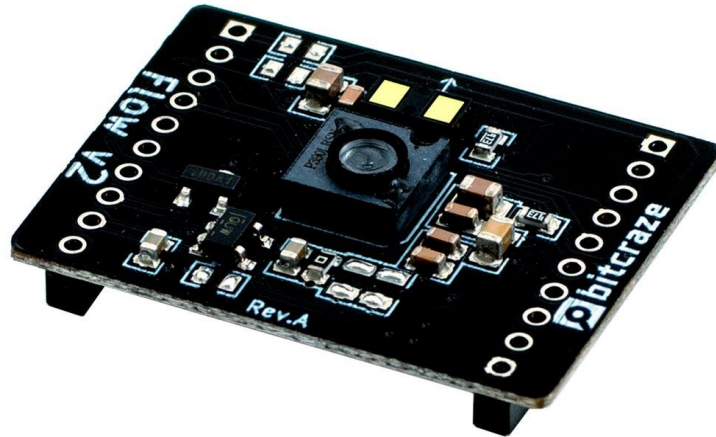
- Will drift over time
- No common knowledge of coordinate system

Optical flow (1/2)



- Relative positioning / on-board position estimation
- Optical flow ASIC
- Possible future application of AI-deck

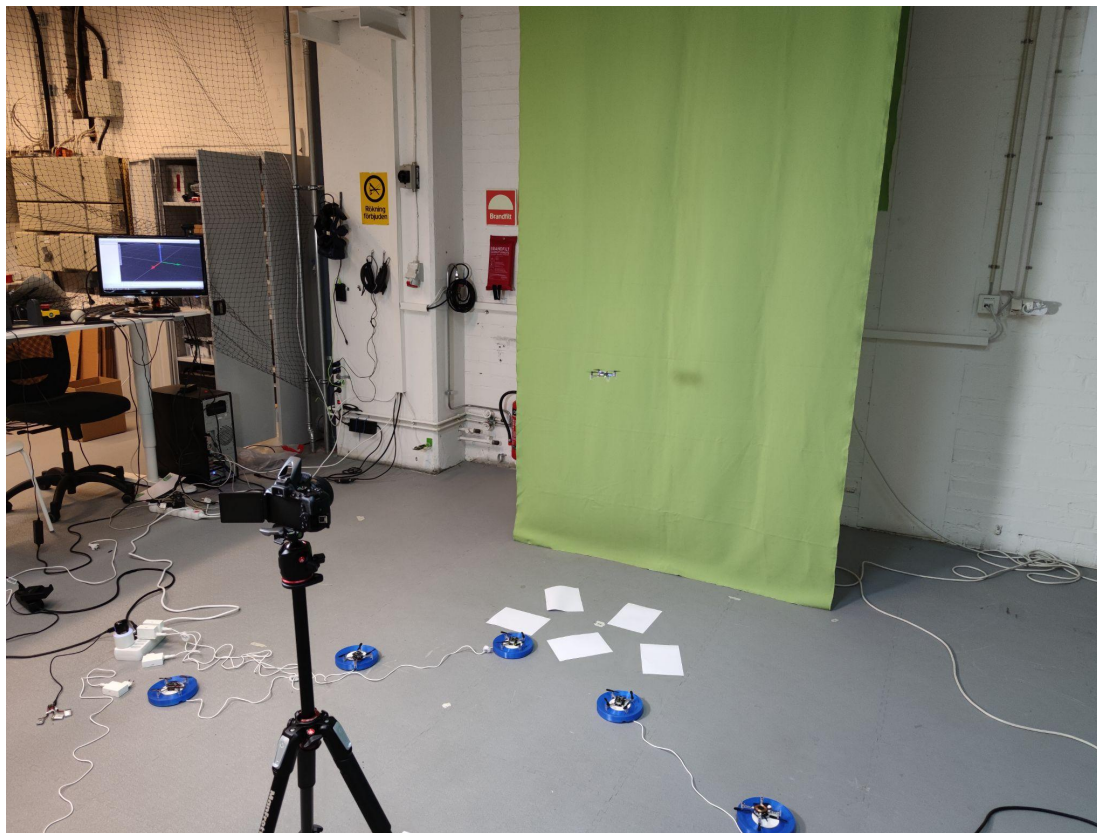
Optical flow (2/2)



- + Quick start
- + Lower cost
- + No external infrastructure

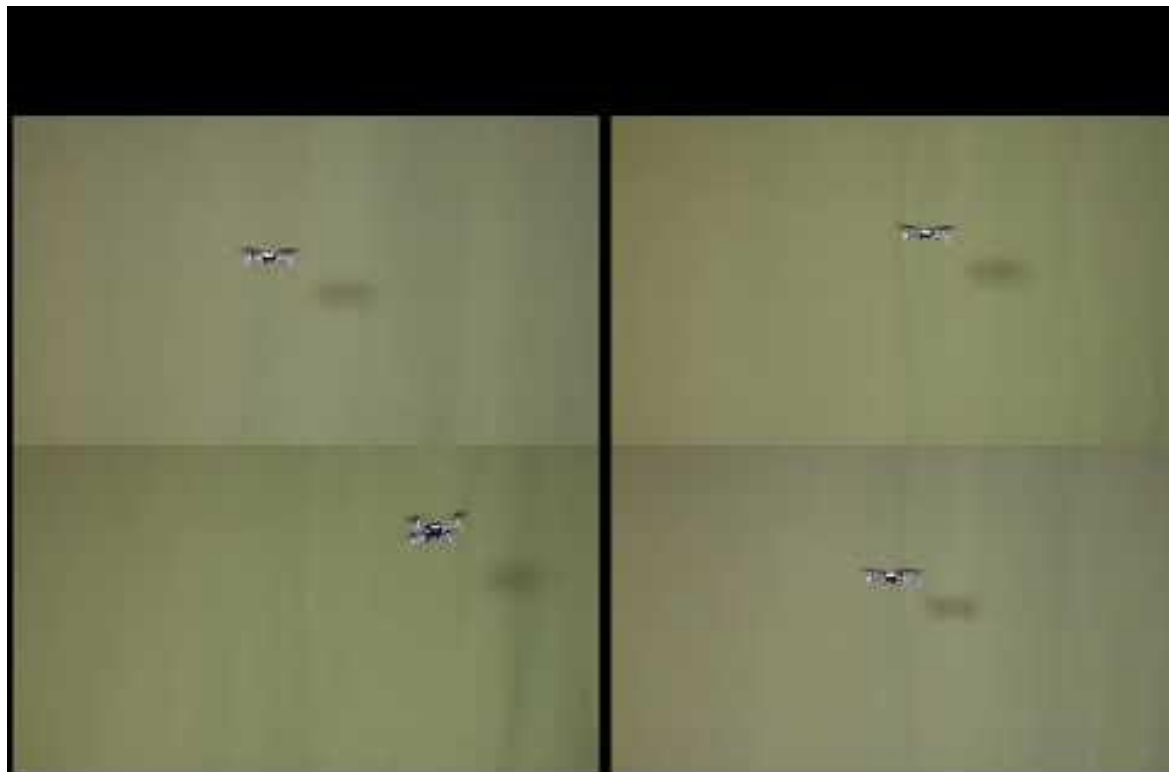
- Will drift over time
- No swarming
- Performance heavily dependant on environment

Video comparing noise (standing still)



Video comparing noise (standing still)

Qualisys active
marker deck

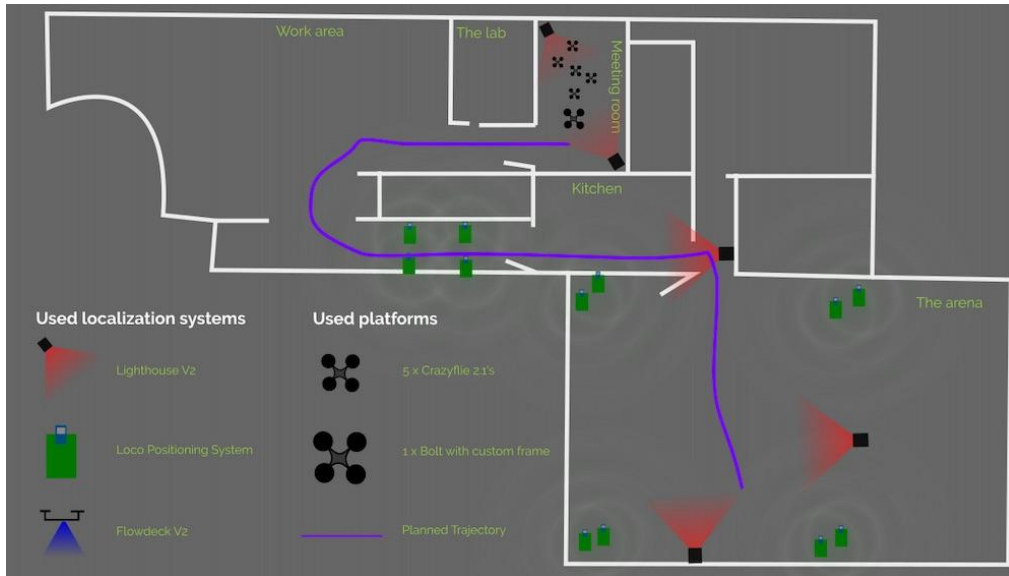


Lighthouse V2

Loco positioning
(TDoA3)

Flow V2 (with
pattern)

Mixing positioning technologies - The Hyper demo



- Use the strength of different systems combined and potentially keep cost down
- On board autonomy, host only used to start it
- Uses high-level commander
- Needs manual setup for combined coordinate system
- Can overlap but doesn't need to



the HyperDemo

Related sessions



Today @ 15:00 Qualisys (Martin & Magnus)

Today @ 16:30 Advanced Lighthouse usage
(Kimberly)

Thursday @ 10:00 CrazySwarm (Wolfgang)

Q & A