DroTrack: High-speed Drone-based Object Tracking Under Uncertainty

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FUZZ-IEEE 2020

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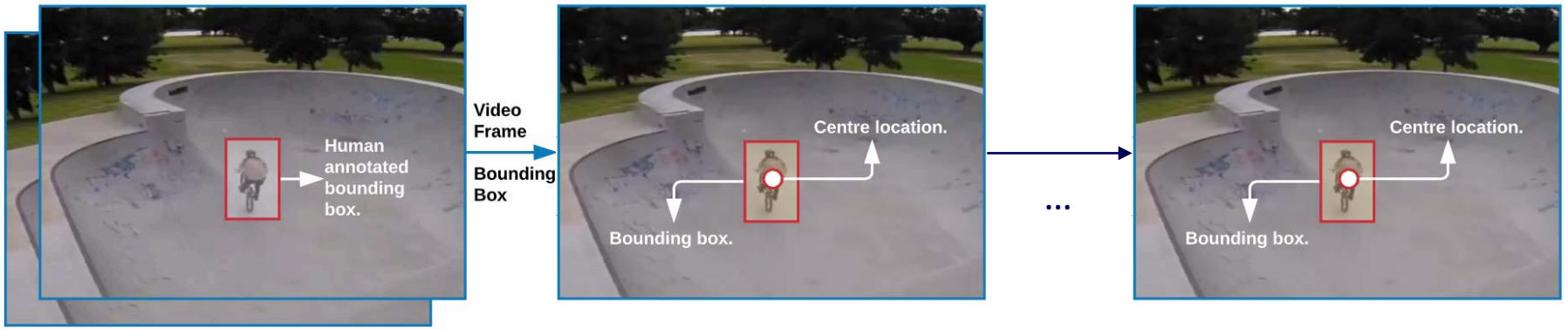
Drone-based Object Tracking



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Research Problem

Inaccurate drone-based object tracking due to:

- **Complex and dynamic Situation uncertainty** [1, 2, 3, 4]
- **High-speed dual motions changing in 360 degrees** [5, 6, 7, 8].

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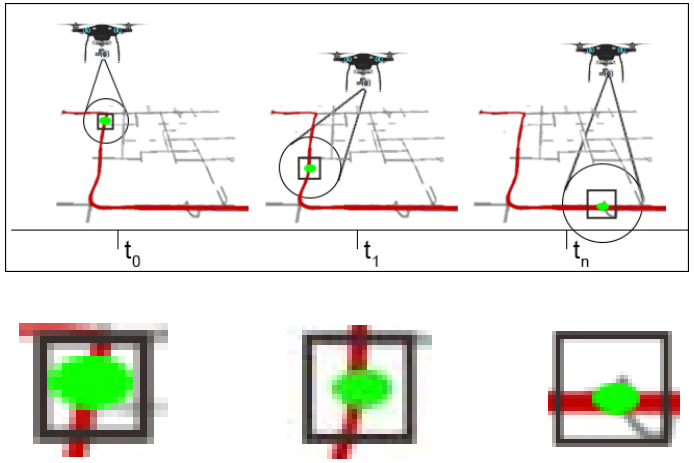
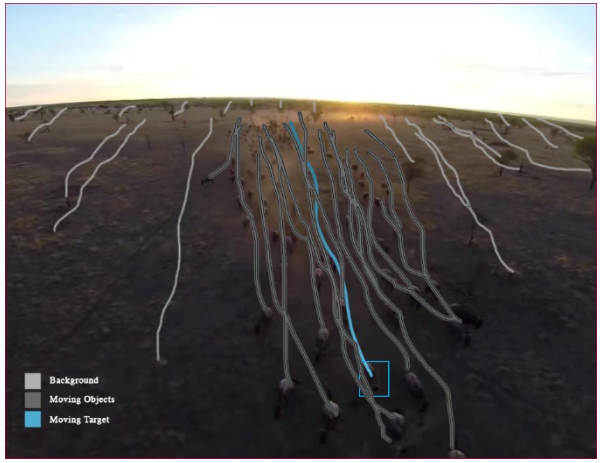
Research Problem



Object locations and scales at three different timestamps



The impact of drone movement on the object optical flow tracking

Challenges:

- Noise
- Occlusion
- Cluttered background

- Object varying features:
  - Position
  - Scale
  - Direction
- Inverse motion
- Out-view
- High-speeding objects

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Contributions

- Adaptive **feature extraction** and optical flow methods that produce real-time single object tracking.
- A **spatial segmentation method** that incorporates a Fuzzy C Means clustering with a CNN transfer learning model.
- A **heuristic geometrical** method to estimate accurate object scales.
- **Comprehensive evaluation** and benchmark with the baseline and state-of-the-art trackers using two drone-captured datasets with 51,462 frames.

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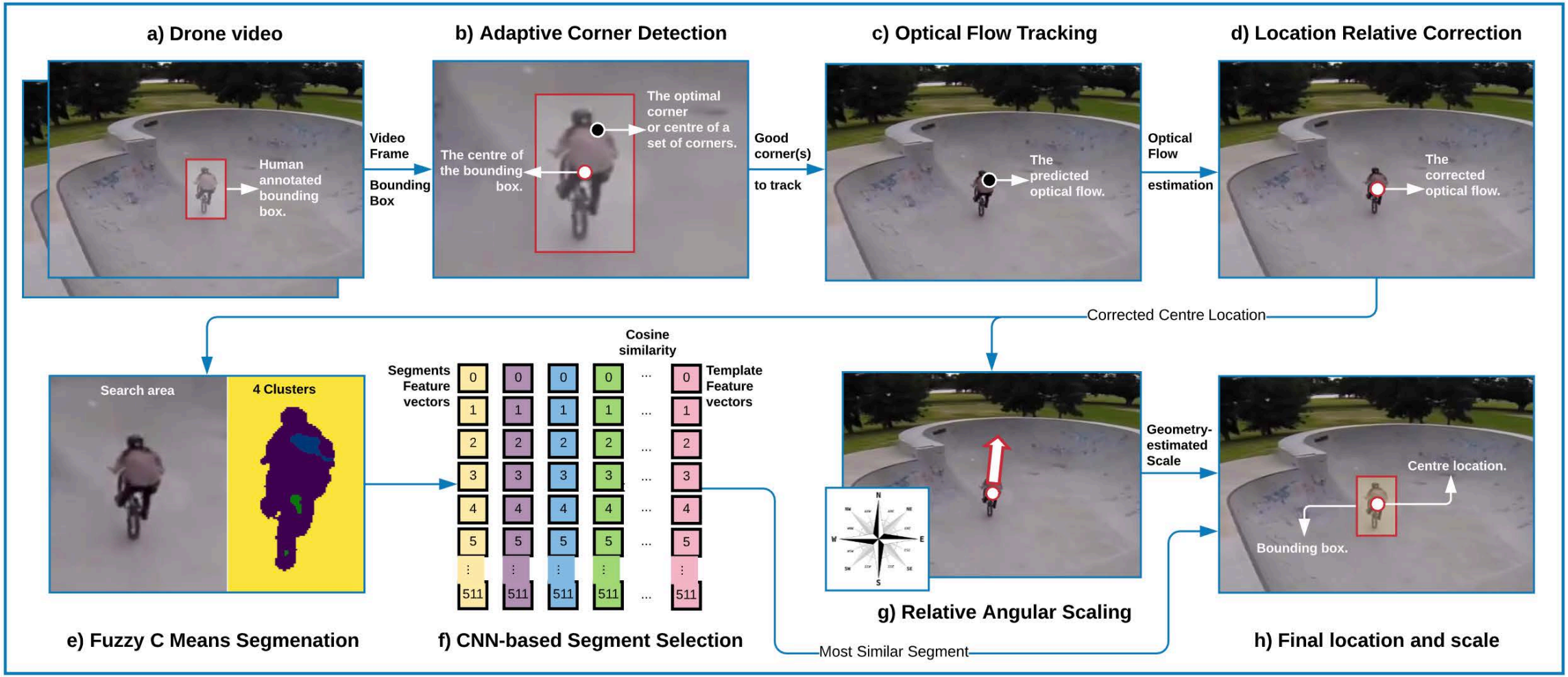
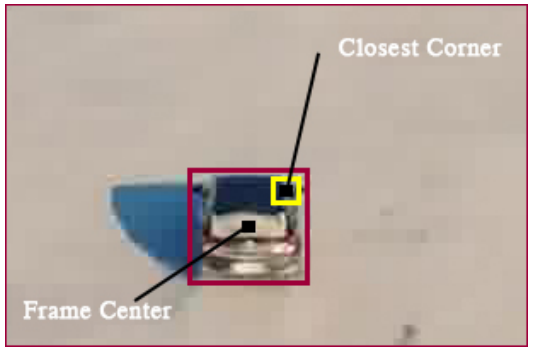
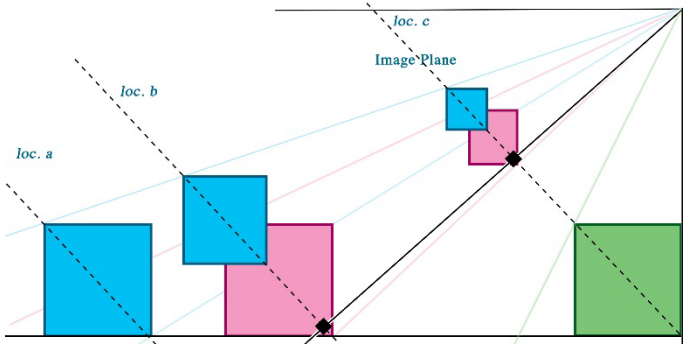
Proposed Methodology: DroTrack

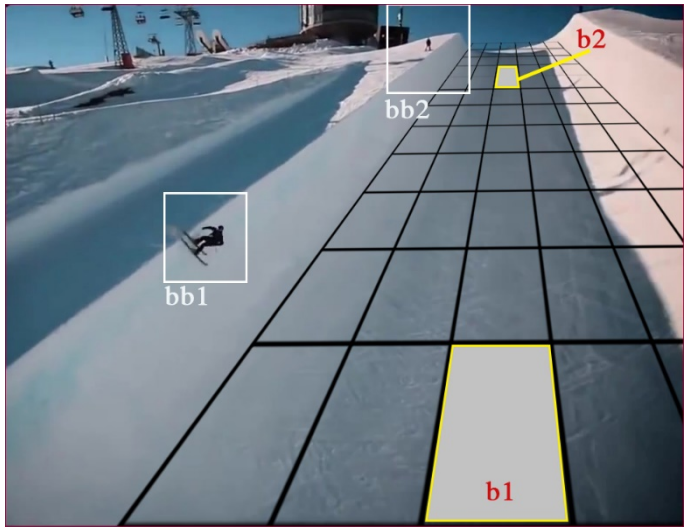
High-speed Drone-based Object Tracking Under Uncertainty



Optical Flow Correction & Relative Scaling







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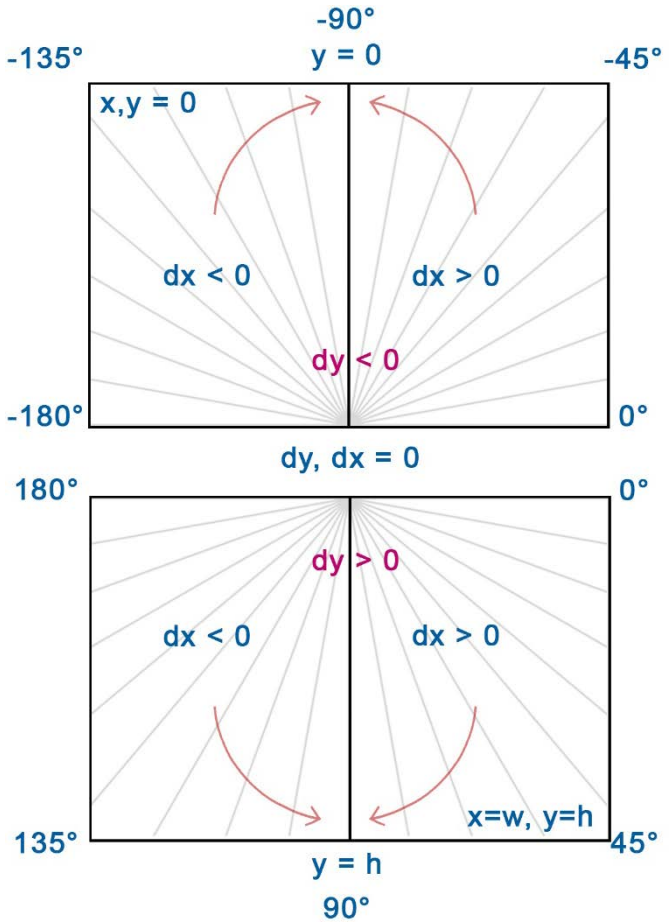
Relative Scaling

$$RT = \begin{cases} PRT & \rightarrow \quad \Delta x \wedge \Delta y = 0; \\ PRT * Scale & \rightarrow \quad \theta = \frac{\pi}{2} \vee \theta = \frac{-\pi}{2}; \\ PRT * Scale * \frac{\theta}{\pi/2} & \rightarrow \quad \Delta x > 0 \wedge \theta > 0; \\ PRT * Scale * \frac{\theta}{\pi/2} & \rightarrow \quad \Delta x > 0 \wedge \theta < 0; \\ PRT * Scale * \frac{\pi - \theta}{\pi/2} & \rightarrow \quad \Delta x < 0 \wedge \theta < 0; \\ PRT * Scale * \frac{\pi - \theta}{\pi/2} & \rightarrow \quad \Delta x < 0 \wedge \theta > 0; \end{cases}$$



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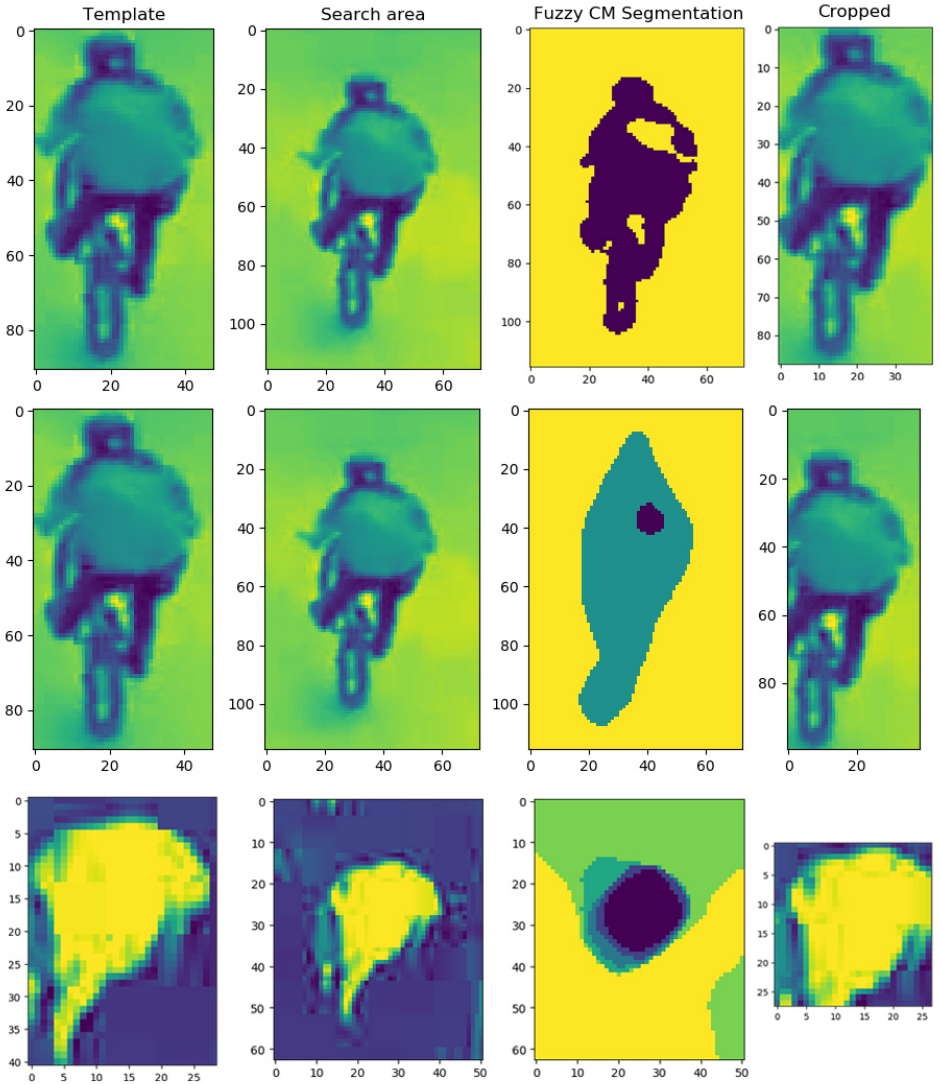
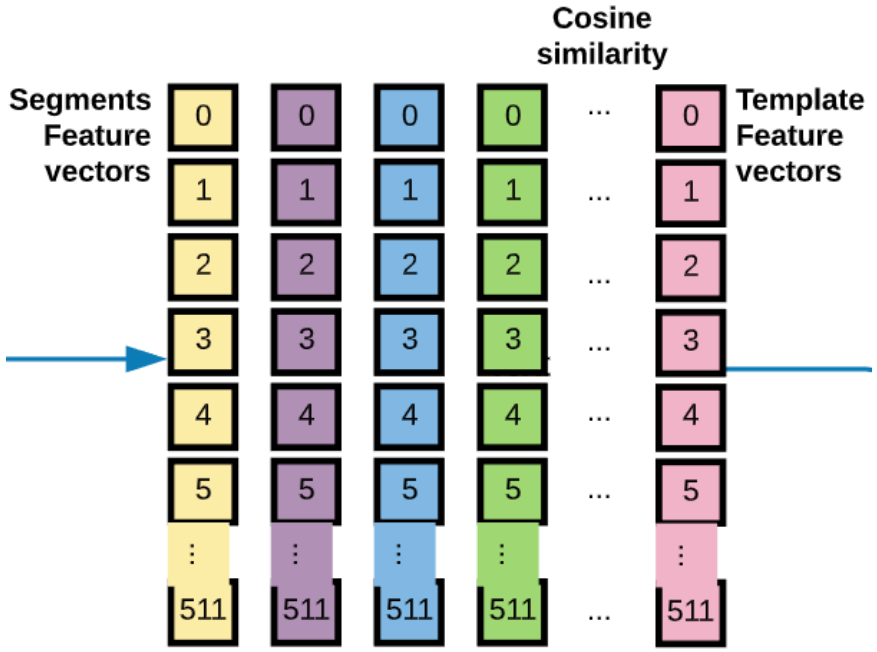
Fuzzy C-means Segmentation



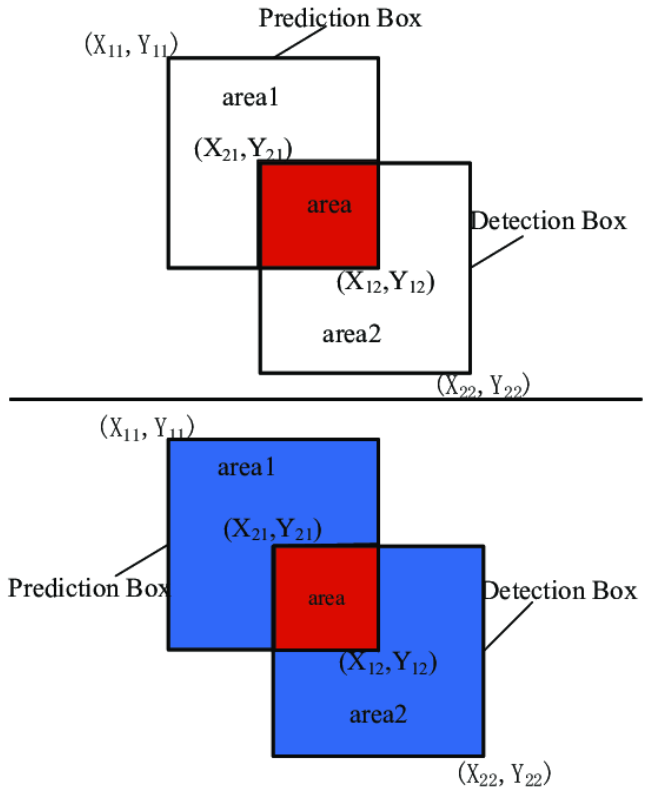


f) CNN-based Segment Selection

Benchmarking & Metrics

1. CSRT [Lukeziuaz et. al., 2018, IJCV]
2. ADNet [yun et. al., 2017, CVPR]
3. SiamFC [Bertinetto et. al., 2016, ECCV]
4. MIL [Babenko et. al., 2009, CVPR]
5. KCF [Henriques et. al., 2015, TPAMI]
6. Median Flow [Kalal et. al., 2010, ICPR]
7. Boosting [grabner et. al., 2006, Bmvc]
8. MOSSE [Bolme et. al., 2010, CVPR}
9. TLD [Kalal et. al., 2012, TPAMI]

$$IOU = \frac{area}{area1 + area2 - area}$$



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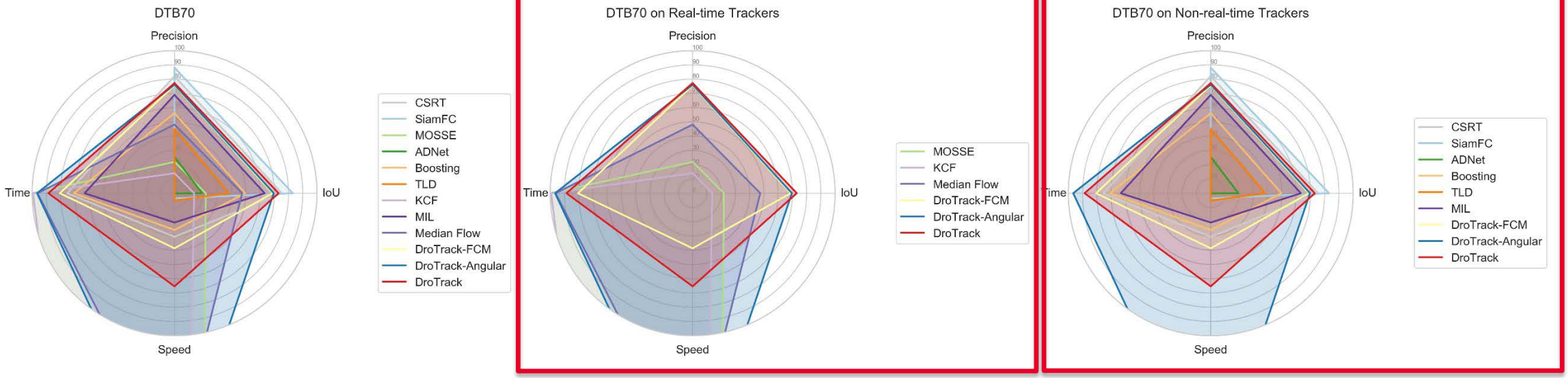
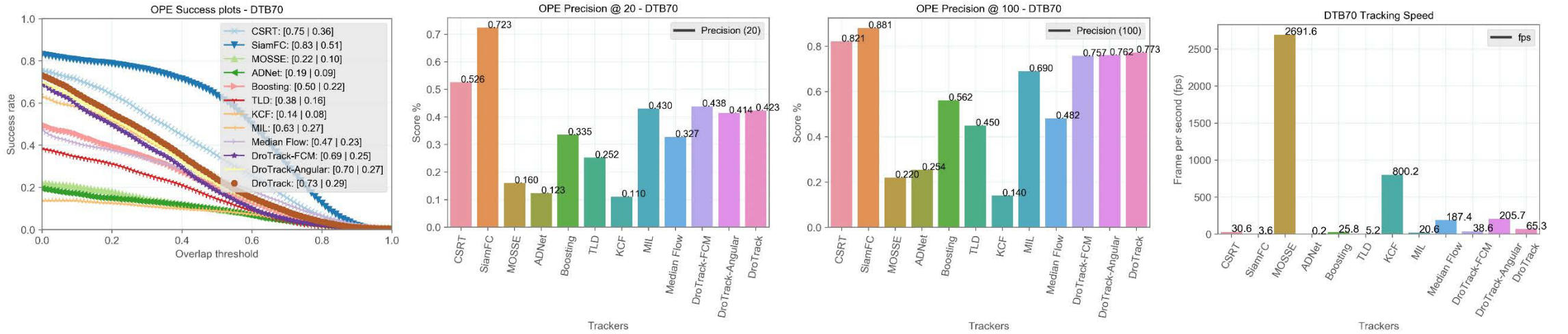
Results (DTB70)

(a)

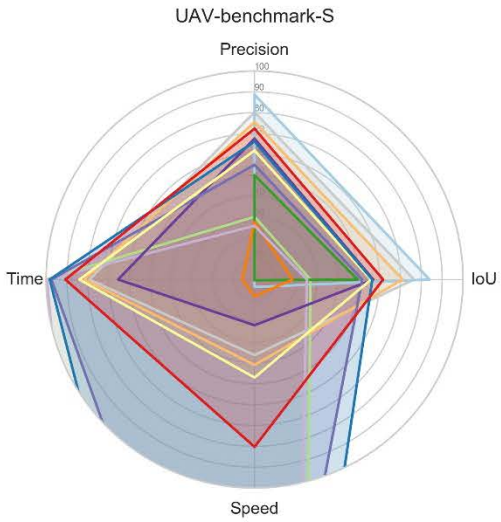


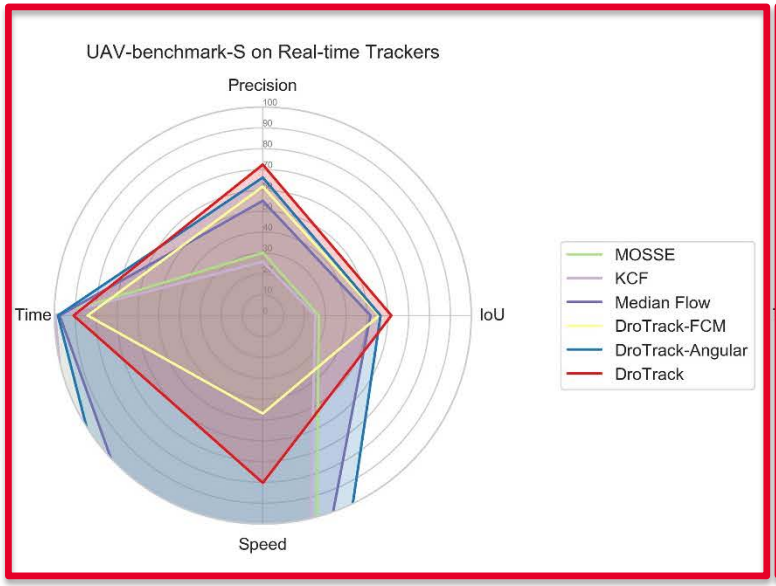
(b)

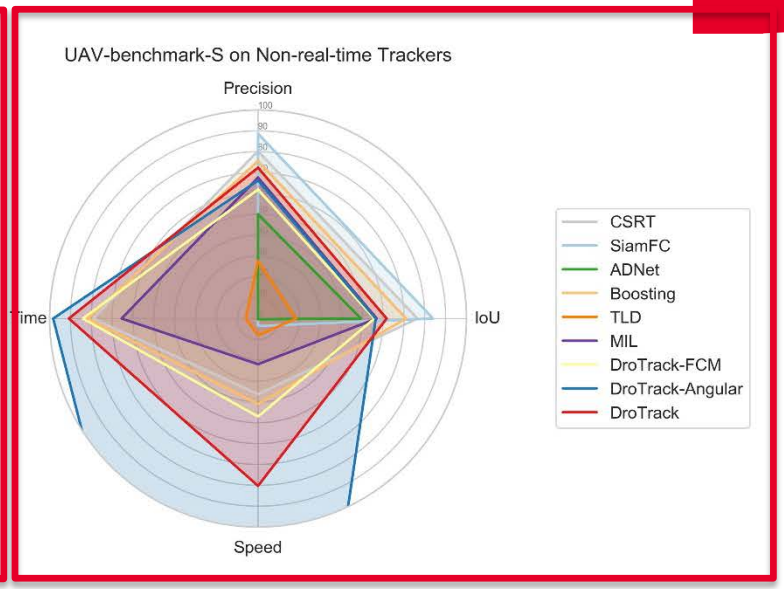


Results (UAVDT-Benchmark-S)

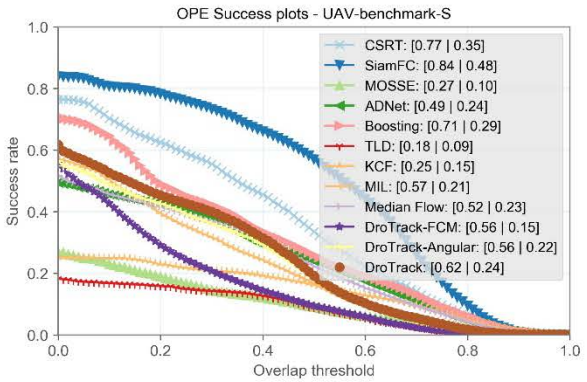
(c)

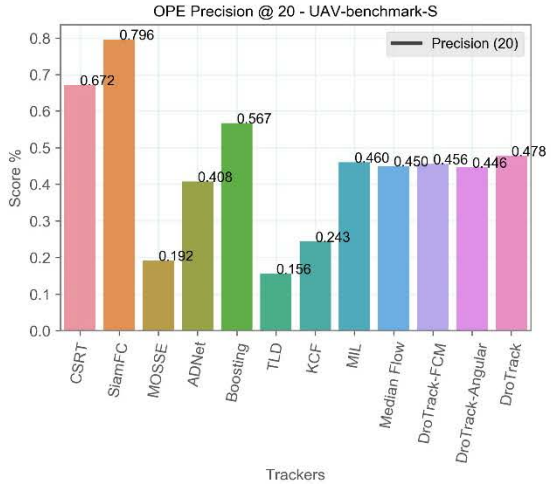


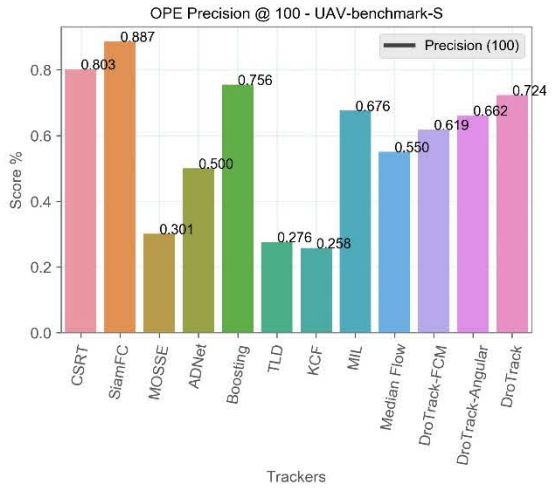


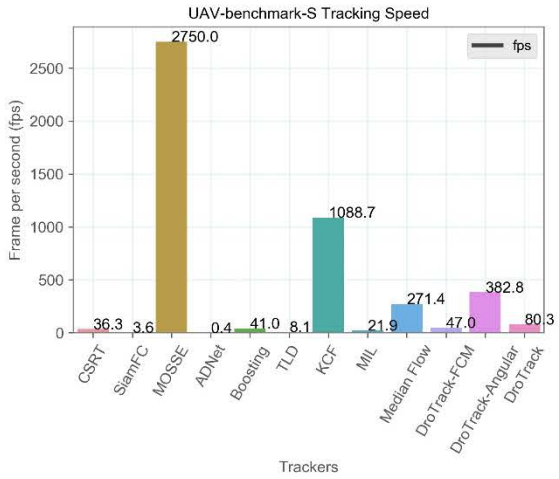


(d)









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Code

https://github.com/cruiseresearchgroup/DroTrack

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Acknowledgments

Ali Hamdi is supported by RMIT Research Stipend Scholarship. This research is also supported partially by the Australian Government through the Australian Research Council's Linkage Projects funding scheme (project LP150100246).

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Thank You !

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