

# Anti-UAVs Surveillance System based on Ground Random Fisheye Camera Array

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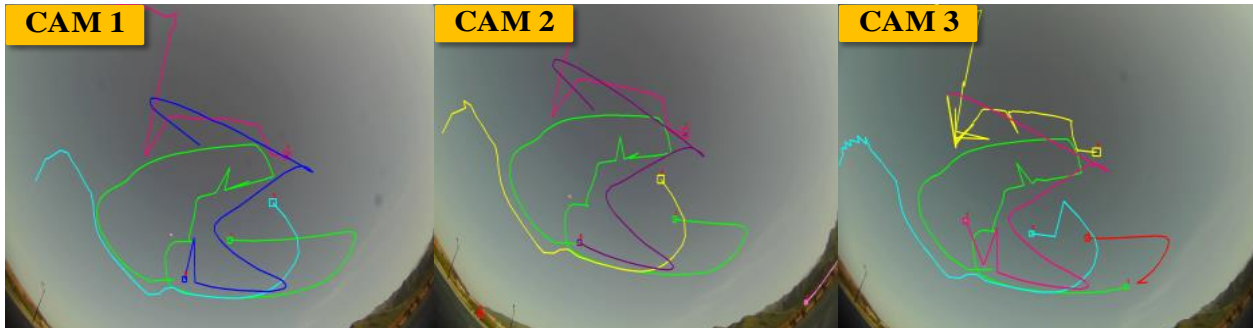
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# Introduction

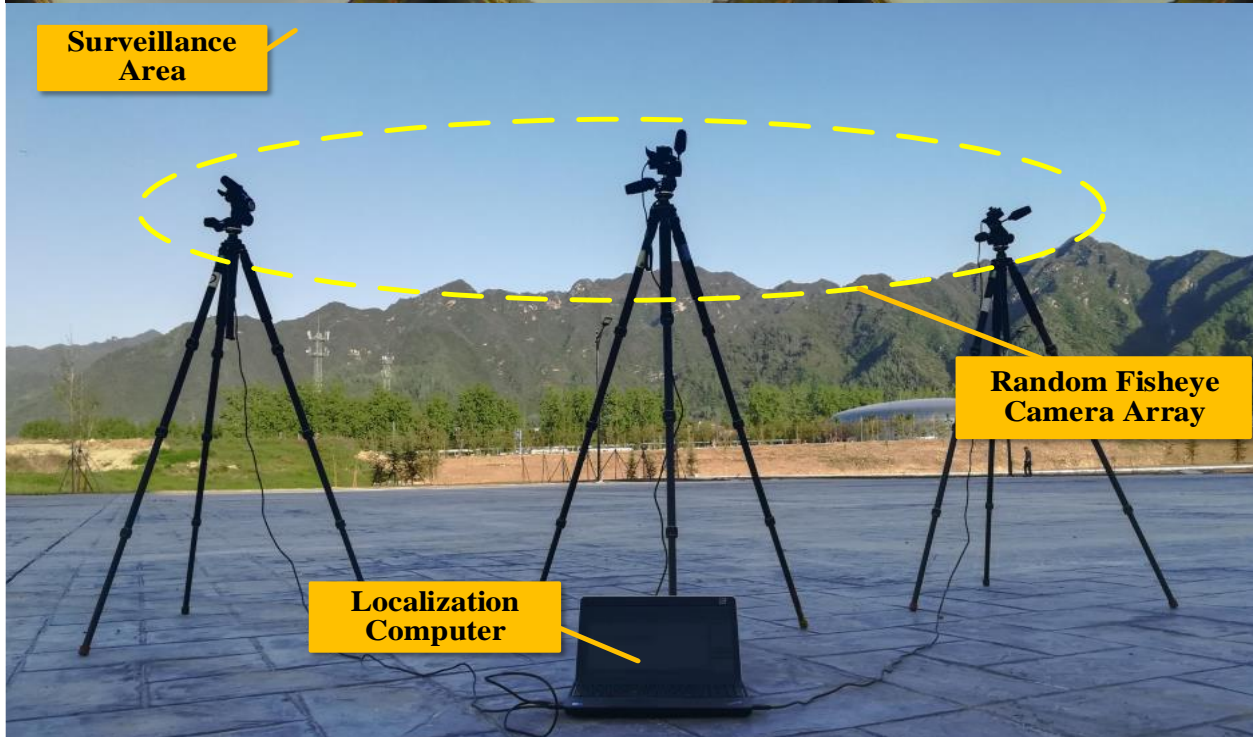
- ❖ with the rapid development of various types of unmanned aerial vehicles, anti-UAVs surveillance is very urgent.
- ❖ From a technical point of view, there are several major types anti-UAVs technology at home and board.

Method	advantage	disadvantage
Signal interference	<ul style="list-style-type: none"><li>• affect the UAV's GPS signal receiver</li></ul>	<ul style="list-style-type: none"><li>• it can not get enough precise coordinate data</li><li>• expensive</li></ul>
Radar detection	<ul style="list-style-type: none"><li>• small and low speed small targets</li></ul>	<ul style="list-style-type: none"><li>• low-level detection problems</li><li>• expensive</li></ul>
<b>Vision-based</b> (monocular, stereo, camera array )	<ul style="list-style-type: none"><li>• cheap</li><li>• a large number of mature algorithms</li></ul>	<ul style="list-style-type: none"><li>• small monitoring distance</li></ul>

# System Architecture



Surveillance results



The ground random fisheye camera array setup

# System Architecture



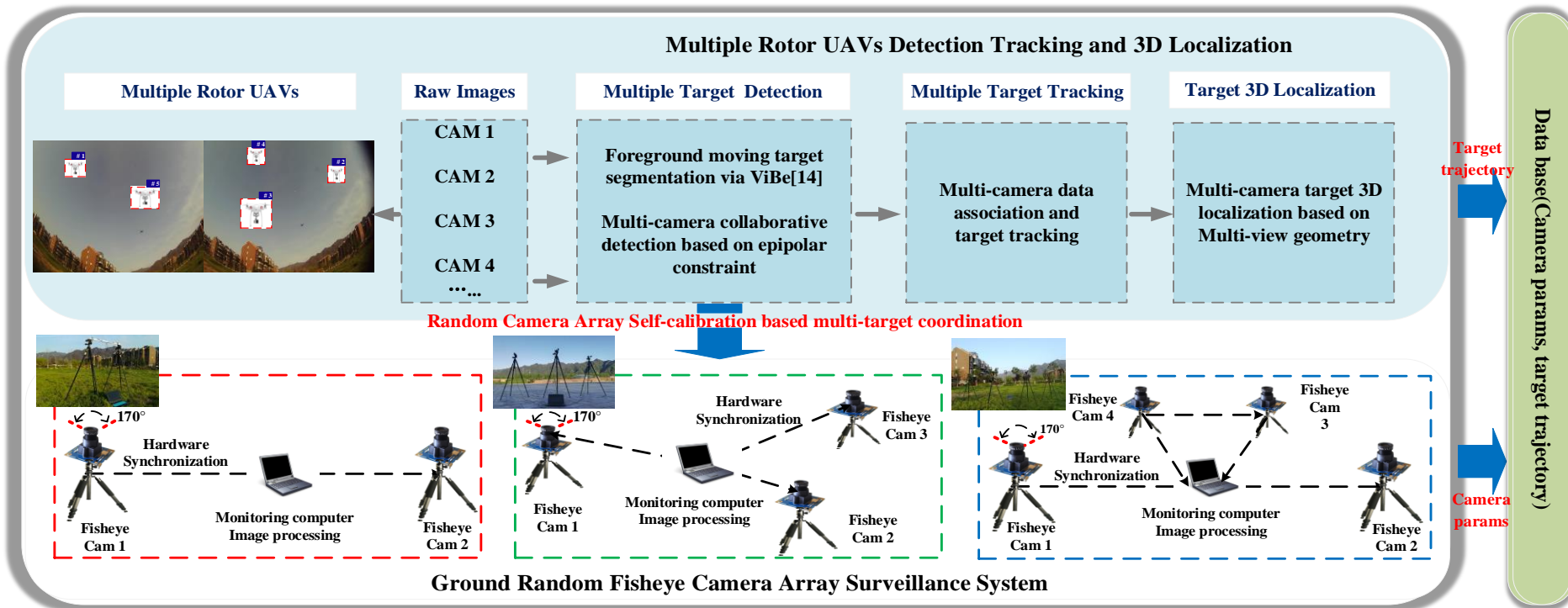
(a) Random camera array system architecture



(b) The experimental rotor UAVs



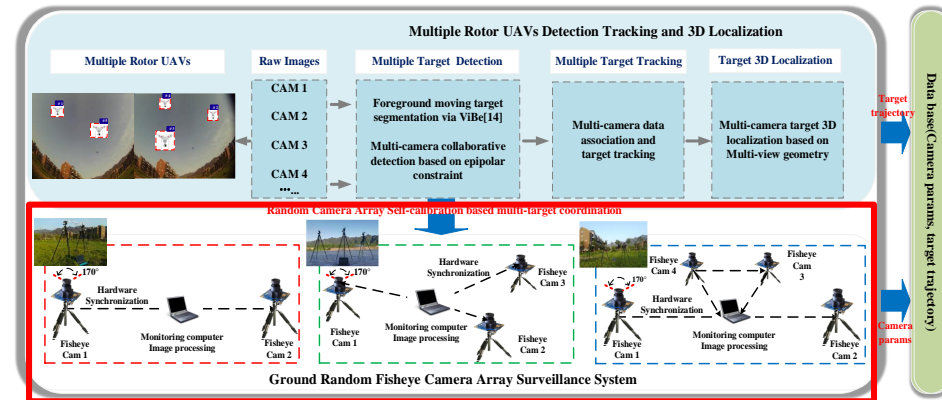
# Anti-UAVs Surveillance System



The framework of the ground fisheye camera array anti-UAVs surveillance system

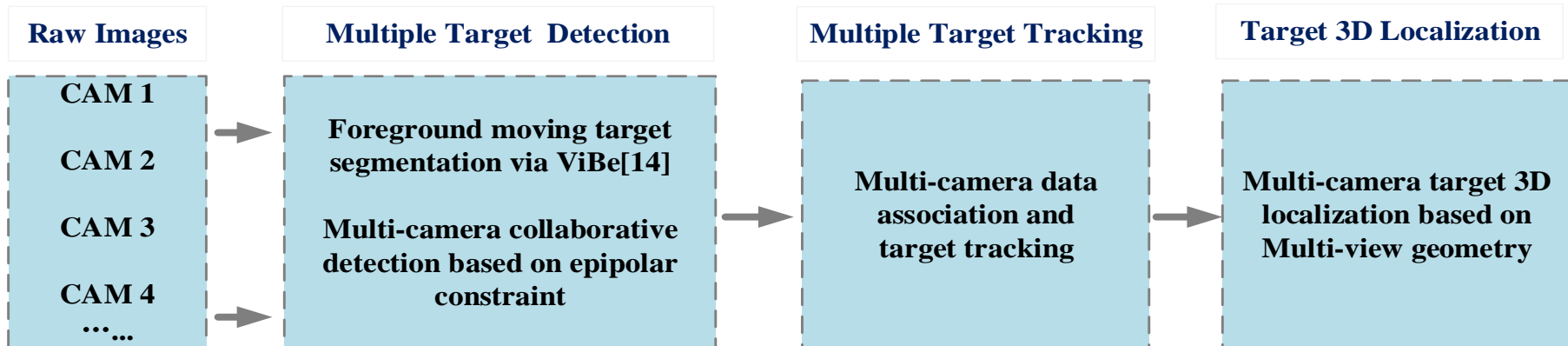
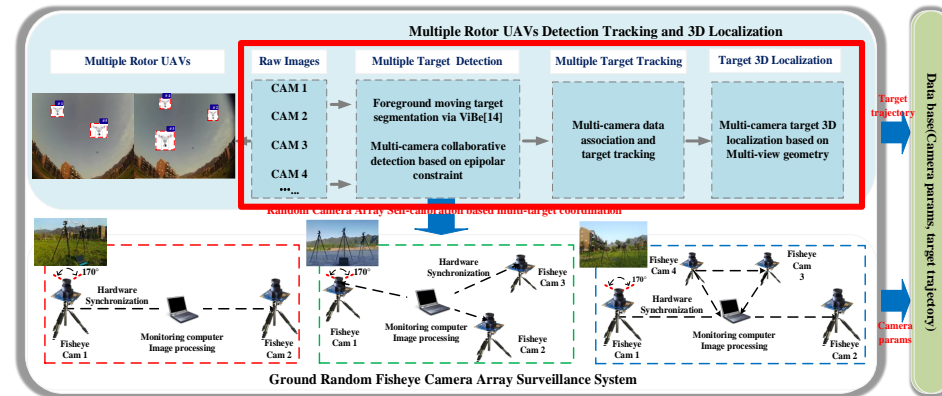
- (1) ground fisheye camera array image synchronization acquisition and self-calibration;
- (2) multiple target detection;
- (3) multiple target tracking;
- (4) target 3D localization and motion trajectories.

# Anti-UAVs Surveillance System



- Camera internal parameters calibration (OPENCV)
- Camera external parameters self-calibration
  - (1) Find essential matrix  $E$ ;
  - (2) SVD decomposition,  $R$  and  $t$ ;
  - (3) Recover scale.
- Reprojection Matrix  $P$

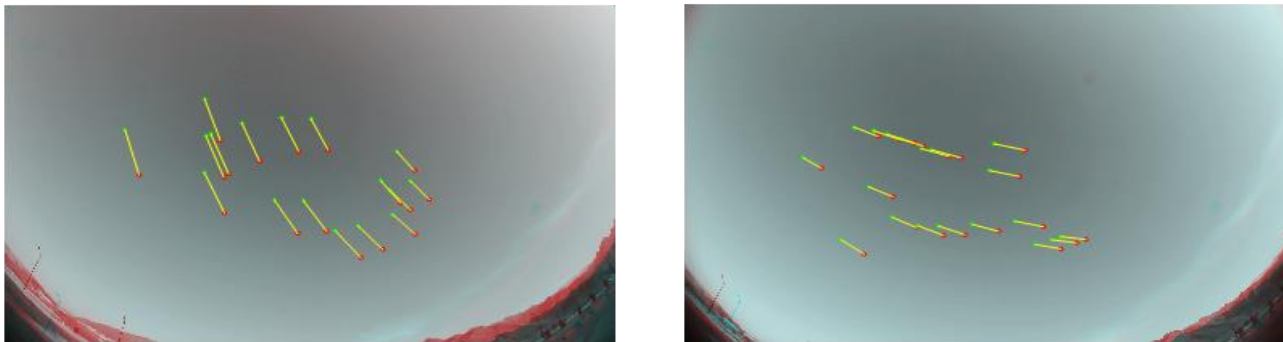
# Anti-UAVs Surveillance System



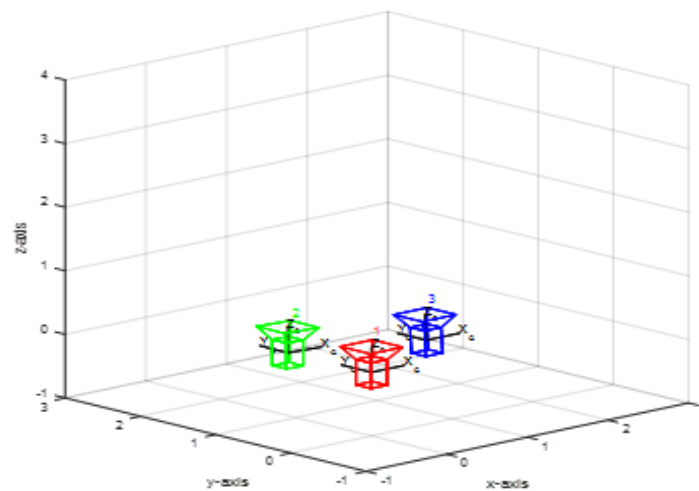
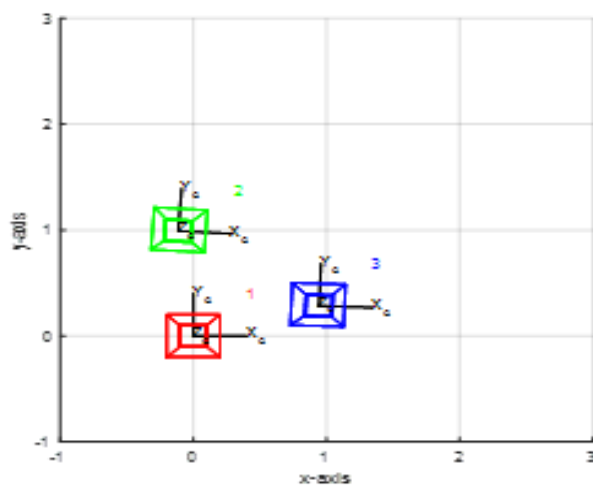


# Experimental Results

## Camera Array Self-calibration



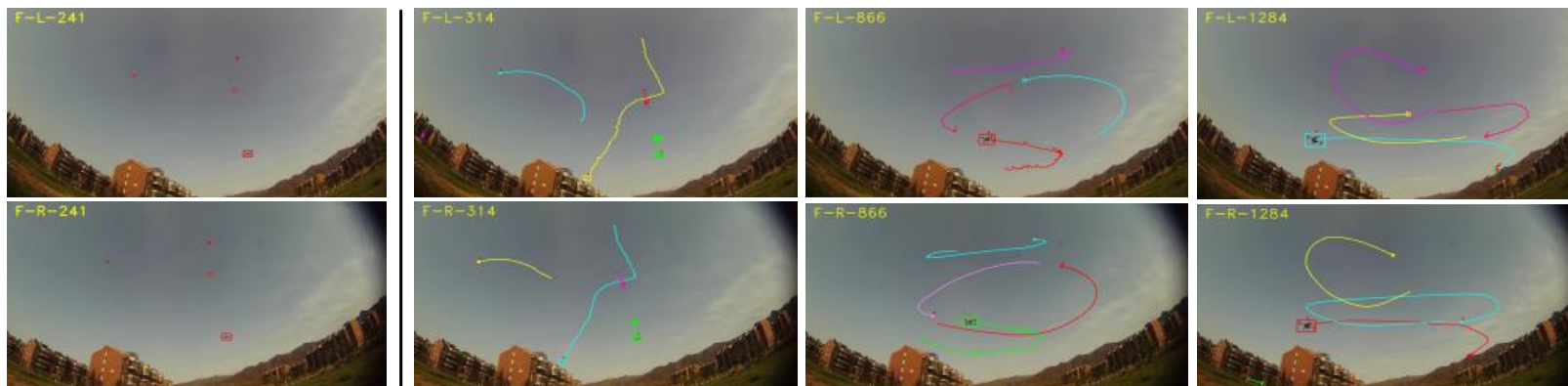
(a) Epipolar Inliers



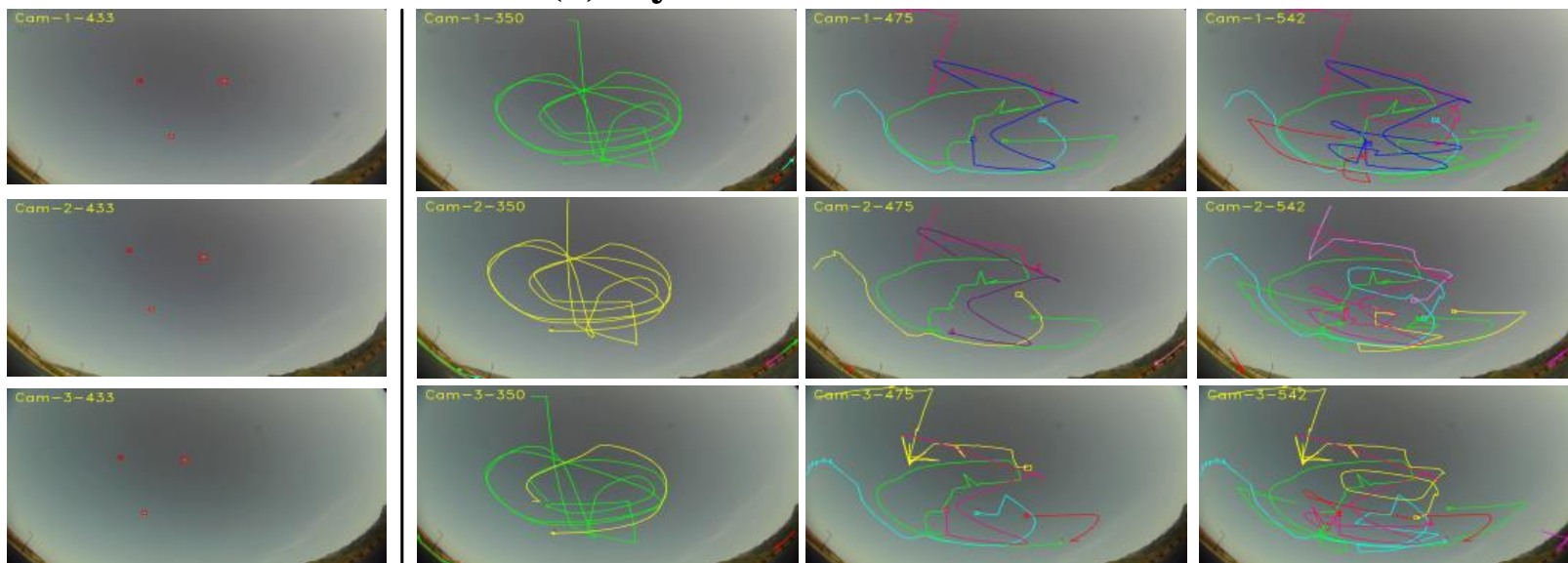
(b) Self-calibration result

# Experimental Results

## Multiple UAVs Detection and Tracking Results



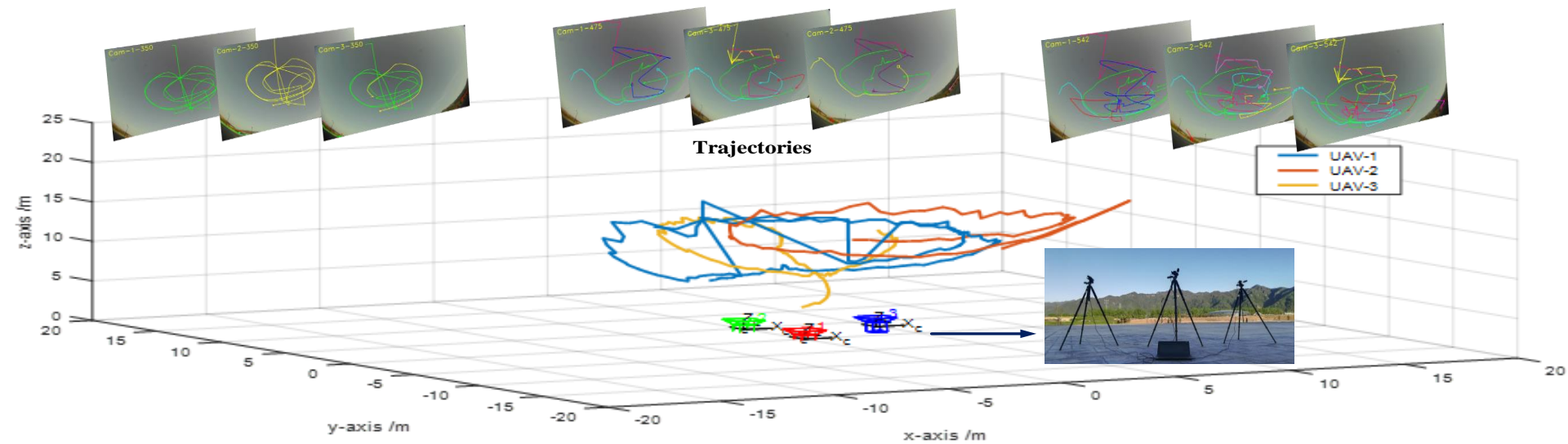
(a) layout of two cameras



(b) layout of three cameras

# Experimental Results

## Multiple UAVs 3D Localization and Trajectory Results



# Conclusion

## Innovation point

- ❖ Constructing a new type of wide-angle ground fisheye camera array for the first time, which applies to monitor and track multiple UAVs in large areas.
- ❖ Proposing a fast self-calibration method for arbitrary layout of ground camera array.
- ❖ Designing a real-time intelligent anti-UAVs surveillance system, plenty of filed experiments fully proved the effectiveness of the system.

## Performance

- ❖ our surveillance system can effectively monitor the airspace within **50m** meters

**Thank you!**