

Google Map Aided Visual Navigation for UAVs in GPS-denied Environment

Mo Shan, Fei Wang, Feng Lin, Zhi Gao, Ya Z. Tang, Ben M. Chen

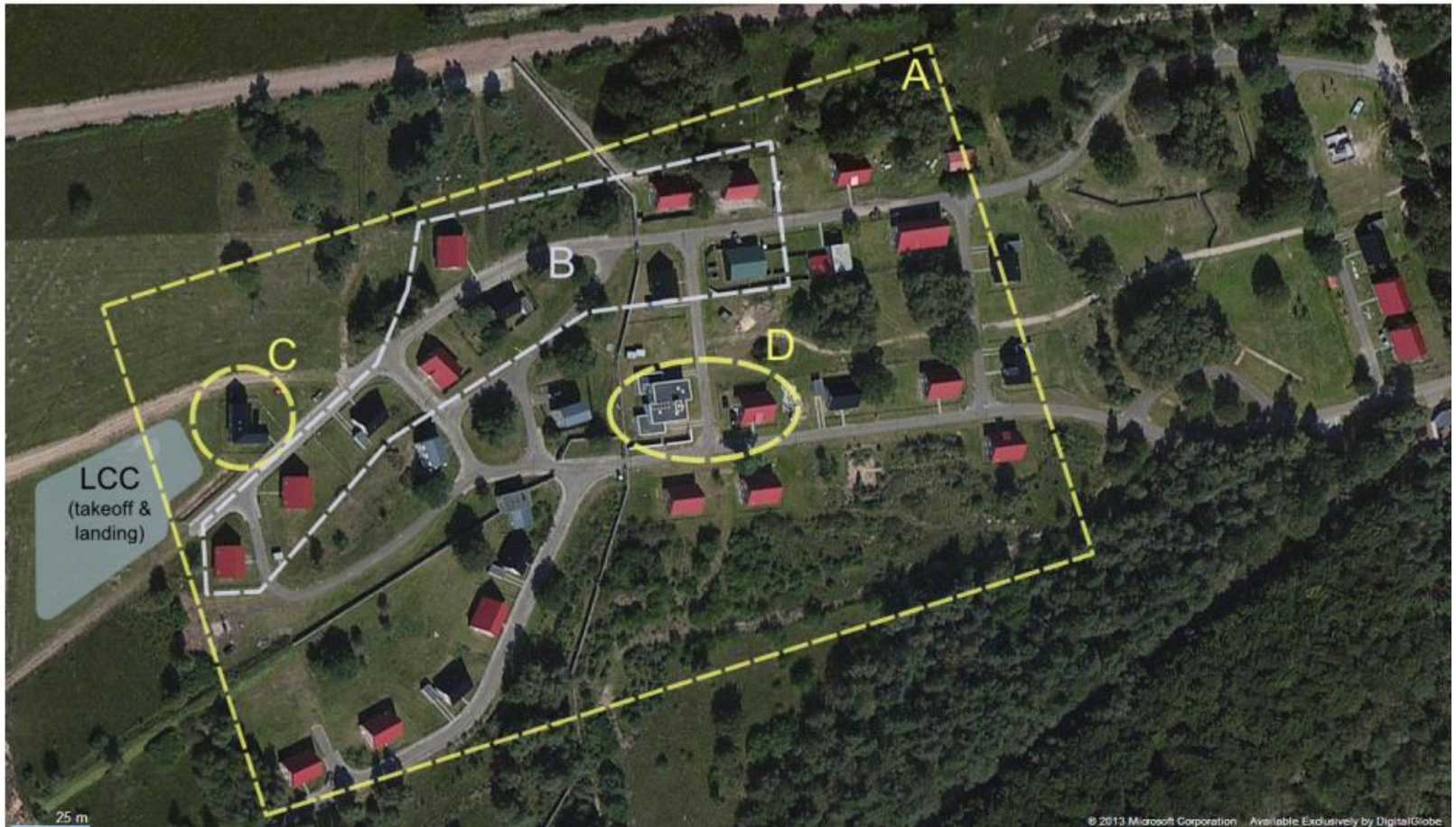
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Temasek Laboratories

National University of Singapore



Visual Navigation

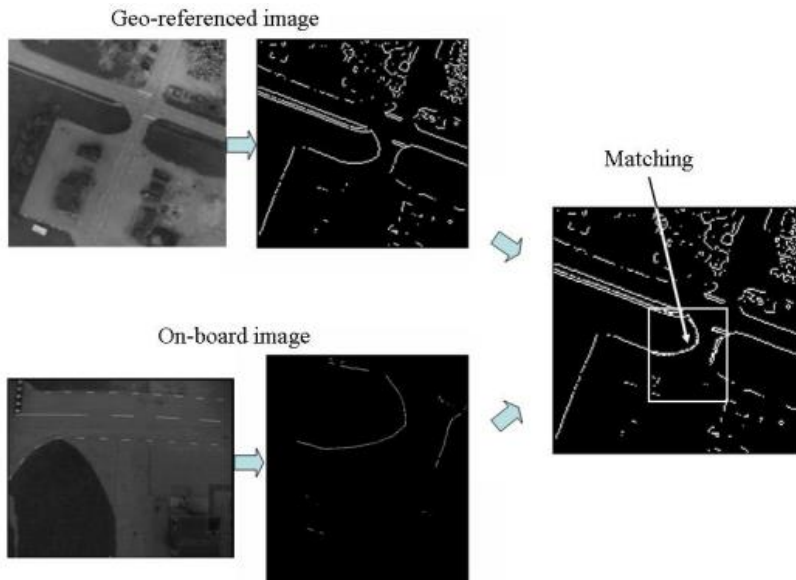


Source: IMAV 2014

Village Photomap



Literature review



Source: Conte and Doherty



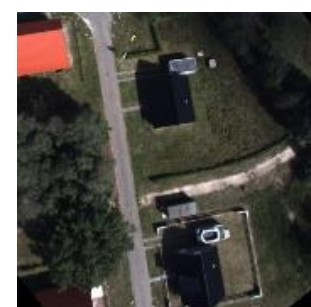
Source: Lindsten et al.

Google Map

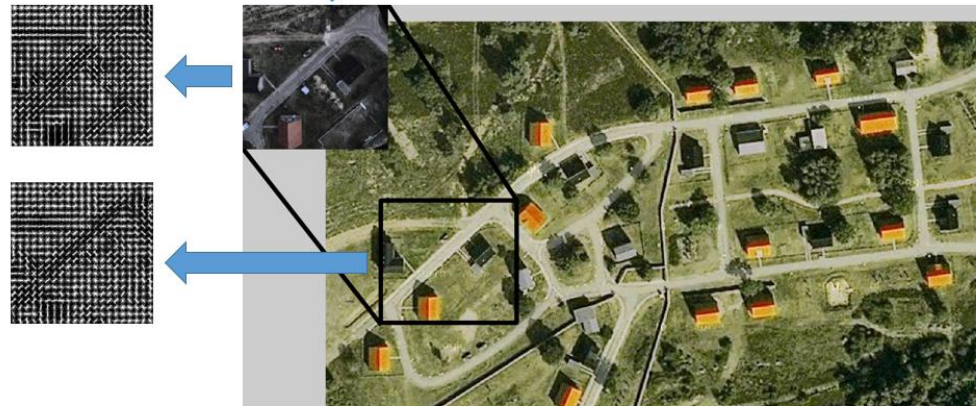
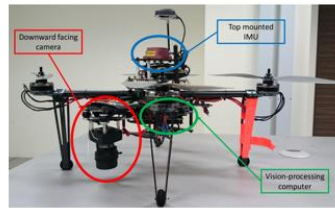
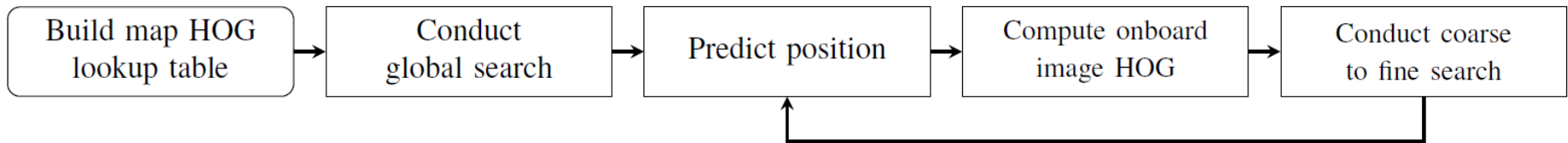


Challenges

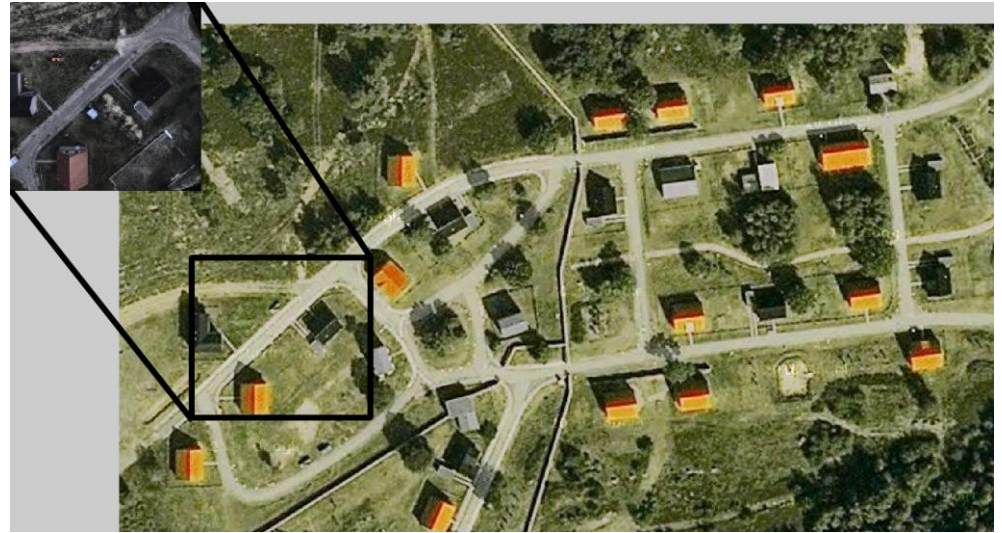
- Modality change
- Scene change
- Illumination change



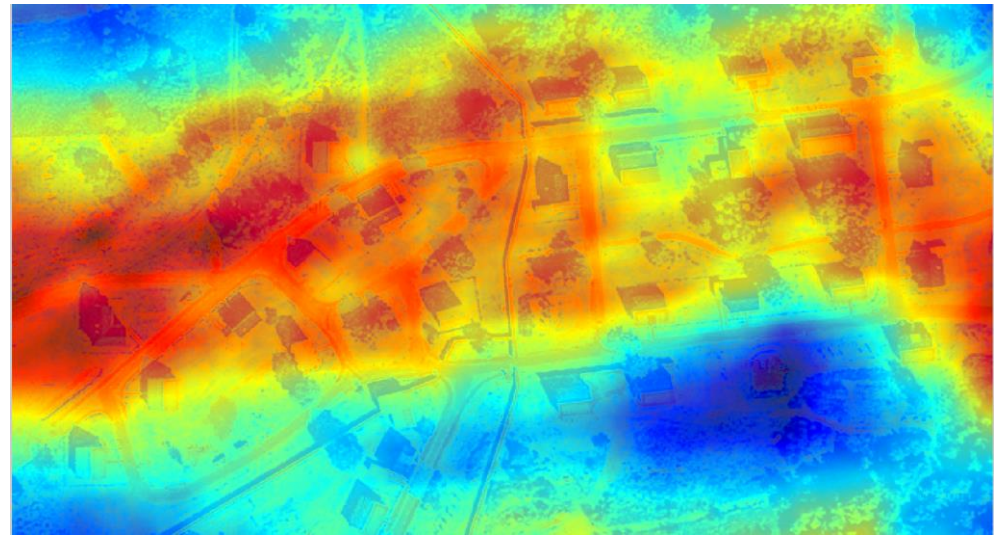
Overview



Initial position



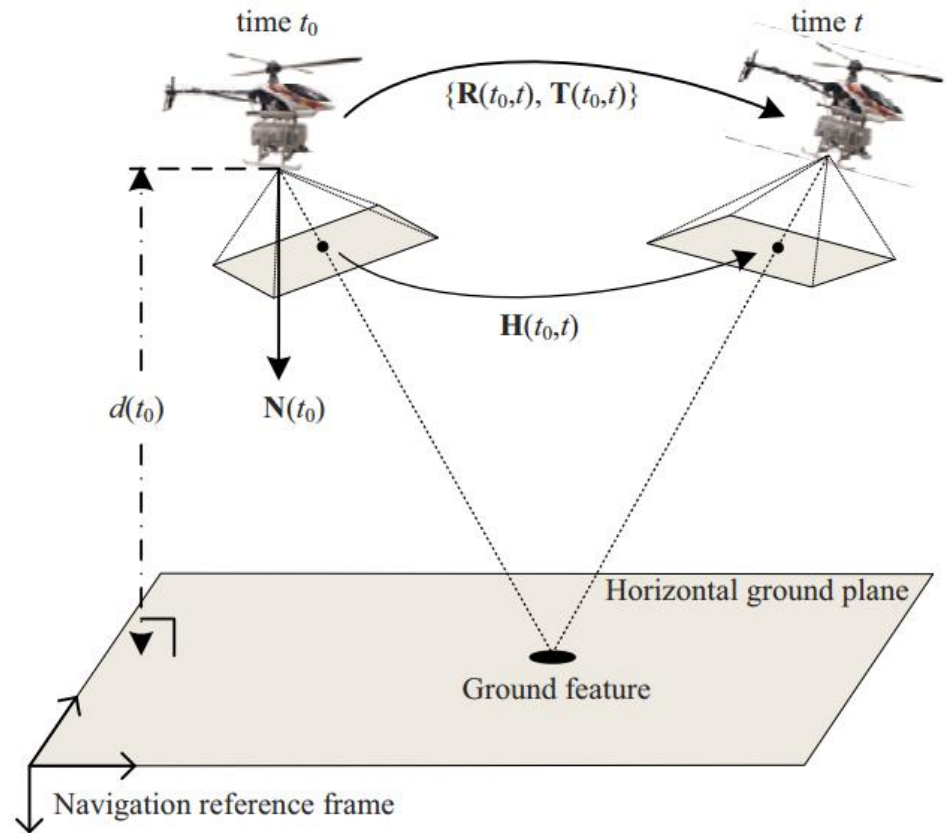
$$G = F \odot H^*$$



Position prediction

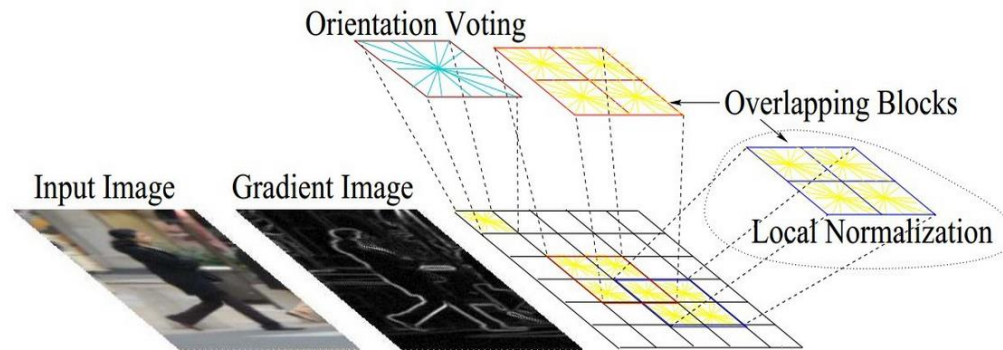
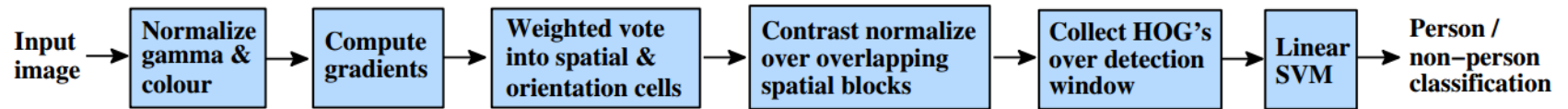
$$\mathbf{H} = \mathbf{R} + \frac{1}{h} \mathbf{T} \mathbf{N}^T$$

$$\mathbf{T} = h(\mathbf{H} - \mathbf{R})\mathbf{N}$$



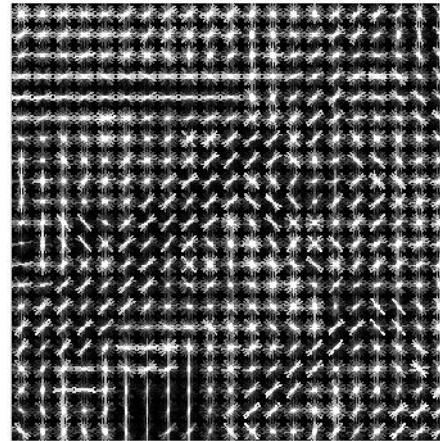
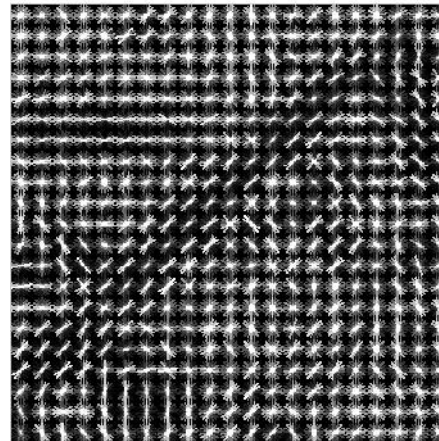
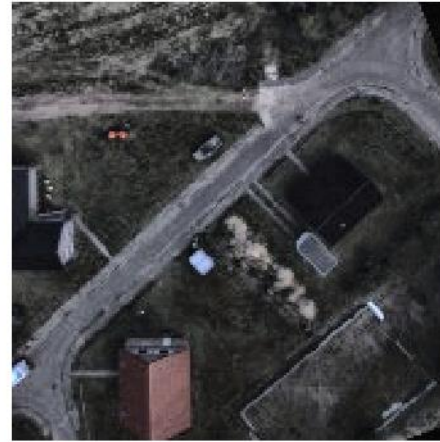
Source: Zhao et al.

HOG



Source: Dalal and Triggs

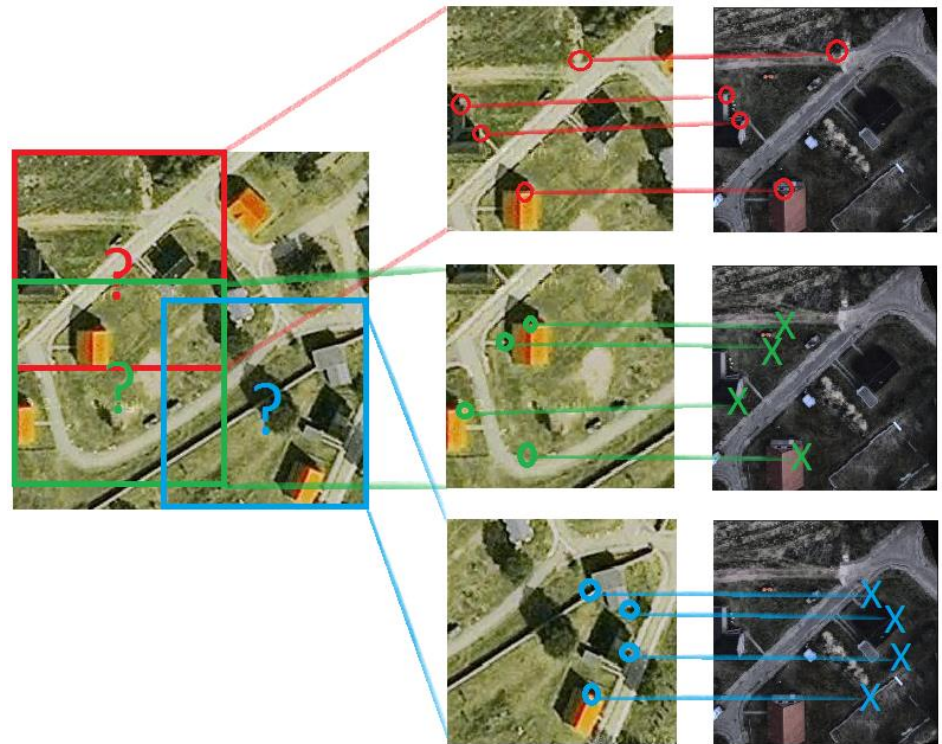
Image descriptor



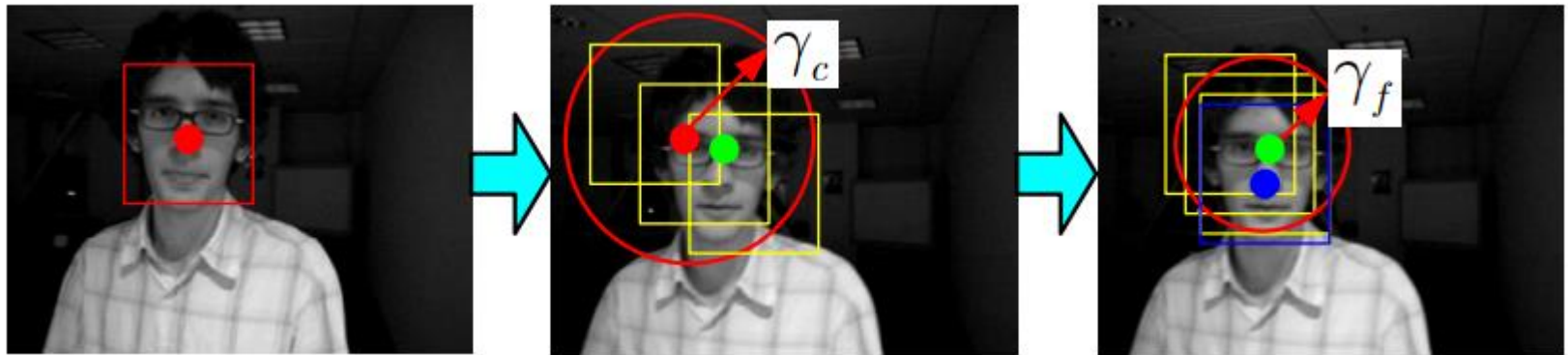
PF localization

$$\hat{w} = \frac{1}{\sqrt{2\pi\sigma}} \exp\left(\frac{-d^2}{2\sigma^2}\right)$$

$$E(l) = \sum_{i=1}^N w_i l_i$$



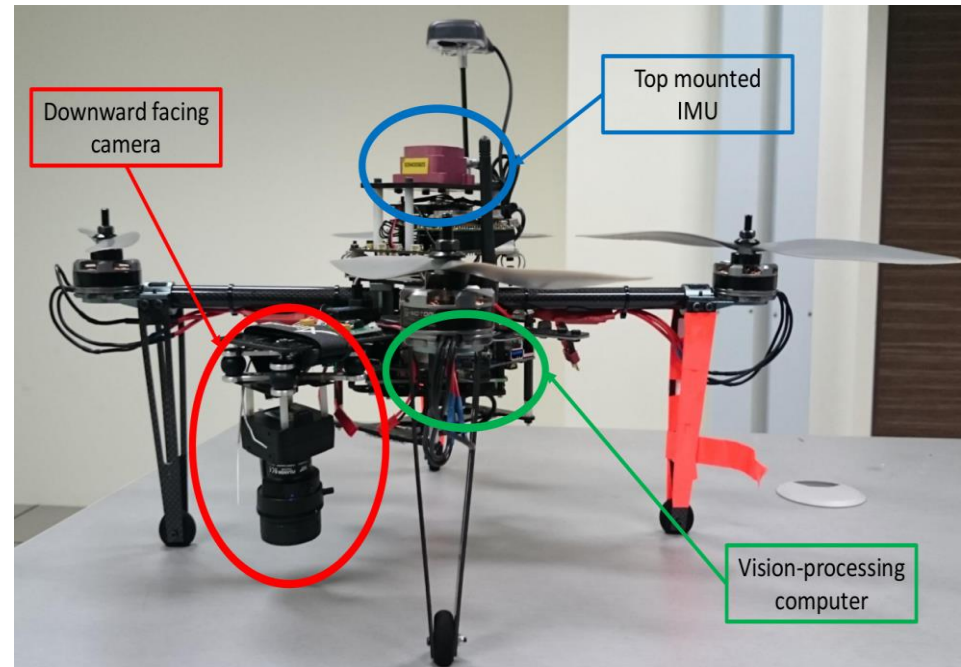
Coarse to fine search



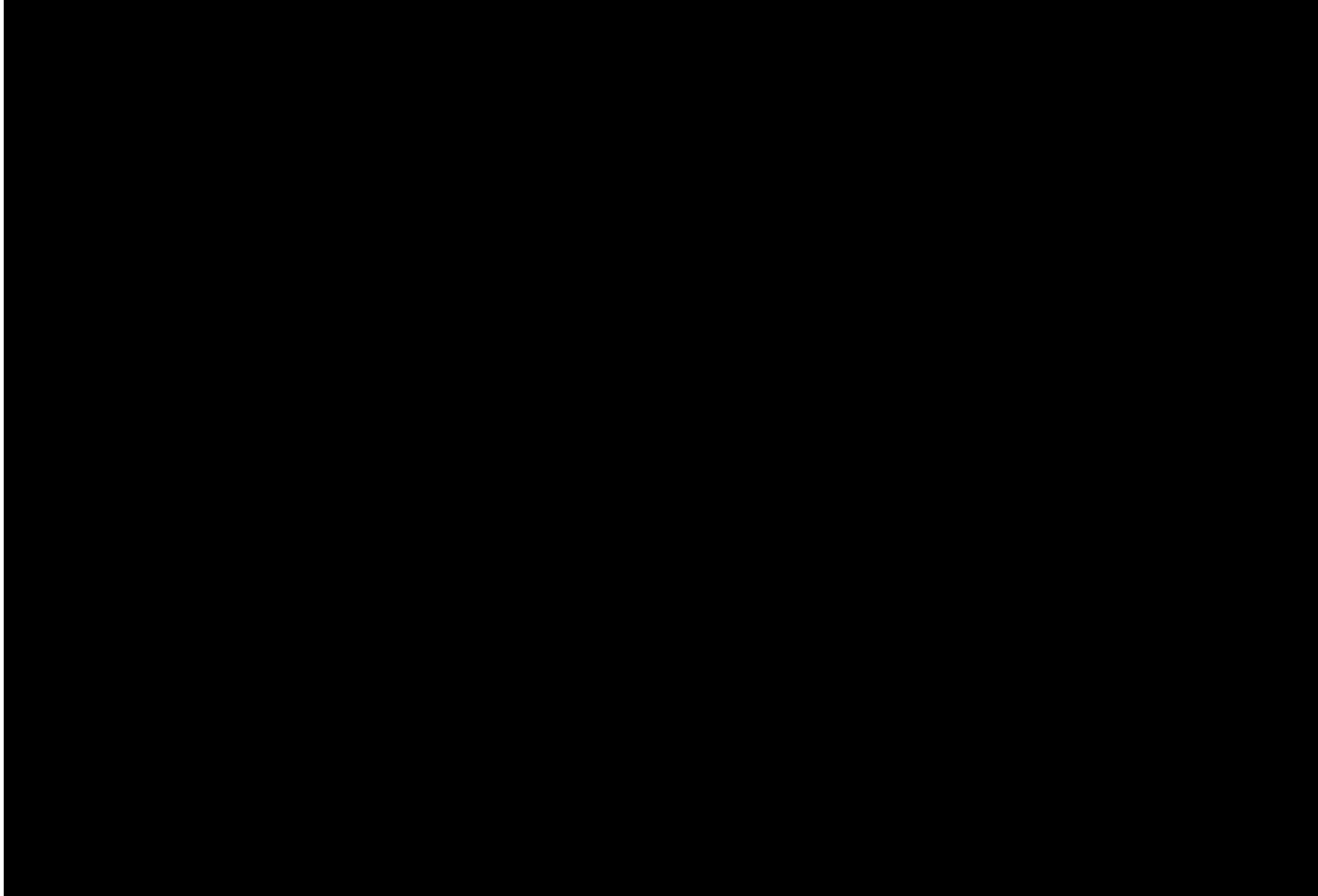
Source: Zhang et al.

UAV platform

- IG-500N
- PointGrey camera
- Mastermind

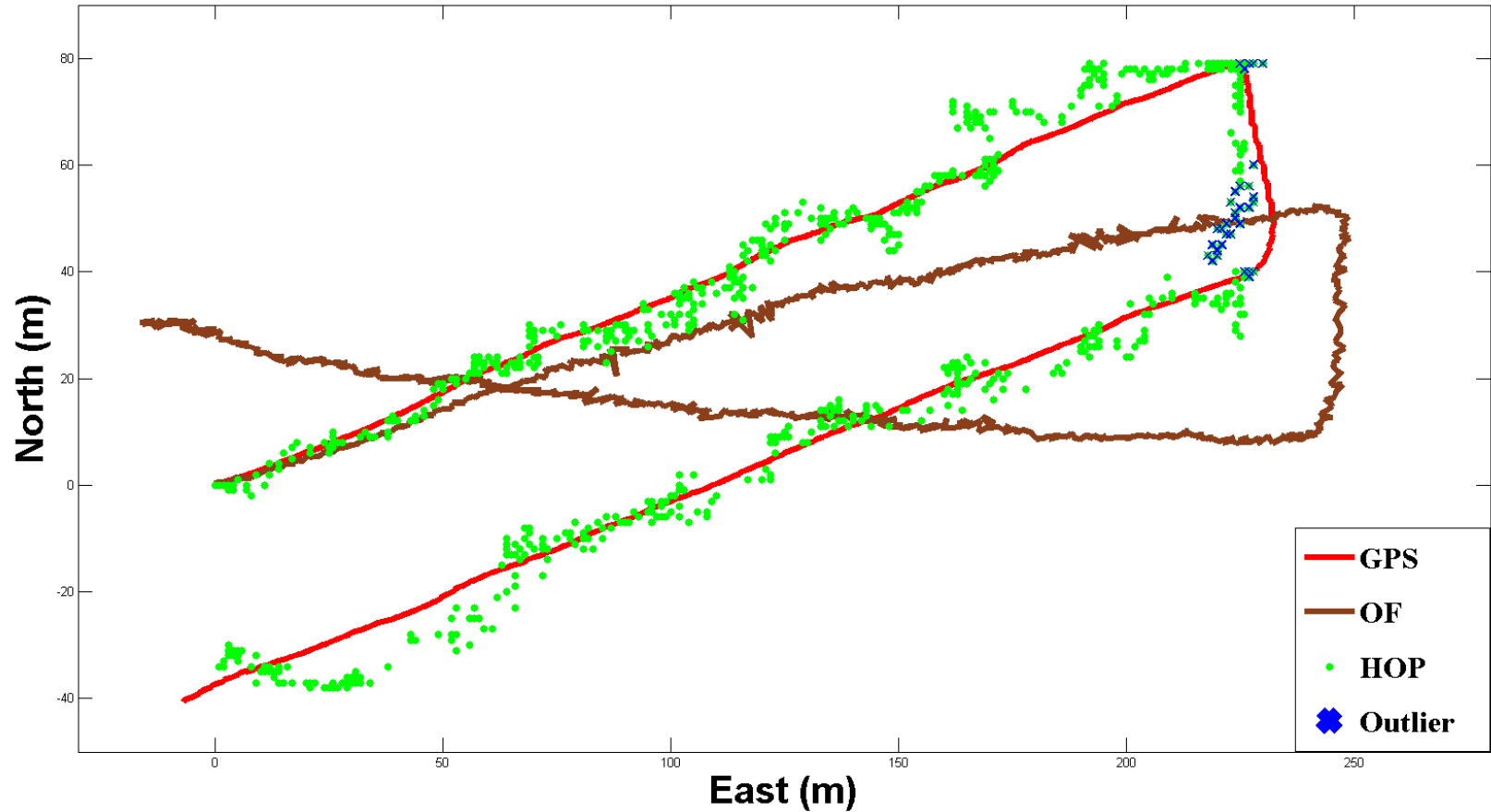


Video demo



Experiment

Trajectory in NED



Conclusion

- UAV localization aided by Google Map
 - Initial position by correlation
 - Position prediction by homography decomposition
 - Image description by HOG
 - Coarse to fine search by particle filter
- A preliminary test as dataset is limited
 - Collect more dataset

References



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- K. Zhang, L. Zhang, and M.-H. Yang, “Fast compressive tracking,” *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, vol. 36, no. 10, pp. 2002–2015, 2014.

THANK YOU

Q&A