Online Learning for Visual Navigation of UAVs

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Background & Motivation

- Fleets of UAVs will carry out rescue, service and surveillance missions.
- Navigation essential to perform missions.
- Visual methods for localization if GPS outage or unreliable reception.
- 3D models commonly available from e.g. satellite imagery.
- Pose estimation by registration of aerial imagery with 3D model.
- Cities, infrastructure and landscape change.

Image from propertycasualty360.com.

3D model of Linköping, courtesy Vricon Systems.

Aerial image from Linköping.

Research Goal & Questions

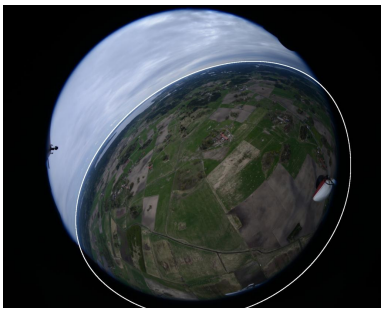
- Develop visual method (CNN) for aerial localization
  - Seasonal variations
  - Structural changes
  - Lighting conditions [4]
- Develop online learning process for aerial localization allowing 3D map updates
  - Change detection
  - Essential features/objects/areas
  - 3D map representation - sharing updates

Rendered image.

Warped aerial image.

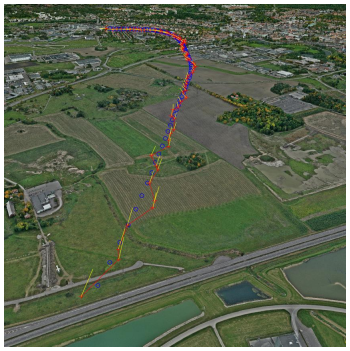
Methods & Preliminary Results

- Attitude estimation from detected horizon line.
- Fine-tune attitude estimate through alignment with geometrical horizon line [1].



Detected horizon line for attitude estimation.

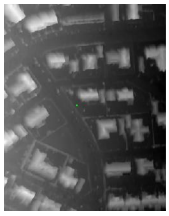
- For localization, use pretrained CNN [2], add pose estimation layer as in [3].
- Trained on 25k rendered images from 3D model of Linköping.
- Achieved median error:
  - Position 25 m
  - Heading 5°



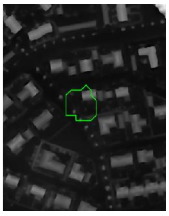
3D map of Linköping with estimated flight path.

Virtual flight path.

- Fine-tune pose estimate by registration of local height patch with 3D model [5].

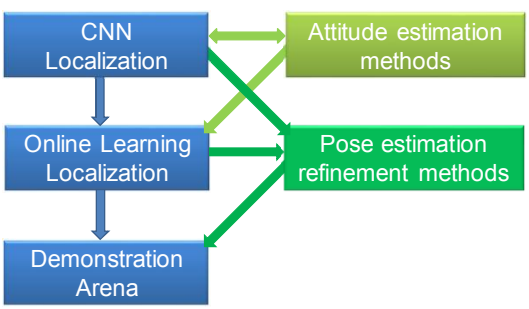


Local height patch from aerial images.



Height map from 3D model.

Roadmap & Milestones



References

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[2] Szegedy, C., Liu, W., Jia, Y., Sermanet, P., Reed, S., Anguelov, D., & Rabinovich, A. (2015). Going deeper with convolutions. In *CVPR*.
[3] Kendall, A., Grimes, M., & Cipolla, R. (2015). PoseNet: A convolutional network for real-time 6-DOF camera relocalization. In *ICCV*.
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