

Geographically Local Representation Learning with a Spatial Prior for Visual Localization



continuation of the research project

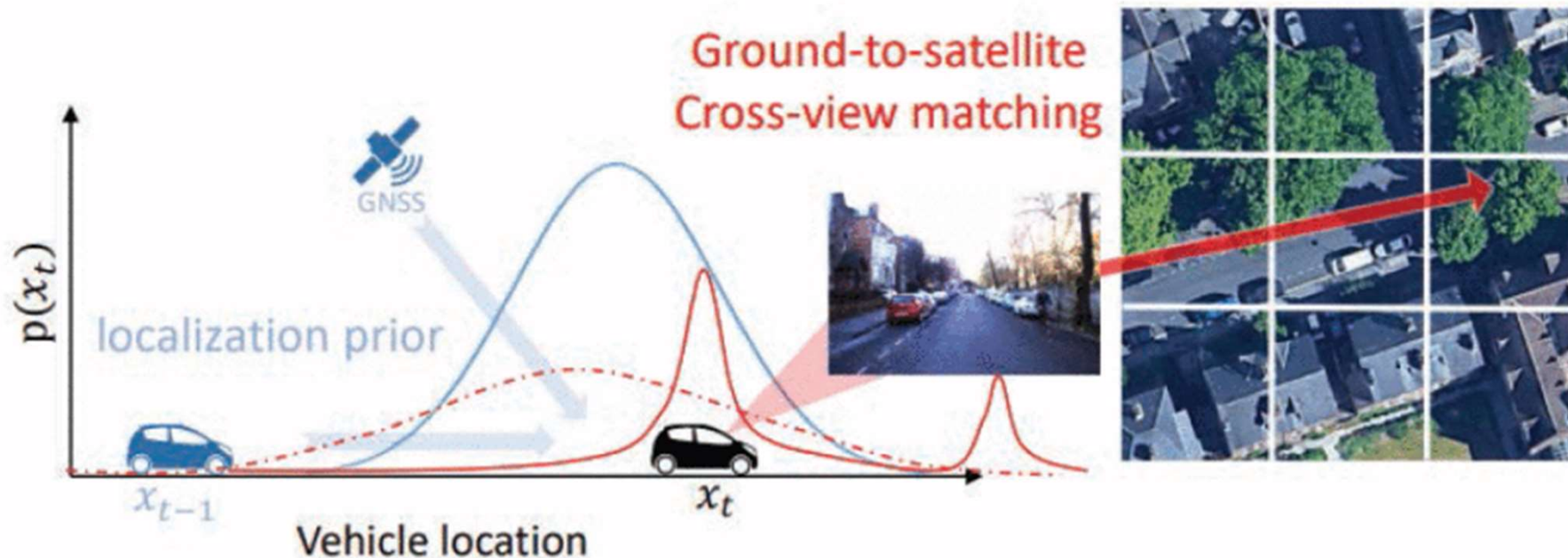
Meaningful Control of Autonomous Systems

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sabbatical @**TU Delft**, Intelligent Vehicles
Feb - May, 2022

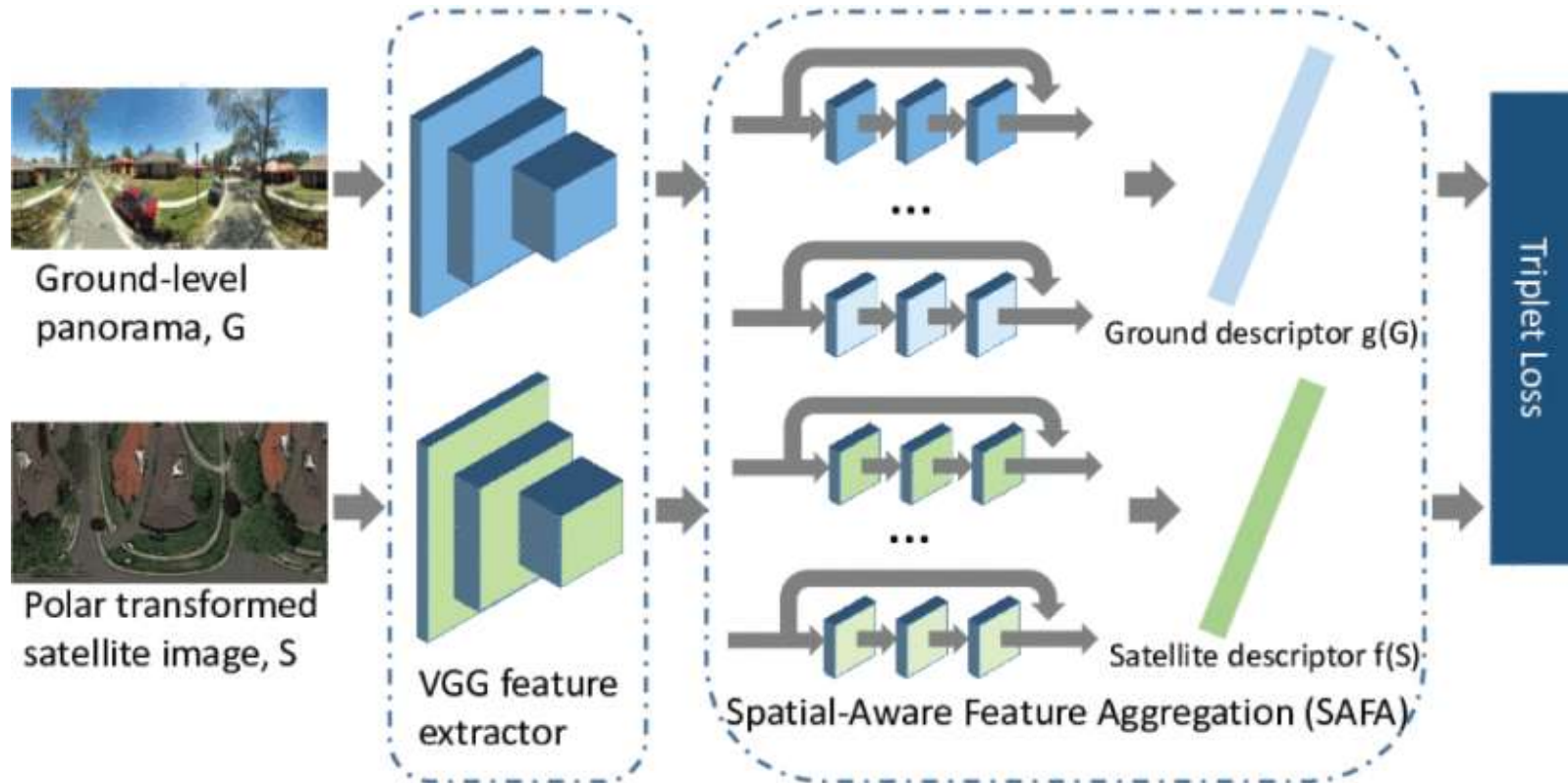


Prior work



Vehicles can use cross-view matching between camera images and satellite patches for self-localization, resulting in a geo-global localization estimate

Method



satellite patches are converted to polar plots,
to be matched with ground level images

Test Results

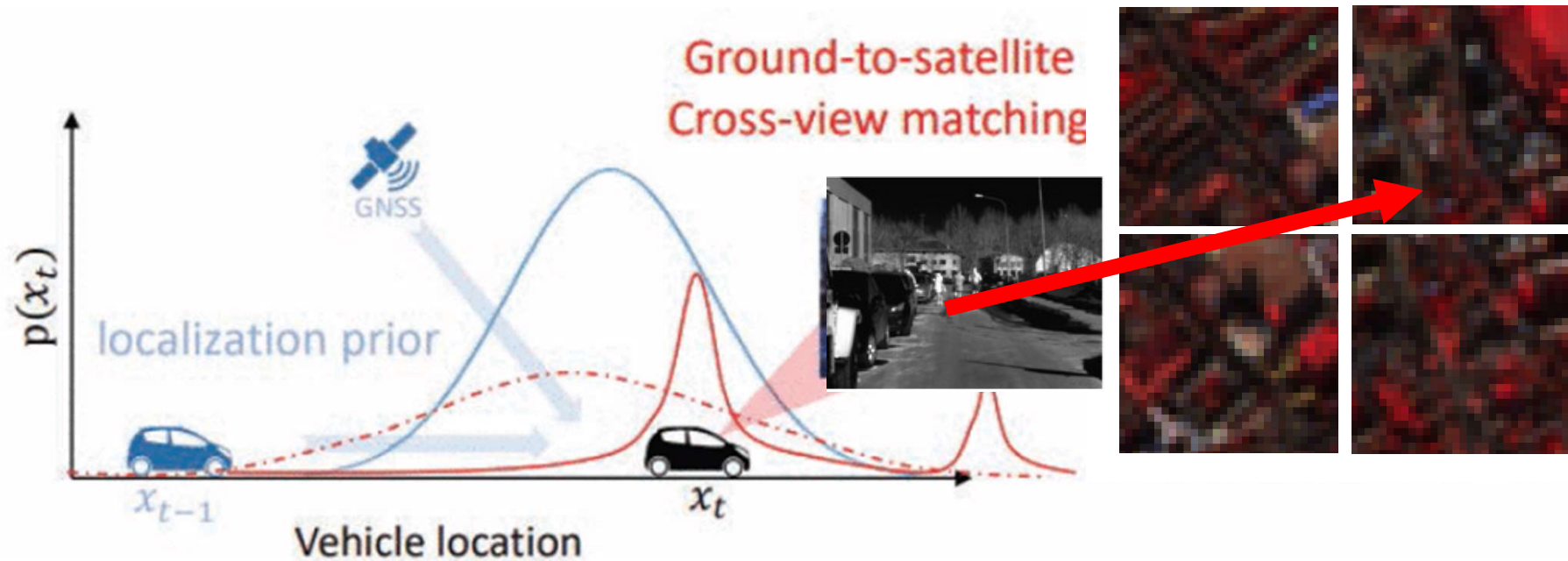


(a)

(b)

Method was evaluated on the Oxford RobotCar dataset

Proposed method work



Using the cross-view method in infrared spectrum,
to localize on vegetation patterns

High resolution IR images



Superview NIR image, Oostervaart, Leystad

Superview 1-2 gives NIR with 2m resolution,
Pléiades NEO would give 1.2m resolution, Worldview 0.5m.

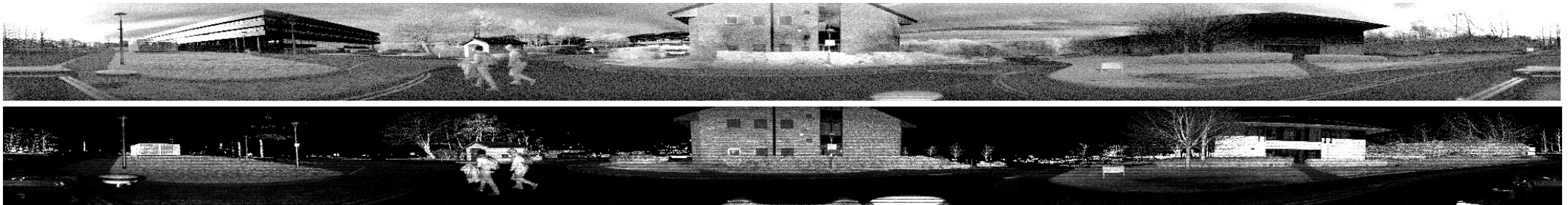
High resolution IR images



SpaceNet 6 dataset NIR+RG image, Grote Kerk, Vlaanderen

0.25m NIR images are available for NL from aerial sensors.

High resolution IR images

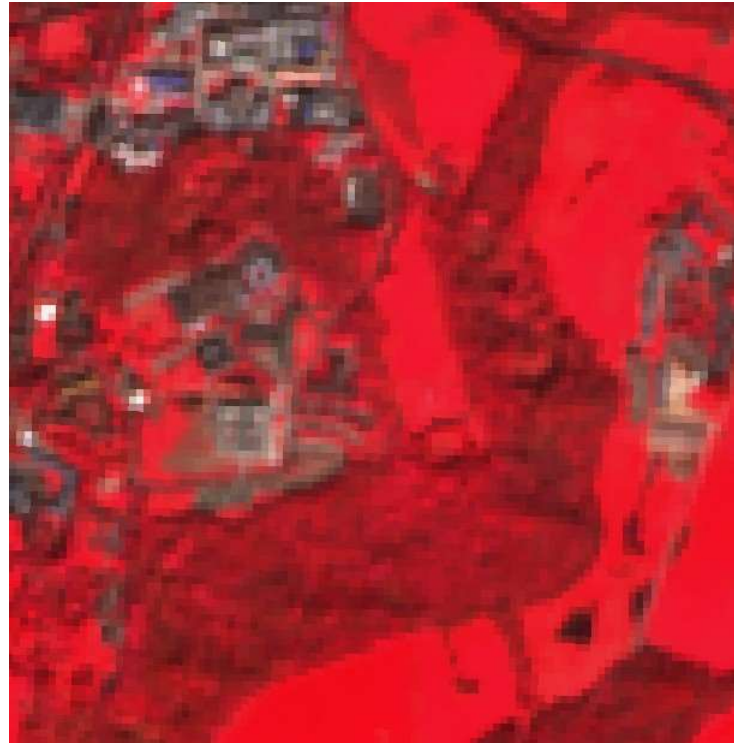


Durham campus, Ouster dataset, NIR, ambient illumination

3D LiDAR like the Ouster OS1-128 provide NIR panoramas.

L. Li et al, [DurLAR: A High-fidelity 128-channel LiDAR Dataset with Panoramic Ambient and Reflectivity Imagery for Multi-modal Autonomous Driving Applications](#),
Proceedings of International Conference on 3D Vision, 2021, pp. 1227-1237

Low resolution IR images



Durham campus, NIR, Sentinel 2

Sentinel-2 only gives 10-20m resolution.

Unfortunately, the access to high resolutions satellite images via the ESA NoR sponsorship programme was only given after the end-date of the project.

Project Results



Could reproduce the results of Oxford RobotCar dataset
with Google Map images on lower resolution.

Note that the high-resolution Google Map images are from aerial sensors

Z. Xia, O. Booij, M. Manfredi, J.F.P. Kooij,
[Cross-View Matching for Vehicle Localization by Learning Geographically Local Representations](#),
IEEE Robotics and Automation Letters (RA-L), 2021, vol. 6(3), 5921-5928

Project Results

The screenshot displays the Sentinel Hub Requests Builder web interface. The browser address bar shows <https://apps.sentinel-hub.com/requests-builder/>. The interface is divided into several sections:

- Select API:** Includes tabs for Process, Batch, 3rd Party Data Import, Catalog, Statistical, and OGC Services.
- Data Collection:** Features a dropdown menu set to 'sentinel-2-12a', a 'Hide advanced options' toggle, 'Cloud Coverage - 20%' slider, 'Mosaicking Order' set to 'Least CC', 'Upsampling' set to 'Default (nearest)', 'Downsampling' set to 'Default (nearest)', and a 'Reset to default' button.
- Time Range:** Includes a 'Disable timerange' toggle, 'Time From' set to '2022-04-12', and 'Time To' set to '2022-05-12'.
- Area of interest:** Shows a map with a blue polygon selection. The 'Area selected' is 0.74 km². A note states: 'When drawing geometries in CRSs other than WGS:84 the resulting text geometry can have some minor errors due to re-projection to EPSG:4326'. The map includes a scale bar (500m, 1000m) and a 'Finish' button.
- Output:** Includes 'Height / Width' and 'Resolution' tabs. 'Width' is 777.668, 'Height' is 294.538, 'Keep auto ratio' is checked, 'Image Format' is 'JPEG', and 'Identifier' is 'default'. An 'Add Response' button is present.
- Request Preview:** Shows a text box with the following coordinates:

```
[  
-1.2716360879,  
51.75834090005,  
-1.2513821943,  
51.76308912605  
]
```

 Below the text box are 'Parse' and 'Upload KML/GeoJSON' buttons.

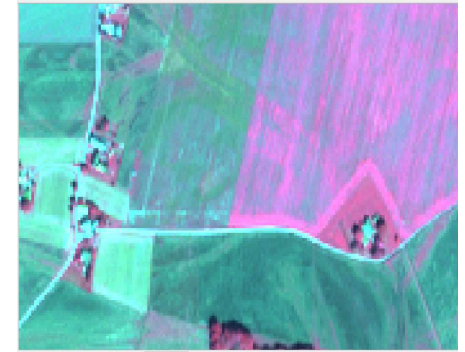
At the bottom left, there is an 'Evalscript' section with 'Set to default evalscript' and 'Custom scripts repo' options.

Learned to automatically request a grid of satellite images via the Sentinel Hub python-API on specific place, time and weather conditions

<https://github.com/sentinel-hub/sentinelhub-py>



Lessons learned



- Satellite images are available in variety of spectral bands, richer than most ground-based datasets.
- Finding a good satellite image at the right time, place, spectral band, weather conditions and resolution require an advanced query language.
- For navigation purposes, aerial sensors can provide the required resolution.
- Combining satellite and aerial imagery from different sources, as seamlessly done by Google Maps, requires impressive skills and resources.
- Doing the same for multi-spectral images would be very beneficial for society.
- Satellite NIR images make it easy to distinguish infrastructure from vegetation, which is an opportunity for robust vehicle navigation.