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ADVANCING ROAD SAFETY THROUGH TWINNING

PhD SEMINAR SESSIONS

Web Page: https://twin-safe.com/

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Enhancing Road Safety through UAV captured Aerial Footage and Deep Learning: Object Detection, Risk Prediction, and Real-time Analysis

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Promoter: Prof. Dr. ir. Wim Ectors

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“Develop an automated road safety workflow in real space and time”

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Why “Real Space”??

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UAV Related Privacy Issues

UAV Live-Streaming Risks

Drones can inadvertently capture sensitive moments, raising privacy issues.

Increasing Surveillance Use

Drones are increasingly used for surveillance, necessitating privacy measures.

Recreational Drone Usage

As recreational drone use rises, so do privacy-related challenges.

Importance of Privacy Protection

Safeguarding privacy is essential to maintain trust in UAV operations.

Location-dependent Video Blurring

Location-based automated blurring can mitigate privacy risks during live-streaming.

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Near Real-time Privacy Protection: Automated Location-dependent Video Blurring in UAV live-streams
Presented at 1st International Conference on Smart Mobility and Logistics Ecosystems
(SMiLE – King Fahd University of Petroleum and Minerals (Dhahran, KSA)
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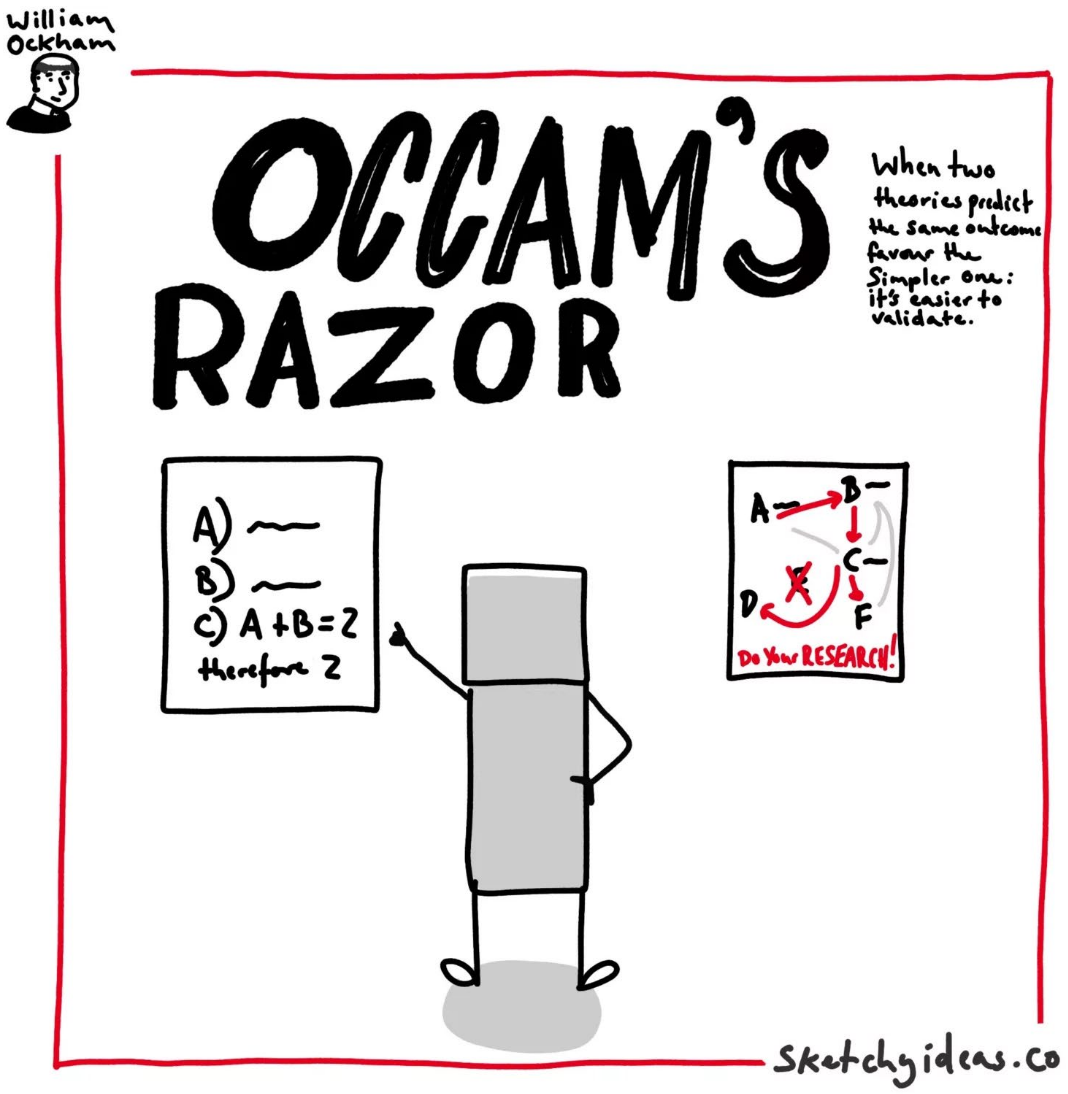
“The simplest explanation (solution) is usually the correct one!”



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Technology Stack: Hardware and Software

UAV Technology Integration

A DJI mini-pro coupled with a ground-based system.

Video Processing with SIFT Algorithm

OpenCV

Utilizing the Scale Invariant Feature Transform (SIFT) algorithm for precise template matching and georeferencing in live video streams.

Real-time Data Analysis Tools

A Real-Time Messaging Protocol (RTMP) for efficient live video processing.

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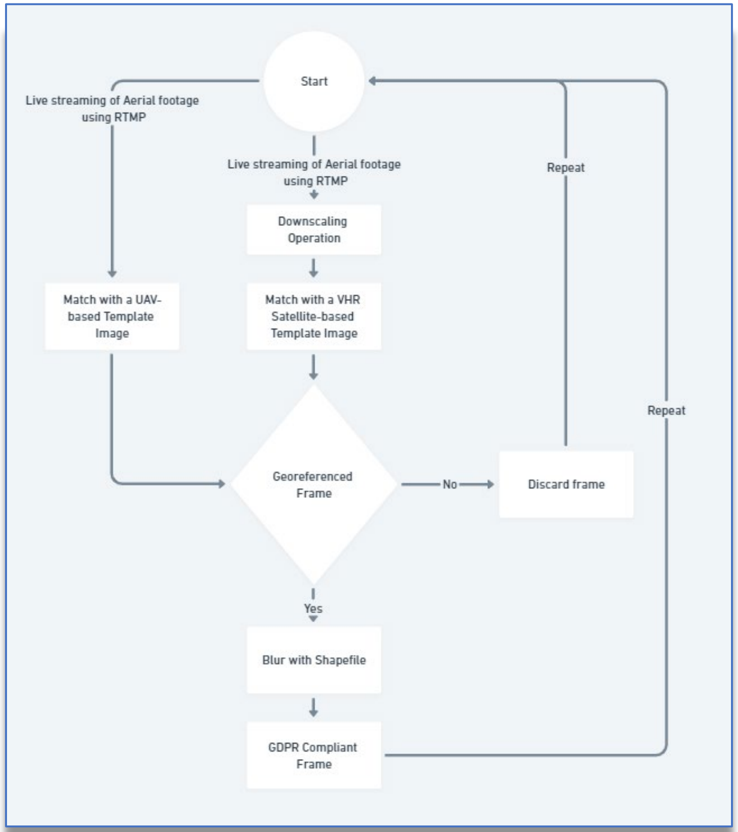
Near Real-time Privacy Preservation System

- A DJI mini pro connected to an RTMP server.
- A Real-time Messaging Protocol (RTMP).
- A Shapefile containing private properties.
- A georeferenced Orthomosaic.
- Scale Invariant Feature Transform (SIFT) algorithm.



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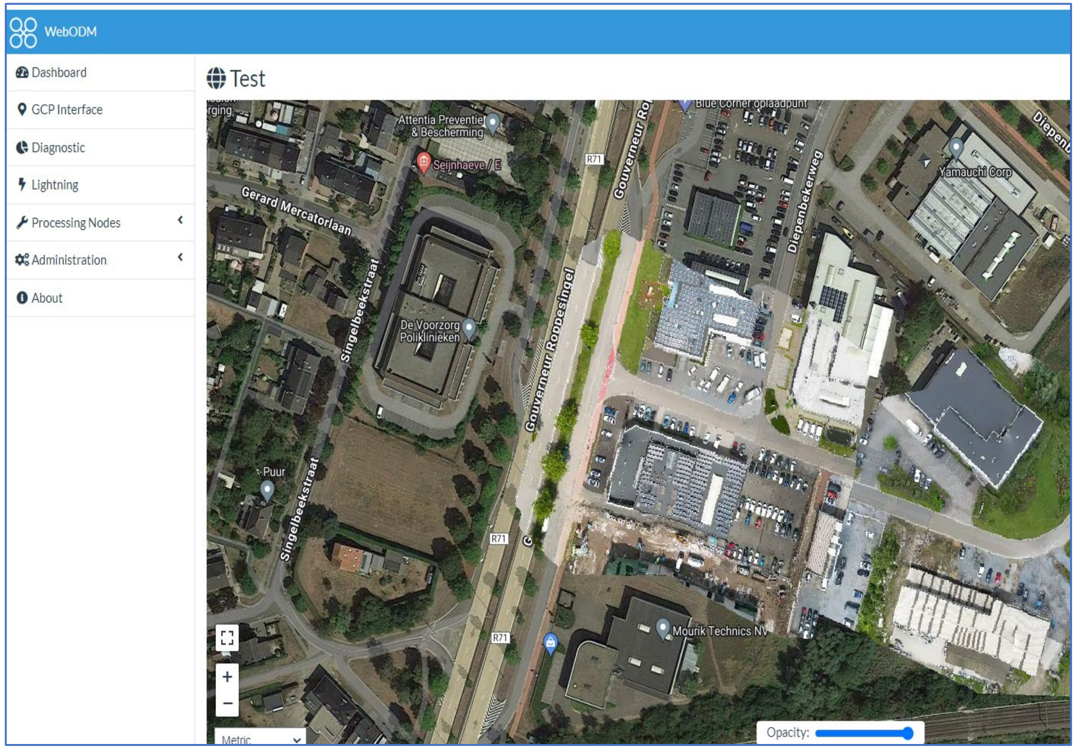
Step # 01: Developing an Orthomosaic Template Image

- The template image for experiment can be developed by either of two opensource tools i.e. QGIS or WebODM.
- WebODM offers faster orthomosaic development with minimal manual intervention.
- The error was checked by comparing sample GCP coordinates of orthomosaic with that of google earth.



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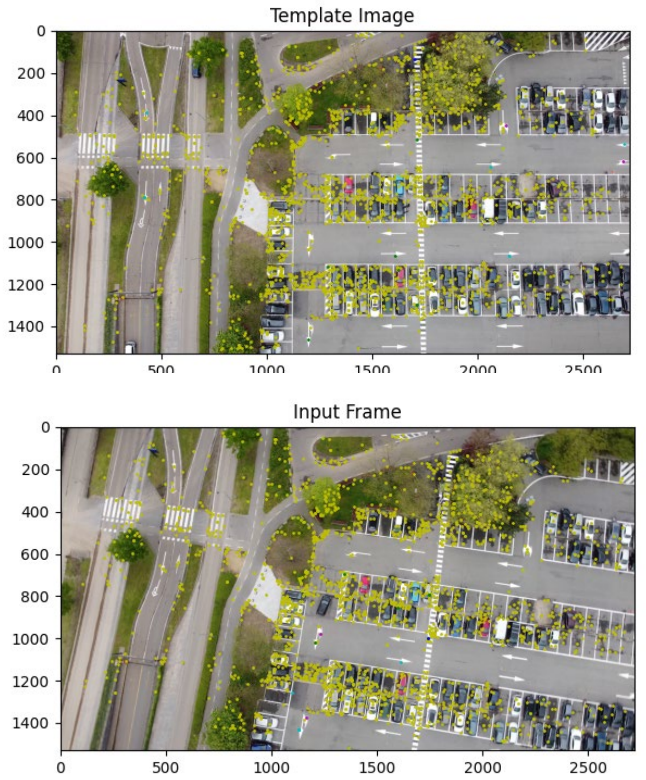
Step # 02: Feature Matching and Pixel to Geographical Space

- SIFT algorithm is used to match template image with live frames.
- Once keypoints are matched, the projection system is replicated onto the live frames based on homography.
- Quality ensured by monitoring the RMSE of geomatching.



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Step # 03: Applying Location-based Blurring

(a) is the template image whereas (b) is the zoomed in area with assumed restricted property for near real-time blurring.
Fig.3(c) shows the resulting image from another temporal period (as evident from the lane marking.

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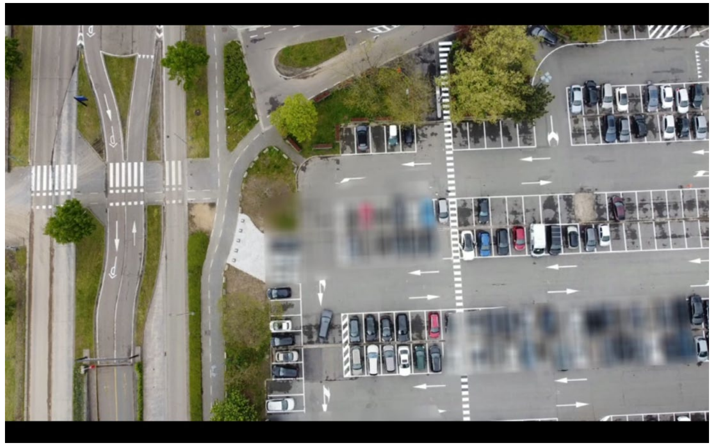
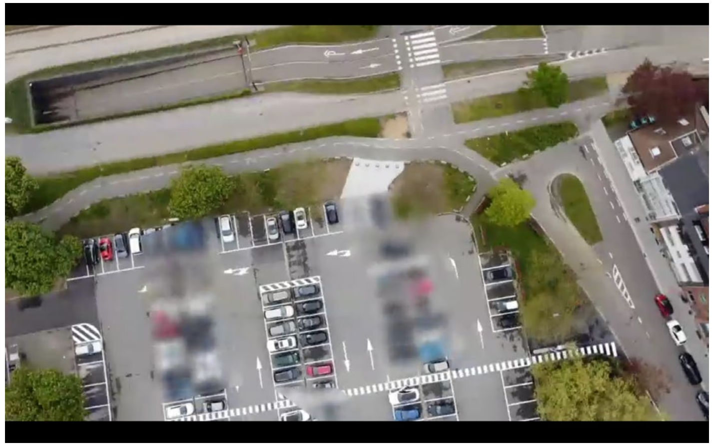
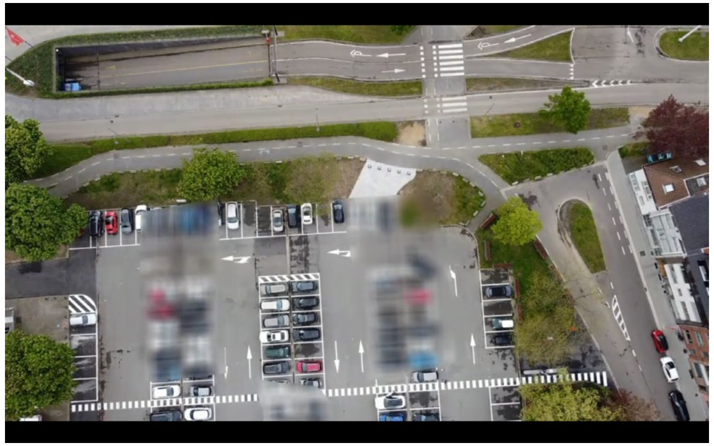
Demonstration







Drone Movement

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Performance under different conditions

Condition	Good	Fair	Poor	Remarks
Daytime	✔			Given that the area covered has a diverse topography and generates enough key points to match.
Night-time			✔	Without natural illumination, the algorithm struggles to find key points.
Decreased Topographic Diversity		✔		Requires threshold adjustments for the minimum key points required to georeference an image.
Angular Changes			✔	The method is affected by angular obscurity. The major limitation of this workflow is that the camera angle at which the input frame was taken must be identical to the template image.
Multi-UAV flight	✔			The workflow works great with mosaicking multiple simultaneous inputs from multiple live streams. The only constraint is the topographic diversity.

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From Stationary to Nonstationary UAVs: Deep-Learning-Based Method for Vehicle Speed Estimation

Published in Algorithms (Volume 17, Issue 12)

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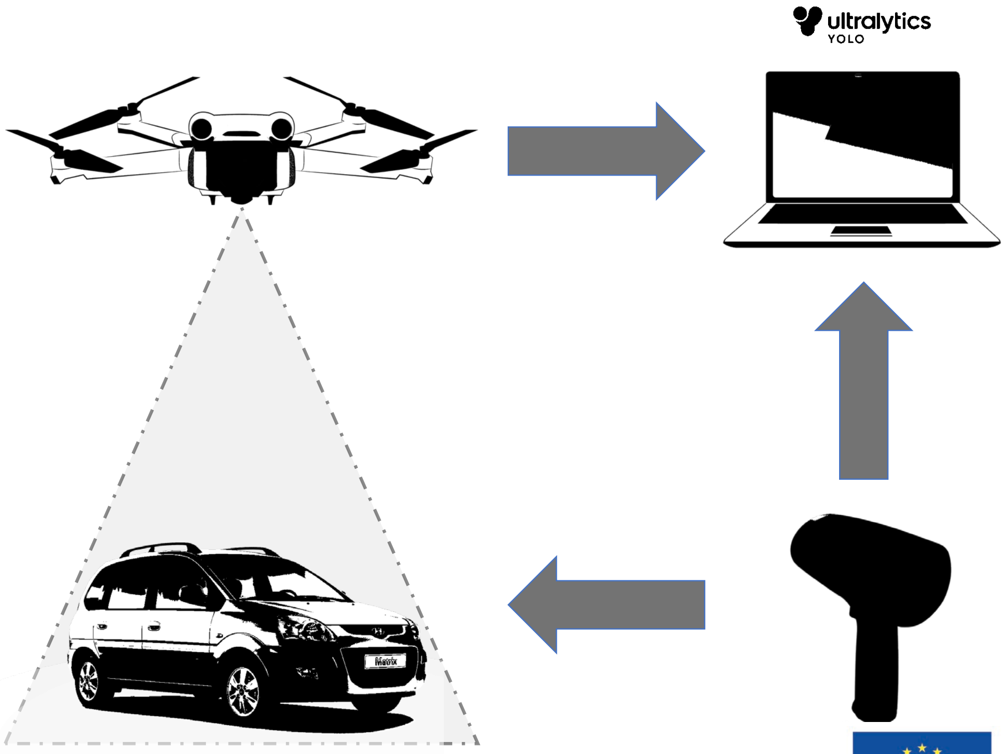
DL-Based Vehicle Speed Estimation

Experimental Setup:

- A vehicle (car) driven at a constant speed.
- DJI Mini pro (Stationary and Non-stationary Settings).
- Lidar-based Speed Gun for Validation



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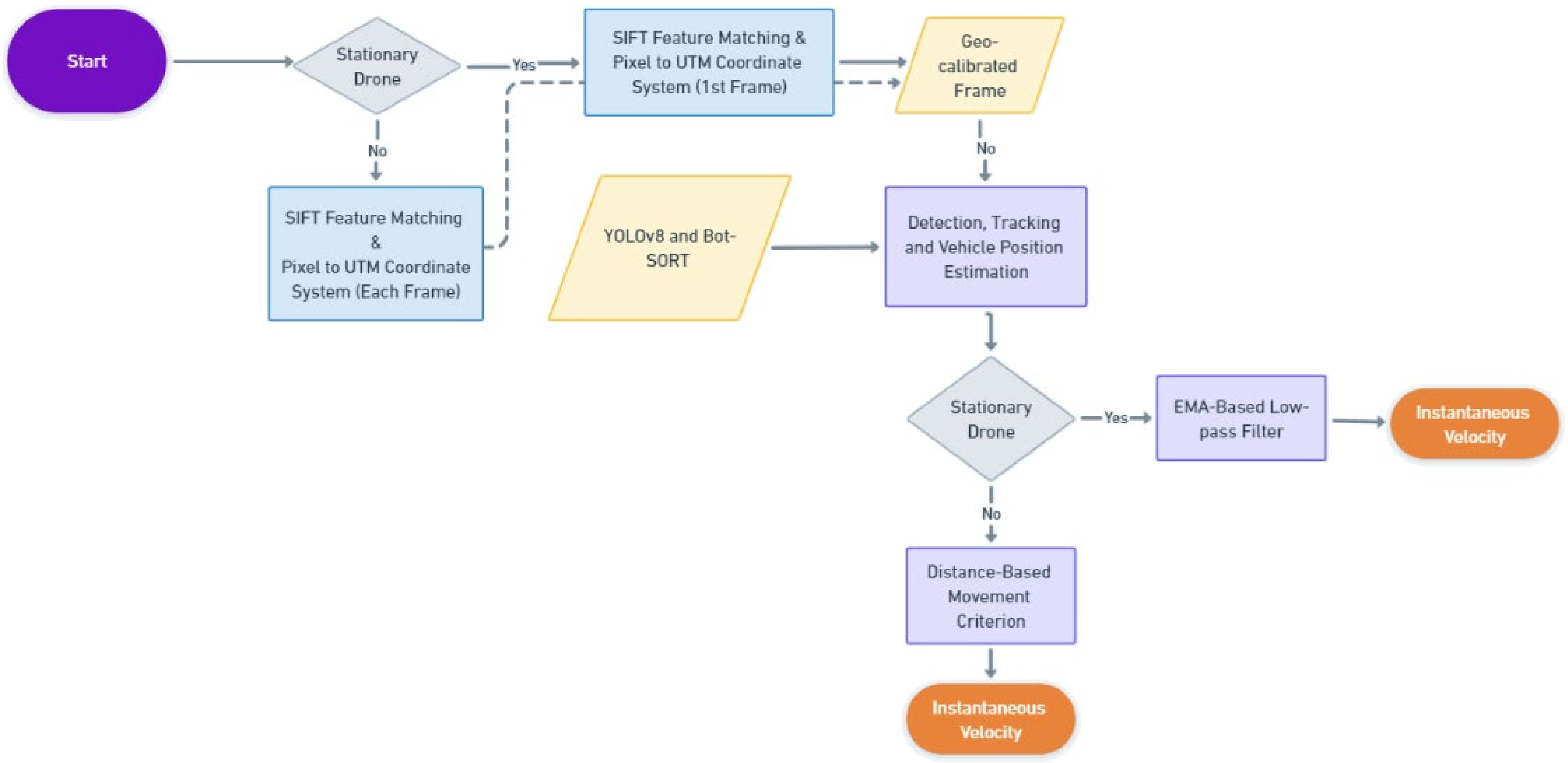
Workflow



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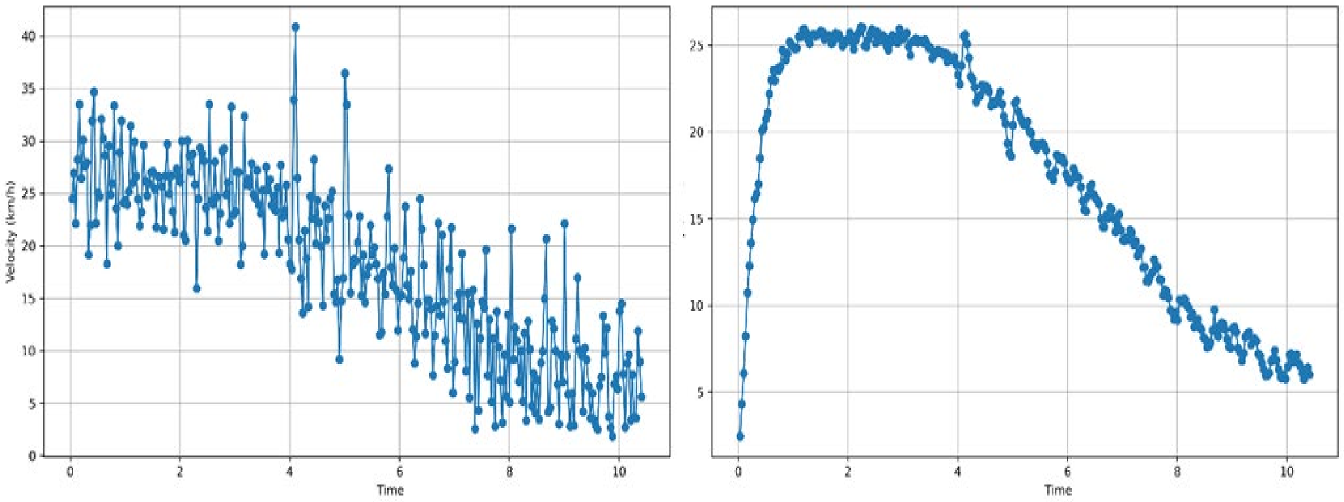
Velocity Measurements: Stationary Drone



Fluctuations in velocity (in km/h) over time (in seconds) and error removal of using an EMA-based low-pass filter ($\alpha = 0.1$). The single-point reference speed measured by the speed gun was 26 km/h.

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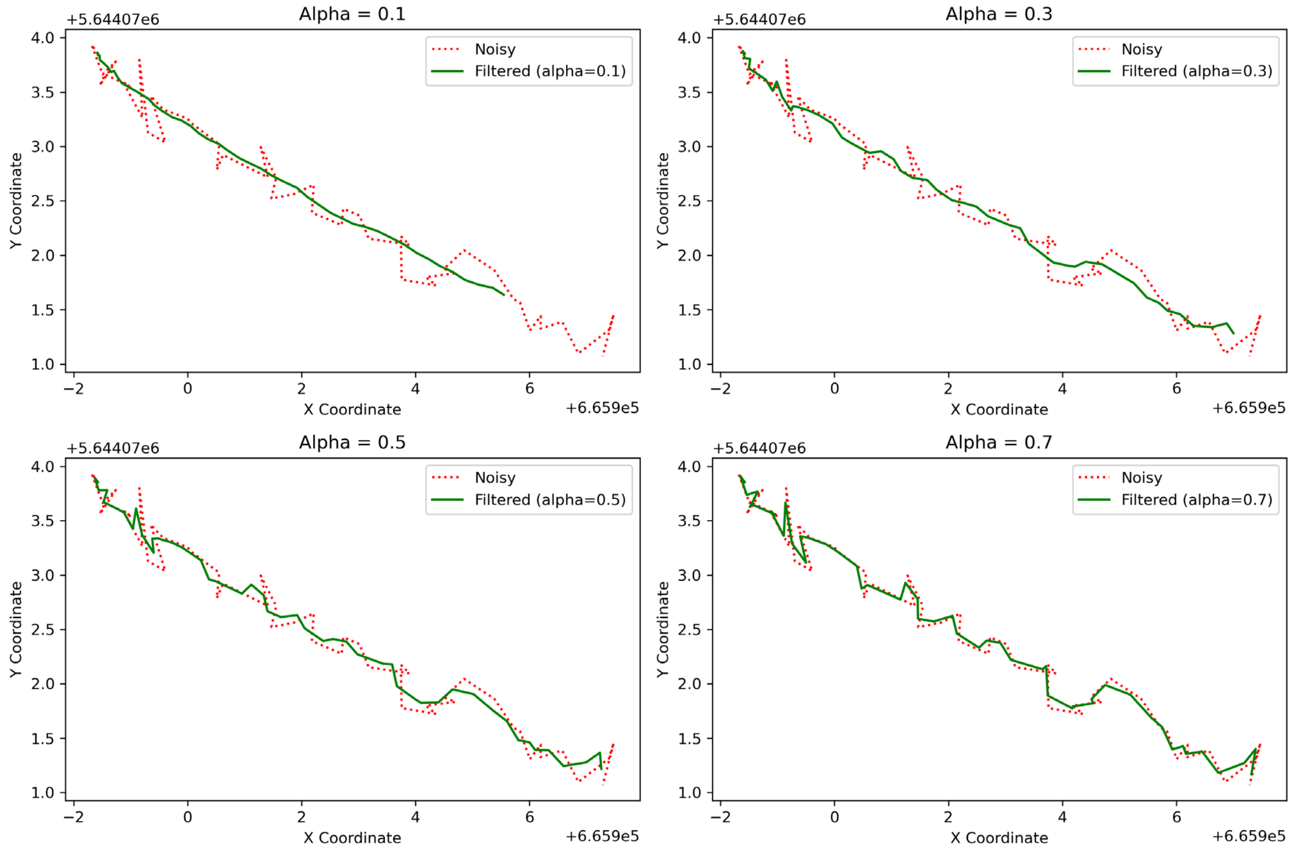
Noise Removal: Stationary Drone



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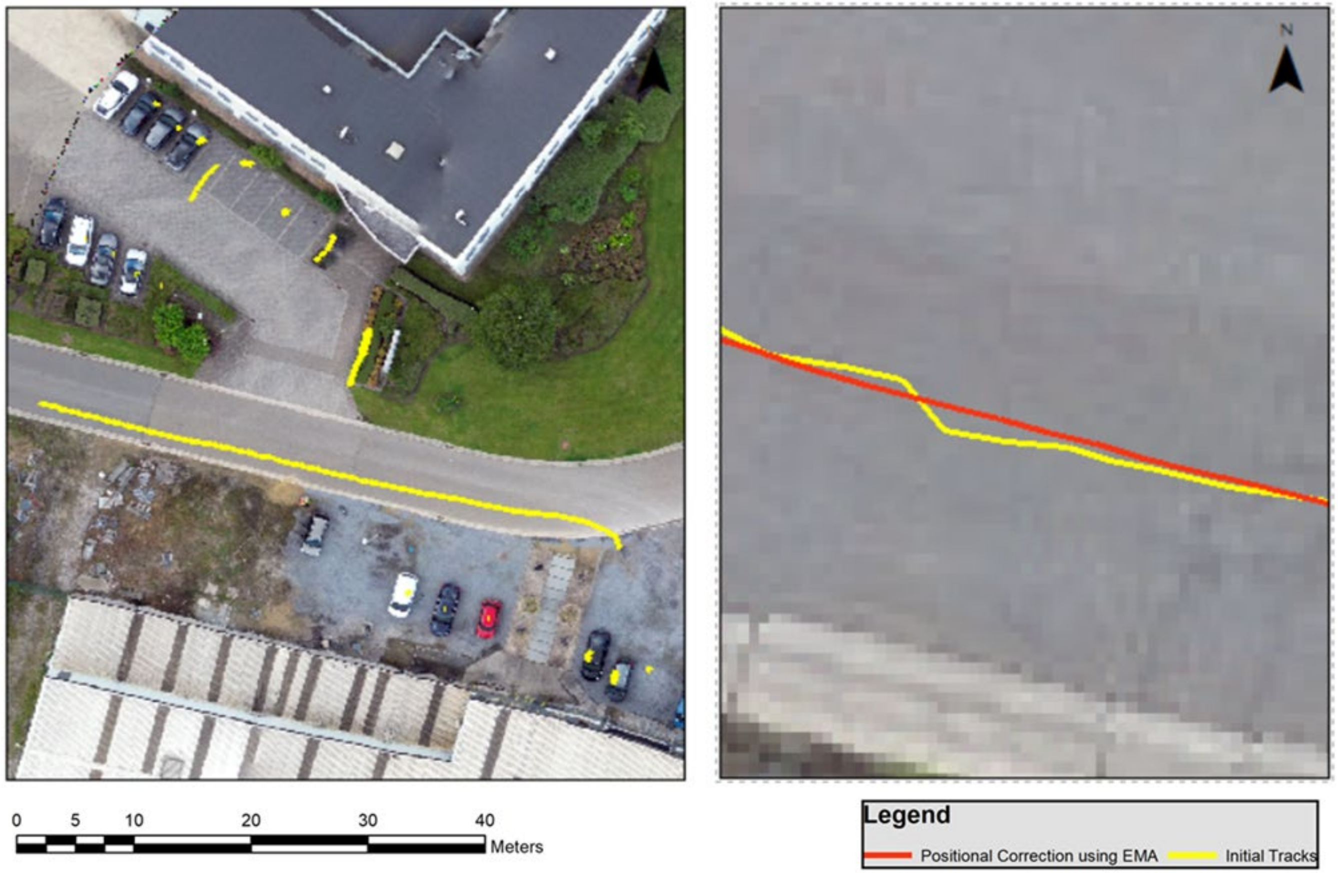
Results: Positional Correction



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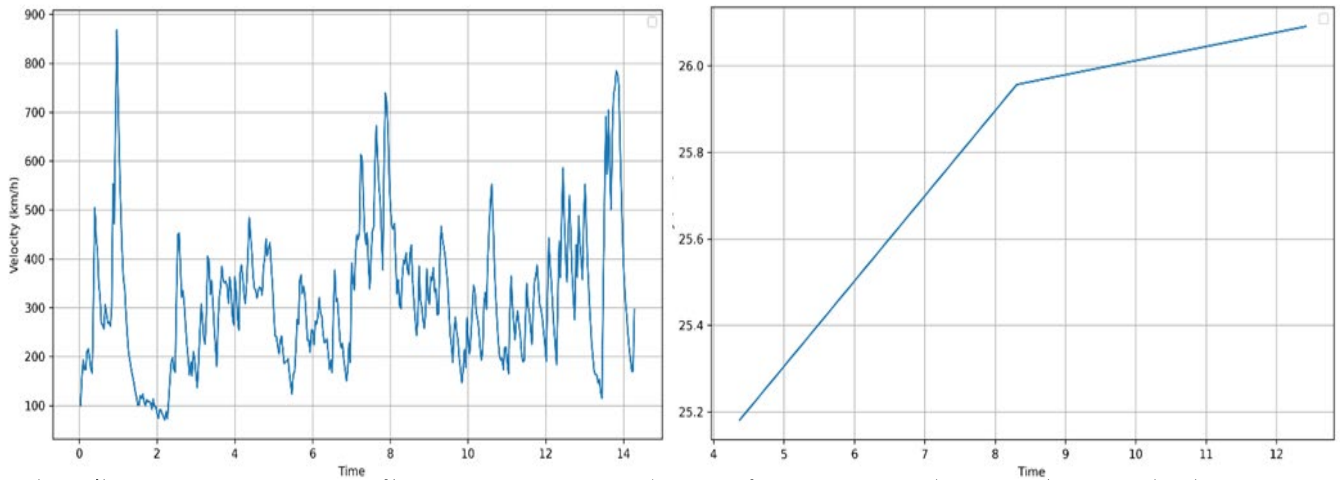
Velocity Measurements: Non-Stationary Drone



velocity(km/h) over time(s) fluctuation resulting from pseudo tracks and their removal from distance-based movement threshold. The single-point reference speed measured by the speed gun was 26 km/h.

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