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PPK vs RTK in Photogrammetry using UAV

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PPK (Post-Processing Kinematic) and RTK (Real-Time Kinematic) Overview

Post-Processing Kinematic (PPK) and Real-Time Kinematic (RTK) are two advanced techniques in satellite navigation that play a crucial role in UAV-based photogrammetry applications. Let's delve into the specifics of each technique:

- **PPK** achieves **high-precision** accuracy by processing GNSS data after data acquisition. It utilizes a base station or CORS network for correction data during post-processing. PPK is suitable for applications where real-time accuracy is not critical, such as surveying and mapping.
- **RTK** provides **real-time** high-precision accuracy by using correction signals from a network of base stations. It offers minimal latency, making it crucial for applications requiring immediate and accurate feedback. RTK is ideal for scenarios like autonomous vehicles and precision agriculture where real-time accuracy is paramount.

DJI Zenmuse P1 & DJI Matrice 300 RTK

We utilized the DJI Zenmuse P1 in RTK mode for data acquisition. RTK mode provides real-time correction for enhanced accuracy.

DJI Matrice 300 RTK

RTK Positioning Accuracy

1 cm+1 ppm (Horizontal)

1.5 cm + 1 ppm (Vertical)

Wingtra RGB61 & Wingtra GEN II

We utilized the Wingtra RGB61 in PPK mode for data acquisition. For the PPK solution, a a-GEO Netbox2 GNSS in single mode serve as the base station on-site to generate a Rinex file for further processing.

Wingtra GEN II
Relative accuracy
Horizontal down to 1 cm
Vertical down to 3 cm

RTK Mode GCP Measurement

Eight Ground Control Points (GCPs) are measured in RTK mode using the LatPOS Cors base station network to achieve precise georeferencing.

PPK Solution Setup

For the PPK solution, LatPOS CORS base station in single mode to generate a Rinex file for further processing.

RTK Picture Processing

All pictures processed using Pix4D Mapper software, a powerful tool for generating accurate and detailed 3D models and maps.

DJI Zenmuse P1 camera (45Mpix)
Average Ground Sampling Distance (GSD) 0.61 cm
224 pictures

Check Point Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
1		0.026	0.006	-22.216	0.192	13 / 13
2		0.023	0.015	-22.209	0.083	15 / 15
3		0.025	0.007	-22.213	0.021	15 / 15
4		0.015	0.037	-22.213	0.029	17 / 17
5		0.022	0.034	-22.175	0.067	13 / 13
6		0.014	-0.010	-22.215	0.161	15 / 15
7		-0.001	-0.033	-22.201	0.012	17 / 17
Mean [m]		0.017867	0.008021	-22.205952		
Sigma [m]		0.008853	0.022666	0.013456		
RMS Error [m]		0.019940	0.024044	22.205956		

RTK Picture Processing results

All pictures processed using Pix4D Mapper software, a powerful tool for generating accurate and detailed 3D models and maps.

RTK Picture Processing results

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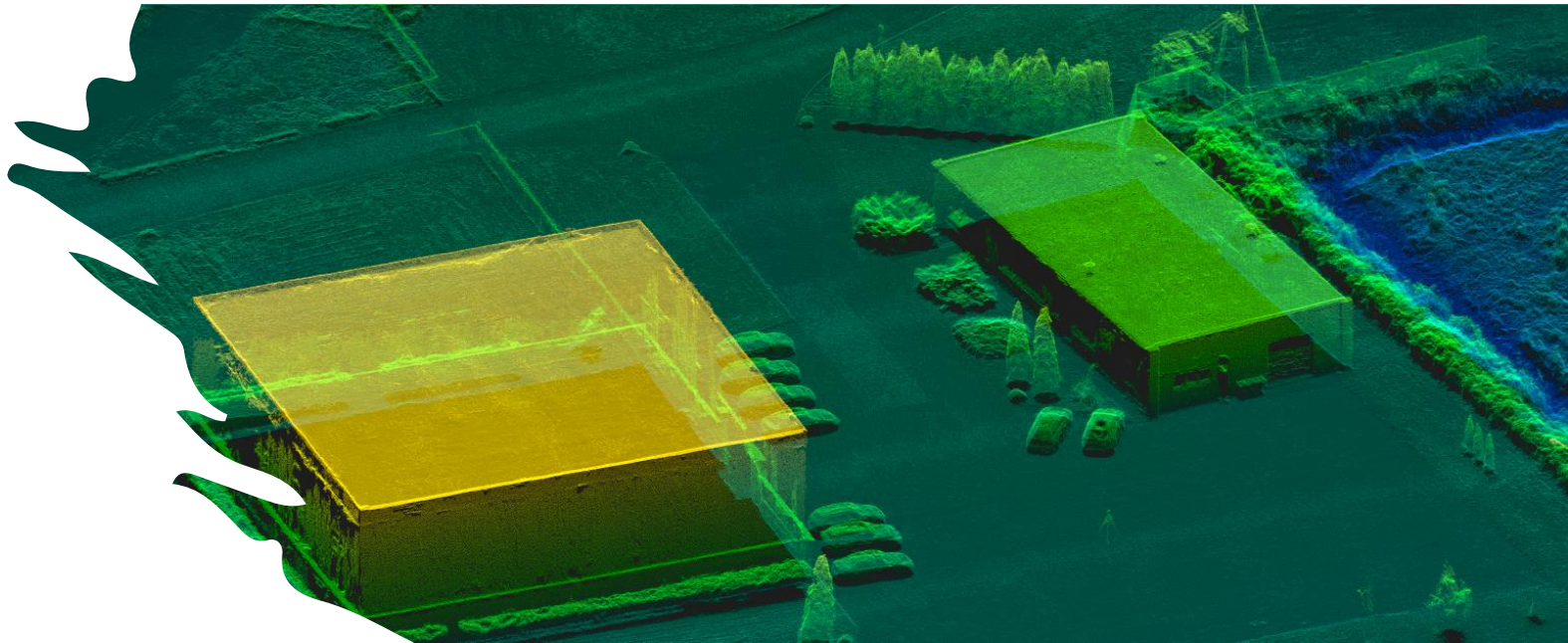

RTK Picture Processing results

All pictures processed using Pix4D Mapper software, a powerful tool for generating accurate and detailed 3D models and maps.

PPK Picture Processing

All pictures processed using Pix4D Mapper software, a powerful tool for generating accurate and detailed 3D models and maps.

Wingtra RGB61 camera (61Mpix)
Average Ground Sampling Distance (GSD) 0.80 cm
83 pictures

Check Point Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
1		-0.002	-0.004	-22.179	0.571	11 / 11
2		-0.011	-0.004	-22.206	0.559	10 / 10
3		-0.001	-0.023	-22.226	0.763	9 / 9
4		0.032	0.031	-22.223	0.238	7 / 7
5		0.030	0.038	-22.241	0.233	9 / 9
6		0.025	-0.005	-22.225	0.355	10 / 10
7		-0.004	-0.034	-22.275	0.250	7 / 7
Mean [m]		0.009807	-0.000068	-22.225007		
Sigma [m]		0.017008	0.024515	0.027590		
RMS Error [m]		0.019633	0.024515	22.225024		

Comparison

RTK

Check Point Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]
1		0.026	0.006	-22.216
2		0.023	0.015	-22.209
3		0.025	0.007	-22.213
4		0.015	0.037	-22.213
5		0.022	0.034	-22.175
6		0.014	-0.010	-22.215
7		-0.001	-0.033	-22.201
Mean [m]		0.017867	0.008021	-22.205952
Sigma [m]		0.008853	0.022666	0.013456
RMS Error [m]		0.019940	0.024044	22.205956

PPK

Check Point Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]
1		-0.002	-0.004	-22.179
2		-0.011	-0.004	-22.206
3		-0.001	-0.023	-22.226
4		0.032	0.031	-22.223
5		0.030	0.038	-22.241
6		0.025	-0.005	-22.225
7		-0.004	-0.034	-22.275
Mean [m]		0.009807	-0.000068	-22.225007
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RMS Error [m]		0.019633	0.024515	22.225024

Based on the provided results for the PPK and RTK solutions without using a GEIOD model for the Z value, here is a conclusion:
The PPK solution demonstrates a slightly lower RMS error compared to the RTK solution in both horizontal (x and y) and vertical (Z) components.
Specifically, the PPK RMS error for x is 0.019633, for y is 0.024515, and for Z is 22.225024 meters. In contrast, the RTK RMS error for x is 0.019940, for y is 0.024044, and for Z is 22.205956 meters.
While the differences in RMS errors are relatively small, the PPK solution exhibits a slightly better accuracy in the vertical component (Z). It's essential to consider the specific project requirements and tolerances when choosing between PPK and RTK solutions. Additionally, further investigations into the impact of not using a GEIOD model for the Z value may provide insights into

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Discussion and Questions