Supplementary Materials for

Accuracy assessment of a UAV block by different software packages, processing schemes and validation strategies

Vittorio Casella [1], Filiberto Chiabrando [2], Marica Franzini [1,*] and Ambrogio Maria Manzino [3]

[1] Department of Civil Engineering and Architecture, University of Pavia, Via Ferrata, 3, 27100, Pavia, Italy; vittorio.casella@unipv.it

[2] Department of Architecture and Design, Polytechnic of Turin, Viale Pier Andrea Mattioli, 39, 10125, Turin, Italy; filiberto.chiabrando@polito.it

[3] Department of Environment, Land and Infrastructure Engineering, Polytechnic of Turin, Corso Duca degli Abruzzi, 24, 10129, Turin, Italy; ambrogio.manzino@polito.it

* Correspondence: marica.franzini@unipv.it

Tables S1-S5 illustrate the behavior of the same software package through the configurations depicted. Table S1 shows, for instance, results concerning Photoscan for all the three scenarios. We report the name of the configuration with the number of the GCPs and CPs used, the mean, standard deviation and RMSE values as explained above.

Table **S1.** Main statistical figures for GCP/CP residuals for Photoscan.

Photoscan		**GCP**			**CP**		
		X [m]	**Y [m]**	**Z [m]**	**X [m]**	**Y [m]**	**Z [m]**
Config 1 [GCP: 18]	mean	0.000	0.000	0.000	-	-	-
	std	0.003	0.003	0.009	-	-	-
	rmse	0.003	0.003	0.009	-	-	-
Config 2 [GCP: 11; CP: 7]	mean	0.000	0.000	0.000	-0.001	-0.001	-0.001
	std	0.003	0.003	0.009	0.004	0.005	0.013
	rmse	0.003	0.003	0.009	0.004	0.005	0.013
Config 3 [GCP: 6; CP: 12]	mean	0.000	0.000	0.000	-0.001	-0.005	-0.007
	std	0.001	0.004	0.006	0.004	0.004	0.016
	rmse	0.001	0.004	0.006	0.004	0.006	0.017

Table **S2.** Main statistical figures for GCP/CP residuals for UAS Master.

UAS Master		**GCP**			**CP**		
		X [m]	**Y [m]**	**Z [m]**	**X [m]**	**Y [m]**	**Z [m]**
Config 1 [GCP: 18]	mean	0.000	0.000	0.000	-	-	-
	std	0.002	0.002	0.008	-	-	-
	rmse	0.002	0.002	0.008	-	-	-
Config 2 [GCP: 11; CP: 7]	mean	0.000	0.000	0.000	0.002	-0.001	0.010
	std	0.003	0.003	0.008	0.007	0.004	0.017
	rmse	0.003	0.003	0.008	0.007	0.004	0.020
Config 3 [GCP: 6; CP: 12]	mean	0.000	-0.001	0.002	0.001	0.00	0.007
	std	0.007	0.005	0.015	0.005	0.004	0.023
	rmse	0.007	0.005	0.015	0.005	0.004	0.024

Table **S3.** Main statistical figures for GCP/CP residuals for Pix4D.

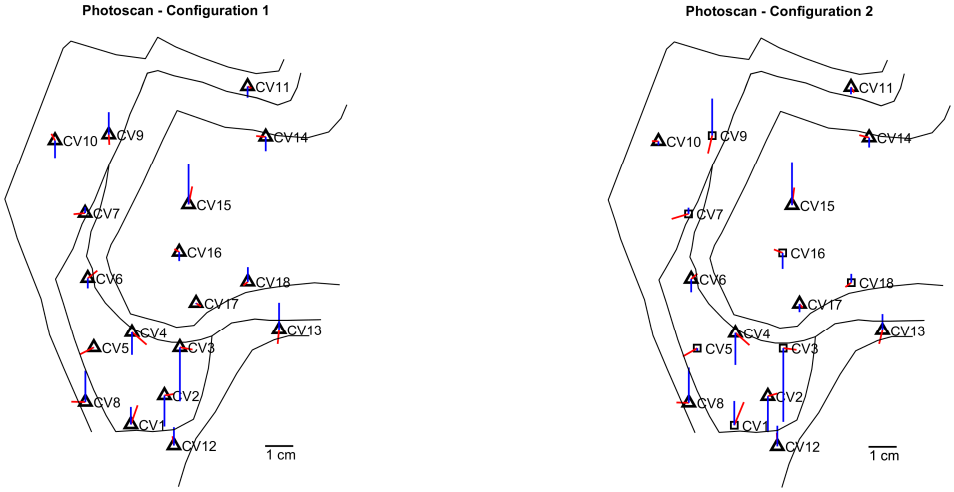
Pix4D		**GCP**			**CP**		
		X [m]	**Y [m]**	**Z [m]**	**X [m]**	**Y [m]**	**Z [m]**
Config 1 [GCP: 18]	mean	0.000	0.000	-0.001	-	-	-
	std	0.004	0.005	0.010	-	-	-
	rmse	0.004	0.005	0.010	-	-	-
Config 2 [GCP: 11; CP: 7]	mean	0.000	0.000	-0.001	0.002	0.002	0.003
	std	0.004	0.005	0.008	0.005	0.007	0.015
	rmse	0.004	0.005	0.008	0.005	0.007	0.015
Config 3 [GCP: 6; CP: 12]	mean	0.000	0.001	-0.001	-0.001	0.001	0.002
	std	0.004	0.008	0.008	0.005	0.005	0.014
	rmse	0.004	0.008	0.008	0.005	0.005	0.014

Table **S4.** Main statistical figures for GCP/CP residuals for Context Capture.

Context Capture		**GCP**			**CP**		
		X [m]	**Y [m]**	**Z [m]**	**X [m]**	**Y [m]**	**Z [m]**
Config 1 [GCP: 18]	mean	0.000	0.000	0.000	-	-	-
	std	0.004	0.004	0.009	-	-	-
	rmse	0.004	0.004	0.009	-	-	-
Config 2 [GCP: 11; CP: 7]	mean	0.001	-0.001	0.000	0.001	-0.002	-0.003
	std	0.005	0.004	0.009	0.008	0.007	0.012
	rmse	0.005	0.004	0.009	0.008	0.007	0.012
Config 3 [GCP: 6; CP: 12]	mean	-0.003	0.002	0.011	-0.007	0.000	0.020
	std	0.007	0.005	0.027	0.009	0.007	0.037
	rmse	0.008	0.005	0.029	0.011	0.007	0.042

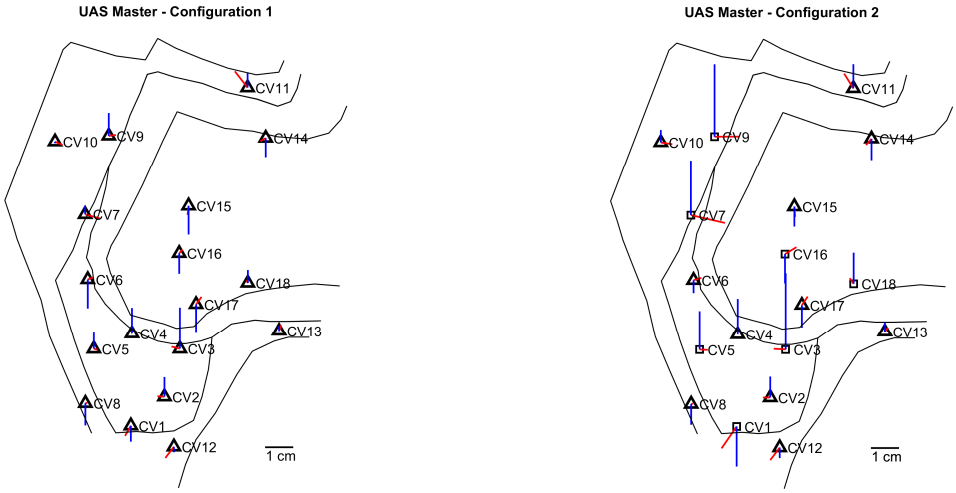
Table **S5.** Main statistical figures for GCP/CP residuals for MicMac.

MicMac		**GCP**			**CP**		
		X [m]	**Y [m]**	**Z [m]**	**X [m]**	**Y [m]**	**Z [m]**
Config 1 [GCP: 18]	mean	0.000	0.000	0.000	-	-	-
	std	0.004	0.005	0.005	-	-	-
	rmse	0.004	0.005	0.005	-	-	-
Config 2 [GCP: 11; CP: 7]	mean	0.000	-0.001	-0.001	0.000	0.000	-0.003
	std	0.004	0.005	0.006	0.005	0.006	0.005
	rmse	0.004	0.005	0.006	0.005	0.005	0.006
Config 3 [GCP: 6; CP: 12]	mean	0.000	0.000	-0.001	-0.001	-0.005	-0.005
	std	0.006	0.005	0.006	0.003	0.005	0.007
	rmse	0.006	0.005	0.006	0.004	0.007	0.009



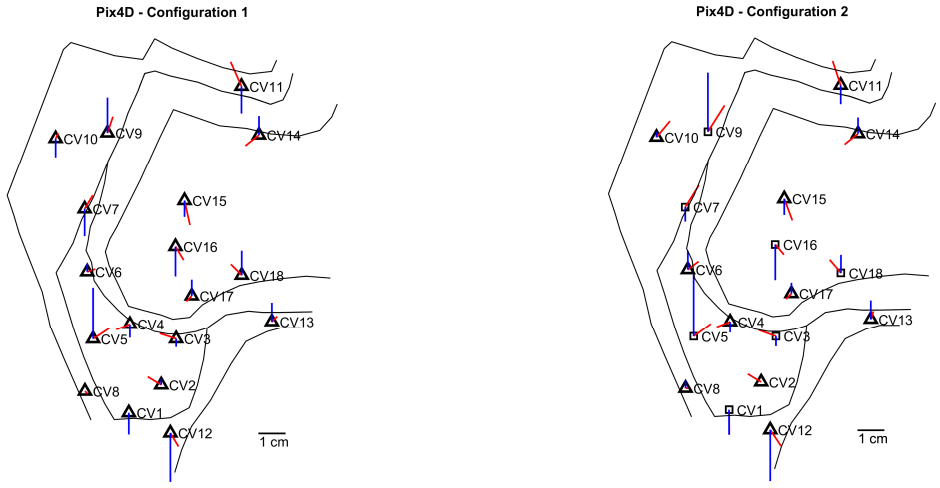
(**a**) (**b**)

Figure S1. GCPs and CPs residuals' distribution for PhotoScan. (a) Configuration 1 with 18/0 GCPs/CPs; (b) Configuration 2 with 11/7 GCPs/CPs. GCPs are represented by triangles while CPs by squares. Red segments report horizontal (2D) residuals; vertical blue lines account for vertical residuals. In the lower right part of each picture a ruler is shown, corresponding to a 1 cm residual.



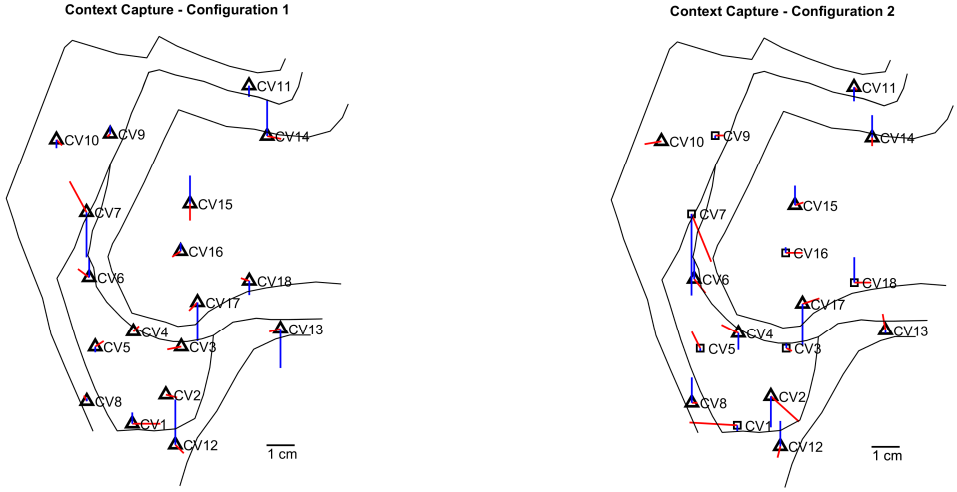
(**a**) (**b**)

Figure S2. GCPs and CPs residuals' distribution for UAS Master (see caption of Figure S1 for details).



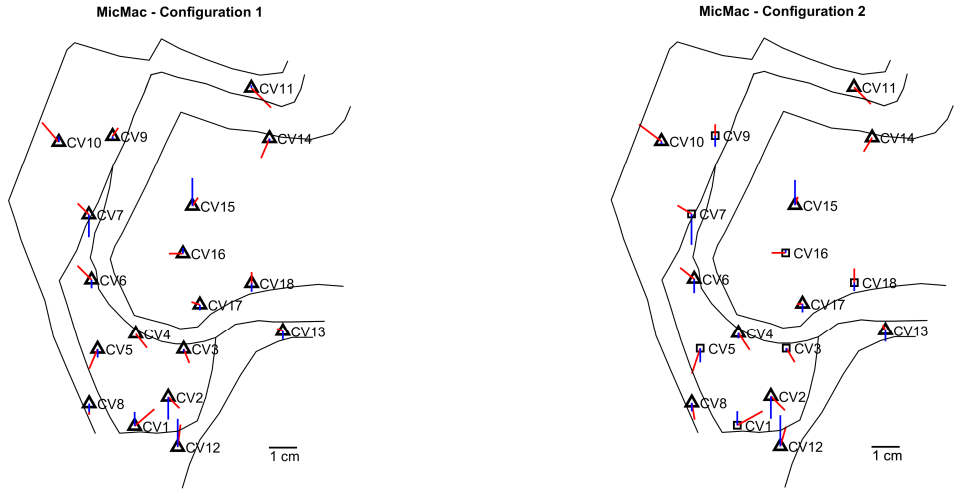
(**a**) (**b**)

Figure S3. GCPs and CPs residuals' distribution for Pix4D (see caption of Figure S1 for details).



(**a**) (**b**)

Figure S4. GCPs and CPs residuals' distribution for ContextCapture (see caption of Figure S1 for details).



(**a**) (**b**)

Figure S5. GCPs and CPs residuals' distribution for MicMac (see caption of Figure S1 for details).

Table **S6.** Summary of the RMSE values obtained for all the packages and configurations.

			PhotoScan	UAS Master	Pix4D	Context Capture	MicMac
Config 1 GCP: 18	GCP	X [m]	0,003	0,002[1]	0,004	0,004	0,004
		Y [m]	0,003	0,002[1]	0,005	0,004	0,005
		Z [m]	0,009	0,008	0,01	0,009	0,005[1]
	CP	X [m]	-	-	-	-	-
		Y [m]	-	-	-	-	-
		Z [m]	-	-	-	-	-
Config 2 GCP 11/CP 7	GCP	X [m]	0,003	0,003	0,004	0,005	0,004
		Y [m]	0,003	0,003	0,005	0,004	0,005
		Z [m]	0,009	0,008	0,008	0,009	0,006
	CP	X [m]	0,004	0,007	0,005	0,008	0,005
		Y [m]	0,005	0,004	0,007	0,007	0,005
		Z [m]	0,013	0,02	0,015	0,012	0,006[1]
Config 3 GCP 6/CP 12	GCP	X [m]	0,001[1]	0,007	0,004	0,008	0,006
		Y [m]	0,004	0,005	0,008	0,005	0,005
		Z [m]	0,006	0,015	0,008	0,029[2]	0,006
	CP	X [m]	0,004	0,005	0,005	0,011[1]	0,004
		Y [m]	0,006	0,004	0,005	0,007	0,007
		Z [m]	0,017	0,024	0,014	0,042[2]	0,009

[1]: values slightly outside the confidence interval;

[2]: outliers.