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LOW COST METHOD FOR EXTRACTING TRAFFIC DATA

Objectives of research

1. Develop low cost model for extracting traffic measures from video taping
2. Develop software platform for automates the work
3. Assess accuracy of model based on GPS referenced traffic data

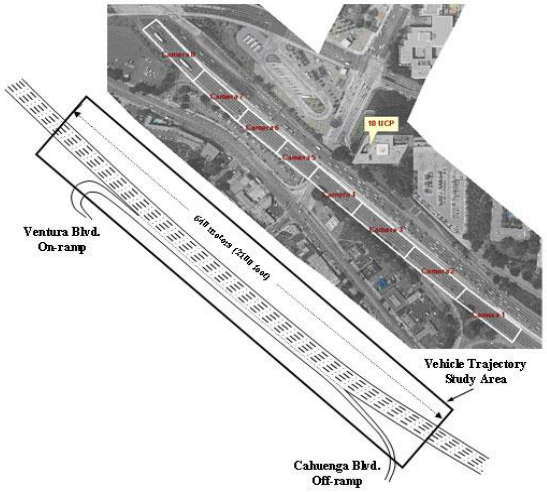
Need for observational traffic data

Calibrate and **validate** operational models of driving behaviour.

Provide a **real world** context for simulated output.

Current source of traffic data

Most widely distributed algorithm provided by the **NGSIM program administered by the FHWA.**



Basic problem:

- Highly restricted video taping requirements (angle, height and dist.)
- Not easily transferable to sites

Features of data extraction model

A simple transferable procedure based on a low cost HD Video Camera

Able to detect traffic over an extended field of vision (with specified set-up errors).

Framework

1

Video Taping traffic data

2

Frame by frame extraction

3

Apply pre-filters to reduce noise

4

Geo referencing frames from GPS date

5

Re-alignment of video angle

6

Search backgroud frame

7

Filter frames

8

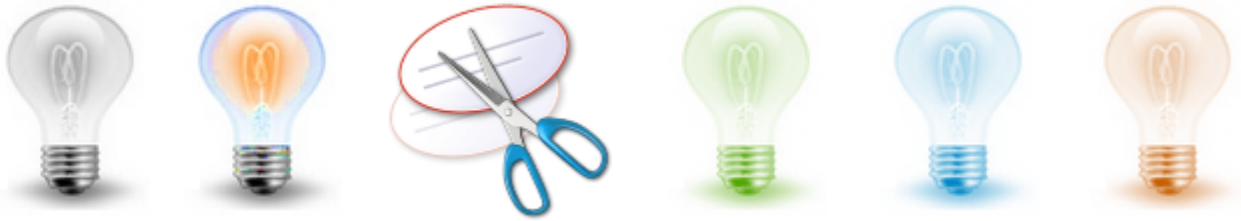
Vehicle identification

9

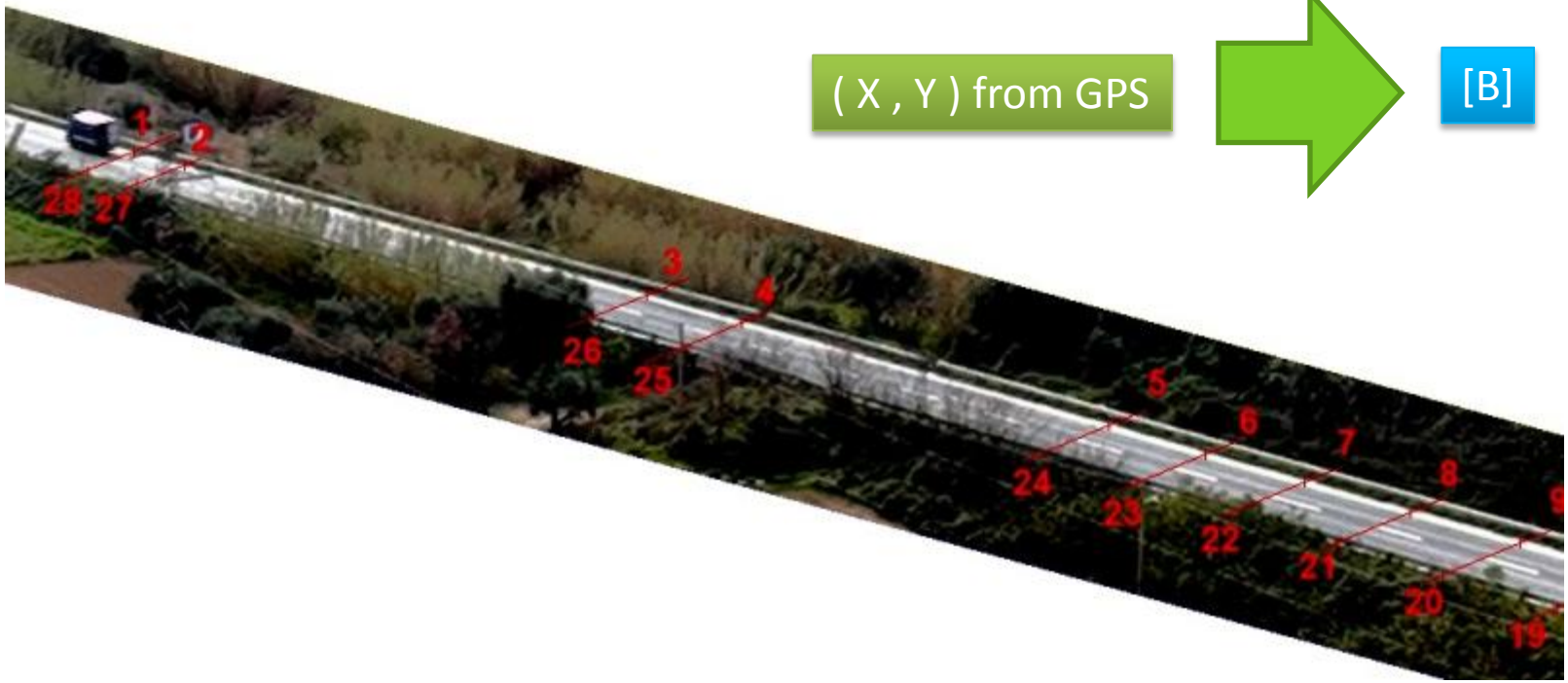
Analysis of traffic date

Pre filters

Light
Cut
Color



Geo referencing



(X , Y) from GPS → [B]

$$X_{real} = \frac{X_{pixel}A_1 + Y_{pixel}A_2 + A_3}{X_{pixel}C_1 + Y_{pixel}C_2 + 1} = [mm]$$

$$Y_{real} = \frac{X_{pixel}B_1 + Y_{pixel}B_2 + B_3}{X_{pixel}C_1 + Y_{pixel}C_2 + 1} = [mm]$$

$$[B] = [A^T A]^{-1}[A][C]$$

(X_{pixel}, Y_{pixel})

(X_{mm}, Y_{mm})

Re-alignment frames

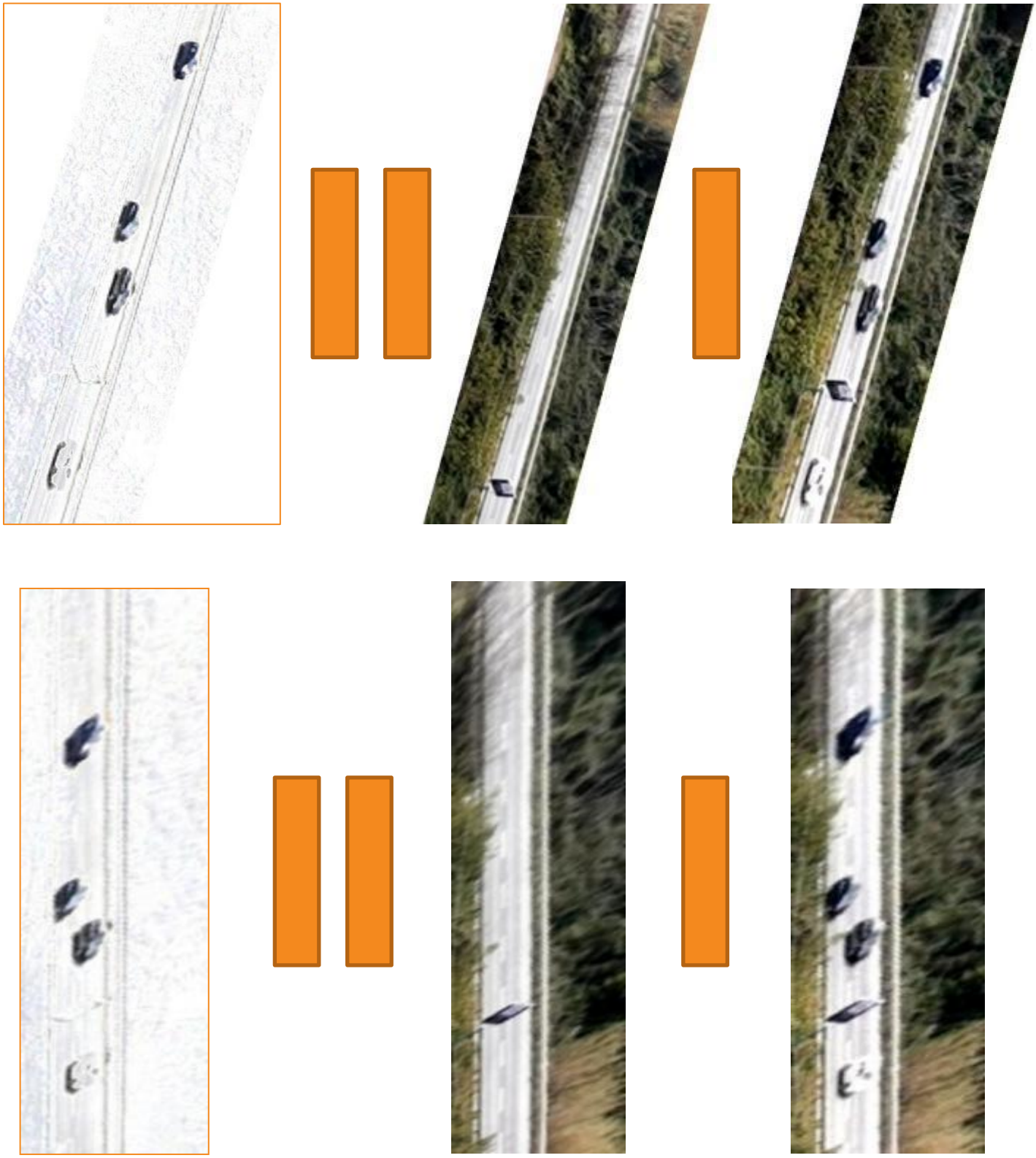
Rebuilding frames pixel by pixel from the original frames to obtain a shaper view of vehicle position

Search backgroud

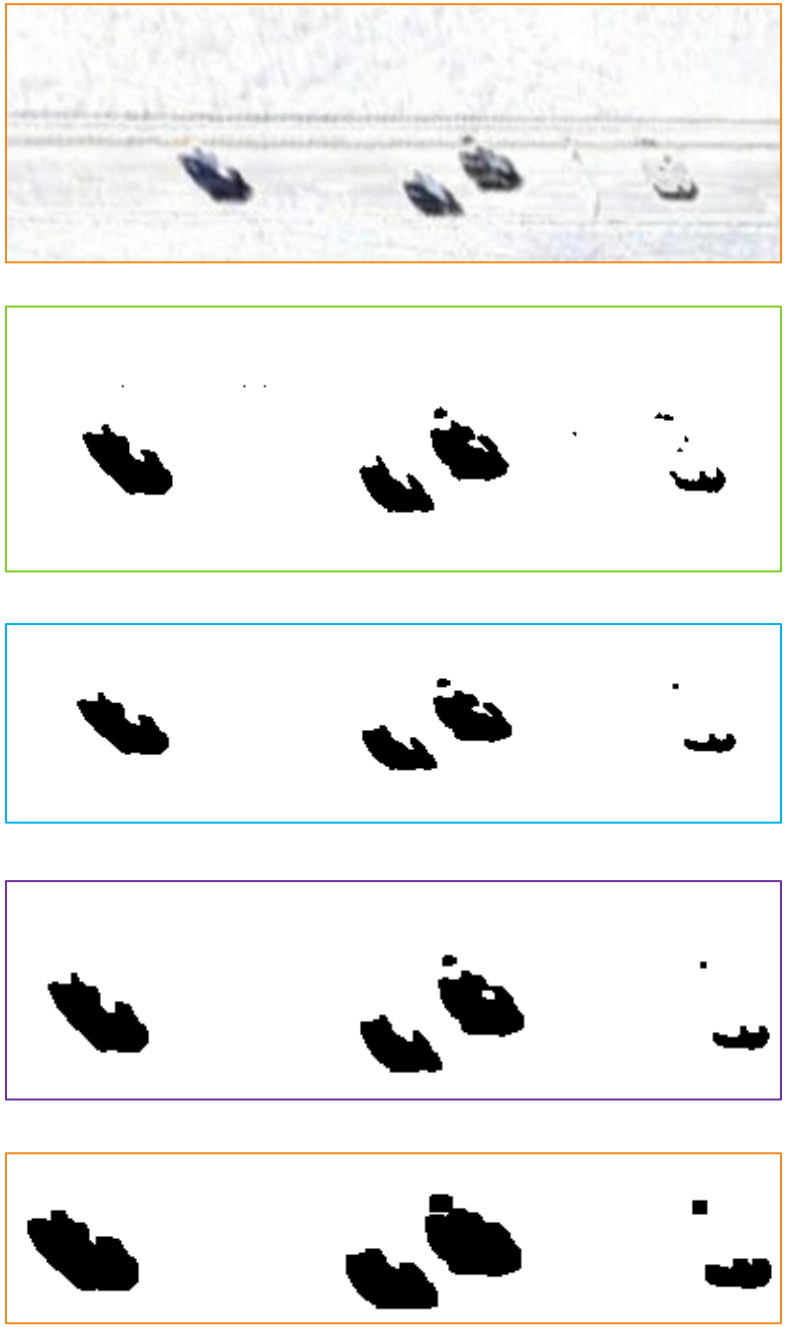
Build background frame to search for moving objects

$$(X, Y) = \frac{\sum_i^F (x, y)_i}{number\ of\ Frames}$$

Filter frames 1

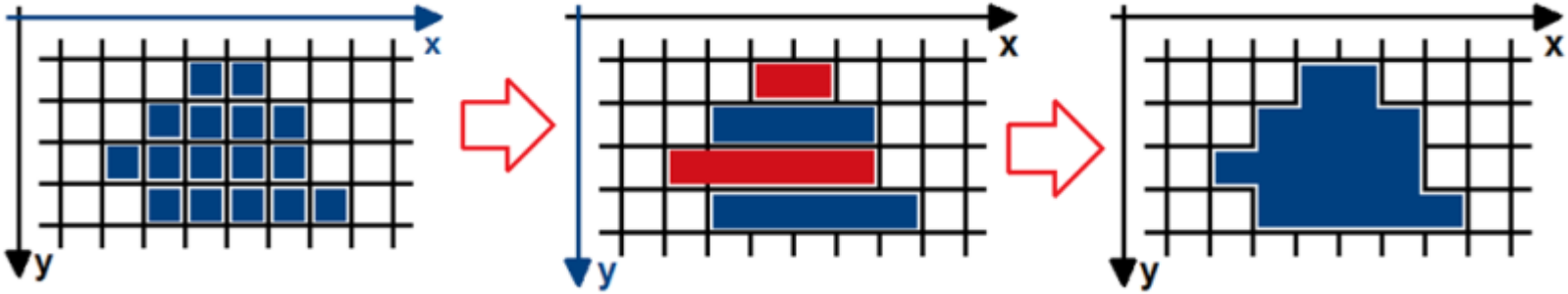


Filter frames 2



Filtering frames with operations of opening and closing of the pixels

Vehicle identification



- Identifying blobs (contiguous pixles)
- Confimation: blob = vehicle
- Tracking vehicle (8 feature errors)

$$\varepsilon = \frac{(x_k - x_i)^2}{x_i^2}$$

1. Length [mm]
2. Heigth [mm]
3. Surfaces [mm2]
4. Gradient of color [byte]
5. Number of pixel
6. Variance of color [byte]
7. Standard deviation of color [byte]
8. Deviation on gradient

Implement software for automates the work

2

Developing program to **automate** video extraction algorithm

Interface of Sputnik

SystemGVP Sputnik - Inseguitore di oggetti in movimento

C:\Rilievi\Belmonte 24-3-2011\STREAM Nord\Sorpassi CamNord 5-6\

Inizializza nuovo rilievo

Apri rilievo

Salva rilievo attuale

Chiudi Sputnik

Ritaglio dei Fotogrammi

Georeferenziazione

Indica area da scansire

Costruisci sfondo

Scansiona fotogrammi

Luogo

SS 18 - Belmonte (CS)

Elaboratore

ing. Giofrè Vincenzo Pasquale

data elaborazione	7 maggio 2011
Numero Fotogram.	129
Intervallo [sec]	1
Nome Fotogrammi	FotogrammaTagliato
Fotogrammi Raddrizzati	
ISO pixel [mm]	0

*****DATI GENERALI*****
elaboratore
ing. Giofrè Vincenzo Pasquale
luogo
SS 18 - Belmonte (CS)
data
7 maggio 2011
Numero Fotogrammi
129
intervallo [sec]
1
Nome Fotogrammi
FotogrammaTagliato
Raddrizzati
no
ISO pixel [mm]
0
*****AREA RITAGLIO*****
X [pixel]
311
1804
1804
277
Y [pixel]
524
99
12
474
*****AREA SCANSIONE*****

Sputnik

realizzato dall' ing. Giofrè Vincenzo Pasquale

Vehicle identification

Automatic process

Reporting of results

SystemGVP Sputnik - Tabelle dei risultati per gli oggetti individuati

Chiudi risultati

n	Xr	Yr	lung
1	108051,8961		722
1	132516,0071		676
1	158107,5593		438
1	184539,429		413
2	105274,7685		723
1	207241,5224		414
2	136375,613		633
1	234302,9668		419
2	167252,1715		493
1	249475,319		652
2	196456,5924		481
1	280420,0172		420
2	227577,9937		424
1	305614,1516		393
1	330726,4671		361
2	256504,7609		491
2	285363,8623		474
1	355743,1705		487
2	315131,4896		483
1	379774,548		435

n	Xr	Yr	lung	alt	gR	gV	gB	T
1	108051,8961		7223,2308		3340,5941		2128,9621	
1	132516,0071		6763,1092		3340,5941		2128,9621	
1	158107,5593		4381,0522		3646,5473		2203,1667	
1	184539,429		4132,6493		3653,6113		3092,3501	
1	207241,5224		4145,1031		2102,5044		3241,2852	
1	234302,9668		4190,1359		3888,6795		3009,7927	
1	249475,319		6521,0608		3888,6795		3009,7927	
1	280420,0172		4200,2953		1547,553	3135,8979		121,2458
1	305614,1516		3934,6801		1703,9858		2867,4005	
1	330726,4671		3619,0515		2421,3726		3032,5961	
1	355743,1705		4874,9585		1148,4775		2364,9078	
1	379774,548		4351,5158		3515,0734		2951,2601	
2	105274,7685		7230,4109		1700,4487		3389,3433	
2	136375,613		6337,4185		6607,4847		2867,0512	
2	167252,1715		4933,1732		1901,7437		4335,3176	
2	196456,5924		4813,9115		1968,276	4027,3229		135,1232
2	227577,9937		4245,7637		5167,2815		4198,6767	
2	256504,7609		4913,3938		5167,2815		4198,6767	
2	285363,8623		4747,6047		2288,612	4137,3035		93,967
2	315131,4896		4836,9983		2340,9588		3729,2814	
2	344391,804		5140,2782		2586,0662		3335,9137	
2	373857,7293		4411,4499		2189,9272		3085,2653	
3	60273,9549		11592,625		1335,6484		6741,2337	
3	83620,0178		9053,115	1781,1027		6301,8076		179,151
3	105760,626		7710,4242		1700,5538		6804,2329	
3	126339,9514		8155,965	2097,9217		4086,2532		187,7313
3	151438,9917		6622,2154		2199,7752		6096,6004	
3	175281,8839		5717,6439		2285,376	7142,7324		152,415
3	198004,3921		5443,4641		2553,1364		6055,3447	
3	222598,4132		4716,5438		5693,8236		3429,0006	

Vel	Num	Percentuale
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0

X centro: 1

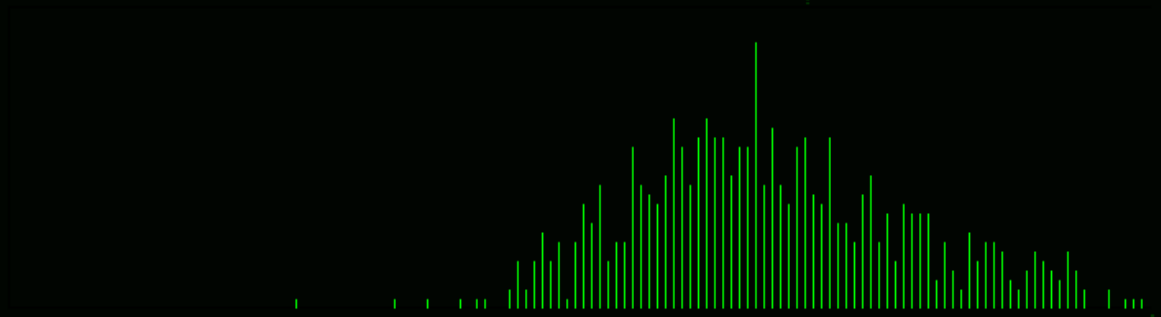
Y centro: 63

Risultati per istanti temp.

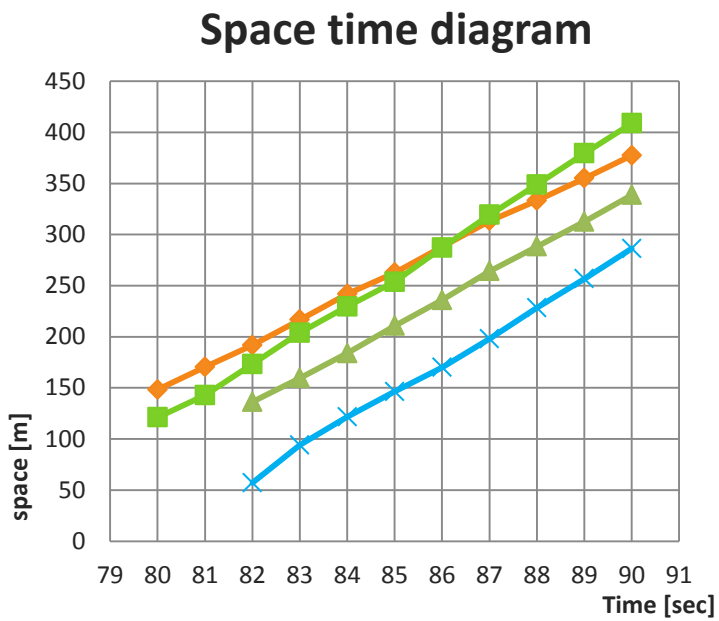
Risultati per veicolo

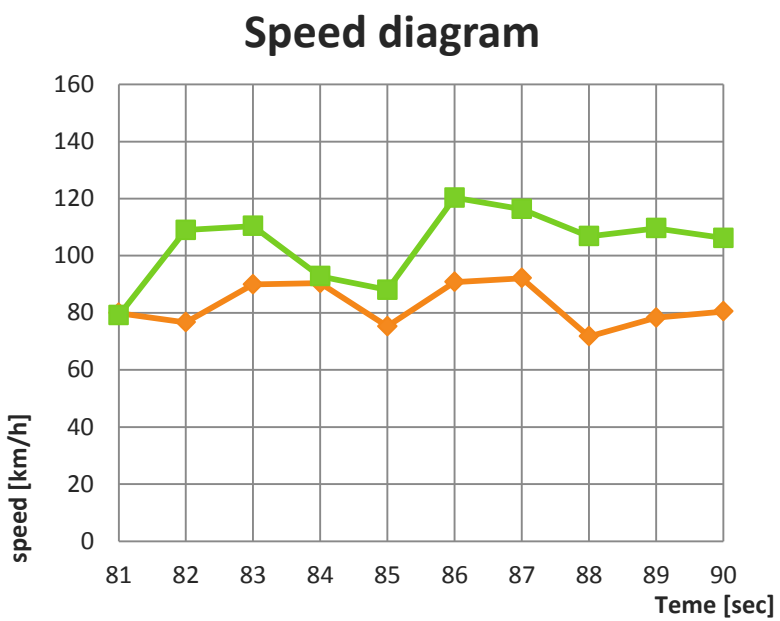
Curva delle velocità

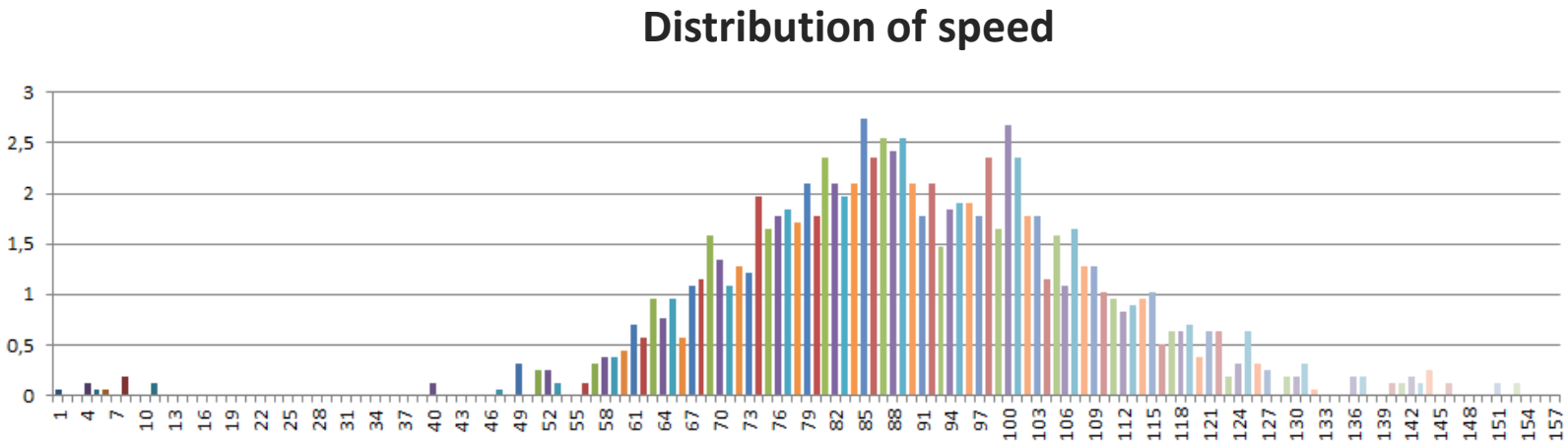
Vedi simulazione



Analisis dates







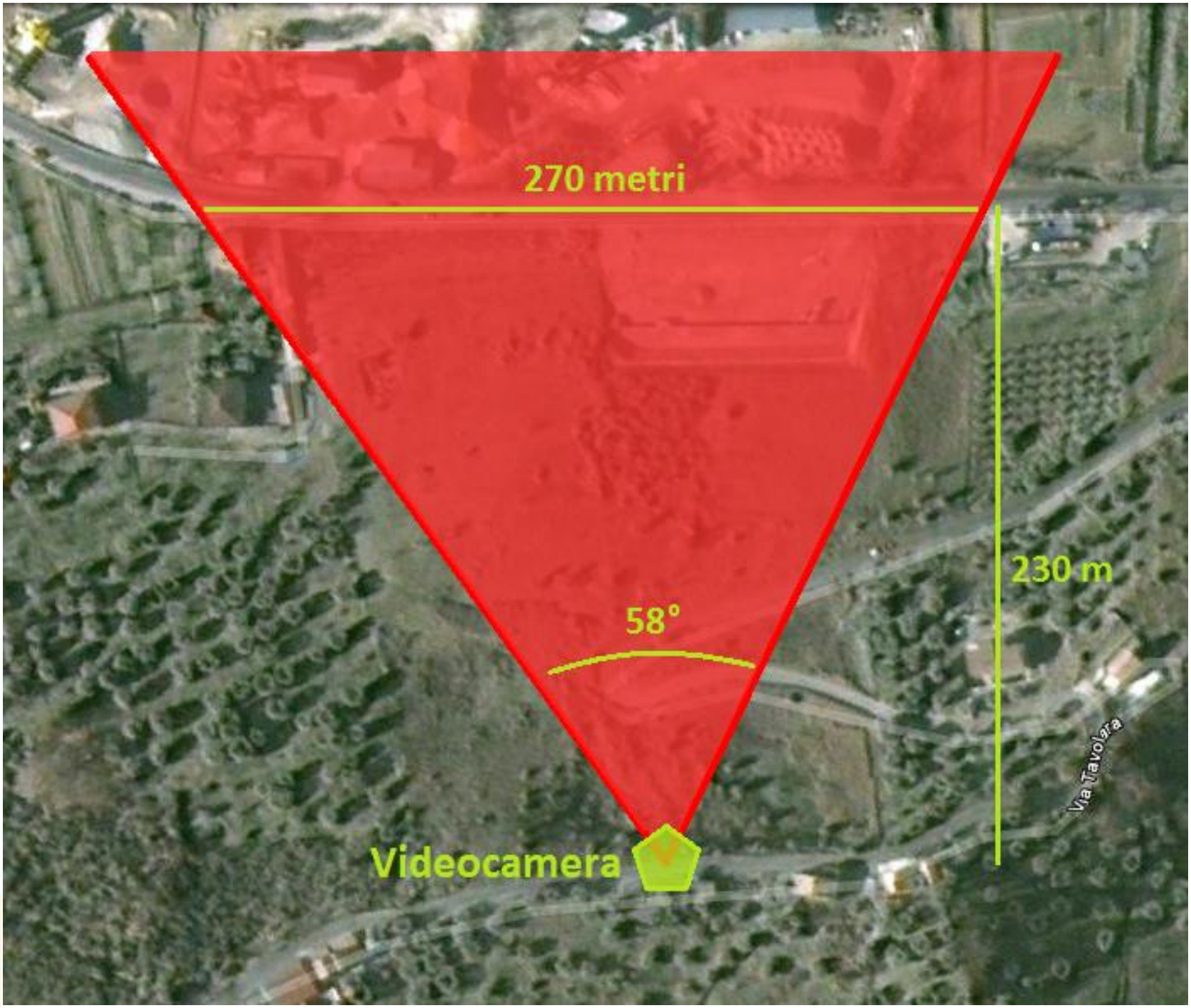
Calibration/Validation this application

3

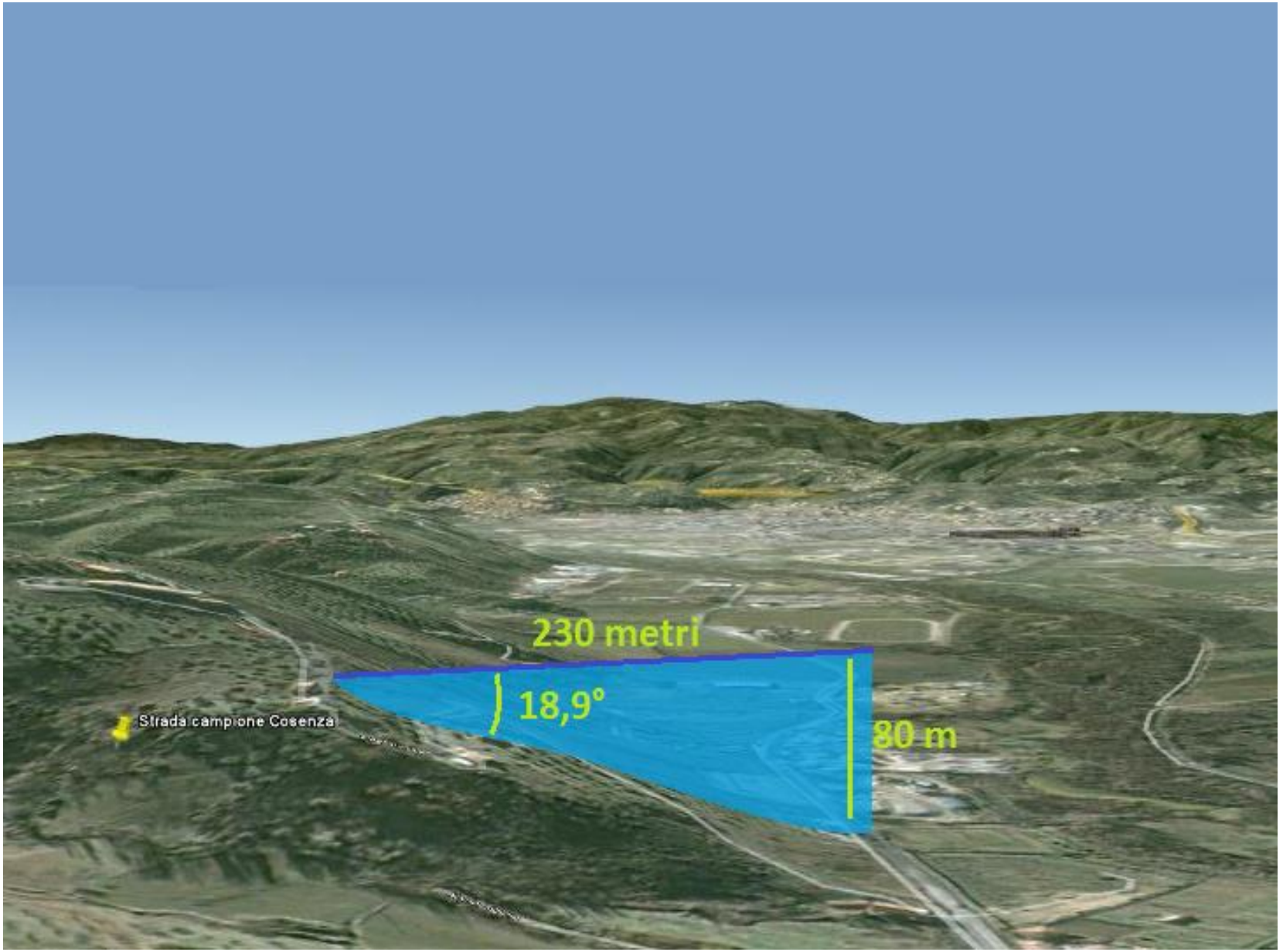
Comparing vehicle trajectories obtained from the video tape with geo-referenced estimates obtained for the same GPS instrumented vehicle

Test site

Site layout



Site elevations



Instrumentation

Geo Referencing points

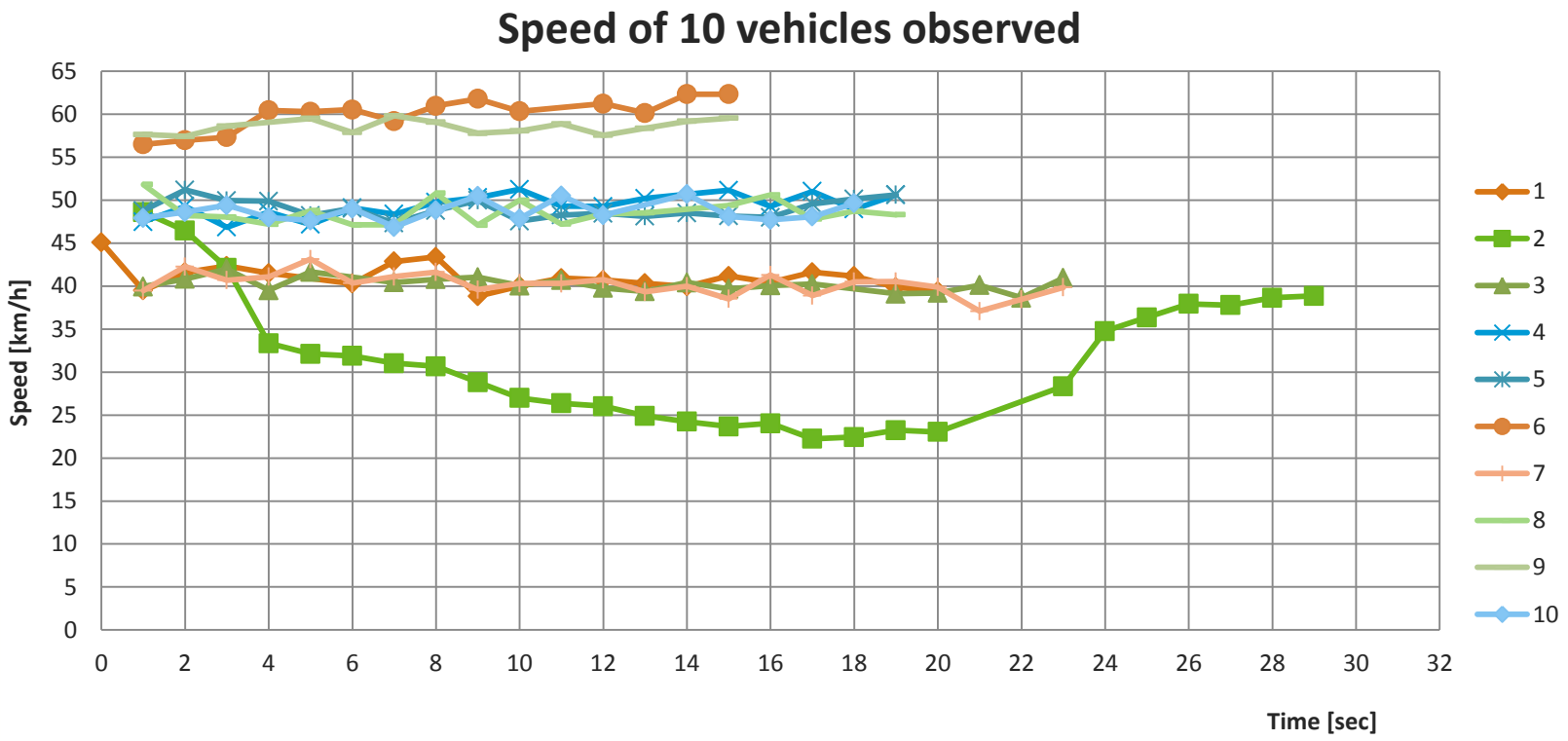
$$\varepsilon_X = \frac{\sum |X_{GPS} - X_{video}|}{N} = 0{,}554\ m$$

$$\varepsilon_Y = \frac{\sum |Y_{GPS} - Y_{video}|}{N} = 0{,}478\ m$$

Extract trajectories

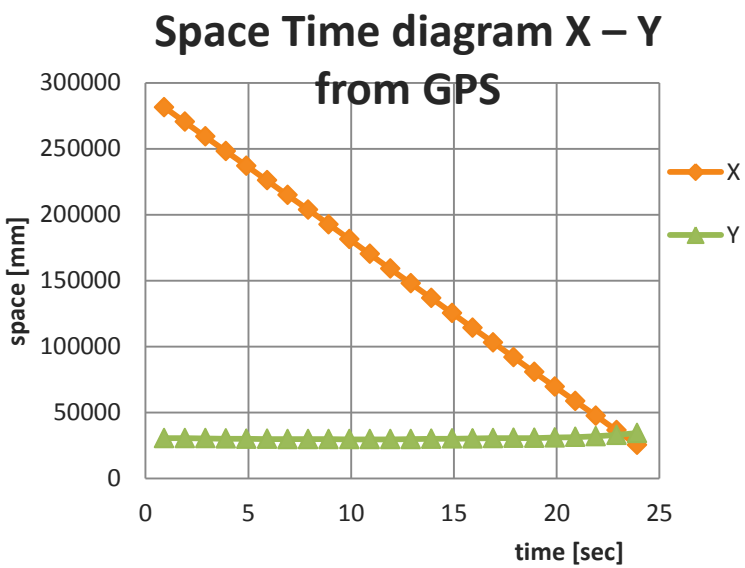
Extracting 10 vehicle trajectories (GPS – video taped)

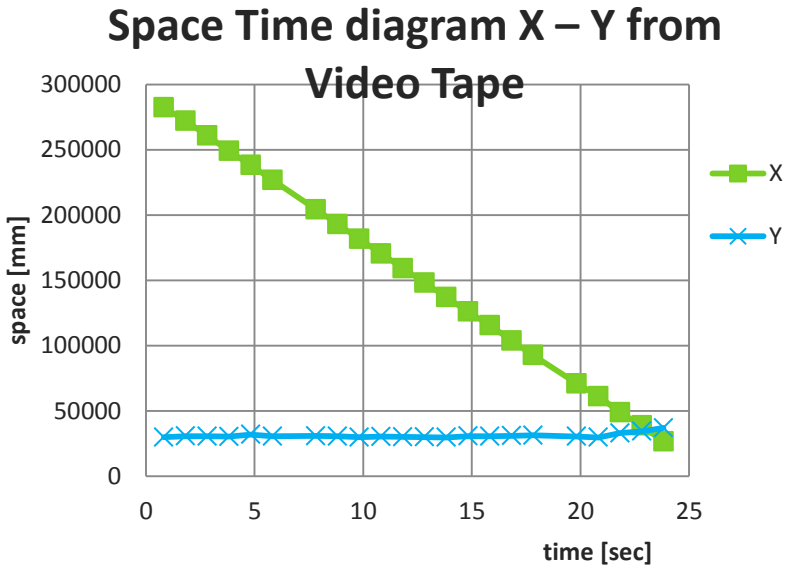
Comparing average speeds

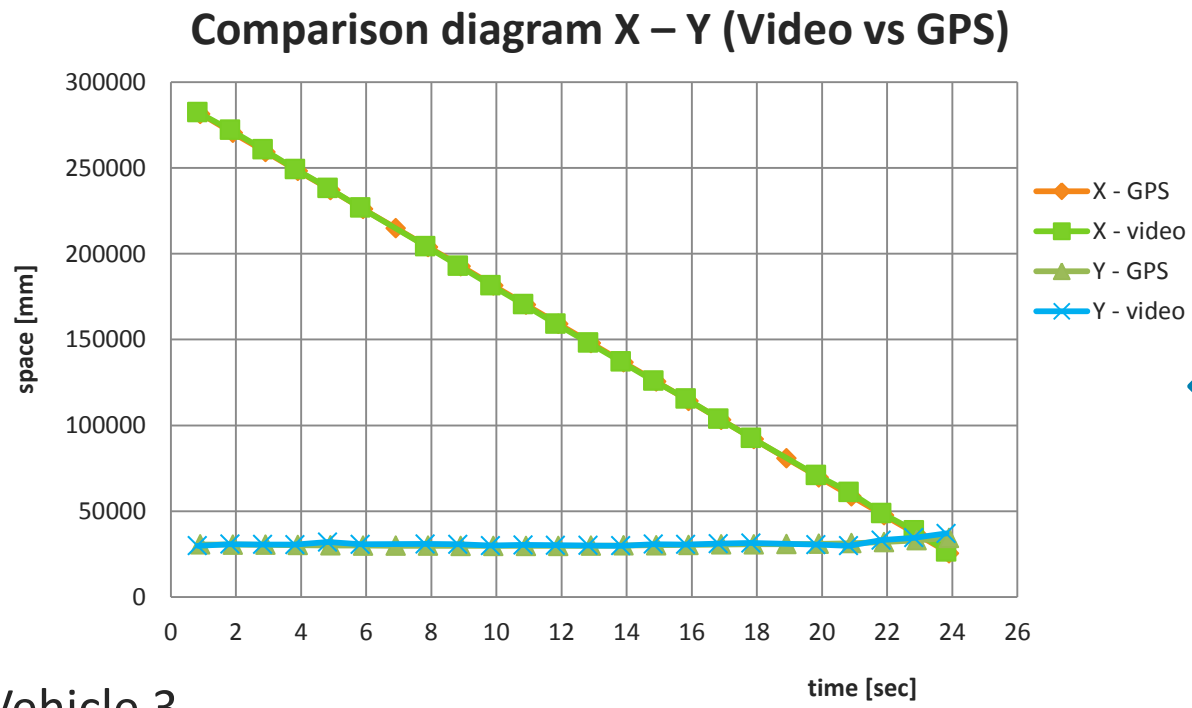


vehicle	direction	time [min]	GPS speed [km/h]	Fot. start	Fot. finish	Video extract [km/h]	difference [km/h]	RMSE
1	<	00:06:16	40,97	334	360	41,05	0,09	0,000
2	>*	00:07:36	31,99	414	447	31,30	0,69	0,000
3	<	00:09:19	40,08	517	543	40,22	0,14	0,000
4	>	00:10:24	46,56	578	600	49,34	2,78	0,004
5	<	00:11:30	48,60	647	669	48,98	0,38	0,000
6	>	00:12:30	58,65	708	725	60,03	1,38	0,001
7	<	00:13:40	41,88	778	804	40,22	1,66	0,002
8	>	00:14:36	49,19	832	853	48,62	0,57	0,000
9	<	00:15:46	62,90	904	922	58,52	4,38	0,005
10	>	00:16:33	49,19	949	970	48,68	0,51	0,000
							[%]	3,37

Comparison trajectories

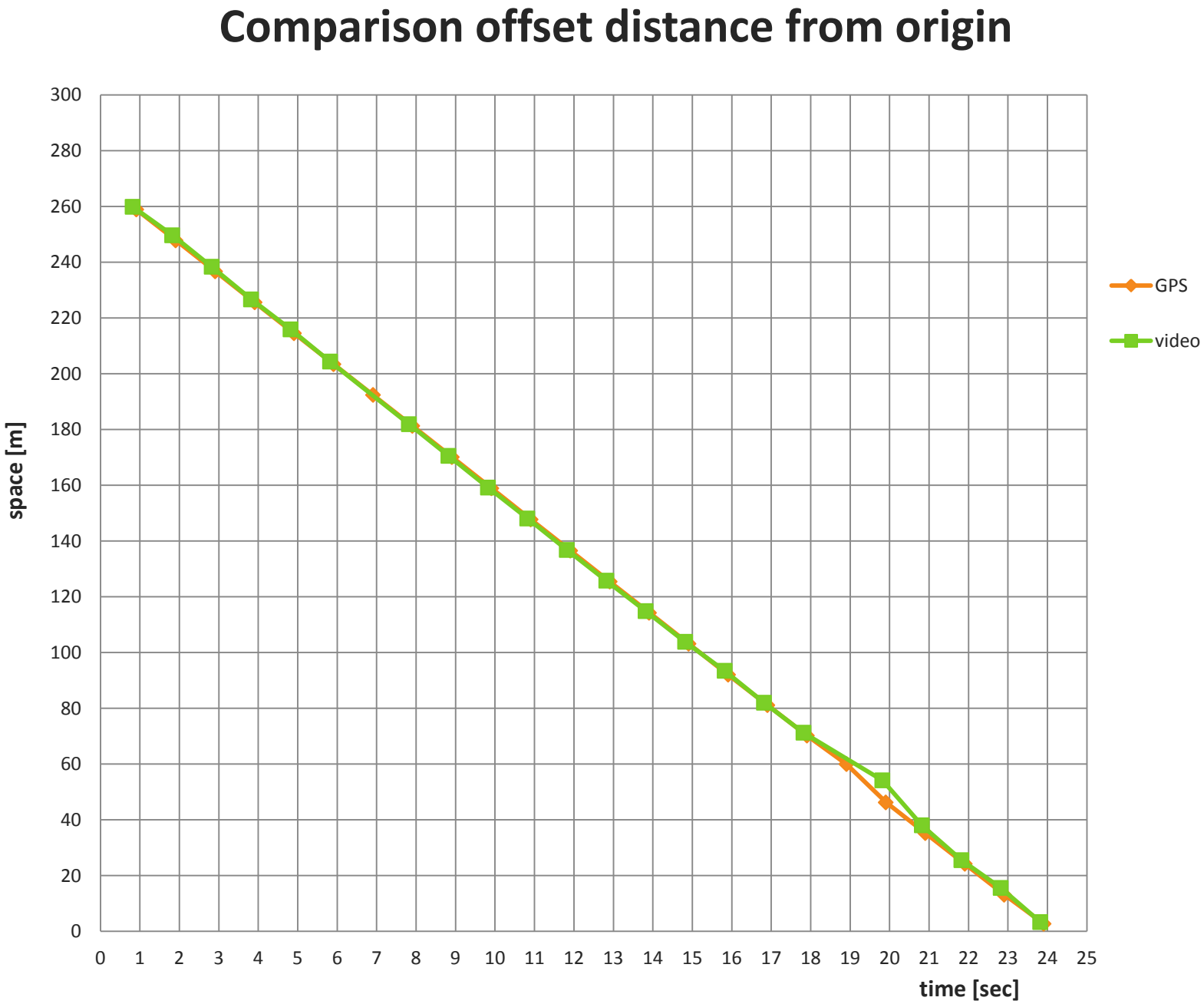






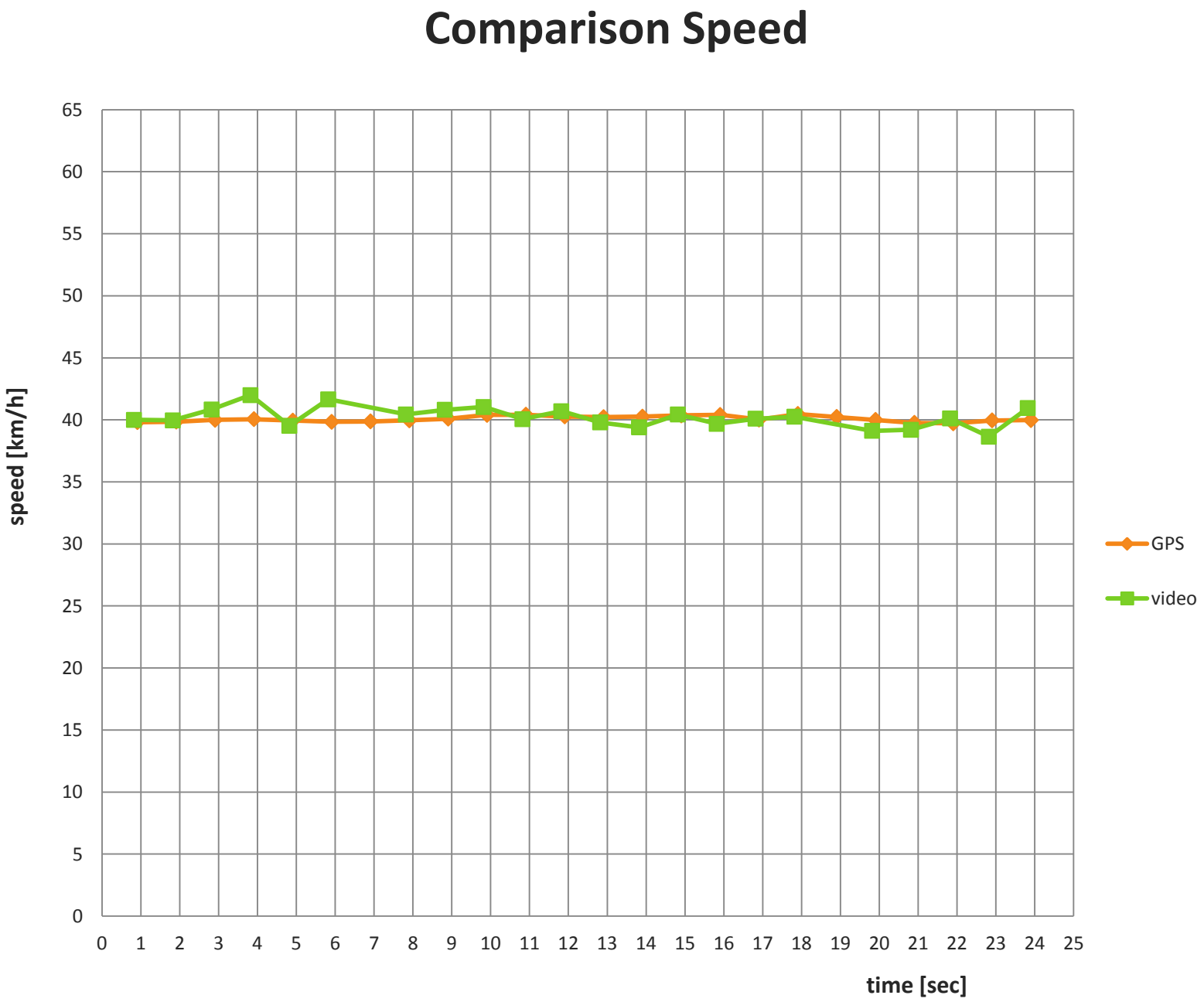
Example Vehicle 3

Comparison distance



Example Vehicle 3

Comparison speed



Example Vehicle 3

RMSE error

Time	Estimate RMSE [%]			
	X	Y	D. cum.	Speed
0,911	1,62E-07	4,59E-04	0,000	0,000
1,911	1,02E-05	7,53E-05	0,000	0,000
2,911	5,40E-06	4,09E-05	0,000	0,001
3,911	2,85E-07	1,47E-04	0,000	0,002
4,911	1,57E-06	3,47E-03	0,000	0,000
5,911	2,32E-07	5,51E-04	0,000	0,002
6,911	1,54E-06	9,51E-04	0,000	0,001
7,911	3,99E-06	1,22E-03	0,000	0,000
8,911	9,94E-06	7,80E-04	0,000	0,000
9,911	1,65E-05	6,52E-05	0,000	0,000
10,911	1,46E-05	4,33E-04	0,000	0,000
11,911	2,20E-05	1,85E-04	0,000	0,000
12,911	1,73E-05	1,01E-05	0,000	0,000
13,911	8,42E-06	2,04E-05	0,000	0,000
14,911	6,08E-06	4,24E-04	0,000	0,000
15,911	8,82E-06	1,71E-04	0,000	0,000
16,911	3,28E-06	2,77E-04	0,000	0,000
17,911	9,67E-07	5,74E-04	0,000	0,000
18,911	8,12E-06	4,10E-05	0,001	0,000
19,911	6,86E-05	2,89E-04	0,020	0,000
20,911	7,75E-04	1,68E-03	0,002	0,000
21,911	1,01E-04	1,51E-03	0,000	0,000
22,911	1,17E-03	2,48E-03	0,010	0,001
RMSE	0,99	2,62	3,85	1,92

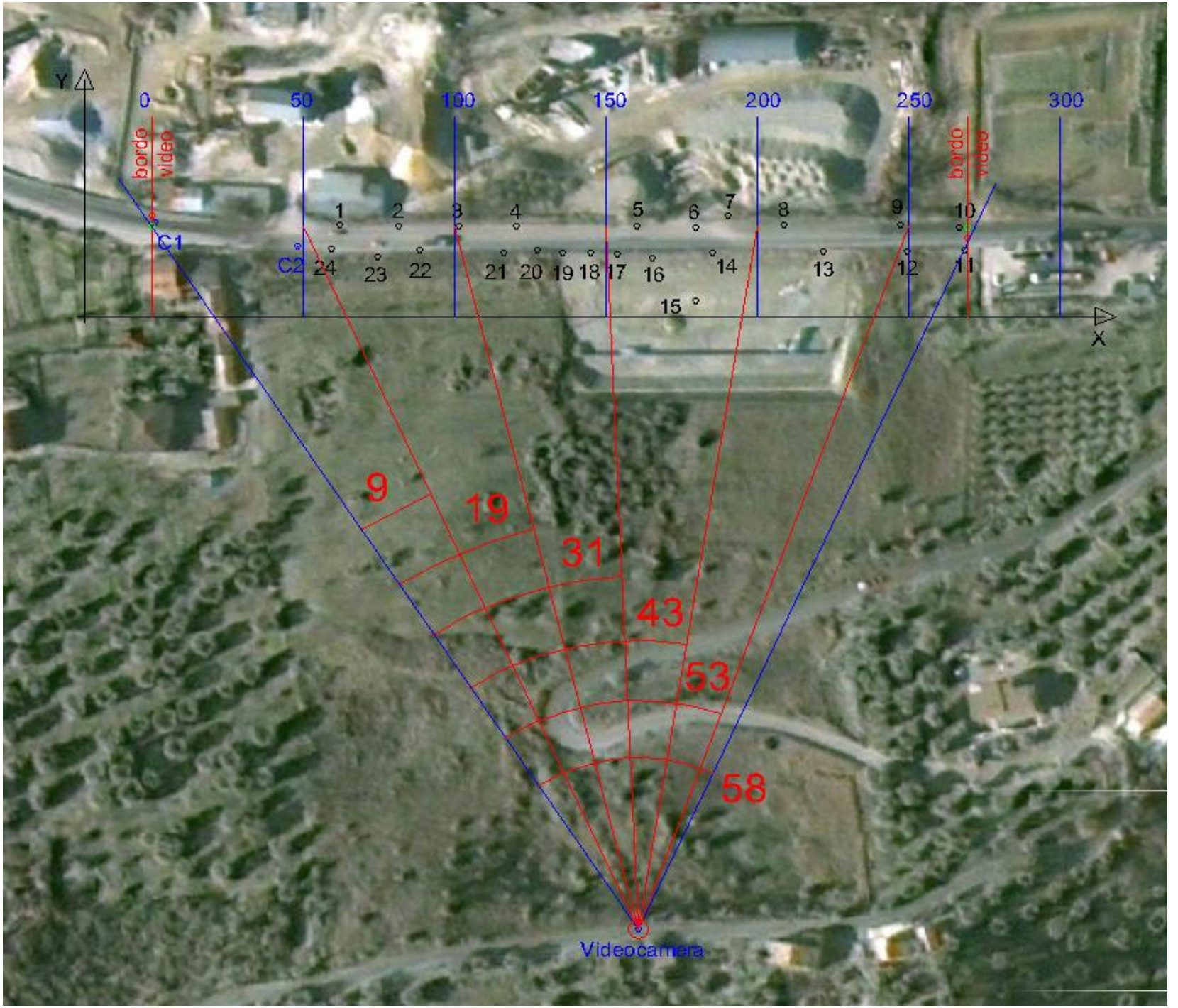
$$RMSE = \sqrt{\frac{\sum \frac{(X_{GPS} - X_{video})^2}{X_{GPS}^2}}{N}}$$

Example Vehicle 3

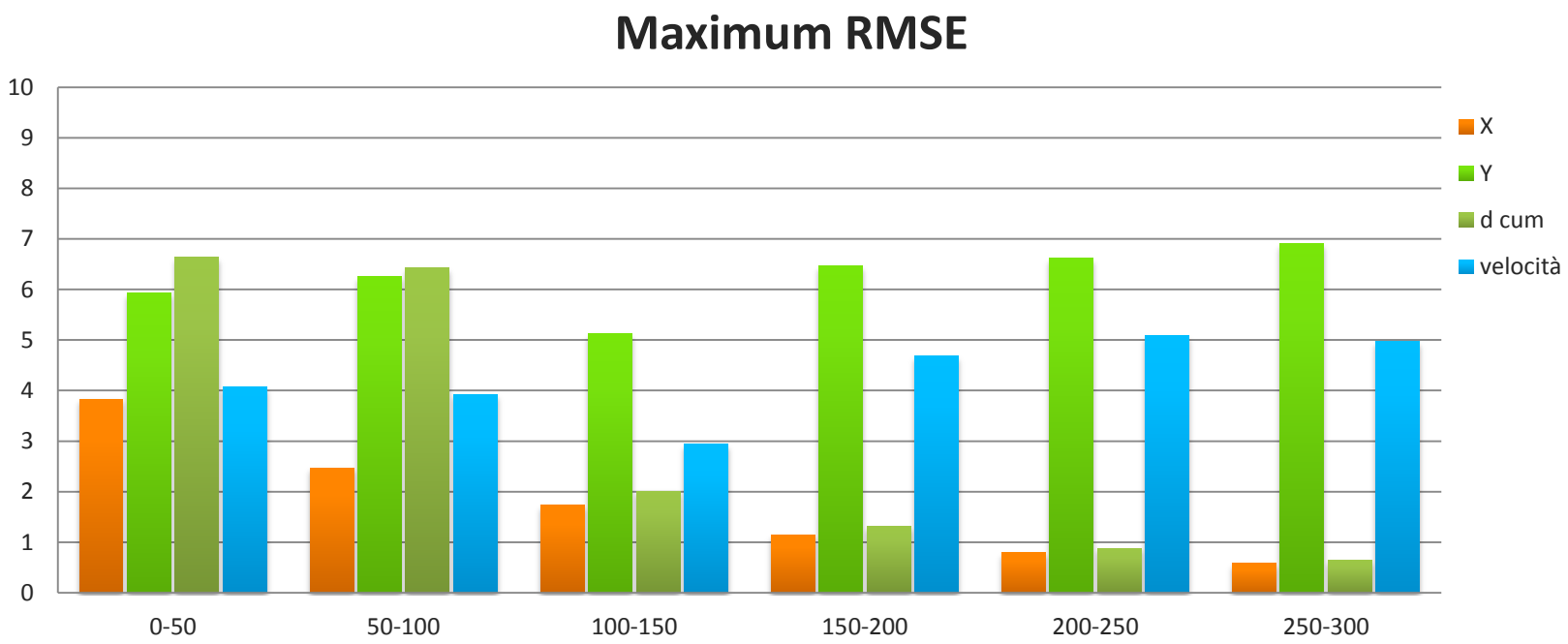
Synthesis RMSE

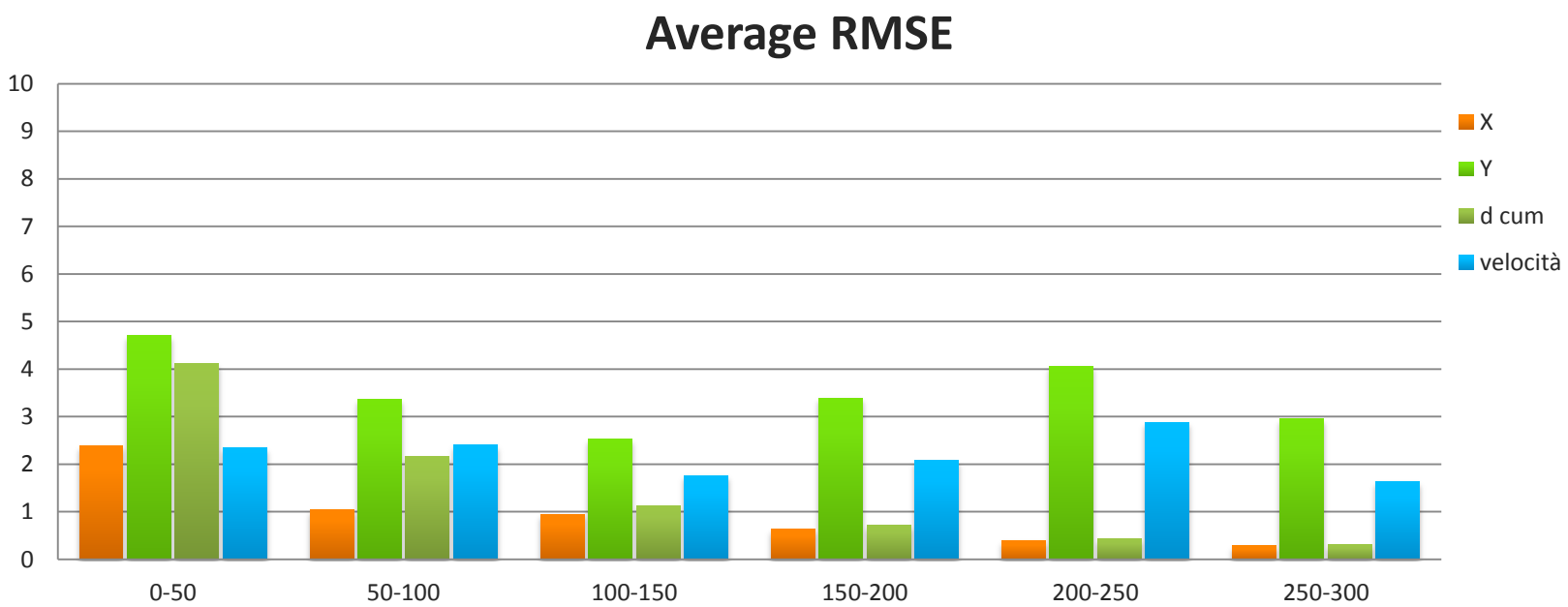
Vehicle	RMSE [%]			
	X	Y	D. cum.	Speed
2	1,76	3,94	2,48	3,34
3	0,99	2,62	3,85	1,92
4	1,51	3,15	2,40	2,10
5	0,79	2,80	1,58	2,35
6	0,72	3,58	0,91	2,25
7	1,63	4,21	2,45	3,24
8	0,92	5,15	1,39	2,67
9	1,85	3,92	2,69	1,47
10	1,16	4,98	1,42	2,35
max	1,85	5,15	3,85	3,34
average	**1,26**	**3,82**	**2,13**	**2,41**
min	0,72	2,62	0,91	1,47

Analysis RMSE in space

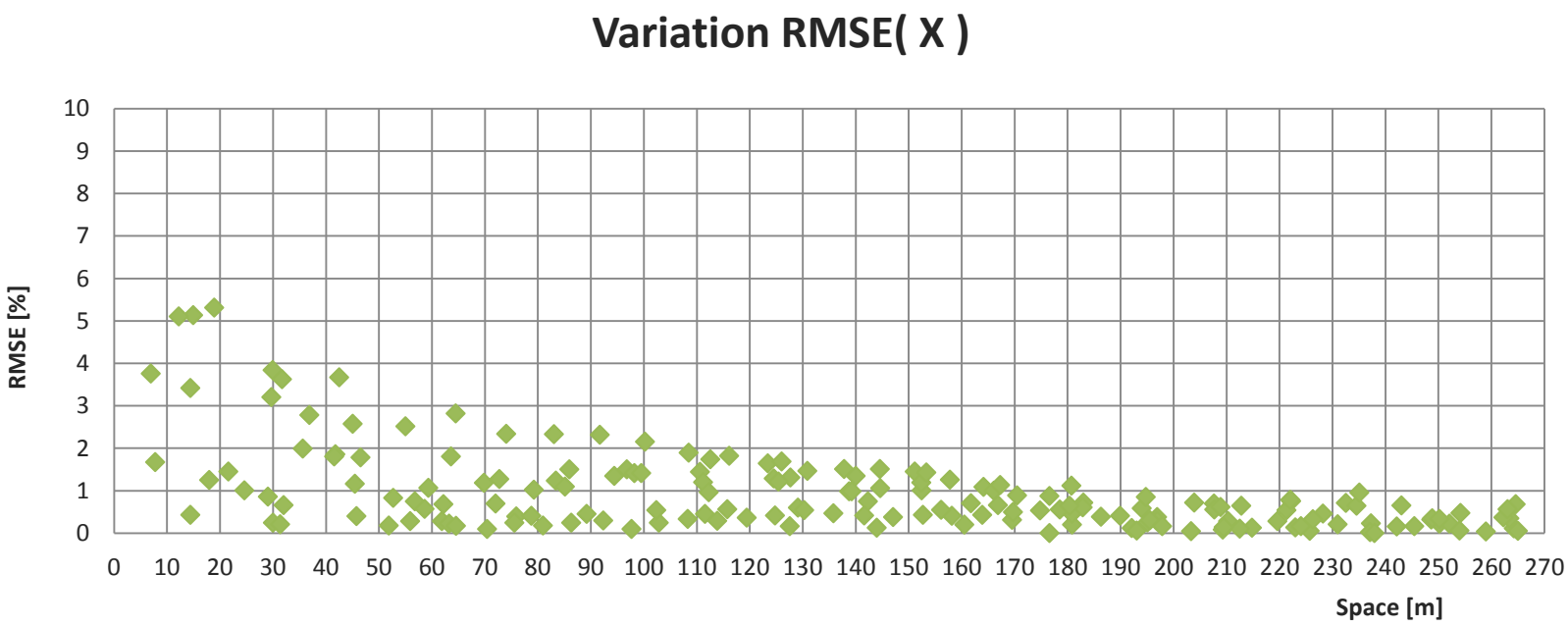


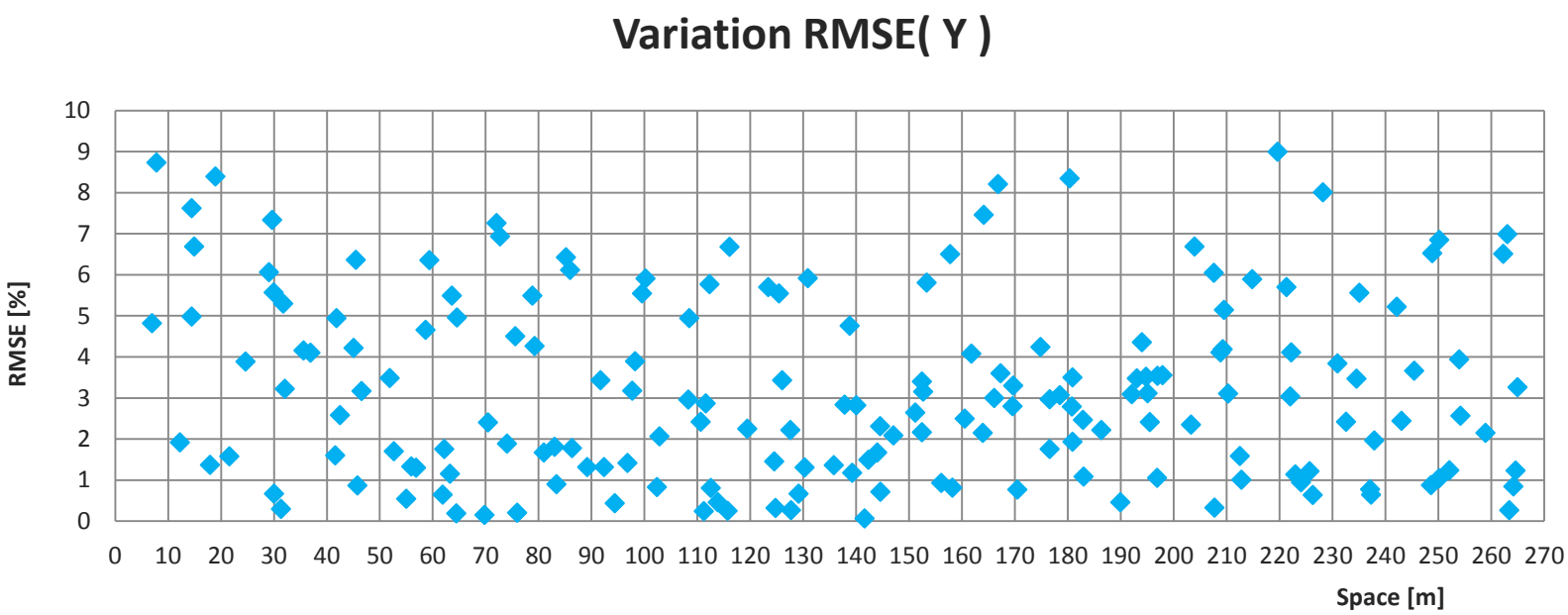
Analysis RMSE in space



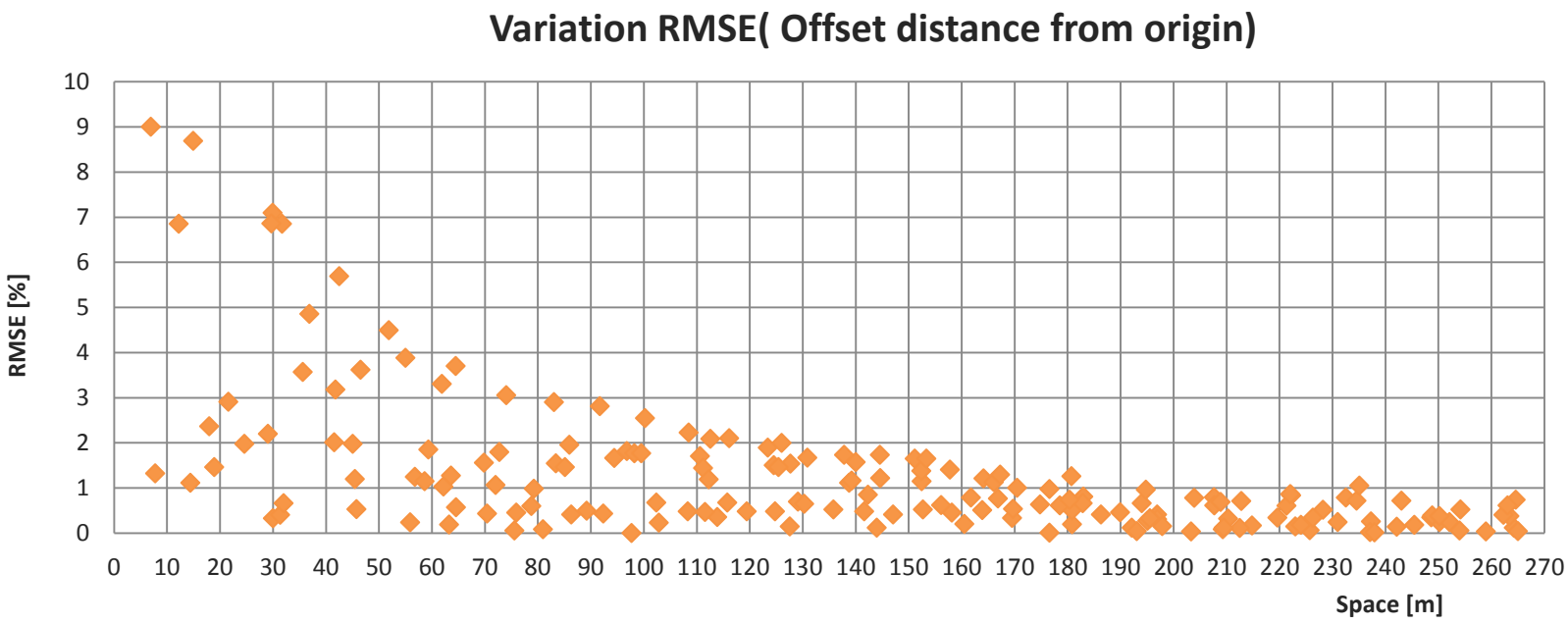


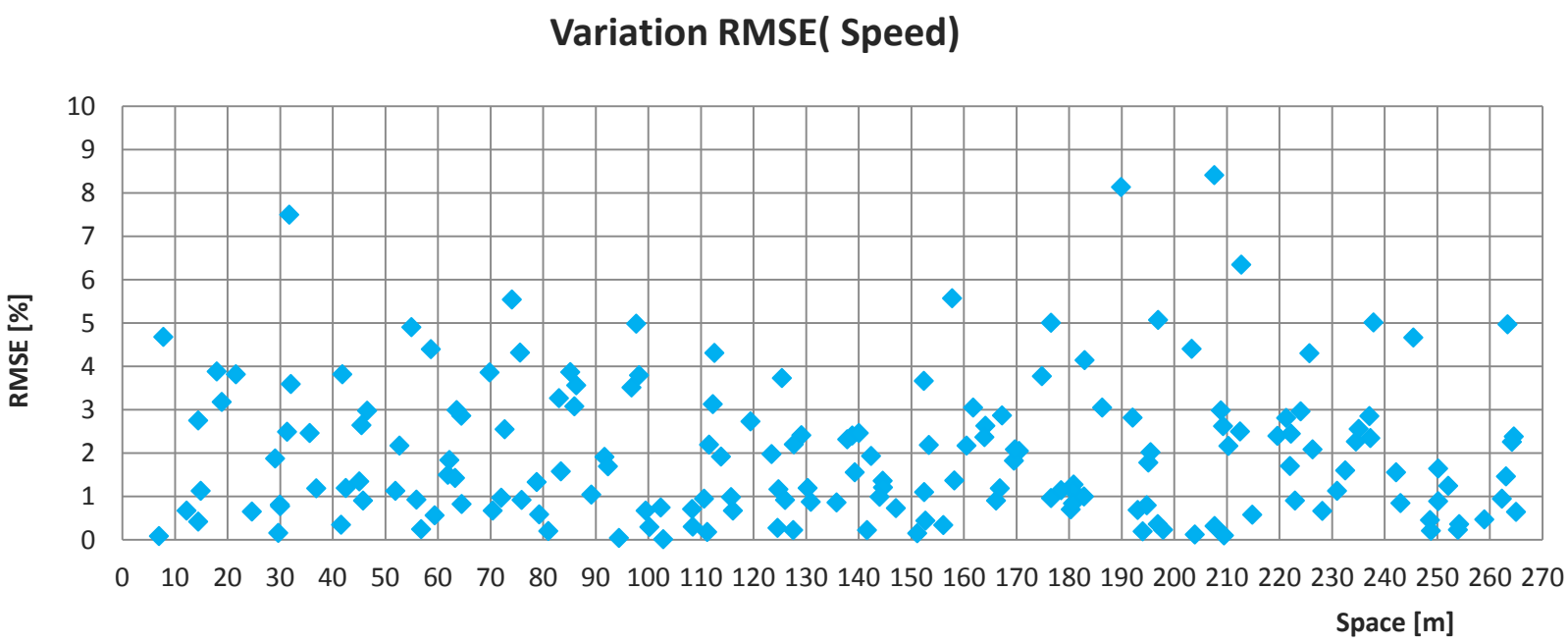
Analysis RMSE in space





Analysis RMSE in space





Conclusions

Possible to have a **standard methodology** for large areas of video record and free geometric constraints

Sputnik

The new application for the vehicle traking