Cerema

Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement

Vehicle occupancy automatic sensor fosters carpooling

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SOMMAIRE

General objectives

- Aximum-NEC system : occupant counting of vehicles in traffic with speed until 90 km/h; placed on road side ;

- Cerema evaluation : evaluate the metrological performances of the sensor based on defined indicators

Issue of vehicle occupancy measurement

- Until now, manual measurements by visual inspection (police forces) with:
  - safety problem: positioning of the police force to arrest of an offender;
  - accuracy problem: up to 50-60% errors in counting (increases with speed);
  - efficiency problem: a maximum of 3 fines per hour.

Issue of vehicle occupancy measurement

- Need to find and set up a reliable automatic count of the number of occupants ;
- Several experiments have been carried out around the world, but the accuracy is at a maximum of 90-95%;
- Problem of false positives to take into account.

The experimentation place

- Motorway A86 North-West of Paris, at Colombes
- Motorway of 2 lanes in each direction, limited at 90km/h, **~100 000 veh**/day/direction

- Only the outside direction is instrumented : a complete system per lane with right vehicle view (shoulder) and left vehicle view (central reservation)
- Variable trafic, fluid to congested, day/night, weekday/weekend
- The two lanes are not real HOV lanes (mixed traffic with car, truck, coach, van…)

Presentation of the NEC system

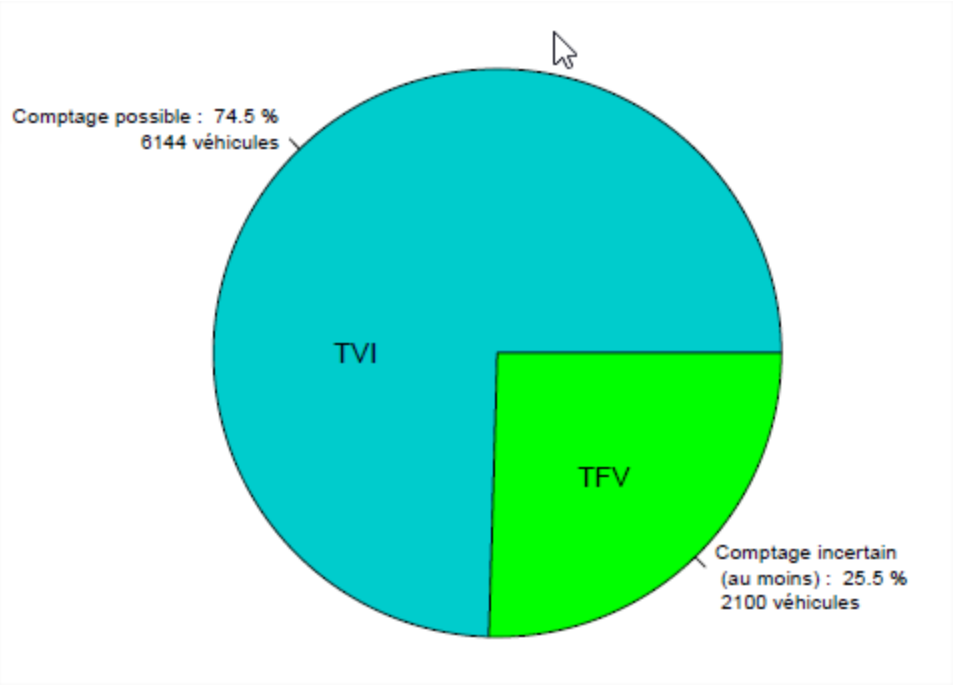
- Camera with Near-infrared flash with many shots (until 25)
- Lenght 150 cm x width 70 cm x Height 150 cm with a 3-4 m for central reesrvation
- Laser sensor for categorisation of car versus truck (and big van) → only cars with height lower than 2 meters are counted

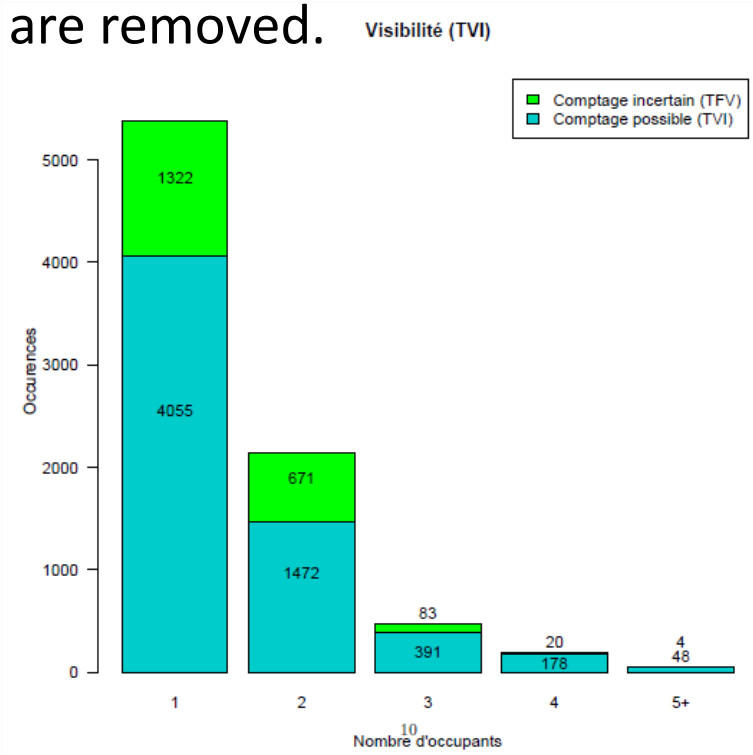
Reference Information

- The Reference is 3 video cameras with NIR flash installed at **45, 60 and 90 ° of the lane and** + NEC shots
- Cameras are adjusted to get a good visibility of occupants

Principle of data exploitation

- On one hand : calculation of the vehicle occupancy by the system ;
- On the other hand : reference of the vehicle occupancy based on manual image and video review. We keep only safe vehicles (TVI): those that it is possible to pronounce with a strict certainty on the exact number of occupants. The others are removed.





The evaluation methodology

Occupancy counting indicators

- Accurate counting (TCO) and incorrect counting (TFO) rate of the number of occupants (and associated matrix), for cars and utilitarian lower than 2 meters by distinguishing 1, 2, 3, 4 or 5+ occupants ;
- Rate of accurate classification (TCL) of the number of occupants for HOV2 + (2 occupants or +) and HOV3 + (3 occupants or +) cases;
- Contextual elements (taxi mode, masked face, occupant in abnormal position…) influencing system accuracy.

Comparison of NEC results with Cerema reference for 1,2,3,4,5 occupants (TCO in%)

NEC system

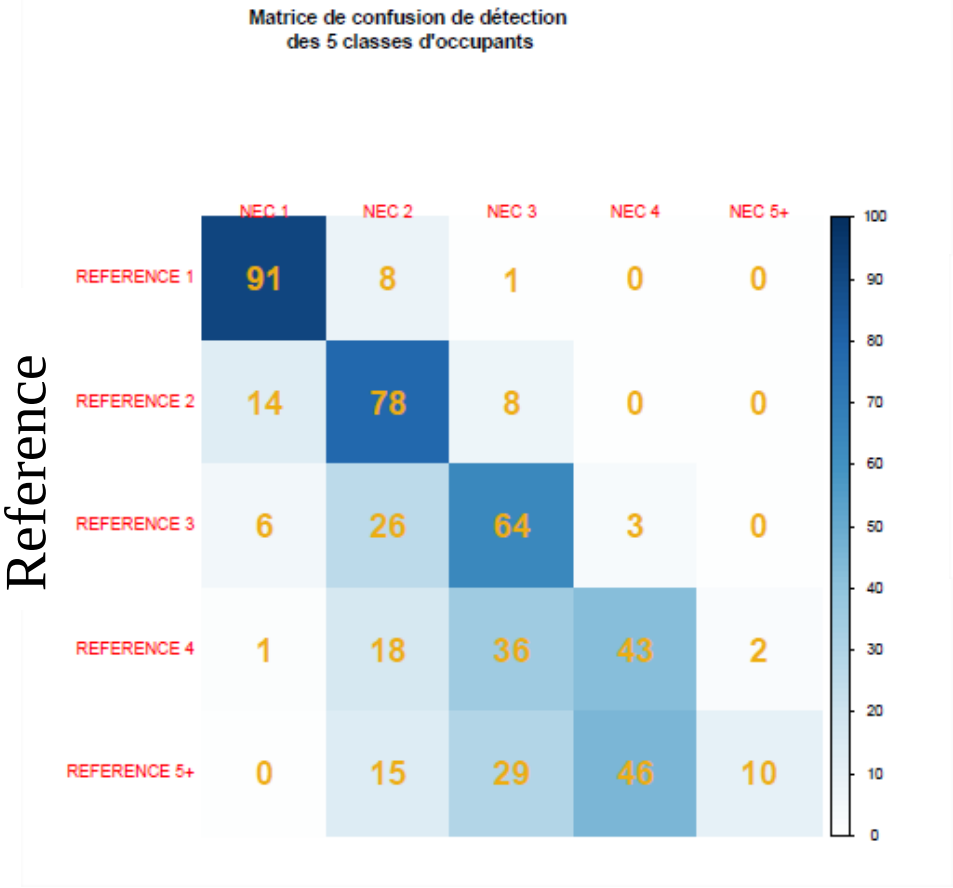


Table 19: Matrice de confusion de détection des 5 classes d'occupants

[Comptage Système NEC ->]	[1]	[2]	[3]	[4]	[5+]	[TOTAL Comptage REF]
Comptage réel 1 occupant	3702	330	23	0	0	4055
Comptage réel 2 occupants	200	1152	116	4	0	1472
Comptage réel occupants	23	103	252	13	0	391
Comptage réel 4 occupants	2	32	64	76	4	178
Comptage réel 5+ occupants	0	7	14	22	5	48
[TOTAL COMPTAGE NEC]	3927	1624	469	115	9	6144

Comparison of NEC results with Cerema reference for VR 2+ and VR3 + (TCL in%)

NEC system

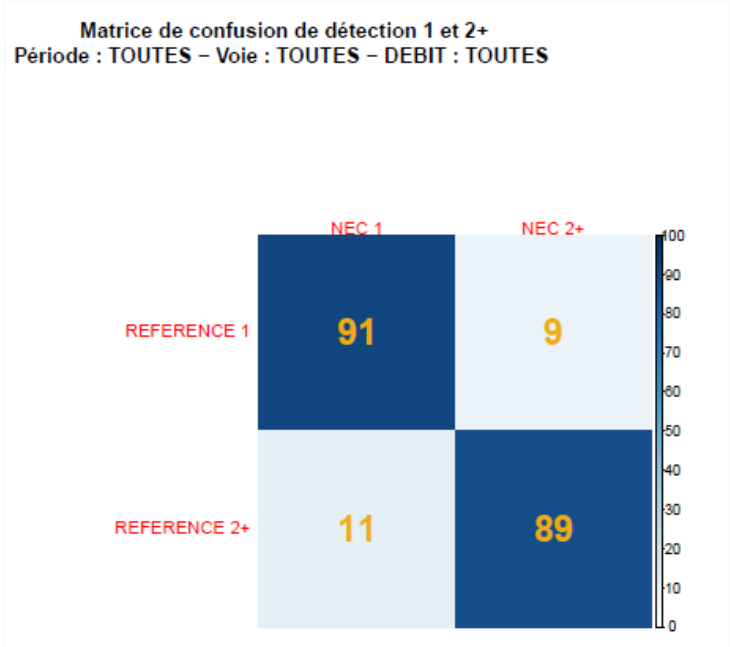


Table 27: MDC numerique - PAP - TOUTES - Voie : TOUTES - DEBIT : TOUTES

[Comptage Système NEC ->]	[1]	[2]	[TOTAL Comptage REF]
Comptage réel 1 occupant	3702	353	4055
Comptage réel 2+ occupants	329	2538	2867
[TOTAL COMPTAGE NEC]	4031	2891	6922

NEC system

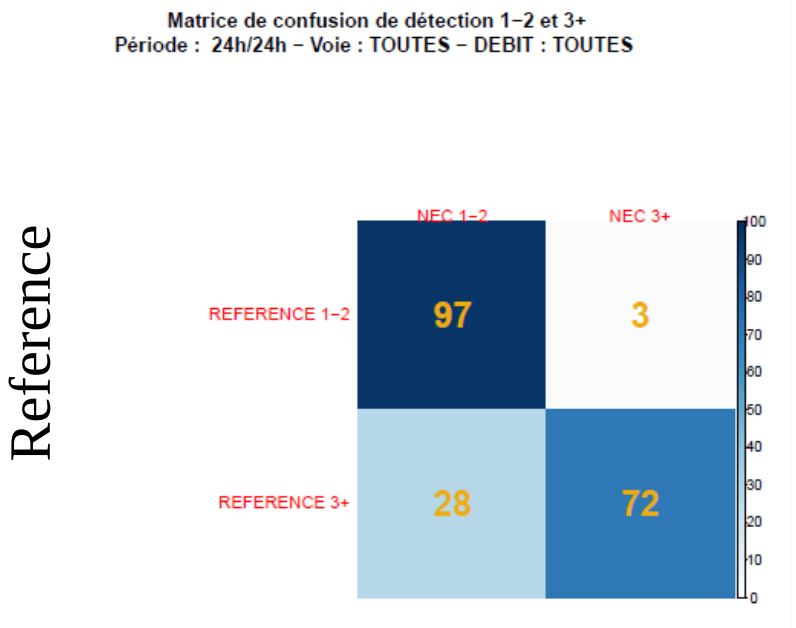
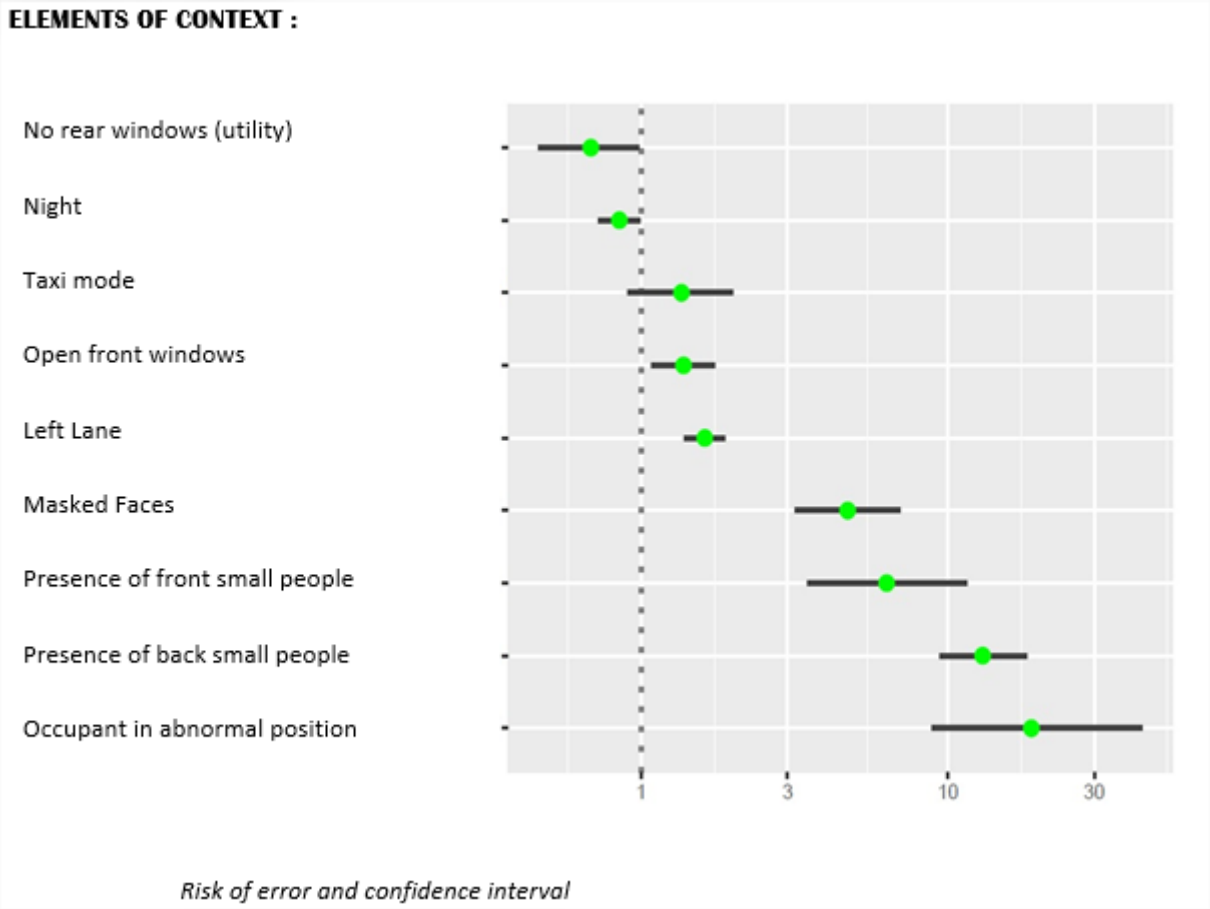


Table 33: MDC numerique - PAP - 24h/24h - Voie : TOUTES - DEBIT : TOUTES

[Comptage Système NEC ->]	[1-2]	[3+]	[TOTAL Comptage REF]
Comptage réel 1-2 occupants	5384	143	5527
Comptage réel 3+ occupants	205	519	724
[TOTAL COMPTAGE NEC]	5589	662	6251

Contextual elements influence on system accuracy

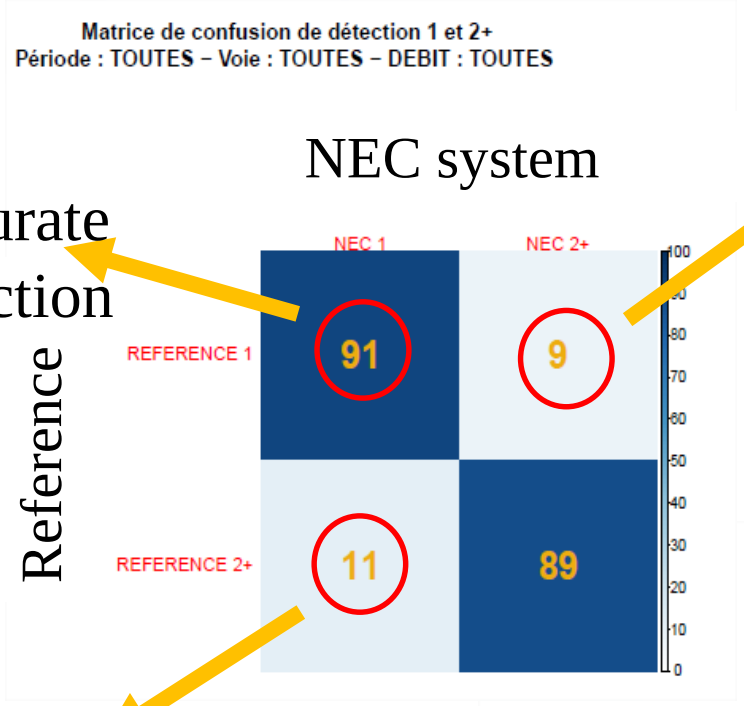


With an occupant in an abnormal position, the NEC system is 20 times more likely to make a counting error.

The problem of false positives

		Automated detection of occupants	
		SOV - 1	HOV2+ - 2+
Actual number of occupants	SOV - 1	Detected cheaters **(True Positives-TP)**	Cheaters detected as carpoolers **(False Negatives-FN)**
	HOV2+ - 2+	False offense detection **(False Positives-FP)**	Detected carpoolers **(True Negatives -VN)**

Our evaluation



		Automated detection of occupants	
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Actual number of occupants	SOV - 1	Detected cheaters **(True Positives-TP)**	Cheaters detected as carpoolers **(False Negatives-FN)**
	HOV2+ - 2+	False offense detection **(False Positives-FP)**	Detected carpoolers **(True Negatives -VN)**

Future prospects

- Is it possible to reduce the number of false positives ? to implement an automatic occupancy enforcement on HOV lanes ;
- The system must provide a confidence index on the quality of occupancy ;
- The NEC system has not been tested in all weather conditions.

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谢谢 !!

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