# ANPR/MMR quality verification for video stream processing

neurocar

Version EN 4.4.1 released on Feb 14, 2024.


Description of the quality verification procedure for the system implementing detection, classification and identification of vehicles from the video stream – license plate recognition (ANPR), vehicle type recognition and make and model recognition (MMR). The procedure is prepared for the *free flow* mode of operation, in which the input video stream is analyzed, and the result is a sequence – one data record for each vehicle passing in the field of view of the camera.

## 1. Definitions

### 1.1. Detection area

The detection area is the place where vehicle detection and identification takes place. By design, the detection area covers the full cross-section of the road, i.e. all lanes where the tested devices are mounted, along with the emergency lane (if any). The system should be designed to ensure detection of all vehicles moving in a given direction.

In locations where there is an emergency lane, the detection area also includes the lane – vehicles moving partially or completely in the emergency lane should be counted as vehicles passing in the slow lane unless the system design provides for a separate detection for the emergency lane.

On a road with two-way traffic, it is stipulated that all vehicles traveling in the indicated lane, in the specified direction, should be detected, even if they only partially pass over it. It is assumed that a vehicle should be detected when at least one wheel from each axle of the vehicle passes entirely in the indicated lane (within the area designated by horizontal markings). In such a measurement system, a vehicle is assumed to be outside the detection area when it has fully moved with all wheels into the opposite lane.

## 1.2. Detection quality

Detection level $r_d$ is a measure quantifying (in percentage terms) the ratio of the number of vehicles detected by the tested system to the number of all vehicles passing through a given detection area, at a given time, in a given direction, in a designated lane, at a speed that allows effective measurement. The detection level can be determined for vehicles moving in any direction or in a well-defined direction, rejecting vehicles moving against the flow, for example.

It is assumed that the system detects only moving vehicles – effective measurement is possible when the vehicle is moving at speed:

- at least ≥ **3.6** km/h (≥1 m/s),
- at most ≤ **252** km/h (≤70 m/s).

**Attention**

The vehicle speed requirement can be extended, for example, by allowing *stop&go* traffic, but it is recommended to treat such cases as special, tested in a separate procedure.

Two sources of error are taken into account in determining the detection level:

- $\varepsilon_m$ – omission of a vehicle by the system (number of vehicles omitted),
- $\varepsilon_f$ – detection of a non-existent vehicle by the system (number of falsely detected vehicles).

If $N$ is the number of vehicles that actually passed through the measurement point then the detection level $r_d$ is determined from the formula:

$$r_d = \frac{(N - \varepsilon_m - \varepsilon_f)}{N} \tag{1}$$

By design, the system should detect the passage of any vehicle, such as:

- motorcycles and mopeds,
- passenger cars, including those with trailers,
- light commercial vehicles (LCV), including those with trailers,
- tractors and other agricultural machinery, including multi-trailers,
- trucks, including those with trailers,
- tractor-trailers, stand-alone and with semi-trailer,
- buses, including those with trailers,
- special, multi-axle vehicles for oversize transport,
- military vehicles, including transporters and tanks.

When calculating the detection level, vehicles that the system may not detect are not taken into account:

- bicycles,
- mopeds,
- light wooden vehicles (such as a carriage),
- road machinery, such as rollers, milling machines, etc.

If multiple vehicles pass through the detection field at the same time, each should be detected independently.

## 1.3. Identification quality

In the simplest case, by identification of a vehicle is meant its detection and subsequent recognition of the license plate number. By the term *identification quality* $r_p$ is meant the percentage value that is the ratio of the number of correctly recognized vehicle plates $K_{OK}$ to the number of all identifiable vehicles $N_{ID}$ that passed through the detection area, in the specified direction, at the specified time, at the correct speed:

$$r_p = \frac{K_{OK}}{N_{ID}} \tag{2}$$

The number of vehicles that can be identified in a certain number of vehicles $N_{ID}$ is determined by an expert during the test. Vehicles are not taken into account:

- motorcycles, for measurements from the front,
- agricultural machinery without a license plate marking,
- vehicles without a license plate,
- vehicles with an illegible license plate, about which the expert has doubts, in determining the registration number.

**Attention**

If the ANPR camera does not cover the entire detection area, as a result of which, for a vehicle detected by detection, the plate is not visible, or visible only partially, such a vehicle should be classified as unidentified (without plate recognition) but identifiable, i.e. included in the $N_{ID}$ group.

It is assumed that the registration number is:

- a string of uppercase letters and numbers – if there is a lowercase letter in the plate, it should be converted to uppercase,
- no longer than 10 characters,
- without separators and other special characters,
- all characters written together – characters other than a letter or number should be omitted.

To avoid ambiguity, the license plate number should be encoded in the output in UTF-8 encoding. For some countries, recognition of the corresponding national characters is required (e.g. umlaut in German plates). For license plates from countries where the Latin alphabet is not used, it is allowed to recognize letters and numbers in the alphabet appropriate for the country (e.g. Cyrillic), but it is also allowed to convert characters from non-Latin to Latin alphabet, for example, such conversion can be used for Russian plates, plates of Middle Eastern countries (Arabic script) or Chinese plates.

Number plate recognition should not be affected:

- letter color and background color,
- reflectivity (at night, the plates must be illuminated with at least infrared light),
- arrangement of characters (single-row, double-row).

If there is more than one vehicle in the image to be analyzed then the detection system should detect each vehicle independently, and the identification system should recognize the license plate of each vehicle separately.

If the ANPR board recognition system provides recognition results in the form of variants (different alternatives), the first variant, i.e. the variant with the highest confidence level (if the manufacturer has marked such a level), is taken as the result, and the other results are discarded.

The license plate is considered to be recognized correctly if the selected variant from the automatic recognition agrees verbatim as to the number of characters and their values with the result indicated by the expert – when comparing any characters other than letters and numbers are ignored. In the comparison, country codes are not taken into account (for example, the so-called eurolabel from European tables). In the comparison, letters are capitalized.

## 1.4. Classification quality

Classification quality, or vehicle type recognition quality $r_t$, is a measure quantifying (in percentage terms) the ratio of the number of correctly recognized vehicle types $T_{OK}$ to the number of all classifiable vehicles $N_{TID}$ that passed through the detection area within a specified time, at the correct speed and in the direction according to the system's configuration (in particular, the system can be adapted to recognize in a given detection area vehicle types coming from one specific direction):

$$r_t = \frac{T_{OK}}{N_{TID}} \tag{3}$$

The number of vehicles that can be classified in a specific series of vehicles is determined by an expert during the test. Vehicles are not taken into account:

- bicycles,
- mopeds,
- light wooden vehicles (such as a carriage),
- road machinery like rollers, milling machines, etc.,
- vehicles that the expert is unable to assign to any of the classes recognized by the system.

The system must be able to recognize the following classes of vehicles:

- personal car
- LCV (light commercial vehicle)
- trucks (vehicles with GVW >3.5 tons and truck tractors),
- buses
- other

## 1.5. Maker recognition quality

It is assumed that the system recognizes the maker of vehicles based on a photo of the front. Recognition of the vehicle maker in rear photos is not evaluated and is, as a rule, significantly worse than for the front. In a large number of cases (e.g., trucks) it is completely impossible.

Maker recognition quality $r_m$ is a measure that quantifies (in percentage terms) the ratio of the number of correctly recognized makers of vehicles $M_{OK}$ to the number of all recognizable vehicles $N_{MID}$ that passed through the detection area) in a specified time, at the correct speed and in the direction according to the system configuration (the system in particular can be adapted to recognize in a given detection area the maker of vehicles coming from one specific direction):

$$r_m = \frac{M_{OK}}{N_{MID}} \tag{4}$$

The number of vehicles that can be recognized in a specific series of vehicles is determined by an expert during the test. Vehicles are not taken into account:

- bicycles,
- mopeds,
- motorcycles,
- road machinery like rollers, milling machines, etc.,
- tractors and other agricultural machinery,
- vehicles not produced in series,
- special and military vehicles,
- vehicles for which no maker was specified by the manufacturer,
- vehicles for which the expert is unable to determine the brand.

**Attention**

The system does not need to be able to recognize vehicle maker at night unless it has been specially prepared for this, e.g. by attaching special high-powered IR lighting.

# 2. Confidence

## 2.1. Random variable

The result of each of the described tasks of the system, i.e. automatic detection, identification, classification, maker recognition – realized for a single vehicle – can be defined as success (correct result) or failure (incorrect result). The result is therefore a random variable with a binominal distribution with a $p$ parameter denoting the probability of success.

Thus, depending on the task, success is correct vehicle detection, correct license plate reading, correct type recognition, correct brand recognition. In each task, the count of vehicles $N$ must be taken into account, except that in the case of detection quality analysis $r_d$ it will be the number of all vehicles $N$, and in the case of the other parameters $r_p$ , $r_t$ , $r_m$ the designated counts of vehicles $N_{ID}$, $N_{TID}$ and $N_{MID}$ must be taken into account.

## 2.2. Confidence interval

The parameters tested (detection level, identification level, classification level, maker recognition efficiency) are the expressed percentage probabilities of $p$.

In order to verify the requirements defined earlier, it is necessary:

- Adopt a specific confidence level for the assessment – most often:

$$1 - \alpha = 95\% \tag{5}$$

- Calculate the estimate of $\hat{p}$ of the given parameter under test.
- Calculate the lower value of the $\hat{p}_L$ symmetric confidence interval calculated using Wilson's [2] method:

$$\hat{p}_L = max\left\{0, \frac{2N\hat{p} + z^2 - \left[z\sqrt{z^2 - (1/N) + 4N\hat{p}(1-\hat{p}) + (4\hat{p} - 2)} + 1\right]}{2 \cdot (N + z^2)}\right\}, \tag{6}$$

  – gdzie wartość $z \approx 1.6448536$ wynika z przyjętego poziomu ufności, a rzeczywista wartość testowanego parametru $p$ jest z prawdopodobieństwem 95% wyższa od wartości $\hat{p}_L$.

  – due to the fact that the requirement is $\hat{p}_L \leq p$ for the value of $\alpha$ in the calculation of $z$ is taken double the value of the assumed confidence level, which in this case is 90%.

- Verify that the value of $\hat{p}_L$ is greater than the threshold value given in the requirements section.Verify that the value of $\hat{p}_L$ is greater than the threshold value given in the requirements section.

### 2.3. Minimum sample sizes

Based on [1], it is known that at least the following numbers of vehicles must be included in the test when evaluating the indicated quality factor, for the selected confidence level:

| **Expected quality** | **Maximum error** | **Number of vehicles** $1-\alpha=95\%$ | **Number of vehicles** $1-\alpha=99\%$ |
|---|---|---|---|
| 80% | 20% | 62 | 107 |
| 85% | 15% | 88 | 151 |
| 90% | 10% | 139 | 239 |
| 95% | 5% | 292 | 505 |
| 97% | 3% | 497 | 859 |
| 98% | 2% | 753 | 1301 |
| 99% | 1% | 1522 | 2628 |

## 3. Evaluation criteria

### 3.1. Quality parameters

The following indicates the typical values of quality parameters that the tested system should achieve under optimal conditions:

- for vehicles observed from the front:

| **Parameter** | **Label** | **Level** |
|---|---|---|
| detection | $r_d$ | ≥97% |
| identification | $r_p$ | ≥95% |
| classification | $r_t$ | ≥90% |
| maker | $r_m$ | ≥80% |

- the required value of these parameters should be agreed with the Customer,
- for vehicles observed from the rear – quality parameters will be lower than for vehicles observed from the front.

**Attention**

Each of the above parameters should be determined at the confidence level = **95%**.

## 3.2. Character sizes

It is expected that the test will be conducted for a video stream in which license plates will be observed, in which the height of the characters expressed in pixels (conventional *optical resolution*) will be **16 pixels** (for a normalized uppercase `X`). If the indicated requirement, in the case of a particular vehicle, is not met, such case should be removed from the test.

## 3.3. Character shapes

When assessing the correctness of license plate recognition, ambiguities may arise due to the quality of the image being verified, such as the problem in determining the correct sign for couples:

- `0` ↔ `O`
- `I` ↔ `1`
- `S` ↔ `5`
- `2` ↔ `Z`
- `6` ↔ `G`

In such cases, the correctness of the recognition should be indicated in an irrefutable manner, for example, by verification in an official database where the data of the analyzed vehicle can be found. If it is not possible to determine the correct recognition of a given sign, such a case should be excluded from the evaluation.

## 3.4. Classification ambiguities

If, on the basis of the photo, the expert is unable to unambiguously assess the type of vehicle in accordance with the accepted taxonomy, such a case should be excluded from the assessment.

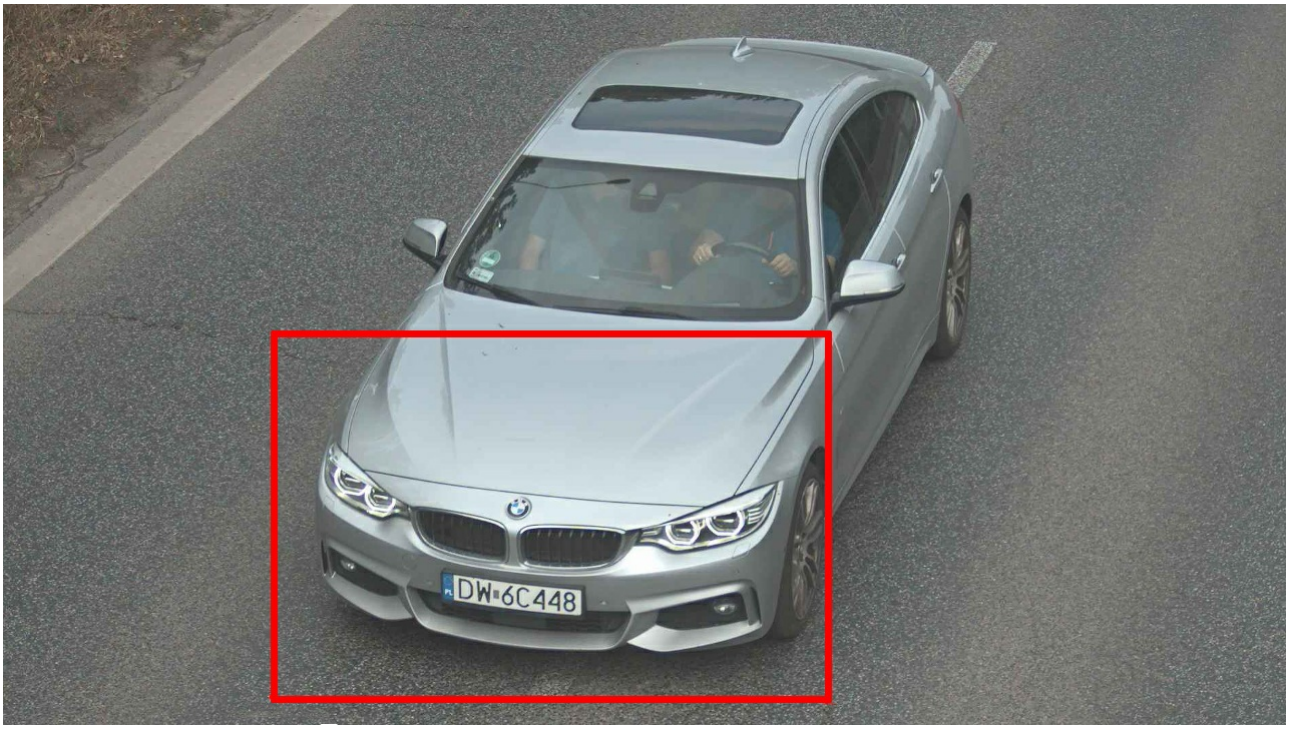
## 3.5. Maker ambiguities

### 3.5.1. Visibility

It is assumed that vehicle maker recognition is possible when the camera image contains a visible silhouette of the entire front of the vehicle. In particular, it is assumed that in addition to the license plate, fully visible should be:

- the right and left headlights of the vehicle,
- the area from the license plate to the lower edge of the windshield (horizontally, upward),
- the area from the license plate to the road surface (horizontally, downward).

Below is an image from the ANPR camera, in which a red box marks the section necessary for correct maker recognition.




If the front of the vehicles is not visible as in the example above, for example, it is partially obscured by other vehicles or infrastructure elements then such a case should be excluded from the evaluation.

### 3.5.2. Night

It is also assumed that all night shots, such as the example below (here the measurement field is illuminated only by an IR illuminator), will be excluded from the evaluation of maker recognition quality:


### 3.5.3. Manufacturer name

In some situations, the manufacturer's name needs to be disambiguated. This situation occurs when:

- the same manufacturer uses a different brand name in different regions (for example, “Opel” is used interchangeably with “Vauxhall”),
- the same manufacturer has transformed itself and changed its name over time (for example, “Citroen” has been producing cars under the name “DS” since June 1, 2016).

# 4. Running the test

## 4.1. Conditions

It is assumed that the system should identify vehicles at the expected level of quality at any time of day or night (except for brand recognition, where only daytime operation is allowed) in any weather conditions. However, the exception is when one of the factors occurs:

- a significant number of vehicles travel at speeds outside the permissible range (e.g., passing out of traffic jams),
- snowfall occurs,
- the ambient air temperature drops below 0° C, which can lead to icing on the number plates and reduce their readability,
- there is a strong atmospheric anomaly in the form of a thunderstorm with hail,
- there is a strong atmospheric anomaly in the form of a dust storm.

If any of the above factors occur during the test, the test should be suspended and rescheduled for another convenient date.

## 4.2. Sample

In order to obtain a statistically reliable result for the test values, it is expected that the test sample size must be no smaller than 1,200 vehicles.

This sample should be divided into three sub-sets:

- `DAM500` – 500 vehicles registered during the day, before noon,
- `DPM500` – 500 vehicles registered during the day, in the afternoon,
- `N200` – 200 vehicles registered at night.

Day should be understood as the period from the beginning of the astronomical day (astronomical sunrise) +1 hour, to the end of the astronomical day (astronomical sunset) -1 hour. Night should be understood as the period of 2 hours after astronomical sunset and up to 2 hours before astronomical sunrise.

The phrase *before noon* means at least 1 hour before astronomical noon while the phrase *after noon* means at least 1 hour after astronomical noon. The determination of astronomical sunrise, sunset and noon is made on the basis of information about the measurement location and the relevant astronomical tables. The calculated values are entered into the test protocol.

## 4.3. Video recording

It is required that video footage covering at least the entire field of view of the ANPR camera be recorded while the test is being conducted. The video should be recorded in digital form, compressed (H.264), with a resolution of at least 640 × 360, 25 frames per second. The reference video recording can come directly from the ANPR camera or from a nearby camera facing the test area.

It is assumed that the video recording should be continuous throughout the sub-test period. It is permissible that there will be gaps in the video material, however, they must not exceed more than 1% of the required recording time, with the length of one gap not exceeding 0.5 s.

## 4.4. Source data

It is required that source data generated by the system under test be collected during the test. For each recorded vehicle trip, this data should include:

- **Metadata**:
    1. timestamp, with an accuracy of at least 0.1 s,
    2. the unique identifier of the measurement site,
    3. ANPR recognition result in test form,
    4. type recognition result in test form,
    5. the result of maker recognition in the test form.

- **Pictures**:
    1. photo of the entire detection are – the ANPR camera snapshot,
    2. a snap of the photo containing the front of the vehicle - allowing to assess the correctness of maker recognition,
    3. a snap of the photo containing the entire license plate (including its surround/frame) – the characters in this slice should be at least 16 px .

## 4.5. Procedure

The test will be conducted in three stages, separately for the `DAM500`, `DPM500` and `N200` sub-sets.

In the first step, the time for performing the test for each sample must be specified. Then, at the specified time, at least as many vehicles as provided for each sample should be registered consecutively, with the proviso that if an unidentifiable vehicle appears during registration (in any of the evaluated criteria) then the sample will be increased by one.

All vehicles excluded from the test must be included in the test report (in the form of a photo), and in addition, for each such case it is necessary to comment on what basis the exclusion was decided.

Each vehicle in the sample must have its own unique sequence number, and all vehicles in the sample must be numbered monotonically increasing with respect to time.

Shortly after the collection of a given sample, the source data and video recording should be digitally signed (the time signature of the signature is important here) and forwarded to the verification committee, with the time from the completion of the sample recording to the handover of the printed documentation not to exceed three hours, under the sanction of classifying the sample as “wholly misrecognized”.

## 4.6. Processed data

After collecting all samples (`DAM500`, `DPPM00`, `N200`), the contractor shall prepare a tabular summary of all source data. Such a summary should be placed in a table saved as a spreadsheet (Microsoft Excel / LibreOffice Calc), where each recorded vehicle passage should be placed in a separate row. The table with processed data should contain at least such columns:

| Name | Format | Example | Description |
|---|---|---|---|
| `counter` | number | 1 | sequential number of the vehicle in the list, numbered from 1 |
| `terminal` | text | ncar-h-cpu-06c00103 | serial number / unique identifier of the data generating device |
| `date` | date | 2022-10-27 | date based on timestamp, local time, displayed in YYYY-MM-DD format |
| `time` | date | 09:00:00 | time based on timestamp, local time, displayed in HH:MM:SS format |
| `ms` | number | 960 | millisecond based on the timestamp |
| `place` | text | pl-wrozyczliwa-wja-l1 | the unique identifier of the location where the vehicle was registered |
| `class` | number | 7 | recognized vehicle type, according to the taxonomy under test (e.g., TLS 5+1) |
| `number` | text | DW6C448 | recognized, normalized registration number |
| `maker` | text | BMW | maker's name recognized |
| `model` | text | 4 | recognized model version (if available) |
| `det_ok` | number | +1 | whether the detection of a particular vehicle is correct ? |
| `class_ok` | number | +1 | is the vehicle class recognized correctly ? |
| `maker_ok` | number | +1 | is the maker recognized correctly ? |
| `anpr_ok` | number | +1 | is the vehicle registration number recognized correctly ? |
| `notice` | text | | comments (if any) |

In the `det_ok`, `class_ok`, `maker_ok` and `anpr_ok` columns, the entered numeric values are interpreted as follows:

| Value | Meaning |
|---|---|
| **+1** | indicated value is correct, vehicle takes part in the evaluation |
| **-1** | indicated value is incorrect, vehicle takes part in the evaluation |
| **0** | the measurement record in question is excluded from the evaluation |

A template for such a table is included as Appendix A to this document.

## 4.7. Results

The detection, identification and classification quality will be determined for all measurements combined. In the case of evaluating maker recognition performance, a 1000-element sample formed by concatenating `DAM500` and `DPM500` samples should be taken.

The results should be tabulated with an indication:

- how many vehicles from a given sample were included in the evaluation
- how many vehicles have correctly recognized parameters,
- what is the average value of a given quality factor,
- what is the statistically reliable value of a given quality factor.

An example of the final statement is shown below:

| | DR500 | DP500 | N200 | SUMA | | | |
|---|---|---|---|---|---|---|---|
| Liczba pojazdów w teście | 510 | 509 | 220 | **1239** | | | |
| Liczba pojazdów do detekcji N | 506 | 506 | 219 | 1231 | Zalecana: | 1000 | ok |
| - pojazdy poprawnie wykryte | 502 | 505 | 219 | 1226 | | | |
| - pojazdy źle wykryte ($\varepsilon_m + \varepsilon_f$) | 4 | 1 | 0 | 5 | | | |
| - poziom detekcji d (średni) | 99,21% | 99,80% | 100,00% | 99,59% | | | |
| - poziom detekcji d (wiarygodny) | 98,12% | 98,96% | 98,36% | 99,11% | Wymagany: | 97,00% | ok |
| Liczba pojazdów do identyfikacji (ANPR) $N_{ID}$ | 502 | 504 | 219 | 1225 | Zalecana: | 1000 | ok |
| - pojazdy poprawnie zidentyfikowane $K_{OK}$ | 495 | 499 | 212 | 1206 | | | |
| - pojazdy źle zidentyfikowane / niezidentyfikowane | 7 | 5 | 5 | 17 | | | |
| - poziom identyfikacji $r_p$ (średni) | 98,61% | 99,01% | 96,80% | 98,45% | | | |
| - poziom identyfikacji $r_p$ (wiarygodny) | 97,32% | 97,84% | 93,92% | 97,70% | Wymagany: | 95,00% | ok |
| Liczba pojazdów do klasyfikacji $N_{TID}$ | 501 | 504 | 219 | 1224 | Zalecana: | 1000 | ok |
| - pojazdy poprawnie sklasyfikowane $T_{OK}$ | 496 | 499 | 218 | 1213 | | | |
| - pojazdy źle sklasyfikowane / niesklasyfikowane | 6 | 5 | 1 | 12 | | | |
| - poziom klasyfikacji $r_t$ (średni) | 99,00% | 99,01% | 99,54% | 99,10% | | | |
| - poziom klasyfikacji $r_t$ (wiarygodny) | 97,83% | 97,84% | 97,62% | 98,49% | Wymagany: | 90,00% | ok |
| Liczba pojazdów do rozpoznawania marki $N_{MID}$ | 502 | 504 | 0 | 1006 | Zalecana: | 1000 | ok |
| - pojazdy z poprawnie rozpoznaną marką $M_{OK}$ | 496 | 501 | 0 | 997 | | | |
| - pojazdy ze źle rozpoznaną / nierozpoznaną marką | 6 | 3 | 0 | 9 | | | |
| - poziom rozpoznawania marki $r_m$ (średni) | 98,80% | 99,40% | | 99,11% | | | |
| - poziom rozpoznawania marki $r_m$ (wiarygodny) | 97,58% | 98,38% | | 98,41% | Wymagany: | 80,00% | ok |

## 4.8. Report

The summary of the test is the preparation of a report (in PDF format) by the provider, which includes:

1. Information about the business project under which the test was conducted,
2. information about the device under test,
3. information about the location,
4. information about the selected moments when the data were acquired ( `DAM500` , `DPM500` , `N200` ),
5. summary of results in accordance with Section 4.7,
6. analysis of the results - determining whether the test was successful in each area tested.

**Attention**

The report should be prepared and delivered to the customer no later than 5 working days from the date of submission of source data.

# 5. Conclusions

## 5.1. Formal verification

Formal verification is carried out by the Customer upon receipt of the report, and consists of:

1. Verification of data completeness (video + raw data),
2. Verification of data compliance with the procedure – evaluation of sample selection,
3. Verification of data submission deadlines.

If at the stage of formal verification the Customer discovers inaccuracies, they should be clarified by the Provider in writing.

Finally, the Customer informs the Provider that the submitted materials were accepted / rejected for formal reasons.

## 5.2. Substantive verification

Substantive verification consists in the Customer's evaluation of the materials provided by the Provider in terms of:

1. Completeness of vehicle detection – based on video provided raw + tabular data,
2. the correctness of assessing the attributes of individual vehicle traces,
3. the correctness of the evaluation of the calculated quality measures,
4. compliance of the determined quality measures with the established requirements.

The Customer may ask the Provider to clarify or supplement or correct the processed data provided.

## 5.3. Test acceptance

The Customer accepts the test on the basis of the results of formal verification and substantive verification – acceptance means that the Provider has met all formal and substantive criteria contained in the requirements. Acceptance is required in writing.

## 5.4. Test repetition

If, for formal or substantive reasons, the test is not accepted, the Provider has the right to repeat the test once again. Re-testing should be agreed upon with the Customer.

# Appendix A

Example table with summary of measurement results ncar-stream-test.xlsx.

# References

1

BASt. *Technische Lieferbedingungen für Streckenstationen (TLS-2012)*. Bundesanstalt für Straßenwesen, Bergisch Gladbach - Deutschalnd, 2012. URL: https://www.bast.de/DE/Publikationen/Regelwerke/Verkehrstechnik/Unterseiten/V5-tls-2012.pdf?

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2

Sean Wallis. *Binomial confidence intervals and contingency tests: mathematical fundamentals and the evaluation of alternative methods*. University College London, London - United Kindom, 2013. URL: https://www.ucl.ac.uk/english-usage/staff/sean/resources/binomialpoisson.pdf.

# Changelog

**4.4.1** `2024-02-12`

- preparation of the document in Sphinx format
- preparation of the `EN` language version

**4.4.0** `2022-11-27`

- modified the assumptions for the correct measurement conditions (speed),
- modified the chapter “Evaluation“
- “Test” section modified
- chapter “Conclusions” was added
- added an example of a table with a summary of results

**4.3.0** `2022-02-13`

- detailing the scope -> quality assessment for the camera video stream processing system

**4.2.0** `2022-02-06`

- introduction of version numbering associated with branch 4
- correction of the reliability test using the Wilson confidence interval

**4.1.0** `2020-08-28`

- Introducing a reliability test using the Wilson confidence interval

**4.0.0** `2020-05-23`

- Document initiation

# License

**Note**



# See also

This document is available online at https://docs.neurocar.pl/pro/ncar-anpr-4-stream-test/.