Eyedea LPM SDK

Technical Sheet

Version 7.8

module 553 version 7.13

module 800 version 7.28

eyedea RECOGNITION

ADVANCED COMPUTER VISION SOLUTIONS

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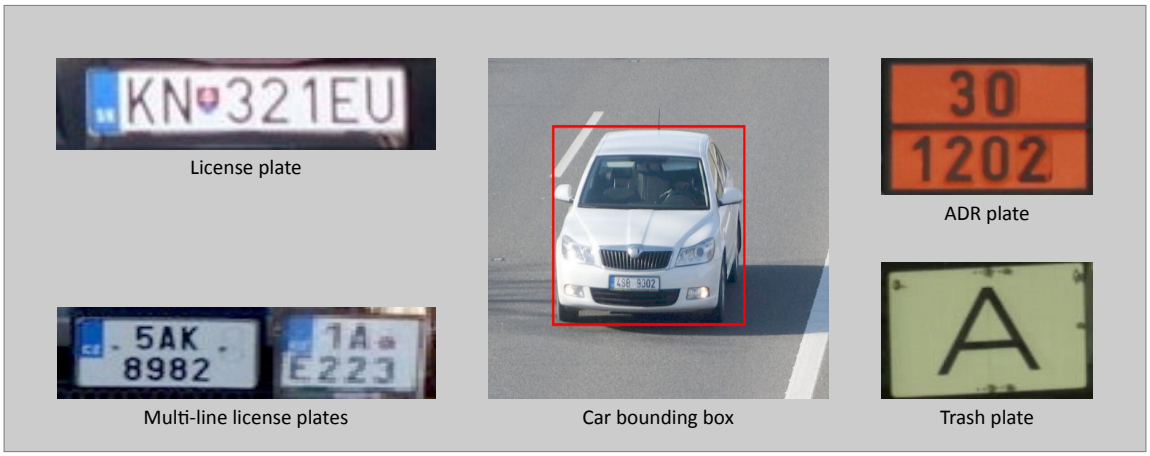
Table of Contents

1 Product Description

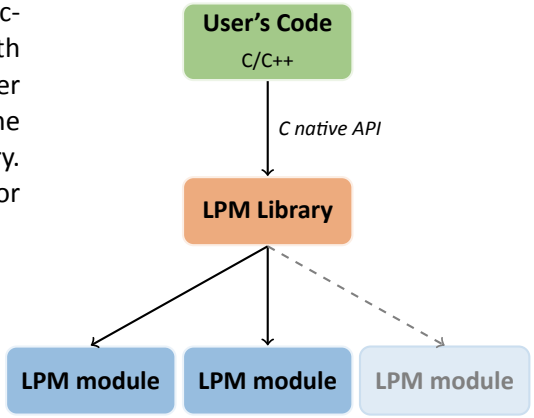
The LPM SDK is a cross-platform software library designed to provide a comfortable detection of car license plates, ADR and Trash plates, and/or cars via bounding boxes, as well as optical character recognition (OCR) of plates including plate type and physical size recognition from input images. It defines an interface between the client's software and our state-of-the-art detection and recognition modules. This special API allows simple module administrations and updates without any need for changes to the client's software.

Each client receives an FTP account automatically created at Eyedea Recognition's server. This FTP access serves as two-way communication between the client and Eyedea Recognition, s. r. o.. Clients have an easy way to regularly upload data samples (or problematic data) to the FTP server, and subsequently receive the corresponding updates of LPM modules. This systematic approach makes it possible to verify result statistics and continuously adapt the LPM modules to the client's specific data, ensuring the best possible performance.

1.1 Technical Details



LPM SDK consists of two parts – base LPM engine and detection/recognition modules. Both are cross platform libraries with C interface. The base LPM library is the only entry point, the user never uses the detection/recognition LPM modules directly. The module is loaded, configured, and executed using the LPM library. Each module can contain a detection routine, an OCR routine, or both.



The LPM library provides the following APIs:

- C native API
- Python wrapper
- Java wrapper

Officially supported operating systems and platforms:

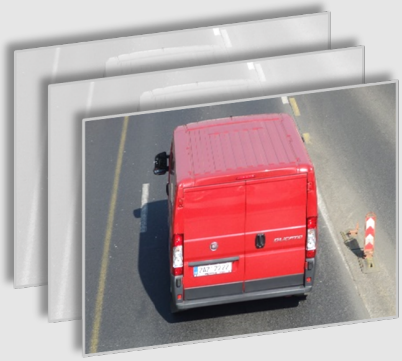
- Windows 7, 8, 8.1, 10 and 11
  32-bit and 64-bit (Visual Studio 2022)
- Ubuntu 18.04 and higher
  64-bit and aarch64
- Other platforms on request

1.2 System Workflow

The workflow of the LPM system consists of: image acquisition, plates or bounding boxes detection, and OCR of detected plates (where applicable). The image acquisition is not part of this SDK and must be solved separately.

The process starts with detection of license plates or ADR/Trash plates or car bounding boxes. Some types of detections can then be supplied to the OCR stage which returns hypotheses of the plate text and plate type, together with their confidences. There is no need to crop the detected plates for the OCR stage, as the OCR stage takes the whole input image and the detection results.

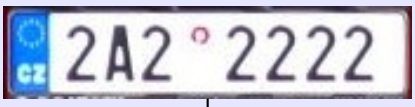
1) Image acquisition
Not part of the SDK



For every single input image:

2) Plates and objects detection
Detect plates and/or other objects in the input image

3) Plates OCR
Plate text and type recognition for detected license plates or ADR tables



TEXT: 2A22222
TYPE: CZ
SIZE: 520x110mm

2 Distribution Contents

The following list is an excerpt from the LPM SDK directory structure, highlighting the most important directories and files contained in the software distribution. A brief description of the items is provided.

- LPM SDK ..... *distribution main folder*
  - LPM ..... *LPM engine folder*
    - include ..... *LPM header files*
    - lib ..... *LPM libraries*
  - examples ..... *LPM examples folder*
    - example-anpr-implink ..... *example of implicit LPM library link*
      - images ..... *example images folder*
      - example-anpr-implink.vcxproj ..... *Visual Studio project (only Windows version)*
      - example.cpp ..... *example source code*
      - Makefile ..... *example makefile (only Linux version)*
  - modules-v7 ..... *LPM modules*
    - x64 ..... *modules for appropriate architecture*
    - config_camera_view.ini ..... *camera view parameters file*
  - hasp ..... *license management software folder*
  - documentation ..... *SDK documentation folder*
  - wrappers ..... *SDK wrappers folder*
  - LICENSE.txt ..... *SDK license*
  - WhatsNew.txt ..... *file with release notes for each SDK version*
  - README.txt ..... *SDK readme file*

3 Input Requirements

The input requirements of the LPM are divided into two parts: image data and scene specification. The first part, which is in the *Input Image section*, specifies the image capture criteria and the way how to represent the image data. The second part, which is covered in the *Scale in Pixels per Meter* and *Image Rotation* sections, describes how to set the input parameters of the LPM system.

3.1 Input Image

The result of OCR is dependent on two facts: the way the image was taken and the way the image is stored. Image capture requirements are specified in the *Scene Criteria* section.

3.1.1 Scene Criteria

To get the highest possible OCR accuracy, several rules must be respected during the road user input image data collection. The criteria that specify camera scene setting are described in the *License Plate Alignment* and *Image Borders* paragraphs. The camera capture quality criteria are described in *Blurred Image*, *Aspect Ratio* and *Color Images* paragraphs.

License Plate Alignment

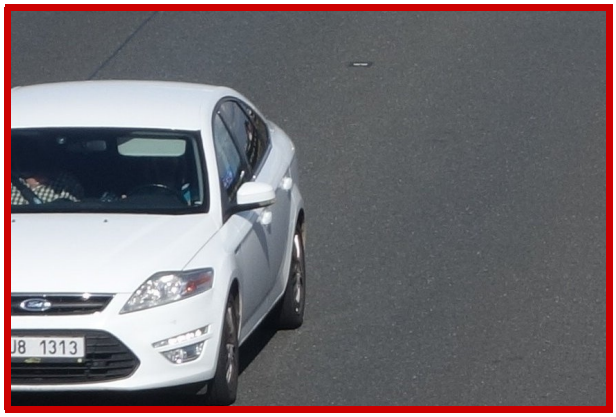
By default, the module is set with the assumption that the plate in the input image is horizontally aligned. Accepted rotation range is $\pm 45°$, recomended is $\pm 15°$. Aligning can be achieved on the user's side. The other option is to configure LPM detector, which can be set to run in a specified range of rotations (see Developers Guide).

WRONG:
The plate is rotated more than 45°

CORRECT:
The plate is horizontally aligned.

Image Borders

The license plate should be sufficiently distant from image borders, should not be cropped or occluded, so that whole text is visible. The surrounding red rectangle in the illustration should not go out of the image and should be fully visible to achieve the best recognition accuracy.



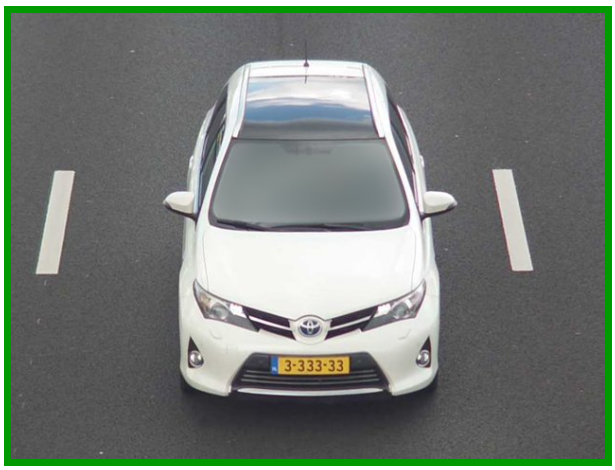
WRONG:
The license plate is partially outside of the image.

CORRECT:
The whole license plate with sufficient surrounding area is located inside the image.

Blurred Image

The road user in the input image should not be blurred by motion or by wrong camera settings. All details on the road user must be clearly visible for successful recognition.

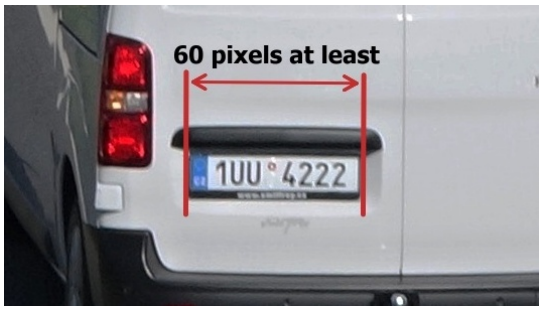
WRONG:
Wrong camera settings and fast motion causes that the car is blurred.



CORRECT:
The image of the car is very sharp and all the details are clearly visible.

Resolution

Resolution of the input images should be 120 pixels per meter at least. For example, the minimal EU license plate's width should be approximately 60 pixels. For more information about the pixels per meter unit see the chapter *Scale in Pixels per Meter*.



Aspect Ratio

LPM SDK is able to work on images with different pixel aspect ratios, see Technical sheet of specific module for more information.

Color Images

LPM SDK does not require input images to have color information, but for accurate recognition of ADR tables color images are needed.

3.2 Scale in Pixels per Meter

To specify size of objects in image with respect to real world size unit ***pixels per meter*** is used in LPM SDK.

3.2.1 Description

Pixels per meter unit is used in LPM to define the resolution of the input image with respect to the dimensions of the observed object in the real world. The physical dimensions of the license plate and its parts are defined by law in each country of origin but in many cases the same format is used. The formula below defines the relation between the size of the object (e.g. plate) in the image in pixels and in real world where the result is the *scale_px_per_m*.

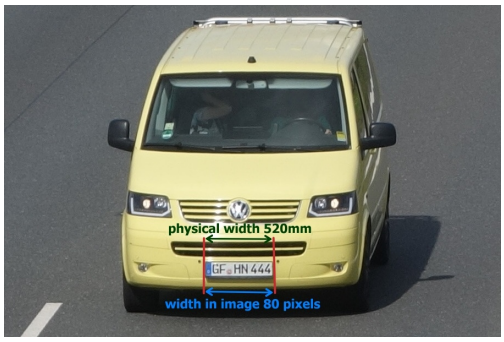
3.2.2 Formula

$$scale\_px\_per\_m = \frac{size\ of\ the\ object\ in\ the\ image\ [px]}{size\ of\ the\ object\ in\ real\ world\ [m]}$$

There are several important facts that must be considered to get correct results:

- The *scale_px_per_m* varies across the image due to perspective projection.
- Estimate of *scale_px_per_m* on small objects has higher error than on large ones (especially on low resolution images). It is therefore recommended to estimate the *scale_px_per_m* from license plate width rather than from license plate's letter height.

3.2.3 Example



$$scale\_px\_per\_m = \frac{detected\ width\ [px]}{physical\ width\ [m]} = \frac{80}{0.52} \approx 154px/m$$

4 Hardware Requirements

4.1 Minimal Requirements

Processor: 1.0 GHz, single core, x86 platform, embedded (i.e. Intel Atom)
or
ARM Cortex-A7, armv7l platform
or
ARM Cortex-A35, aarch64 platform

RAM: 2 GB

Hard disk: 1 GB free space

4.2 Recommended Requirements

Processor: 2.0 GHz, dual core, x86 platform (i.e. Intel i5)
or
ARM Cortex-A15, armv7l platform
or
ARM Cortex-A57, aarch64 platform

RAM: 4 GB

Hard disk: 2 GB free space

4.3 Supported GPU Requirements (x64, x86_64)

GPU: NVIDIA® GeForce® GTX 10 series and higher GPU supporting OpenCL

4.4 Supported GPU Requirements (aarch64)

GPU – OpenGL backend: NVIDIA® Jetson® with JetPack 4.2 and higher
GPU – TensorRT backend: NVIDIA® Jetson® with JetPack 4.6 and JetPack 5.0

IMPORTANT: The OpenGL backend requires the DISPLAY environment variable be set! Problems can appear especially with ssh connection with X forwarding. Setting the DISPLAY environment solves the problem.
This can be done by: `export DISPLAY=:0`

4.5 Supported Operating Systems

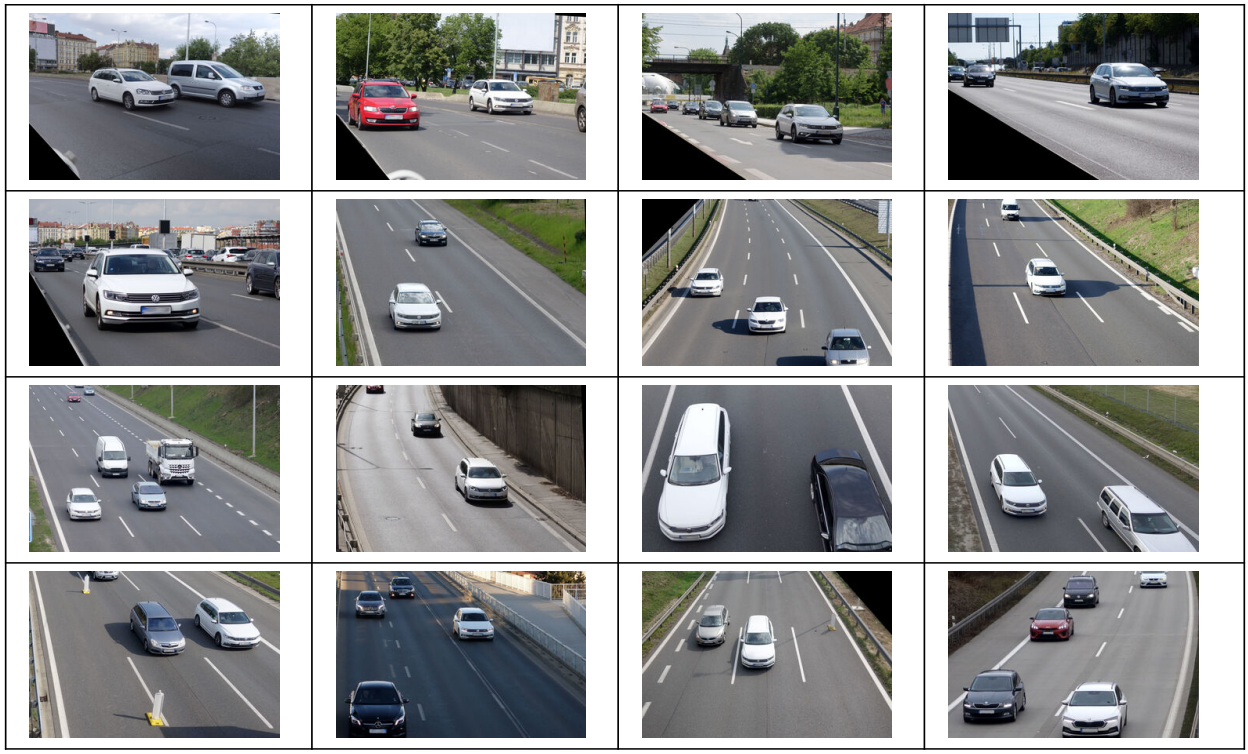
4.5.1 Windows

- Microsoft Windows 7/8/8.1/10/11
  - Win32 and x64 platform
  - GPU version supports x64 platform only

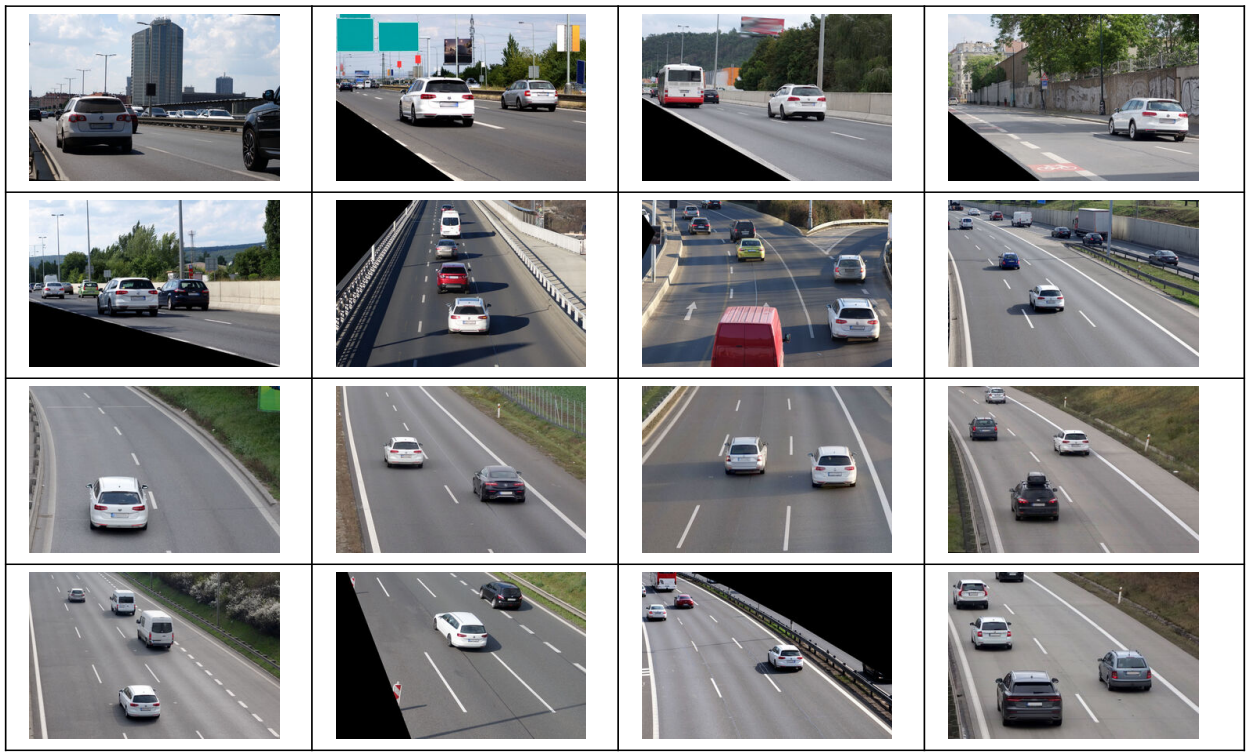
4.5.2 Linux

- Ubuntu 20.04 and higher
  - i686 and x86_64 platform
  - GPU version supports x86_64 and aarch64 platforms only

5 Camera Installation Examples



Example images from a frontal camera. Camera can be installed also in a mirrored case.



Example images from a rear camera. Camera can be installed also in a mirrored case.

6 Release 553v7.13 (2024-11-07)

6.1 Summary

- OCR Notes
  - updates OCR model
  - improves state recognition and reading in Peru, Idaho, Oregon

6.2 Description of used models

See **Plate Types** for an explanation of what each type code means.

CNN_ANPRTF2LITE_NA_BGR_88x44_NONE_LIN_EXP13.dat

- Possible outputs:

Characters	0-9, A-Z, &, ;
Num lines	2
Num chars per line	12, 12
Dimensions	300x150, 400x130, 440x120, 520x110, UNKxUNK, UNLxUNL
Type	BOL, BR, CDN-AB, CDN-BC, CDN-MB, CDN-NB, CDN-NL, CDN-NS, CDN-NT, CDN-NU, CDN-ON, CDN-PE, CDN-QC, CDN-SK, CDN-YT, CO, EC, GUY, MEX, PE, PY, RA, RCH, SME, UNK, USA-AK, USA-AL, USA-AR, USA-AZ, USA-CA, USA-CO, USA-CT, USA-DC, USA-DE, USA-FL, USA-GA, USA-GOV, USA-HI, USA-IA, USA-ID, USA-IL, USA-IN, USA-KS, USA-KY, USA-LA, USA-MA, USA-MD, USA-ME, USA-MI, USA-MN, USA-MO, USA-MS, USA-MT, USA-NC, USA-ND, USA-NE, USA-NH, USA-NJ, USA-NM, USA-NV, USA-NY, USA-OH, USA-OK, USA-OR, USA-PA, USA-PR, USA-RI, USA-SC, USA-SD, USA-TN, USA-TX, USA-UT, USA-VA, USA-VT, USA-WA, USA-WI, USA-WV, USA-WY, UY, YV

6.3 Plate Types

Tables below are showing all posible types that can this module return. It can be plate type of license plates for different countries or it can be ADR or Trash marker or other type for object detected depending on module.

UNL	Unrecognized country
UNK	Detection FP
BOL	Bolivia
BR	Brazil
CDN-AB	Canada-Alberta
CDN-BC	Canada-British Columbia
CDN-MB	Canada-Manitoba
CDN-NB	Canada-New Brunswick
CDN-NL	Canada-Newfoundland and Labrador
CDN-NS	Canada-Nova Scotia
CDN-NT	Canada-Northwest Territories
CDN-NU	Canada-Nunavut
CDN-ON	Canada-Ontario
CDN-PE	Canada-Prince Edward Island
CDN-QC	Canada-Quebec
CDN-SK	Canada-Saskatchewan
CDN-YT	Canada-Yukon
CO	Colombia
EC	Ecuador
GUY	Guyana
MEX	Mexico
PE	Peru
PY	Paraguay
RA	Argentina
RCH	Chile
SME	Suriname
USA-AK	United States-Alaska
USA-AL	United States-Alabama
USA-AR	United States-Arkansas
USA-AZ	United States-Arizona
USA-CA	United States-California
USA-CO	United States-Colorado
USA-CT	United States-Connecticut
USA-DC	United States-District of Columbia
USA-DE	United States-Delaware
USA-FL	United States-Florida
USA-GA	United States-Georgia

USA-GOV	United States-Government
USA-HI	United States-Hawaii
USA-IA	United States-Iowa
USA-ID	United States-Idaho
USA-IL	United States-Illinois
USA-IN	United States-Indiana
USA-KS	United States-Kansas
USA-KY	United States-Kentucky
USA-LA	United States-Louisiana
USA-MA	United States-Massachusetts
USA-MD	United States-Maryland
USA-ME	United States-Maine
USA-MI	United States-Michigan
USA-MN	United States-Minnesota
USA-MO	United States-Missouri
USA-MS	United States-Mississippi
USA-MT	United States-Montana
USA-NC	United States-North Carolina
USA-ND	United States-North Dakota
USA-NE	United States-Nebraska
USA-NH	United States-New Hampshire
USA-NJ	United States-New Jersey
USA-NM	United States-New Mexico
USA-NV	United States-Nevada
USA-NY	United States-New York
USA-OH	United States-Ohio
USA-OK	United States-Oklahoma
USA-OR	United States-Oregon
USA-PA	United States-Pennsylvania
USA-PR	United States-Puerto Rico
USA-RI	United States-Rhode Island
USA-SC	United States-South Carolina
USA-SD	United States-South Dakota
USA-TN	United States-Tennessee
USA-TX	United States-Texas
USA-UT	United States-Utah
USA-VA	United States-Virginia

USA-VT	United States-Vermont
USA-WA	United States-Washington
USA-WI	United States-Wisconsin
USA-WV	United States-West Virginia
USA-WY	United States-Wyoming
UY	Uruguay
YV	Venezuela

6.4 Speed

Processing times for tested LPM modules are shown in tables below for detection and OCR function. All times are in miliseconds. Colours are highlighting times where there are significant changes among versions. Description of tested configurations can be seen in section List of Tested Devices.

6.4.1 Detection

Dataset generic:

	GPU_JX(TRT)	GPU_JT(TRT)	GPU_JN(TRT)	GPU_AO(TRT)	CPU_3(TF)	GPU_1(TF)
553v7.13	22.2	36.3	57.1	14.7	24.5	7.2
553v7.12	22.2	36.3	57.1	14.7	24.5	7.2
553v7.11	21.5	34.2	57.3	15.7	26.0	7.2
553v7.9	23.5	36.9	56.5	16.5	24.5	7.2
553v7.8	24.5	39.1	73.5	14.1	42.0	7.3
553v7.7	27.6	41.7	78.8	-	42.4	7.7

6.4.2 OCR

Dataset generic:

	GPU_JX(TRT)	GPU_JT(TRT)	GPU_JN(TRT)	GPU_AO(TRT)	CPU_3(TF)	GPU_1(TF)
553v7.13	2.4	4.0	6.2	1.5	12.6	1.0
553v7.12	2.4	4.0	6.2	1.5	12.6	1.0
553v7.11	2.0	2.8	4.7	1.1	12.1	0.8
553v7.9	2.1	2.5	5.3	1.8	13.1	0.8
553v7.8	2.1	2.5	5.3	1.8	13.1	0.8
553v7.7	2.2	2.9	4.8	-	13.1	0.9

6.5 List of Tested Devices

CPU_1	Intel(R) Core(TM) i3-3220 (Windows 10 64bit)
CPU_2	Intel(R) Core(TM) i7-4930K @3.40GHz (Ubuntu 22.04 64bit)
CPU_3	Intel(R) Core(TM) i7-7700K CPU @4.20GHz (Ubuntu 22.04 64bit)
GPU_1	NVIDIA® GeForce® GTX Titan X (Ubuntu 22.04 64bit)
GPU_JN	Jetson Nano
GPU_JT	Jetson TX2
GPU_JX	Jetson Xavier NX
GPU_AO	Jetson AGX Orin

6.6 Performance metrics

Tables below are showing various performance metrics for tested modules. Colours are highlighting metrics where there are significant changes among versions. For more information about used metrics see section Performance Metrics Description. For description of test sets see section List of Test Sets.

6.6.1 System performance

Dataset 553vBMUSA1:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
553v7.13	8108	1268	36	13.9	86.5	99.6	97.5	86.7	95.4	97.1	96.2
553v7.12	8108	1268	36	13.9	86.5	99.6	97.8	92.8	96.7	97.4	97.0
553v7.11	8108	1268	36	13.9	86.5	99.6	97.8	94.2	96.8	97.3	97.1
553v7.9	8108	1282	36	13.9	86.3	99.6	97.5	87.9	95.5	97.0	96.3
553v7.8	8073	564	71	36.6	93.5	99.1	95.5	71.6	93.6	94.6	94.1
553v7.7	8061	456	83	33.7	94.6	99.0	96.4	0.0	91.0	95.4	93.2

Dataset 553vBMUSA2:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
553v7.13	1532	249	0	0	86.0	100.0	94.6	39.4	85.8	94.6	90.0
553v7.12	1532	249	0	0	86.0	100.0	96.0	36.9	86.8	96.0	91.1
553v7.11	1532	249	0	0	86.0	100.0	95.9	34.1	86.3	95.9	90.8
553v7.9	1532	252	0	0	85.9	100.0	96.8	34.5	87.1	96.8	91.7
553v7.8	1477	85	55	36.4	94.6	96.4	92.1	21.2	88.0	88.8	88.4
553v7.7	1446	79	86	26.7	94.8	94.4	88.6	0.0	83.9	83.5	83.7

Dataset 553vBMUSA3:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
553v7.13	7588	776	7	28.6	90.7	99.9	94.6	93.7	93.9	94.5	94.2

553v7.12	7588	776	7	28.6	90.7	99.9	95.2	97.7	94.9	95.1	95.0
553v7.11	7588	776	7	28.6	90.7	99.9	94.9	97.7	94.7	94.8	94.8
553v7.9	7588	778	7	28.6	90.7	99.9	94.5	86.0	93.1	94.5	93.8
553v7.8	7042	109	553	8.5	98.5	92.7	92.0	59.6	91.4	84.6	87.9
553v7.7	6823	74	772	6.7	98.9	89.8	88.9	0.0	87.9	79.0	83.2

Dataset 553vBMUSA5:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
553v7.13	1339	11	5	80.0	99.2	99.6	97.3	90.9	97.2	96.9	97.0
553v7.12	1339	11	5	80.0	99.2	99.6	97.7	100.0	97.7	97.3	97.5
553v7.11	1339	11	5	80.0	99.2	99.6	94.8	100.0	94.8	94.4	94.6
553v7.9	1338	11	6	83.3	99.2	99.6	92.4	81.8	92.2	91.9	92.1
553v7.8	1239	3	105	61.0	99.8	92.2	86.0	66.7	85.9	78.8	82.2
553v7.7	1233	3	111	60.4	99.8	91.7	78.3	0.0	78.1	71.4	74.6

Dataset 553vBMUSA6:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
553v7.13	1114	7	2	0.0	99.4	99.8	96.5	100.0	96.5	96.3	96.4
553v7.12	1114	7	2	0.0	99.4	99.8	96.9	100.0	96.9	96.7	96.8
553v7.11	1114	7	2	0.0	99.4	99.8	95.1	100.0	95.1	94.9	95.0
553v7.9	1114	7	2	0.0	99.4	99.8	92.9	100.0	92.9	92.8	92.8
553v7.8	1109	9	7	14.3	99.2	99.4	78.7	100.0	78.7	78.2	78.4
553v7.7	1105	8	11	9.1	99.3	99.0	76.7	0.0	76.2	76.0	76.1

6.6.2 OCR text reading performance

Dataset 553vBMUSA1:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
USA-CA (#2310)	98.05	97.97	98.4	97.79	94.83	97.08

USA-TX (#1829)	99.51	99.34	99.18	99.13	98.31	98.41
USA-OH (#791)	98.86	99.12	98.99	98.99	97.85	97.72
USA-WI (#509)	93.52	96.07	96.07	95.48	92.09	94.66
CDN-BC (#493)	97.57	98.17	97.97	97.16	95.93	97.15
USA-IL (#356)	98.31	97.75	98.31	97.46	96.91	94.94
CDN-AB (#323)	97.21	98.45	97.52	97.21	96.59	96.59
USA-CO (#178)	92.13	96.07	94.38	97.19	91.43	90.23
USA-FL (#137)	86.13	87.59	84.67	85.51	79.14	82.01
CDN-ON (#131)	91.6	93.89	93.89	91.6	91.54	93.08
USA-WA (#82)	96.34	98.78	97.56	97.56	97.53	96.3
USA-NJ (#78)	97.44	97.44	98.72	96.15	94.81	97.4
USA-MI (#74)	95.95	93.24	93.24	97.3	93.24	89.19
USA-OR (#74)	97.3	93.24	93.24	91.89	90.54	91.89
USA-PA (#48)	100.0	100.0	100.0	100.0	100.0	95.83
USA-VA (#43)	88.37	90.7	93.02	95.35	93.02	100.0
USA-NM (#34)	97.06	94.12	94.12	94.12	82.35	88.24
USA-NV (#33)	90.91	93.94	90.91	90.91	84.38	84.38
USA-GA (#26)	96.15	96.15	96.15	96.15	92.59	96.3
USA-KY (#24)	95.83	95.83	95.83	95.83	95.83	95.83
USA-MN (#24)	100.0	100.0	100.0	95.83	100.0	100.0
USA-NC (#24)	95.83	95.83	95.83	95.83	92.31	96.15
USA-NY (#20)	100.0	100.0	100.0	100.0	95.0	100.0

USA-IA (#14)	100.0	100.0	100.0	100.0	92.86	92.86
USA-MA (#13)	84.62	84.62	76.92	69.23	84.62	76.92
USA-LA (#11)	100.0	100.0	100.0	100.0	100.0	100.0
USA-AZ (#4)	100.0	100.0	100.0	100.0	100.0	100.0
RCH (#1)	100.0	0.0	0.0	0.0	100.0	0.0
USA-AK (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-HI (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-IN (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-MO (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 553vBMUSA2:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
USA-SD (#1215)	95.23	96.79	96.79	96.95	92.08	88.24
USA-MN (#141)	98.58	98.58	97.87	98.58	96.32	93.89
USA-IA (#50)	96.0	100.0	100.0	96.0	81.63	83.67
USA-NE (#23)	65.22	65.22	65.22	86.96	100.0	95.45
USA-WI (#10)	90.0	90.0	90.0	90.0	90.0	90.0
USA-GOV (#5)	100.0	60.0	60.0	100.0	100.0	100.0
USA-MT (#5)	0.0	0.0	0.0	100.0	100.0	60.0
USA-CA (#4)	75.0	100.0	75.0	75.0	75.0	75.0
USA-VA (#4)	100.0	100.0	100.0	100.0	100.0	100.0
USA-FL (#3)	100.0	100.0	100.0	100.0	100.0	66.67
USA-ND (#3)	100.0	100.0	100.0	100.0	66.67	100.0
USA-TX (#3)	100.0	100.0	100.0	100.0	100.0	100.0

USA-WA (#3)	100.0	100.0	100.0	100.0	100.0	100.0
USA-MO (#2)	100.0	100.0	100.0	100.0	100.0	100.0
USA-WY (#2)	0.0	0.0	0.0	50.0	0.0	0.0
USA-LA (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 553vBMUSA3:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
USA-SD (#5804)	94.92	95.61	95.26	94.61	92.37	89.31
USA-MN (#511)	98.24	97.65	97.85	95.89	94.16	92.34
USA-IA (#263)	96.2	96.96	97.34	93.16	83.4	75.42
USA-NE (#68)	44.12	42.65	44.12	95.59	89.06	88.52
USA-TX (#37)	89.19	94.59	89.19	89.19	91.89	88.89
USA-ND (#35)	100.0	100.0	100.0	100.0	96.97	93.94
USA-CA (#20)	100.0	100.0	100.0	100.0	100.0	100.0
USA-IL (#15)	93.33	93.33	100.0	80.0	73.33	80.0
USA-WI (#13)	84.62	92.31	92.31	84.62	75.0	75.0
USA-MT (#10)	30.0	30.0	30.0	80.0	70.0	70.0
USA-WA (#10)	100.0	100.0	100.0	100.0	100.0	100.0
USA-MO (#8)	100.0	100.0	100.0	100.0	100.0	100.0
USA-CO (#7)	85.71	100.0	100.0	85.71	85.71	71.43
USA-ID (#5)	100.0	100.0	100.0	80.0	100.0	60.0
USA-GOV (#4)	100.0	100.0	100.0	100.0	100.0	100.0
USA-MA (#4)	100.0	100.0	100.0	100.0	100.0	100.0

USA-NY (#4)	100.0	100.0	100.0	100.0	100.0	100.0
USA-VA (#4)	75.0	100.0	100.0	75.0	75.0	100.0
USA-AK (#3)	100.0	100.0	100.0	100.0	100.0	100.0
USA-CT (#2)	100.0	100.0	100.0	100.0	100.0	100.0
USA-NJ (#2)	100.0	100.0	100.0	100.0	100.0	100.0
USA-OR (#2)	100.0	100.0	100.0	100.0	100.0	100.0
USA-RI (#2)	100.0	100.0	100.0	100.0	100.0	100.0
USA-WY (#2)	0.0	0.0	0.0	0.0	0.0	0.0
CDN-MB (#1)	100.0	100.0	100.0	100.0	100.0	0.0
USA-AZ (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-GA (#1)	100.0	100.0	100.0	100.0	0.0	100.0
USA-IN (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-NV (#1)	100.0	0.0	0.0	0.0	0.0	0.0
USA-PA (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-UT (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-VT (#1)	0.0	0.0	0.0	0.0	0.0	0.0

Dataset 553vBMUSA5:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
UY (#1120)	97.41	97.86	95.62	93.48	88.07	79.96
RA (#31)	90.32	96.77	83.87	70.97	54.84	48.39
BR (#24)	100.0	95.83	70.83	70.83	41.67	37.5
PY (#5)	100.0	100.0	80.0	100.0	60.0	100.0
RCH (#2)	100.0	50.0	100.0	50.0	50.0	50.0

Dataset 553vBMUSA6:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
UY (#1028)	96.6	97.08	95.43	93.29	80.37	78.82
BR (#27)	92.59	92.59	81.48	85.19	33.33	14.81
RA (#19)	94.74	94.74	94.74	84.21	52.63	52.63

6.6.3 ILPC recognition performance

Dataset 553vBMUSA1:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
USA-CA (#2310)	99.74	99.78	99.87	99.61	97.7	99.74
USA-TX (#1831)	99.84	99.95	99.84	99.84	99.67	99.84
UNK (#1268)	86.67	92.82	94.16	87.91	71.63	0.0
USA-OH (#791)	99.37	99.49	99.49	99.62	89.86	98.86
USA-WI (#510)	97.45	98.82	99.02	98.63	54.83	96.25
CDN-BC (#493)	96.55	97.57	95.94	99.39	96.95	99.39
USA-IL (#356)	99.72	100.0	100.0	100.0	78.09	99.44
CDN-AB (#323)	94.74	95.67	93.81	99.69	77.71	98.14
USA-CO (#178)	98.31	97.19	96.63	98.31	91.43	95.4
USA-FL (#137)	97.08	99.27	97.08	95.65	85.61	95.68
CDN-ON (#131)	88.55	87.79	81.68	92.37	66.92	90.77
USA-WA (#82)	100.0	100.0	100.0	100.0	67.9	100.0
USA-NJ (#78)	100.0	100.0	100.0	100.0	46.75	94.81
USA-MI (#74)	100.0	100.0	98.65	95.95	59.46	97.3
USA-OR (#74)	97.3	100.0	100.0	100.0	78.38	100.0
USA-PA (#48)	100.0	100.0	100.0	100.0	66.67	97.92

USA-VA (#43)	100.0	100.0	97.67	100.0	97.67	97.67
USA-NM (#34)	97.06	97.06	97.06	97.06	52.94	94.12
USA-NV (#33)	100.0	100.0	100.0	93.94	53.12	93.75
USA-GA (#26)	96.15	100.0	96.15	96.15	92.59	96.3
USA-NC (#24)	95.83	100.0	100.0	100.0	76.92	84.62
USA-MN (#24)	100.0	100.0	95.83	91.67	50.0	91.67
USA-KY (#24)	100.0	95.83	100.0	91.67	75.0	95.83
USA-NY (#20)	100.0	95.0	95.0	100.0	100.0	95.0
USA-IA (#14)	100.0	100.0	100.0	92.86	71.43	92.86
USA-MA (#13)	100.0	100.0	100.0	100.0	53.85	100.0
USA-LA (#11)	100.0	100.0	100.0	100.0	81.82	100.0
USA-AZ (#4)	100.0	100.0	100.0	100.0	25.0	100.0
USA-HI (#1)	100.0	100.0	100.0	100.0	0.0	100.0
USA-MO (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-IN (#1)	100.0	100.0	100.0	100.0	100.0	100.0
RCH (#1)	100.0	0.0	0.0	0.0	0.0	0.0
USA-AK (#1)	0.0	0.0	0.0	0.0	0.0	0.0

Dataset 553vBMUSA2:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
USA-SD (#1215)	99.51	99.67	99.51	98.35	92.92	90.99
UNK (#249)	39.36	36.95	34.14	34.52	21.18	0.0
USA-MN (#141)	100.0	100.0	100.0	97.87	91.91	96.95
USA-IA (#50)	100.0	100.0	100.0	96.0	53.06	69.39

USA-NE (#23)	95.65	91.3	91.3	91.3	50.0	50.0
USA-WI (#10)	100.0	100.0	100.0	100.0	50.0	70.0
USA-GOV (#5)	100.0	100.0	100.0	0.0	0.0	0.0
USA-MT (#5)	100.0	100.0	100.0	60.0	20.0	20.0
USA-CA (#4)	100.0	100.0	100.0	100.0	100.0	100.0
USA-VA (#4)	100.0	100.0	100.0	100.0	100.0	100.0
USA-WA (#3)	100.0	100.0	100.0	100.0	0.0	100.0
USA-FL (#3)	100.0	100.0	100.0	100.0	66.67	100.0
USA-TX (#3)	100.0	100.0	100.0	100.0	100.0	100.0
USA-ND (#3)	100.0	100.0	100.0	100.0	0.0	100.0
USA-MO (#2)	100.0	100.0	100.0	100.0	100.0	100.0
USA-WY (#2)	100.0	100.0	100.0	0.0	0.0	0.0
USA-LA (#1)	100.0	100.0	100.0	100.0	0.0	100.0

Dataset 553vBMUSA3:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
USA-SD (#5806)	99.81	99.93	99.83	99.43	95.15	96.44
UNK (#776)	93.69	97.68	97.68	85.99	59.63	0.0
USA-MN (#511)	99.41	99.61	99.41	97.46	87.88	92.12
USA-IA (#263)	99.62	100.0	100.0	99.62	62.75	79.17
USA-NE (#68)	100.0	98.53	98.53	95.59	73.44	68.85
USA-TX (#37)	100.0	100.0	100.0	100.0	100.0	100.0
USA-ND (#35)	100.0	100.0	100.0	100.0	9.09	72.73

USA-CA (#20)	95.0	100.0	95.0	95.0	94.74	100.0
USA-IL (#15)	100.0	100.0	100.0	100.0	80.0	100.0
USA-WI (#13)	92.31	92.31	92.31	84.62	75.0	66.67
USA-MT (#10)	100.0	100.0	100.0	60.0	50.0	50.0
USA-WA (#10)	100.0	100.0	100.0	90.0	60.0	100.0
USA-MO (#8)	100.0	100.0	100.0	100.0	100.0	100.0
USA-CO (#7)	100.0	100.0	100.0	100.0	100.0	85.71
USA-ID (#5)	100.0	100.0	80.0	80.0	20.0	80.0
USA-GOV (#4)	100.0	100.0	100.0	0.0	0.0	0.0
USA-MA (#4)	100.0	100.0	100.0	100.0	75.0	100.0
USA-NY (#4)	100.0	100.0	75.0	75.0	75.0	75.0
USA-VA (#4)	100.0	100.0	100.0	100.0	100.0	100.0
USA-AK (#3)	100.0	100.0	100.0	100.0	100.0	100.0
USA-OR (#2)	100.0	100.0	100.0	100.0	100.0	100.0
USA-CT (#2)	100.0	100.0	100.0	100.0	0.0	100.0
USA-WY (#2)	100.0	100.0	100.0	50.0	0.0	0.0
USA-NJ (#2)	100.0	100.0	100.0	100.0	50.0	100.0
USA-RI (#2)	100.0	100.0	100.0	100.0	0.0	0.0
USA-UT (#1)	100.0	100.0	100.0	100.0	0.0	100.0
CDN-MB (#1)	100.0	100.0	100.0	0.0	0.0	0.0
USA-PA (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-NV (#1)	100.0	100.0	100.0	100.0	0.0	100.0

USA-VT (#1)	100.0	100.0	100.0	0.0	0.0	0.0
USA-IN (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-GA (#1)	100.0	100.0	100.0	100.0	100.0	100.0
USA-AZ (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 553vBMUSA5:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
UY (#1139)	99.82	99.91	51.98	50.31	0.0	0.0
RA (#33)	100.0	100.0	69.7	63.64	0.0	0.0
BR (#24)	100.0	100.0	75.0	20.83	0.0	0.0
UNK (#11)	90.91	100.0	100.0	81.82	66.67	0.0
PY (#5)	100.0	100.0	0.0	0.0	0.0	0.0
RCH (#2)	100.0	50.0	0.0	50.0	0.0	0.0

Dataset 553vBMUSA6:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
UY (#1028)	99.61	99.61	77.92	80.74	0.0	0.0
BR (#27)	96.3	92.59	74.07	55.56	0.0	0.0
RA (#19)	100.0	100.0	89.47	89.47	0.0	0.0
UNK (#7)	100.0	100.0	100.0	100.0	100.0	0.0

6.6.4 Dimensions recognition performance

Dataset 553vBMUSA1:

	553v7.13	553v7.12	553v7.11	553v7.9	553v7.8	553v7.7
300x150 (#7663)	100.0	100.0	100.0	100.0	100.0	100.0
UNKxUNK (#1268)	0.0	0.0	0.0	0.0	0.0	0.0
520x110 (#25)	0.0	0.0	0.0	0.0	0.0	0.0
300x80 (#2)	0.0	0.0	0.0	0.0	0.0	0.0

180x100 (#1)	**0.0**	**0.0**	**0.0**	**0.0**	**-**	**-**

Dataset 553vBMUSA2:

	553v7.13	**553v7.12**	**553v7.11**	**553v7.9**	**553v7.8**	**553v7.7**
300x150 (#1474)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
UNKxUNK (#249)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Dataset 553vBMUSA3:

	553v7.13	**553v7.12**	**553v7.11**	**553v7.9**	**553v7.8**	**553v7.7**
300x150 (#6845)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
UNKxUNK (#776)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Dataset 553vBMUSA5:

	553v7.13	**553v7.12**	**553v7.11**	**553v7.9**	**553v7.8**	**553v7.7**
400x130 (#1193)	**76.45**	**35.37**	**27.91**	**47.02**	**0.0**	**0.0**
UNKxUNK (#11)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
300x150 (#9)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

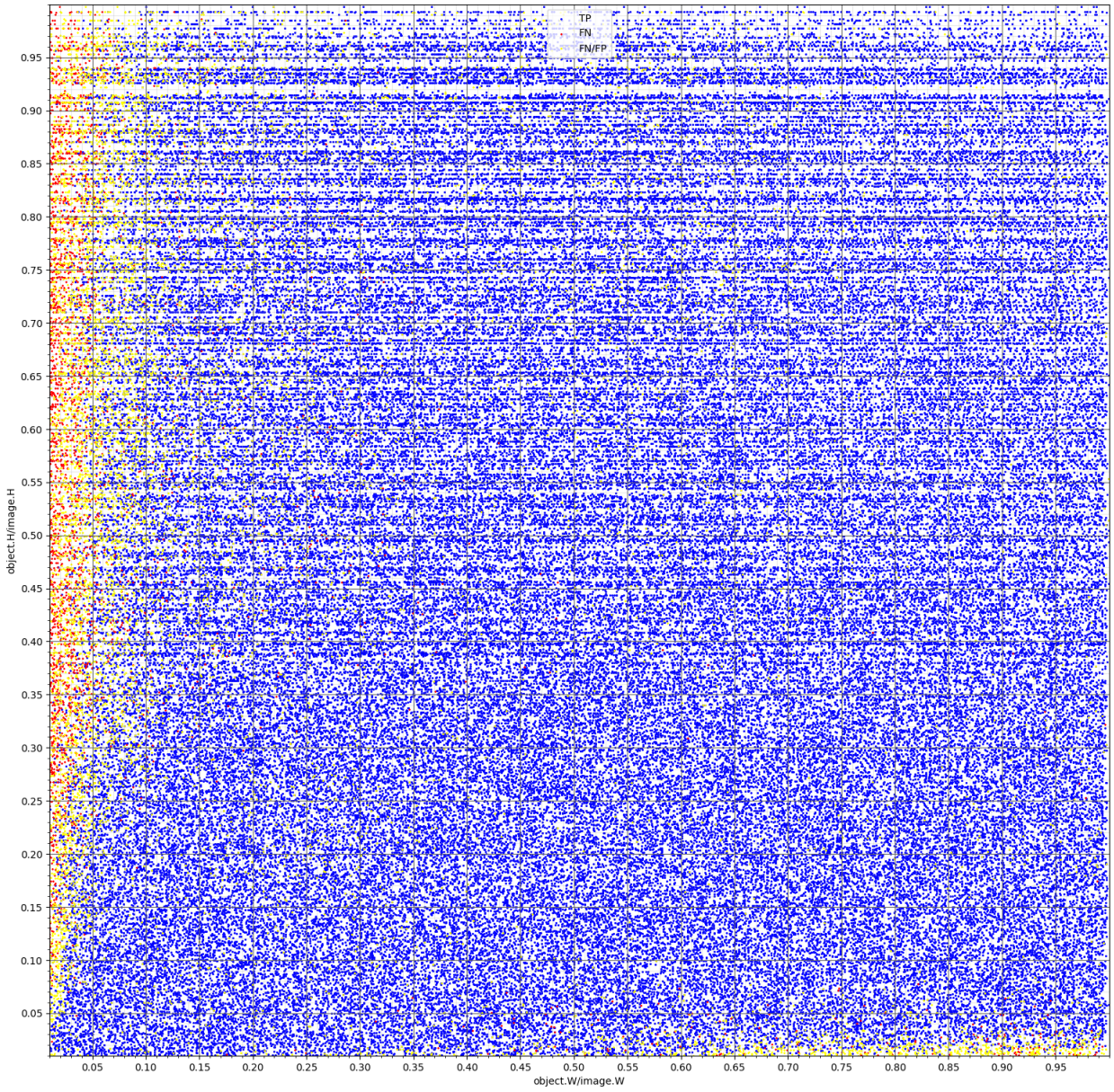
Dataset 553vBMUSA6:

	553v7.13	**553v7.12**	**553v7.11**	**553v7.9**	**553v7.8**	**553v7.7**
400x130 (#1066)	**78.14**	**38.09**	**42.03**	**57.97**	**0.0**	**0.0**
300x150 (#8)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
UNKxUNK (#7)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

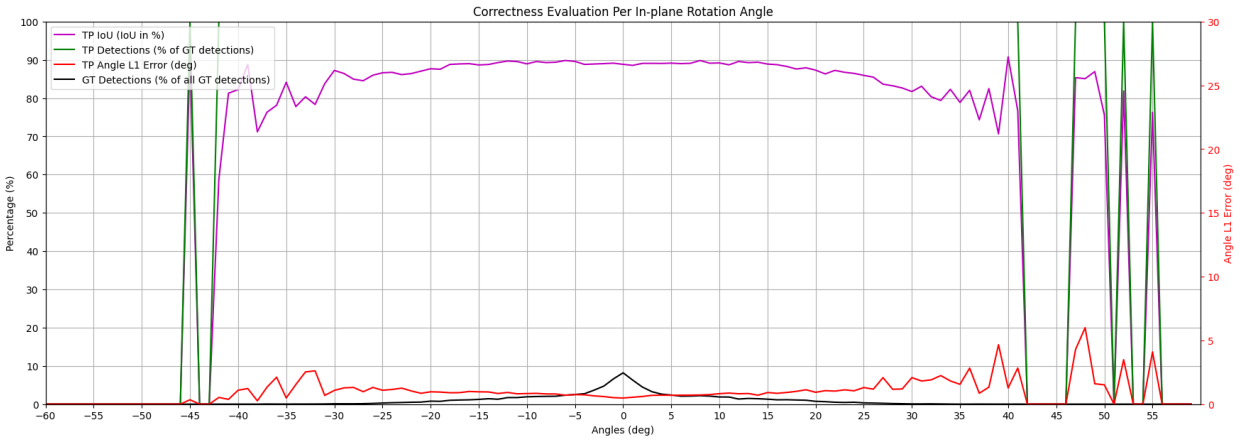
6.6.5 Plots

For additional information on the plots, please refer to the section Plot Methods Description.

- Pyramidal Test



- Rotational Test



6.7 List of Test Sets

553vBMUSA1	8k images from USA and Canada
553vBMUSA2	1k images, mostly South Dakota
553vBMUSA3	6k color images, mostly South Dakota
553vBMUSA5	1k infrared images, mostly Uruguay
553vBMUSA6	1k infrared images, mostly Uruguay

7 Release 800v7.28 (2024-11-28)

7.1 Summary

- OCR Notes
  - improves reading accuracy
  - adds support for two-line MD plates
  - adds support for more types of LT plates
  - improves ADR recognition

7.2 Description of used models

See **Plate Types** for an explanation of what each type code means.

EU_GRAY_96x48_NONE_LIN_EXP17.dat

- Possible outputs:

Characters	0-9, A-Z, ;, Ä, Í, Ö, Ü, Ć, Č, Đ, Ě, Š, Ť, Ž, -
Num lines	2
Num chars per line	9, 9
Dimensions	100x175, 145x125, 165x165, 180x100, 200x160, 200x200, 210x143, 260x110, 280x200, 300x80, 300x150, 300x200, 305x114, 320x160, 325x105, 340x200, 360x110, 372x134, 390x120, 400x300, 440x120, 490x110, 520x110, UNKx110, UNKxUNK, UNLxUNL
Type	A, ADR, AL, AM, AND, AZ, B, BG, BIH, BY, CH, CY, CZ, D, DK, DPR, E, EST, F, FIN, FL, GB, GE, GR, H, HR, I, IL, IRL, IS, KS, KZ, L, LPR, LT, LV, M, MC, MD, MNE, N, NAT, NL, NMK, P, PALESTINE, PL, RKS, RO, RSM, RUS, S, SK, SLO, SRB, TR, TRASH, UA, UNK, UZ, V

7.3 Plate Types

Tables below are showing all posible types that can this module return. It can be plate type of license plates for different countries or it can be ADR or Trash marker or other type for object detected depending on module.

UNL	Unrecognized country
UNK	Detection FP
A	Austria
ADR	Dangerous goods
ADR-EMPTY	Empty ADR
ADR-TEXT	ADR containing text/code
AL	Albania
AM	Armenia
AND	Andorra
AZ	Azerbaijan
B	Belgium
BG	Bulgaria
BIH	Bosnia and Herzegovina
BOL	Bolivia
BR	Brazil
BY	Belarus
CDN-AB	Canada-Alberta
CDN-BC	Canada-British Columbia
CDN-MB	Canada-Manitoba
CDN-NB	Canada-New Brunswick
CDN-NL	Canada-Newfoundland and Labrador
CDN-NS	Canada-Nova Scotia
CDN-NT	Canada-Northwest Territories
CDN-NU	Canada-Nunavut
CDN-ON	Canada-Ontario
CDN-PE	Canada-Prince Edward Island
CDN-QC	Canada-Quebec
CDN-SK	Canada-Saskatchewan
CDN-YT	Canada-Yukon
CH	Switzerland
CI	Ivory Coast
CO	Colombia
CY	Cyprus
CZ	Czech Republic
D	Germany
DK	Denmark
DPR	Donetsk Peoples Republic

E	Spain
EC	Ecuador
EST	Estonia
F	France
FIN	Finland
FL	Liechtenstein
GB	Great Britain
GE	Georgia
GR	Greece
GUY	Guyana
H	Hungary
HR	Croatia
I	Italy
IL	Israel
IRL	Ireland
IS	Iceland
KS	Kyrgyzstan
KZ	Kazakhstan
L	Luxembourg
LPR	Luhansk Peoples Republic
LT	Lithuania
LV	Latvia
M	Malta
MC	Monaco
MD	Moldova
MEX	Mexico
MNE	Montenegro
N	Norway
NAT	NATO
NL	Netherlands
NMK	North Macedonia
P	Portugal
PALESTINE	Palestine
PE	Peru
PL	Poland
PY	Paraguay
Q-ARMY	Qatar, Military

Q-BIKE	Qatar, Bike
Q-COM	Qatar, Commercial
Q-DIP	Qatar, Diplomatic
Q-EQ	Qatar, Equipment
Q-EXP	Qatar, Export
Q-GOV	Qatar, Government
Q-PLC	Qatar, Police
Q-PRV	Qatar, Private
Q-PRVT	Qatar, Private transport
Q-PUBT	Qatar, Public transport
Q-TAXI	Qatar, Taxi
Q-TRAILER	Qatar, Trailer
Q-TRANS	Qatar, Transport
Q-UE	Qatar, Under experiment
Q-UN	Qatar, UN
Q-VB	Qatar, Lekhwiya
RA	Argentina
RCH	Chile
RKS	Kosovo
RO	Romania
RSM	San Marino
RUS	Russia
S	Sweden
SK	Slovakia
SLO	Slovenia
SME	Suriname
SRB	Serbia
TR	Turkey
TRAILER	TRAILER
TRAILER-E	Spain, Trailer
TRAILER-I	Italy, Trailer
TRASH	Trash marker (A)
UA	Ukraine
UAE-AJ	United Arab Emirates-Ajman
UAE-AZ	United Arab Emirates-Abu Dhabi
UAE-DU	United Arab Emirates-Dubai
UAE-FU	United Arab Emirates-Fujairah
UAE-RK	United Arab Emirates-Ras Al Khaimah
UAE-SH	United Arab Emirates-Sharjah
UAE-UQ	United Arab Emirates-Umm Al Quwain
USA	United States-UNL
USA-AK	United States-Alaska
USA-AL	United States-Alabama
USA-AR	United States-Arkansas
USA-AZ	United States-Arizona
USA-CA	United States-California
USA-CO	United States-Colorado
USA-CT	United States-Connecticut
USA-DC	United States-District of Columbia
USA-DE	United States-Delaware
USA-FL	United States-Florida
USA-GA	United States-Georgia
USA-GOV	United States-Government
USA-HI	United States-Hawaii
USA-IA	United States-Iowa
USA-ID	United States-Idaho
USA-IL	United States-Illinois
USA-IN	United States-Indiana
USA-KS	United States-Kansas
USA-KY	United States-Kentucky
USA-LA	United States-Louisiana
USA-MA	United States-Massachusetts
USA-MD	United States-Maryland
USA-ME	United States-Maine
USA-MI	United States-Michigan
USA-MN	United States-Minnesota
USA-MO	United States-Missouri
USA-MS	United States-Mississippi
USA-MT	United States-Montana
USA-NC	United States-North Carolina
USA-ND	United States-North Dakota
USA-NE	United States-Nebraska
USA-NH	United States-New Hampshire
USA-NJ	United States-New Jersey

USA-NM	United States-New Mexico
USA-NV	United States-Nevada
USA-NY	United States-New York
USA-OH	United States-Ohio
USA-OK	United States-Oklahoma
USA-OR	United States-Oregon
USA-PA	United States-Pennsylvania
USA-PR	United States-Puerto Rico
USA-RI	United States-Rhode Island
USA-SC	United States-South Carolina
USA-SD	United States-South Dakota
USA-TN	United States-Tennessee
USA-TX	United States-Texas
USA-UT	United States-Utah
USA-VA	United States-Virginia
USA-VT	United States-Vermont
USA-WA	United States-Washington
USA-WI	United States-Wisconsin
USA-WV	United States-West Virginia
USA-WY	United States-Wyoming
UY	Uruguay
UZ	Uzbekistan
V	Vatican
VN	Vietnam
YV	Venezuela

7.4 Speed

Processing times for tested LPM modules are shown in tables below for detection and OCR function. All times are in miliseconds. Colours are highlighting times where there are significant changes among versions. Description of tested configurations can be seen in section List of Tested Devices.

7.4.1 Detection

Dataset generic:

	GPU_JX(TRT)	GPU_JX(TF)	GPU_JT(TRT)	GPU_JT(TF)	GPU_JN(TRT)	GPU_JN(TF)	GPU_AO(TRT)	CPU_3(TF)	GPU_1(TF)
800v7.28	22.2	-	37.0	-	56.0	-	16.8	25.6	7.4
800v7.27	22.1	-	36.9	-	56.1	-	16.9	25.7	7.3
800v7.26	23.5	-	36.9	-	56.5	-	16.5	24.5	7.2
800v7.25	23.5	-	36.9	-	56.5	-	16.5	24.5	7.2
800v7.24	24.6	-	36.7	-	56.8	-	11.1	25.1	7.2
800v7.23	24.6	-	36.7	-	56.8	-	11.1	25.1	7.2

7.4.2 OCR

Dataset generic:

	GPU_JX(TRT)	GPU_JX(TF)	GPU_JT(TRT)	GPU_JT(TF)	GPU_JN(TRT)	GPU_JN(TF)	GPU_AO(TRT)	CPU_3(TF)	GPU_1(TF)
800v7.28	3.2	-	4.1	-	6.5	-	2.6	14.1	1.0
800v7.27	3.1	-	4.2	-	6.3	-	2.6	14.2	1.0
800v7.26	3.1	-	4.1	-	6.3	-	2.1	15.0	1.0
800v7.25	3.1	-	4.1	-	6.3	-	2.1	15.0	1.0
800v7.24	1.9	-	2.1	-	3.9	-	1.0	7.2	0.5
800v7.23	1.9	-	2.1	-	3.9	-	1.0	7.2	0.5

7.5 List of Tested Devices

CPU_1	Intel(R) Core(TM) i3-3220 (Windows 10 64bit)
CPU_2	Intel(R) Core(TM) i7-4930K @3.40GHz (Ubuntu 22.04 64bit)
CPU_3	Intel(R) Core(TM) i7-7700K CPU @4.20GHz (Ubuntu 22.04 64bit)
GPU_1	NVIDIA® GeForce® GTX Titan X (Ubuntu 22.04 64bit)
GPU_JN	Jetson Nano
GPU_JT	Jetson TX2
GPU_JX	Jetson Xavier NX
GPU_AO	Jetson AGX Orin

7.6 Performance metrics

Tables below are showing various performance metrics for tested modules. Colours are highlighting metrics where there are significant changes among versions. For more information about used metrics see section Performance Metrics Description. For description of test sets see section List of Test Sets.

7.6.1 System performance

Dataset 800v230126:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
800v7.28	22991	624	773	66.8	97.4	96.7	98.3	84.5	97.8	94.8	96.3
800v7.27	23109	484	655	69.5	97.9	97.2	98.3	82.9	97.9	95.4	96.6
800v7.26	23021	614	1099	53.0	97.4	95.4	97.7	89.1	97.4	92.7	95.0
800v7.25	23018	620	1102	53.4	97.4	95.4	97.7	32.9	95.8	92.7	94.2
800v7.24	22856	484	1264	51.7	97.9	94.8	97.1	31.6	95.6	91.4	93.5
800v7.23	22856	484	1264	51.7	97.9	94.8	97.1	31.2	95.6	91.4	93.5

Dataset 800BMML1:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
800v7.28	7190	63	23	73.9	99.1	99.7	99.7	77.8	99.5	99.4	99.4
800v7.27	7192	41	21	76.2	99.4	99.7	99.7	87.8	99.6	99.4	99.5
800v7.26	7189	63	25	68.0	99.1	99.7	99.6	74.6	99.4	99.3	99.3
800v7.25	7189	64	25	68.0	99.1	99.7	99.6	56.2	99.2	99.2	99.2
800v7.24	7187	20	27	77.8	99.7	99.6	99.8	60.0	99.7	99.4	99.6
800v7.23	7187	20	27	77.8	99.7	99.6	99.8	60.0	99.7	99.4	99.6

Dataset 800BMML3:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
800v7.28	4239	107	28	60.7	97.5	99.3	98.3	94.4	98.2	97.5	97.8

800v7.27	4251	78	16	62.5	98.2	99.6	98.2	96.2	98.1	97.8	97.9
800v7.26	4239	107	29	62.1	97.5	99.3	98.1	93.5	97.9	97.3	97.6
800v7.25	4239	110	29	62.1	97.5	99.3	97.9	60.0	96.7	97.1	96.9
800v7.24	4206	73	62	58.1	98.3	98.5	97.2	61.6	96.5	95.6	96.0
800v7.23	4206	73	62	58.1	98.3	98.5	97.2	61.6	96.5	95.6	96.0

Dataset 800BMML4:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
800v7.28	790	20	9	66.7	97.5	98.9	99.5	90.0	99.3	98.2	98.7
800v7.27	791	11	8	62.5	98.6	99.0	99.8	100.0	99.8	98.7	99.3
800v7.26	790	21	10	70.0	97.4	98.8	99.1	85.7	98.7	97.6	98.1
800v7.25	789	16	11	72.7	98.0	98.6	99.7	50.0	98.5	98.1	98.3
800v7.24	789	15	11	81.8	98.1	98.6	98.8	20.0	97.1	97.2	97.1
800v7.23	789	15	11	81.8	98.1	98.6	98.8	20.0	97.1	97.2	97.1

Dataset 800BMML5:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
800v7.28	3084	17	24	87.5	99.5	99.2	92.6	88.2	92.5	91.8	92.1
800v7.27	3082	19	26	96.2	99.4	99.2	92.2	100.0	92.2	91.3	91.7
800v7.26	3084	17	24	87.5	99.5	99.2	91.4	88.2	91.3	90.6	91.0
800v7.25	3083	18	25	88.0	99.4	99.2	91.6	38.9	91.2	90.8	91.0
800v7.24	3081	14	27	74.1	99.5	99.1	90.3	42.9	90.0	89.4	89.7
800v7.23	3081	14	27	74.1	99.5	99.1	90.3	42.9	90.0	89.4	89.7

Dataset 800CZ2024:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta

800v7.28	208	13	5	80.0	94.1	97.7	100.0	76.9	98.4	97.4	97.9
800v7.27	211	12	2	100.0	94.6	99.1	99.5	91.7	98.9	98.4	98.7
800v7.26	211	15	5	80.0	93.4	97.7	98.9	73.3	96.9	96.4	96.6
800v7.25	211	15	5	80.0	93.4	97.7	94.1	6.7	87.6	91.7	89.6
800v7.24	203	3	13	53.8	98.5	94.0	70.9	0.0	69.7	66.2	67.9
800v7.23	203	3	13	53.8	98.5	94.0	70.9	0.0	69.7	66.2	67.9

Dataset 800BMML6:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
800v7.28	4812	16	5	60.0	99.7	99.9	99.9	56.2	99.7	99.8	99.7
800v7.27	4812	16	5	60.0	99.7	99.9	99.8	56.2	99.6	99.7	99.7

Dataset 800BMML7:

	TP	FP	FN	hard FN	Precision	Recall	OCR TP correct	OCR FP correct	System precision	System recall	System F_beta
800v7.28	1226	203	73	9.6	85.8	94.4	97.8	89.7	96.1	92.0	94.0
800v7.27	1226	203	73	9.6	85.8	94.4	97.3	89.2	95.5	91.5	93.5

7.6.2 OCR text reading performance

Dataset 800v230126:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#9678)	99.8	99.74	99.45	99.56	99.52	99.53
ADR-TEXT (#2119)	99.81	99.62	99.53	99.43	99.67	99.67
NL (#1504)	97.27	97.28	96.74	96.88	97.52	97.52
ADR-EMPTY (#837)	100.0	99.88	-	-	-	-
SLO (#737)	95.39	96.34	93.22	95.25	93.33	93.33
I (#666)	96.1	95.49	95.49	94.89	93.53	93.53
B (#569)	97.19	97.18	97.19	95.78	95.77	95.77

D (#491)	97.35	97.96	97.35	97.55	97.55	97.55
PL (#419)	98.33	99.52	98.1	97.62	97.85	97.85
TR (#399)	97.99	97.74	96.99	97.49	95.98	95.98
TRASH (#327)	100.0	100.0	100.0	100.0	100.0	100.0
AM (#260)	95.77	95.77	95.77	91.92	76.15	76.15
SK (#251)	98.8	98.8	98.8	98.8	99.6	99.6
RUS (#237)	89.45	89.87	89.45	90.3	89.03	89.03
F (#217)	98.16	98.17	97.7	97.7	97.71	98.17
RO (#159)	98.74	98.74	98.74	97.48	98.74	98.74
GB (#143)	55.94	69.23	55.94	57.04	48.45	48.45
HR (#143)	95.8	95.77	95.8	97.9	97.2	97.2
AZ (#135)	94.81	92.65	93.33	88.15	72.39	72.39
KS (#130)	85.38	83.08	86.15	84.62	51.18	50.39
SRB (#130)	94.62	93.85	92.31	92.31	93.08	93.08
BY (#124)	95.97	96.77	95.16	94.35	92.68	92.68
BG (#119)	100.0	100.0	100.0	100.0	99.16	99.16
E (#119)	95.8	97.46	93.28	94.96	95.8	95.8
S (#117)	99.15	99.15	99.15	98.29	99.15	99.15
DK (#111)	100.0	100.0	98.2	99.1	99.1	99.1
UA (#110)	89.09	93.58	86.49	89.19	81.08	81.08
CH (#105)	99.05	99.05	99.05	100.0	94.29	94.29
A (#98)	85.71	86.73	83.67	83.67	84.69	84.69
LT (#91)	98.9	98.9	98.9	98.9	100.0	100.0
L (#74)	100.0	100.0	100.0	100.0	100.0	100.0
EST (#69)	89.86	94.2	88.41	89.86	91.04	91.04
H (#67)	100.0	100.0	98.51	100.0	100.0	100.0
NMK (#66)	100.0	100.0	98.48	100.0	100.0	100.0
KZ (#62)	93.55	95.16	93.55	91.94	91.94	91.94
BIH (#53)	100.0	100.0	98.11	100.0	100.0	100.0
N (#43)	100.0	100.0	97.67	100.0	100.0	100.0
GR (#42)	95.24	95.35	97.62	95.24	95.24	95.24
P (#40)	97.5	97.5	97.5	95.0	97.5	97.5
I-TRAILER (#38)	100.0	100.0	100.0	100.0	94.44	94.44
MC (#26)	100.0	100.0	96.15	96.15	100.0	100.0
LV (#24)	100.0	100.0	100.0	100.0	91.67	91.67
E-TRAILER (#22)	95.45	95.65	100.0	95.45	95.65	95.65
MD (#20)	100.0	100.0	100.0	100.0	100.0	100.0
AL (#12)	100.0	100.0	100.0	100.0	100.0	100.0
FIN (#11)	100.0	100.0	100.0	100.0	100.0	100.0

IL (#11)	100.0	100.0	100.0	100.0	100.0	100.0
IRL (#11)	100.0	90.91	100.0	90.91	90.91	90.91
MNE (#6)	83.33	83.33	83.33	83.33	83.33	83.33
RKS (#5)	100.0	100.0	100.0	100.0	100.0	100.0
UZ (#5)	100.0	80.0	60.0	20.0	40.0	40.0
GE (#4)	100.0	100.0	100.0	100.0	100.0	100.0
RSM (#3)	100.0	66.67	100.0	66.67	100.0	100.0
CY (#2)	100.0	100.0	100.0	100.0	100.0	100.0
FL (#2)	50.0	50.0	50.0	100.0	100.0	100.0
AND (#1)	0.0	100.0	100.0	-	-	-

Dataset 800BMML1:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#6532)	99.79	99.8	99.76	99.68	99.89	99.89
D (#144)	95.83	95.83	95.83	95.83	95.83	95.83
SK (#101)	99.01	99.01	98.02	99.01	100.0	100.0
PL (#54)	100.0	100.0	98.15	100.0	100.0	100.0
RO (#36)	100.0	100.0	100.0	100.0	100.0	100.0
H (#24)	100.0	100.0	100.0	100.0	100.0	100.0
TRASH (#16)	100.0	100.0	100.0	100.0	100.0	100.0
GB (#13)	100.0	100.0	100.0	100.0	100.0	100.0
A (#11)	100.0	100.0	100.0	100.0	100.0	100.0
BG (#11)	100.0	100.0	100.0	100.0	100.0	100.0
NL (#9)	100.0	100.0	100.0	100.0	100.0	100.0
UA (#9)	100.0	100.0	100.0	100.0	100.0	100.0
ADR-TEXT (#8)	100.0	100.0	100.0	100.0	100.0	100.0
RUS (#8)	100.0	100.0	100.0	100.0	100.0	100.0
SRB (#7)	85.71	85.71	85.71	85.71	85.71	85.71
DK (#6)	100.0	100.0	100.0	100.0	100.0	100.0
F (#6)	100.0	100.0	100.0	100.0	100.0	100.0
E (#4)	100.0	100.0	100.0	100.0	100.0	100.0
S (#4)	100.0	100.0	100.0	100.0	100.0	100.0
N (#3)	100.0	100.0	100.0	100.0	100.0	100.0
B (#2)	100.0	100.0	100.0	100.0	100.0	100.0
LT (#2)	100.0	100.0	100.0	100.0	100.0	100.0
SLO (#2)	100.0	100.0	100.0	100.0	100.0	100.0
HR (#1)	100.0	100.0	100.0	100.0	100.0	100.0
NMK (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML3:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
F (#3134)	98.28	98.31	98.09	97.89	97.18	97.18
B (#322)	98.14	96.59	97.52	97.2	97.49	97.49
PL (#25)	100.0	100.0	100.0	100.0	96.0	96.0
D (#23)	100.0	100.0	95.65	95.65	95.65	95.65
NL (#20)	100.0	100.0	100.0	100.0	100.0	100.0
P (#10)	100.0	100.0	100.0	100.0	100.0	100.0
RO (#9)	100.0	100.0	100.0	100.0	100.0	100.0
BG (#7)	100.0	100.0	100.0	100.0	100.0	100.0
LT (#5)	100.0	100.0	100.0	100.0	100.0	100.0
GB (#3)	100.0	100.0	100.0	100.0	100.0	100.0
MD (#2)	100.0	100.0	100.0	100.0	100.0	100.0
CH (#1)	100.0	100.0	100.0	100.0	100.0	100.0
I (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML4:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#641)	99.69	99.84	99.22	99.69	98.75	98.75
SK (#14)	100.0	100.0	100.0	100.0	100.0	100.0
UA (#5)	80.0	100.0	80.0	100.0	100.0	100.0
LT (#3)	100.0	100.0	100.0	100.0	100.0	100.0
GR (#1)	100.0	100.0	100.0	100.0	100.0	100.0
I (#1)	100.0	100.0	100.0	100.0	100.0	100.0
PL (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML5:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
B (#2647)	92.41	91.99	91.27	91.5	90.09	90.09
F (#35)	94.29	94.29	94.29	91.43	94.29	94.29
D (#24)	100.0	100.0	91.67	91.67	91.67	91.67
UA (#20)	100.0	100.0	100.0	100.0	100.0	100.0
GB (#5)	80.0	80.0	100.0	100.0	100.0	100.0
P (#5)	100.0	100.0	100.0	100.0	100.0	100.0
E (#4)	100.0	100.0	100.0	100.0	100.0	100.0
L (#4)	75.0	75.0	75.0	75.0	75.0	75.0
PL (#4)	100.0	100.0	100.0	100.0	100.0	100.0
RO (#4)	100.0	100.0	100.0	100.0	100.0	100.0
BG (#2)	100.0	100.0	100.0	100.0	100.0	100.0
IRL (#2)	50.0	50.0	33.33	33.33	33.33	33.33
LV (#2)	100.0	100.0	100.0	100.0	100.0	100.0

NL (#2)	100.0	100.0	100.0	100.0	100.0	100.0
SK (#2)	100.0	100.0	100.0	100.0	100.0	100.0
ADR-EMPTY (#1)	100.0	100.0	-	-	-	-
CH (#1)	100.0	100.0	100.0	100.0	100.0	100.0
CZ (#1)	100.0	100.0	100.0	100.0	100.0	100.0
I (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800CZ2024:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#180)	100.0	99.45	98.91	93.99	70.39	70.39
ADR-TEXT (#1)	100.0	100.0	100.0	100.0	100.0	100.0
PL (#1)	100.0	100.0	100.0	100.0	-	-
SK (#1)	100.0	100.0	100.0	100.0	100.0	100.0
SRB (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML6:

	800v7.28	800v7.27
LT (#4597)	99.89	99.83
LV (#77)	100.0	100.0
PL (#34)	97.06	97.06
GB (#17)	100.0	100.0
D (#16)	100.0	100.0
UA (#16)	100.0	100.0
EST (#10)	100.0	100.0
FIN (#8)	100.0	100.0
F (#7)	100.0	100.0
S (#7)	100.0	100.0
N (#4)	100.0	100.0
DK (#3)	100.0	100.0
CZ (#2)	100.0	100.0
IRL (#2)	100.0	100.0
ADR-EMPTY (#1)	100.0	100.0
BY (#1)	100.0	100.0
I (#1)	100.0	100.0
MD (#1)	100.0	100.0
NL (#1)	100.0	100.0

P (#1)	100.0	100.0
RUS (#1)	0.0	0.0

Dataset 800BMML7:

	800v7.28	800v7.27
F (#753)	97.74	97.74
ADR-TEXT (#251)	98.01	96.41
ADR-EMPTY (#72)	100.0	97.22
CH (#32)	96.88	96.88
I (#12)	91.67	91.67
LT (#8)	100.0	100.0
E (#7)	100.0	100.0
B (#6)	100.0	100.0
PL (#5)	100.0	100.0
D (#3)	66.67	66.67
MC (#2)	100.0	100.0
SRB (#2)	100.0	100.0
GE (#1)	100.0	100.0
RO (#1)	100.0	100.0
SLO (#1)	100.0	100.0

7.6.3 ILPC recognition performance

Dataset 800v230126:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#9678)	100.0	100.0	100.0	99.98	99.97	99.97
ADR-TEXT (#2119)	100.0	100.0	100.0	100.0	99.95	99.95
NL (#1504)	100.0	100.0	100.0	99.87	99.87	99.87
ADR-EMPTY (#837)	99.64	99.04	99.09	98.84	99.48	99.48
SLO (#737)	99.73	100.0	99.46	99.32	99.32	99.18
I (#666)	99.85	99.7	99.7	99.85	99.7	99.7
UNK (#624)	84.46	82.85	87.85	33.07	31.14	30.74
B (#569)	99.3	99.3	99.3	98.59	98.77	98.77
D (#491)	100.0	99.8	100.0	100.0	99.8	99.8

PL (#419)	100.0	100.0	100.0	100.0	99.76	99.76
TR (#399)	99.0	99.5	99.0	98.25	98.49	98.49
TRASH (#327)	99.69	100.0	100.0	100.0	100.0	100.0
AM (#260)	96.15	95.77	93.08	88.46	0.0	0.0
SK (#251)	100.0	99.6	100.0	100.0	99.6	99.6
RUS (#237)	95.78	96.2	94.94	92.83	95.36	95.36
F (#217)	99.54	99.54	99.54	98.62	98.62	98.62
RO (#159)	100.0	100.0	100.0	100.0	100.0	100.0
HR (#143)	100.0	100.0	100.0	100.0	100.0	100.0
GB (#143)	88.81	92.31	90.91	93.66	89.69	89.69
AZ (#135)	97.78	97.79	97.04	91.11	3.73	3.73
KS (#130)	93.08	95.38	95.38	82.31	16.54	16.54
SRB (#130)	99.23	99.23	99.23	99.23	99.23	99.23
BY (#124)	96.77	95.97	96.77	95.97	95.12	95.12
BG (#119)	99.16	99.16	99.16	99.16	99.16	99.16
E (#119)	100.0	100.0	100.0	99.16	98.32	98.32
S (#117)	95.73	95.73	93.16	93.16	94.02	94.02
DK (#111)	100.0	99.1	100.0	100.0	100.0	100.0
UA (#110)	97.27	97.25	96.4	83.78	78.38	78.38
CH (#105)	99.05	99.05	99.05	99.05	99.05	99.05
A (#98)	97.96	97.96	97.96	97.96	98.98	98.98
LT (#91)	100.0	100.0	100.0	97.8	97.8	97.8
L (#74)	98.65	98.65	98.65	98.65	98.65	98.65
EST (#69)	86.96	85.51	75.36	71.01	80.6	80.6
H (#67)	100.0	100.0	98.51	100.0	98.51	98.51
NMK (#66)	95.45	96.97	96.97	86.36	92.42	92.42
KZ (#62)	98.39	98.39	96.77	98.39	98.39	98.39
BIH (#53)	100.0	100.0	100.0	100.0	100.0	100.0
N (#43)	97.67	97.67	97.67	95.35	97.67	97.67
GR (#42)	100.0	97.67	100.0	95.24	97.62	97.62
P (#40)	97.5	92.5	97.5	92.5	92.5	92.5
I-TRAILER (#38)	0.0	0.0	0.0	100.0	0.0	0.0
MC (#26)	96.15	100.0	96.15	96.15	100.0	100.0
LV (#24)	100.0	100.0	100.0	100.0	95.83	95.83
E-TRAILER (#22)	0.0	0.0	0.0	77.27	78.26	78.26
MD (#20)	100.0	100.0	94.74	100.0	100.0	100.0
AL (#12)	100.0	100.0	100.0	100.0	83.33	83.33
FIN (#11)	100.0	100.0	100.0	100.0	100.0	100.0
IRL (#11)	100.0	100.0	100.0	100.0	100.0	100.0

IL (#11)	100.0	100.0	100.0	100.0	100.0	100.0
MNE (#6)	100.0	100.0	100.0	100.0	100.0	100.0
RKS (#5)	100.0	100.0	100.0	100.0	80.0	80.0
UZ (#5)	100.0	100.0	100.0	100.0	100.0	100.0
GE (#4)	75.0	75.0	100.0	75.0	100.0	100.0
RSM (#3)	100.0	100.0	100.0	66.67	66.67	66.67
FL (#2)	100.0	100.0	50.0	100.0	100.0	100.0
CY (#2)	0.0	0.0	0.0	0.0	0.0	0.0
AND (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML1:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#6532)	100.0	100.0	100.0	100.0	99.98	99.98
D (#144)	100.0	100.0	100.0	100.0	99.31	99.31
SK (#101)	100.0	100.0	100.0	100.0	100.0	100.0
UNK (#63)	77.78	87.8	74.6	56.25	60.0	60.0
PL (#54)	100.0	100.0	100.0	100.0	100.0	100.0
RO (#36)	100.0	100.0	100.0	100.0	100.0	100.0
H (#24)	95.83	95.83	95.83	95.83	95.83	95.83
TRASH (#16)	100.0	100.0	100.0	100.0	100.0	100.0
GB (#13)	100.0	100.0	100.0	100.0	100.0	100.0
A (#11)	100.0	100.0	100.0	100.0	100.0	100.0
BG (#11)	100.0	100.0	100.0	100.0	100.0	100.0
UA (#9)	100.0	100.0	100.0	100.0	100.0	100.0
NL (#9)	100.0	100.0	100.0	100.0	100.0	100.0
RUS (#8)	100.0	100.0	100.0	100.0	100.0	100.0
ADR-TEXT (#8)	100.0	100.0	100.0	100.0	100.0	100.0
SRB (#7)	100.0	100.0	100.0	100.0	100.0	100.0
DK (#6)	100.0	100.0	83.33	83.33	100.0	100.0
F (#6)	100.0	100.0	100.0	100.0	100.0	100.0
S (#4)	100.0	100.0	100.0	100.0	100.0	100.0
E (#4)	100.0	100.0	100.0	100.0	100.0	100.0
N (#3)	100.0	100.0	100.0	100.0	100.0	100.0
B (#2)	100.0	100.0	100.0	100.0	100.0	100.0
LT (#2)	100.0	100.0	100.0	100.0	100.0	100.0
SLO (#2)	100.0	100.0	100.0	100.0	100.0	100.0
HR (#1)	100.0	100.0	100.0	100.0	100.0	100.0
NMK (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML3:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
F (#3134)	99.84	99.87	99.74	99.78	99.78	99.78
B (#322)	100.0	99.69	100.0	98.76	98.75	98.75
UNK (#107)	94.39	96.15	93.46	60.0	61.64	61.64
PL (#25)	100.0	100.0	100.0	100.0	100.0	100.0
D (#23)	100.0	100.0	100.0	100.0	100.0	100.0
NL (#20)	100.0	100.0	100.0	100.0	100.0	100.0
P (#10)	100.0	100.0	100.0	100.0	100.0	100.0
RO (#9)	100.0	100.0	100.0	100.0	100.0	100.0
BG (#7)	100.0	100.0	100.0	100.0	100.0	100.0
LT (#5)	100.0	100.0	100.0	100.0	100.0	100.0
GB (#3)	100.0	100.0	100.0	100.0	100.0	100.0
MD (#2)	100.0	100.0	100.0	100.0	100.0	100.0
I (#1)	100.0	100.0	100.0	100.0	100.0	100.0
CH (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML4:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#641)	100.0	99.84	100.0	100.0	99.84	99.84
UNK (#20)	90.0	100.0	85.71	50.0	20.0	20.0
SK (#14)	100.0	100.0	100.0	100.0	100.0	100.0
UA (#5)	100.0	100.0	100.0	100.0	100.0	100.0
LT (#3)	100.0	100.0	100.0	100.0	100.0	100.0
PL (#1)	100.0	100.0	100.0	100.0	100.0	100.0
I (#1)	100.0	100.0	100.0	100.0	100.0	100.0
GR (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML5:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
B (#2647)	99.4	99.47	99.55	99.32	99.55	99.55
F (#35)	100.0	100.0	100.0	100.0	100.0	100.0
D (#24)	100.0	100.0	100.0	100.0	100.0	100.0
UA (#20)	100.0	100.0	100.0	100.0	100.0	100.0
UNK (#17)	88.24	100.0	88.24	38.89	42.86	42.86
P (#5)	100.0	100.0	100.0	80.0	80.0	80.0
GB (#5)	80.0	80.0	100.0	100.0	100.0	100.0
L (#4)	75.0	75.0	75.0	75.0	75.0	75.0
PL (#4)	100.0	100.0	100.0	100.0	100.0	100.0
RO (#4)	100.0	100.0	100.0	100.0	100.0	100.0

E (#4)	100.0	100.0	100.0	100.0	100.0	100.0
IRL (#2)	50.0	50.0	33.33	33.33	33.33	33.33
NL (#2)	100.0	100.0	100.0	100.0	100.0	100.0
BG (#2)	100.0	100.0	100.0	100.0	100.0	100.0
LV (#2)	100.0	100.0	100.0	100.0	100.0	100.0
SK (#2)	100.0	100.0	100.0	100.0	100.0	100.0
ADR-EMPTY (#1)	100.0	100.0	100.0	100.0	-	-
I (#1)	100.0	100.0	100.0	100.0	100.0	100.0
CH (#1)	100.0	100.0	100.0	100.0	100.0	100.0
CZ (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800CZ2024:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
CZ (#180)	100.0	100.0	100.0	100.0	99.44	99.44
UNK (#13)	76.92	91.67	73.33	6.67	0.0	0.0
SRB (#1)	100.0	100.0	100.0	100.0	100.0	100.0
ADR-TEXT (#1)	100.0	100.0	100.0	100.0	100.0	100.0
PL (#1)	100.0	100.0	100.0	100.0	-	-
SK (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML6:

	800v7.28	800v7.27
LT (#4597)	99.91	99.89
LV (#77)	100.0	100.0
PL (#34)	100.0	100.0
GB (#17)	100.0	100.0
UA (#16)	100.0	100.0
UNK (#16)	56.25	56.25
D (#16)	100.0	100.0
EST (#10)	90.0	90.0
FIN (#8)	100.0	100.0
S (#7)	85.71	85.71
F (#7)	100.0	100.0
N (#4)	100.0	100.0
DK (#3)	66.67	66.67
CZ (#2)	100.0	100.0
IRL (#2)	100.0	100.0

ADR-EMPTY (#1)	100.0	100.0
P (#1)	100.0	100.0
BY (#1)	100.0	100.0
NL (#1)	100.0	100.0
I (#1)	100.0	100.0
MD (#1)	100.0	100.0
RUS (#1)	100.0	100.0

Dataset 800BMML7:

	800v7.28	800v7.27
F (#753)	100.0	99.47
ADR-TEXT (#251)	99.2	96.81
UNK (#203)	89.66	89.16
ADR-EMPTY (#72)	100.0	87.5
CH (#32)	100.0	100.0
I (#12)	100.0	100.0
LT (#8)	100.0	100.0
E (#7)	100.0	100.0
B (#6)	100.0	100.0
PL (#5)	100.0	100.0
D (#3)	100.0	100.0
SRB (#2)	100.0	100.0
MC (#2)	100.0	100.0
RO (#1)	100.0	100.0
GE (#1)	0.0	100.0
SLO (#1)	100.0	100.0

7.6.4 Dimensions recognition performance

Dataset 800v230126:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
520x110 (#15000)	99.95	99.92	99.91	99.92	99.93	99.93
400x300 (#3270)	99.97	99.94	99.72	99.72	99.78	99.78

UNKxUNK (#624)	0.0	0.0	0.0	0.0	0.0	0.0
360x110 (#579)	99.31	99.31	99.31	99.65	99.31	99.31
145x125 (#410)	99.51	99.51	99.51	99.27	99.51	99.51
300x150 (#310)	85.81	80.65	90.97	81.29	90.65	90.65
280x200 (#275)	84.73	88.36	89.89	86.64	86.86	86.86
200x160 (#173)	99.42	99.42	98.28	98.28	98.28	98.28
210x143 (#162)	95.06	94.44	94.44	95.71	96.25	96.25
320x160 (#161)	96.27	96.91	95.68	95.06	90.12	90.12
340x200 (#159)	89.31	88.05	89.31	91.19	89.31	89.31
325x105 (#128)	98.44	99.22	98.44	98.44	97.66	97.66
100x175 (#112)	95.54	95.54	95.54	95.54	93.52	93.52
300x80 (#91)	98.9	98.9	98.9	98.9	98.9	98.9
400x130 (#38)	0.0	0.0	0.0	0.0	0.0	0.0
260x110 (#26)	96.15	100.0	96.15	96.15	100.0	100.0
240x150 (#20)	0.0	0.0	0.0	0.0	90.0	90.0
285x203 (#17)	0.0	0.0	0.0	0.0	76.47	76.47
440x120 (#14)	92.86	92.86	100.0	100.0	92.86	92.86
300x200 (#11)	27.27	27.27	36.36	18.18	9.09	9.09
100x100 (#7)	0.0	0.0	0.0	0.0	0.0	0.0
335x155 (#6)	0.0	0.0	0.0	0.0	16.67	16.67
305x114 (#3)	100.0	100.0	66.67	100.0	100.0	100.0
190x140 (#3)	0.0	0.0	0.0	0.0	33.33	33.33

165x165 (#3)	100.0	100.0	100.0	100.0	100.0	100.0
390x120 (#3)	100.0	100.0	100.0	66.67	100.0	100.0
200x200 (#2)	100.0	100.0	100.0	100.0	100.0	100.0
290x170 (#1)	0.0	0.0	0.0	0.0	0.0	0.0
330x140 (#1)	0.0	0.0	0.0	0.0	0.0	0.0

Dataset 800BMML1:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
520x110 (#5991)	100.0	100.0	100.0	100.0	100.0	100.0
320x160 (#724)	99.17	99.17	99.45	98.62	99.31	99.31
280x200 (#132)	100.0	99.24	99.24	100.0	100.0	100.0
200x160 (#80)	100.0	100.0	100.0	100.0	100.0	100.0
UNKxUNK (#63)	0.0	0.0	0.0	0.0	0.0	0.0
340x200 (#34)	88.24	91.18	85.29	91.18	91.18	91.18
400x300 (#21)	100.0	100.0	100.0	100.0	100.0	100.0
240x150 (#8)	0.0	0.0	0.0	0.0	100.0	100.0
285x203 (#5)	0.0	0.0	0.0	0.0	100.0	100.0
300x200 (#2)	50.0	50.0	50.0	50.0	0.0	0.0
210x143 (#1)	0.0	100.0	0.0	100.0	100.0	100.0

Dataset 800BMML3:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
520x110 (#3474)	99.91	99.86	99.94	100.0	99.91	99.91
UNKxUNK (#107)	0.0	0.0	0.0	0.0	0.0	0.0

210x143 (#61)	85.25	86.89	95.08	88.52	55.74	55.74
280x200 (#19)	100.0	95.24	89.47	84.21	80.0	80.0
325x105 (#5)	100.0	100.0	100.0	100.0	100.0	100.0
340x200 (#2)	100.0	100.0	100.0	100.0	50.0	50.0
300x80 (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML4:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
520x110 (#666)	100.0	100.0	100.0	100.0	100.0	100.0
UNKxUNK (#20)	0.0	0.0	0.0	0.0	0.0	0.0

Dataset 800BMML5:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
520x110 (#2542)	100.0	100.0	100.0	100.0	100.0	100.0
210x143 (#82)	100.0	100.0	100.0	98.78	97.47	97.47
325x105 (#49)	95.92	100.0	97.96	97.96	97.96	97.96
100x120 (#29)	0.0	0.0	0.0	0.0	0.0	0.0
UNKxUNK (#17)	0.0	0.0	0.0	0.0	0.0	0.0
340x200 (#9)	66.67	66.67	66.67	66.67	55.56	55.56
145x125 (#2)	100.0	100.0	100.0	100.0	50.0	50.0
400x300 (#1)	100.0	100.0	100.0	100.0	-	-
360x110 (#1)	100.0	100.0	100.0	100.0	100.0	100.0
300x80 (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800CZ2024:

	800v7.28	800v7.27	800v7.26	800v7.25	800v7.24	800v7.23
520x110 (#183)	100.0	100.0	100.0	100.0	100.0	100.0
UNKxUNK (#13)	0.0	0.0	0.0	0.0	0.0	0.0
400x300 (#1)	100.0	100.0	100.0	100.0	100.0	100.0

Dataset 800BMML6:

	800v7.28	800v7.27
520x110 (#4757)	99.77	99.77
300x150 (#18)	100.0	100.0
UNKxUNK (#16)	0.0	0.0
440x120 (#8)	100.0	100.0
335x155 (#3)	0.0	0.0
280x200 (#2)	100.0	100.0
325x105 (#2)	0.0	0.0
360x110 (#2)	100.0	100.0
400x300 (#1)	100.0	100.0
200x160 (#1)	100.0	100.0

Dataset 800BMML7:

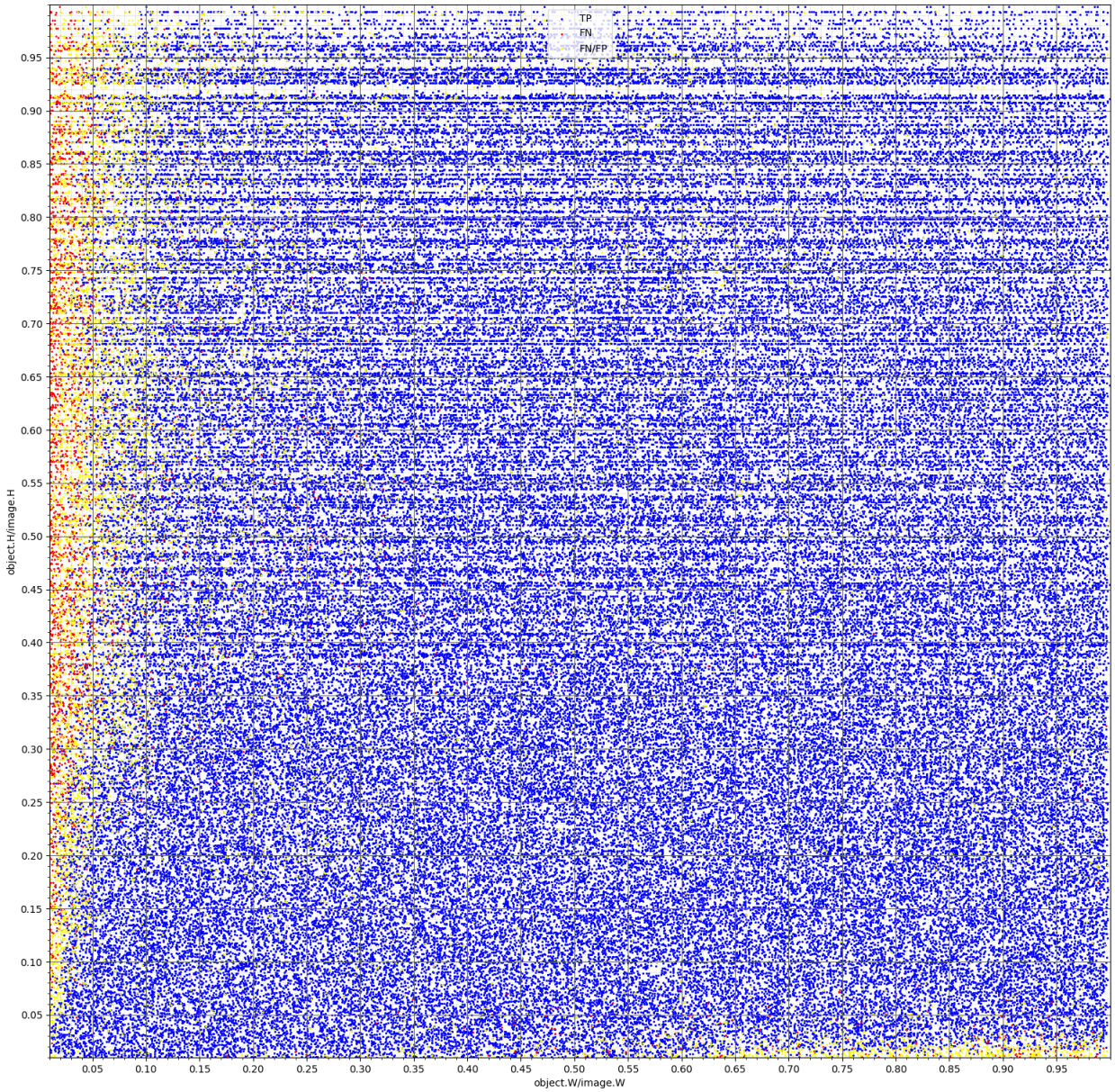
	800v7.28	800v7.27
520x110 (#796)	99.87	99.87
400x300 (#319)	99.69	99.06
UNKxUNK (#203)	0.0	0.0
300x80 (#23)	100.0	100.0

360x110 (#12)	**100.0**	**100.0**
260x110 (#2)	**100.0**	**100.0**

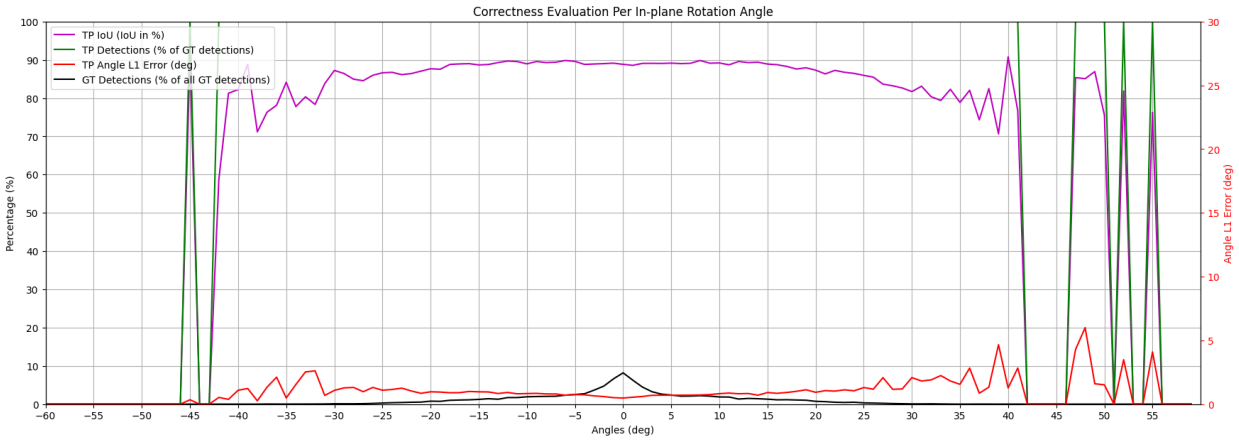
7.6.5 Plots

For additional information on the plots, please refer to the section Plot Methods Description.

- Pyramidal Test



- Rotational Test



7.7 List of Test Sets

800v230125	105k images with ILPC diversity
800v230126	17k images with ILPC diversity, frontal and rear view, mostly CZ
800vBMML1	7k images, frontal and rear view, CZ
800vBMML3	1.5k images, frontal and rear view, mostly F and B
800vBMML4	3k images, rotated license plates, generic view, mostly CZ
800vBMML5	4k images, frontal view, RGB and gray, mostly B
800CZ2024	images containing CZ plates with ”NLL LNNN” format
800vBMML6	5k images, grayscale, frontal and rear view, mainly LT
800vBMML7	800 images, color, frontal, mostly ADR and F

8 Appendix

8.1 Performance Metrics Desription

The results are computed on datasets that demand the detector to identify all objects within an image, including unreadable and obstructed plates. Detections and ANPR processes are ignored for objects that do not appear on the list of potential outputs or they are not present in the region of interest.

TP Total number of detection true positives

FP Total number of detection false positives

FN Total number of detection false negatives

hard FN Percentage of unreadable false negatives from all FN

Precision Standard detection precision computed as $\frac{TP}{TP+FP}$

Recall Standard detection recall computed as $\frac{TP}{TP+FN}$

OCR TP correct Total number of correct ANPR predictions on readable TP

OCR FP correct Total number of correct ANPR recognitions of FP detections

System precision System precision computed as $\frac{\text{OCR TP correct}}{\text{OCR TP}+\text{OCR FP incorrect}}$

System recall System recall computed as $\frac{\text{OCR TP correct}}{\text{OCR TP}+\text{FN}}$

System F_β System F_β score computed as $\frac{(1+\beta^2)\cdot\text{System Precision}\cdot\text{System Recall}}{\beta^2\cdot\text{System Precision}+\text{System Recall}}$, we use $\beta = 1$

8.2 Plot Methods Description

This part describes plots which are included for each release in Performance metrix / Plots.

8.2.1 Pyramidal Test

Plot where each dot represents either a correct text prediction (blue color), wrong text prediction (yellow color) or undetected object (red color). The axes represent the relative size of the ground-truth object with respect to the image size. The X axis represents the relative width of the ground-truth object with respect to the image width and the Y axis represents the relative height of the ground-truth object with respect to the image height. The more blue dots are in the plot, the better the model is at detecting and recognizing objects of different sizes.

8.2.2 Rotational Test

Plot computed for a dataset, where there is a high variation of objects orientation. For each angle (in degrees) of the ground-truth object, the plot shows multiple metrics (number of objects, IoU, L_1 angle error) for the model. The measured text accuracy does not have to be representative as the license plates do not have to be readable for the ANPR model.

8.2.3 F_β Thresholds Test

Shows the F_β score valley of the whole system for different DETection and OCR thresholds.