Time Series Analysis for Enhancing the Recognition of License Plate Number in Video Stream of IOT Camera

Bada Kim, Doohyuk Chang, Junyoung Heo

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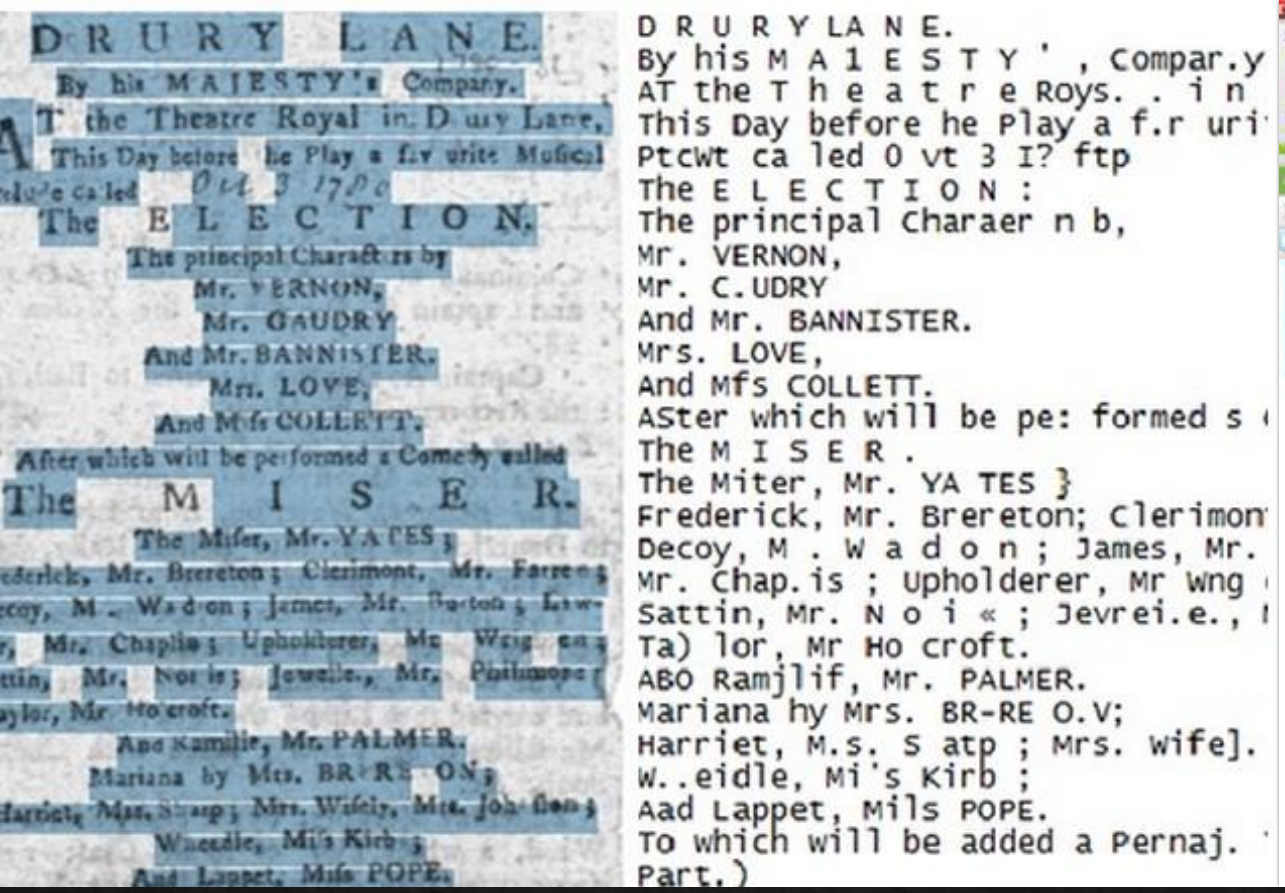

DRURY LANE.
By his MAJESTY's Company.
AT the Theatre Royal in Drury Lane,
This Day before he Play a fav'rite Musical
[illegible] called
The ELECTION.
The principal Characters by
Mr. VERNON,
Mr. GAUDRY
And Mr. BANNISTER.
Mrs. LOVE,
And Mrs COLLETT.
After which will be performed a Comedy called
The MISER.
The Miser, Mr. YATES;
[illegible]derick, Mr. Brereton; Clerimont, Mr. Farren;
[illegible]coy, Mr. Wa[illegible]don; James, Mr. Burton; Law-
[illegible]r, Mr. Chaplin; Upholderer, Mr. Wrighton;
[illegible]ttin, Mr. Norris; Jeweller, Mr. Philmore;
[illegible]aylor, Mr. Hollcroft.
And Ramillie, Mr. PALMER.
Mariana by Mrs. BR[illegible]RE[illegible]ON;
[illegible]arriet, Mrs. Sharp; Mrs. Wrighty, Mrs. Johnston;
Wheedle, Mrs Kirby;
And Lappet, Miss POPE.

DRURY LANE.
By his MAJESTY', Compar.y
AT the Theatre Roys. . in
This Day before he Play a f.r uri
PtcWt ca led 0 vt 3 I? ftp
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Mr. C.UDRY
And Mr. BANNISTER.
Mrs. LOVE,
And Mfs COLLETT.
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Frederick, Mr. Brereton; Clerimon
Decoy, M. Wadon; James, Mr.
Mr. Chap.is; Upholderer, Mr Wng
Sattin, Mr. Noi«; Jevrei.e.,
Ta) lor, Mr Ho croft.
ABO Ramjlif, Mr. PALMER.
Mariana hy Mrs. BR-RE O.V;
Harriet, M.s. S atp; Mrs. Wife].
W..eidle, Mi's Kirb;
Aad Lappet, Mils POPE.
To which will be added a Pernaj.
Part.)

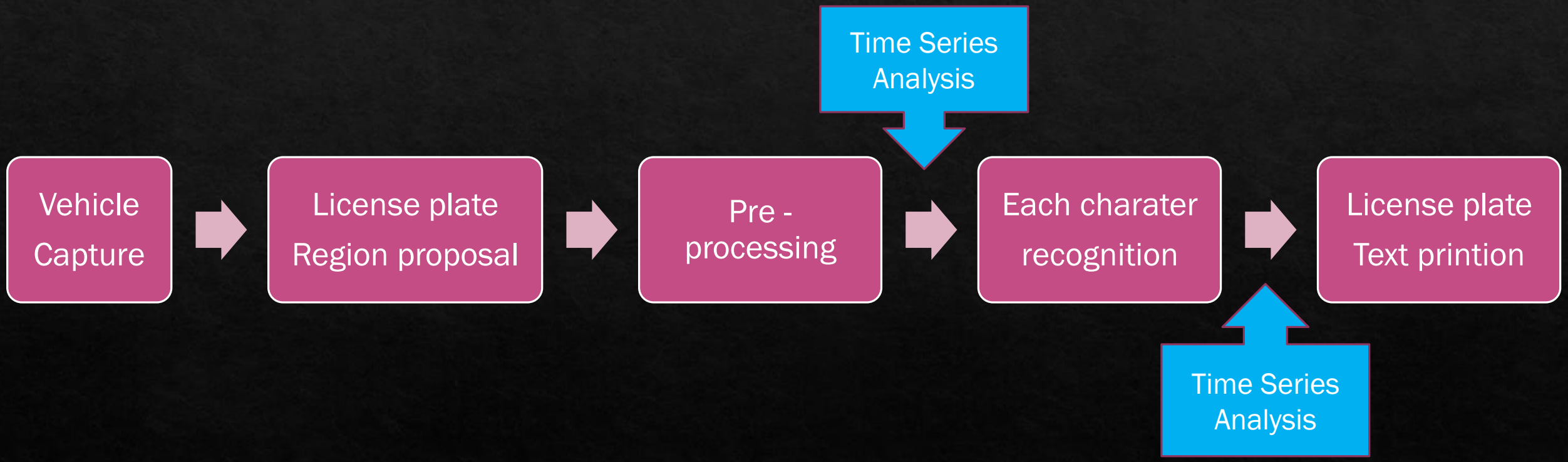
OCR ?

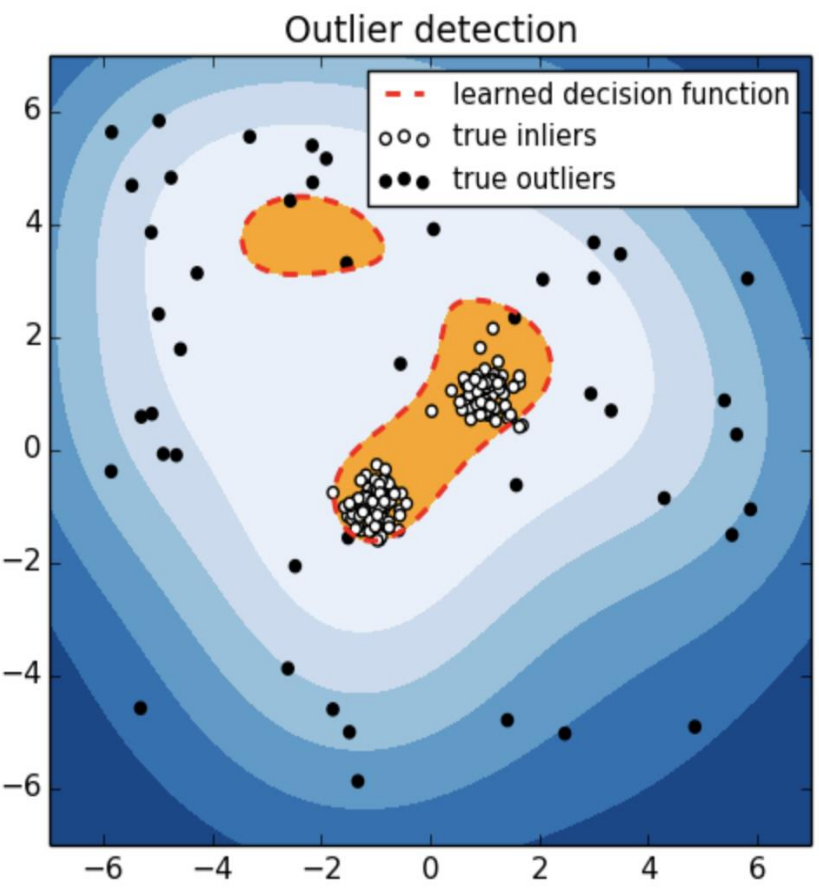
Necessity of Classification the Outlier

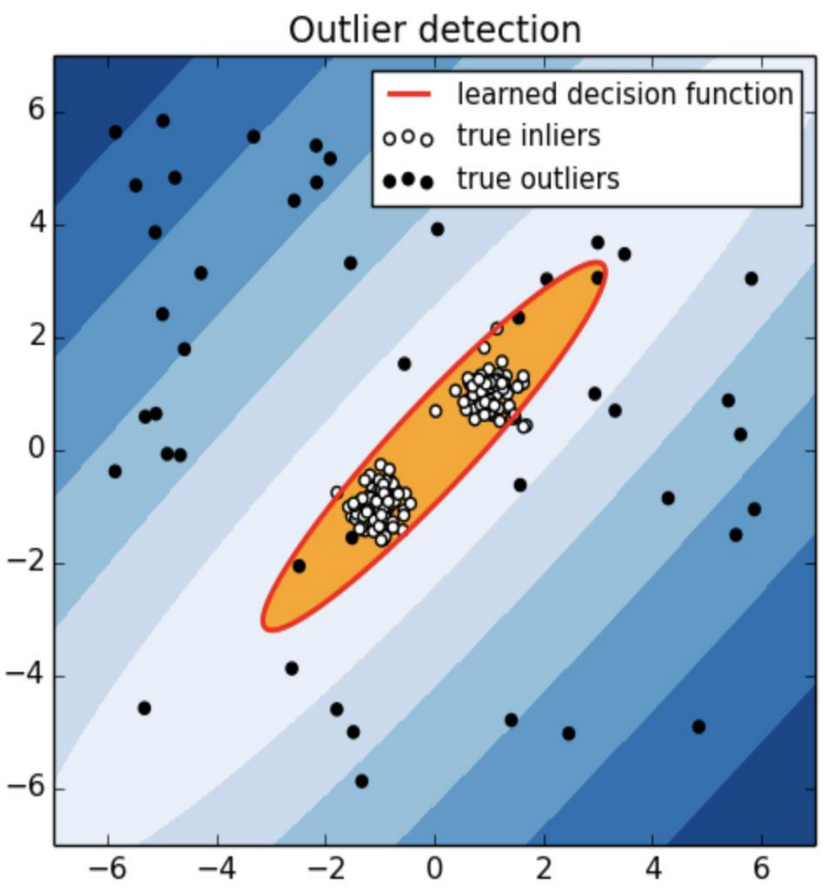
Diversity of Input Data

Configuration of Various Environment

Recognition of License Plate




Outlier detection
learned decision function
true inliers
true outliers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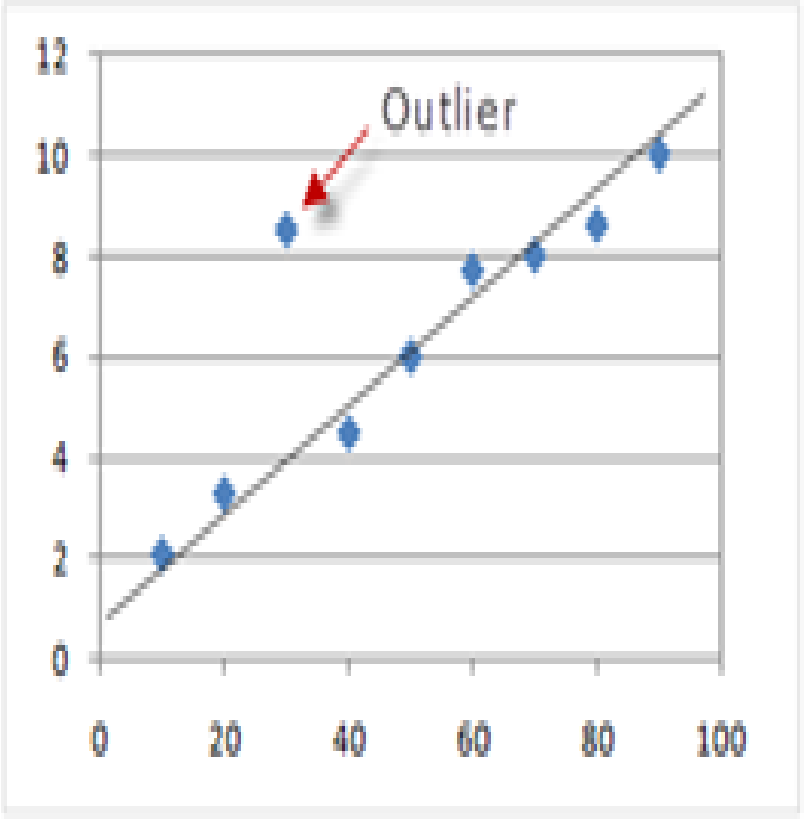

Outlier

OUTLIER ?

Experiment Method

5 -1. location tracking

5 -2. template matching

5 -3. analysis of hamming distance

5 -4. analysis of score

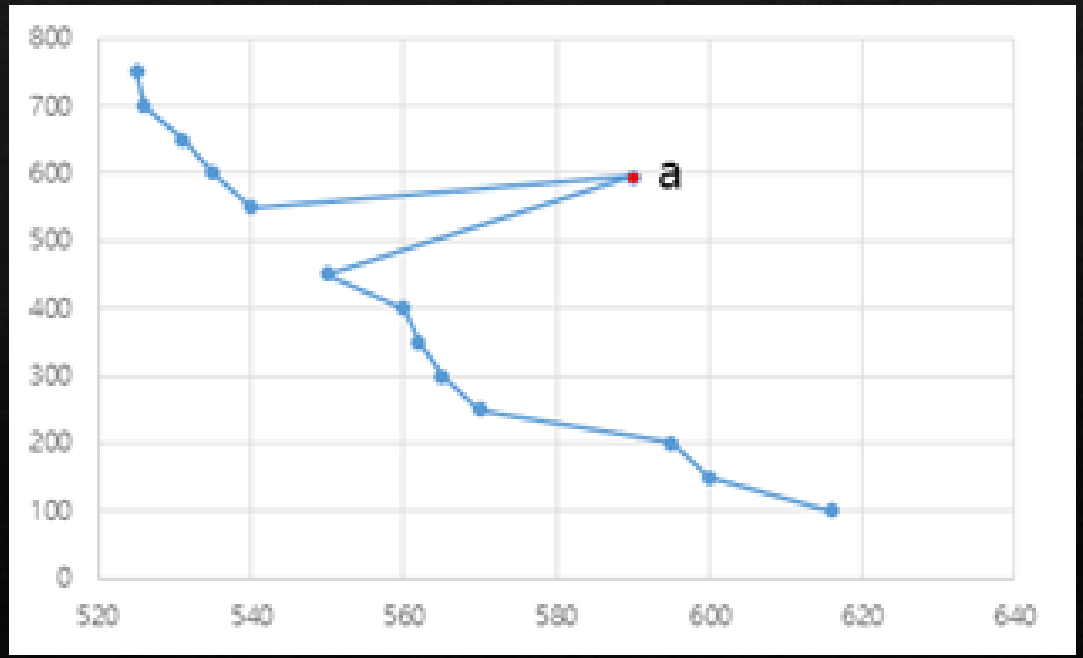
Location Tracking

(1)

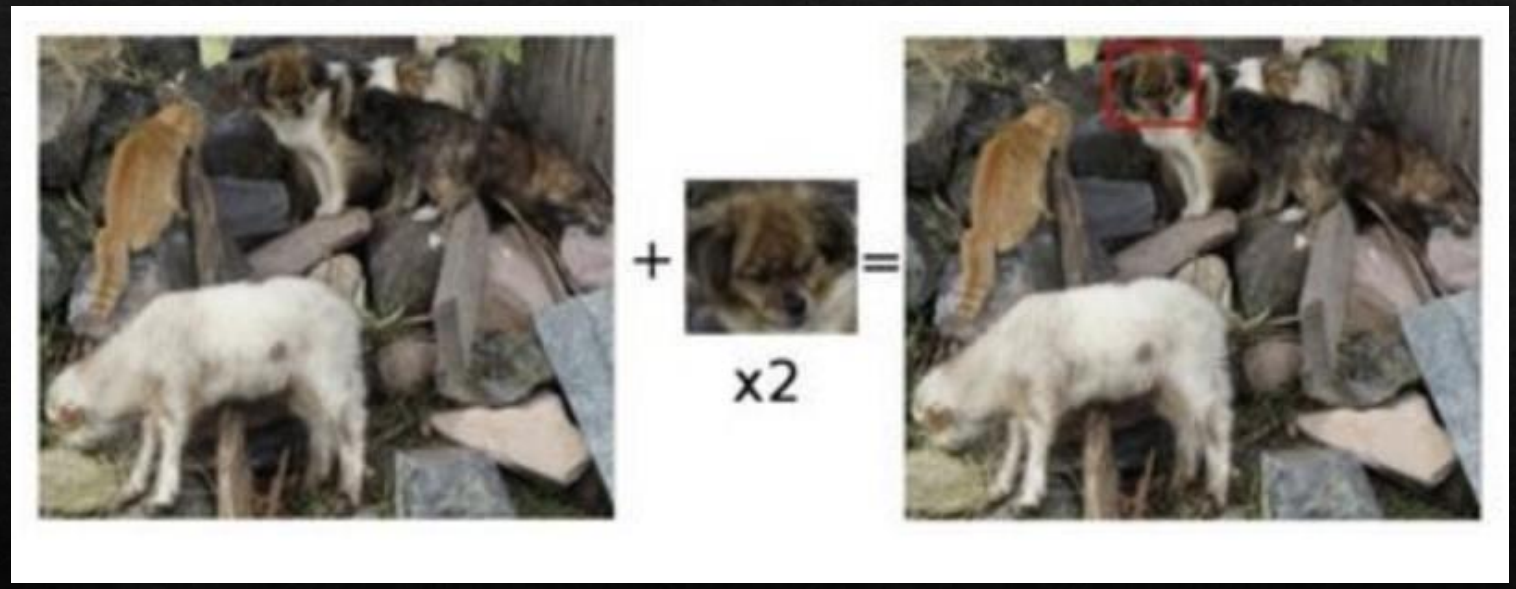
$$d_{distance} = |\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}|$$

(2)

$$f'(a) = \lim_{h \to 0} \frac{f(a+h) - f(a)}{h}$$



Template Matching



$$R(x,y) = \frac{\sum_{x',y'}(T(x',y') - I(x+x',y+y'))^2}{\sqrt{\sum_{x',y'} T(x',y')^2 \cdot \sum_{x',y'} I(x+x',y+y')^2}}$$

Analysis of Hamming Distance

Analysis of Score

	Region Proposal	prediction	score
Frame 1	2	2	1635
Frame 2	2	2	1810
Frame 3	2	2	1763
Frame 4	2	4	503
Frame 5	2	2	1758
Frame 6	2	7	262
Frame 7	2	2	1870

Experiment

Model Configuration Standard & Training Data

Verification

Model Configuration Standard

Category	content
Layer	4layers
Image Channel	Gray Scale
Loss function	Categorical cross-entropy
Optimizer	Adam optimization
Language	Python3.6
Deep Learning library	Keras 2.2.4
CNN model	Based on Shufflenet

Training Data

Model	Training Data	Testing Data	Outlier Data
City recognition	9421	972	101
Number recognition	24278	2366	207
Char recognition	41597	4098	405

Verification

Model	Including Outlier data	Accuracy
City recognition model	Not included	0.9702
Number recognition model	Not included	0.9978
Char recognition model	Not included	0.9769
City recognition model	included	0.9193
Number recognition model	included	0.9478
Char recognition model	included	0.9356

Model	Precision	Recall	F1- score	Accuracy
Integration performance	0.9015	0.8517	0.8759	0.7793
Integration performance + time series analysis	0.9836	0.8797	0.9287	0.8525

Conclusion

1. If time series analysis is a useful example, such as real-time license plate recognition, it can be seen that outlier detection is possible

2. The limitations of this study are that it has already assessed performance based on data or circumstances known as Outlier.