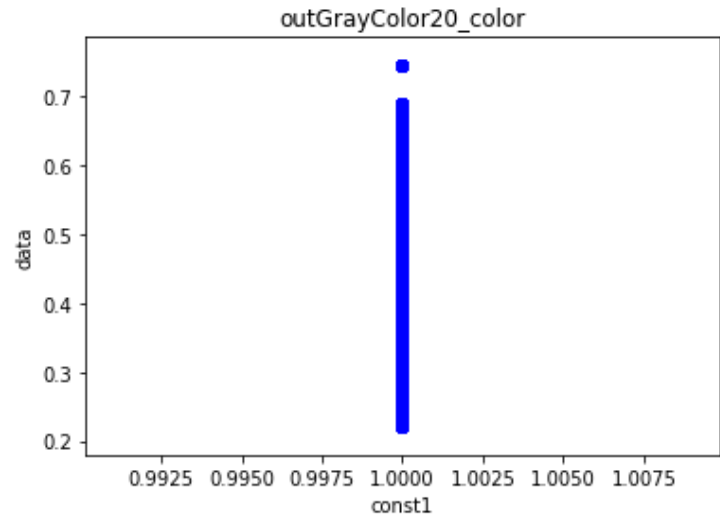
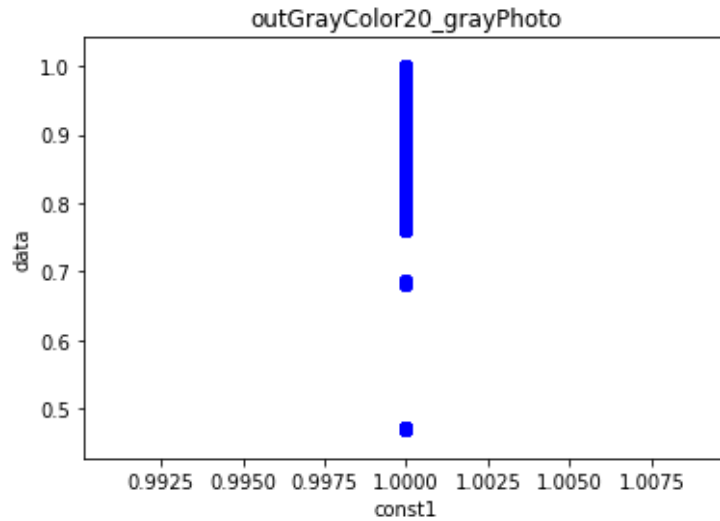


Anti-Spoofing



RGB2HSV → accumulate saturate → top 20 highest ratio (thresh: 0.72)

calcHist → compareHist or SVM

FEATURE	TPR/FPR	METHOD
blue	TPR:0.468383, FPR:0.078383	compareHist(3)
green	TPR:0.502229, FPR:0.104818	compareHist(3)
red	TPR:0.521289, FPR:0.128218	compareHist(5)
gray	TPR:0.573354, FPR:0.133175	compareHist(3)
v(hsv)	TPR:0.150812, FPR:0.0789211	compareHist(3)
y(yuv)	TPR:0.457717, FPR:0.064205	compareHist(3)
sob(3*3)	TPR:0.972468, FPR:0.23271	SVM
sob(5*5)	TPR:0.946282, FPR:0.270108	SVM
sob(7*7)	TPR:0.92133, FPR:0.290727	SVM
sob_open(3*3)	TPR:0.350374, FPR:0.100899	compareHist(4)
sob_open(5*5)	TPR:0.343393, FPR:0.0858372	compareHist(4)
sob_open(7*7)	TPR:0.299453, FPR:0.0679321	compareHist(4)



FEATURE	TPR/FPR	METHOD
highFreq(3*3)	TPR:0.89363, FPR:0.29918	SVM
highFreq(5*5)	TPR:0.919928, FPR:0.315318	SVM
highFreq(7*7)	TPR:0.945049, FPR:0.195953	SVM
highFreq(9*9)	TPR:0.925648, FPR:0.156634	SVM
highFreq(11*11)	TPR:0.974879, FPR:0.0905482	SVM
highFreq(13*13)	TPR:0.943983, FPR:0.202741	SVM
hf_open(3*3)	TPR:0.133687, FPR:0.0768078	compareHist(2)
hf_open(5*5)	TPR:0.20614, FPR:0.127872	compareHist(2)
hf_open(7*7)	TPR:0.214972, FPR:0.0979405	compareHist(2)
hog	TPR:0.333804, FPR:0.101283	compareHist(3)
lbp	TPR:1, FPR:0.0759477	SVM





Dataset:

- ◆ old: 2018.12;
- ◆ new: 2019.7 human videos and corresponding photos;
- ◆ 7_15: 7_15_1/2/3/4, 50 photos.

		Train Dataset	Validate Dataset
real	/	90	42
attack	internal	88(new)	42(new)
	external_1	130(new) + 200(7_15_1/2/3/4)	42(old)
	external_2	130(new) + 42(old) + 150(7_15_2/3/4)	50(7_15_1)
	external_3	130(new) + 42(old) + 150(7_15_1/3/4)	50(7_15_2)
	external_4	130(new) + 42(old) + 150(7_15_1/2/4)	50(7_15_3)
	external_5	130(new) + 42(old) + 150(7_15_1/2/3)	50(7_15_4)
	cross_1	109(new) + 21(old) + 200(7_15_1/2/3/4)	21(new) + 21(old)
	cross_2	130(new) + 42(old) + 25(7_15_1) + 125(7_15_2/3/4)	25(7_15_1) + 25(7_15_2/3/4)
	cross_3	130(new) + 42(old) + 25(7_15_2) + 125(7_15_1/3/4)	25(7_15_2) + 25(7_15_1/3/4)
	cross_4	130(new) + 42(old) + 25(7_15_3) + 125(7_15_1/2/4)	25(7_15_3) + 25(7_15_1/2/4)
	cross_5	130(new) + 42(old) + 25(7_15_4) + 125(7_15_1/2/3)	25(7_15_4) + 25(7_15_1/2/3)



FEATURE	MODE	SVM
highFreq(3*3)	internal	TPR:0.957388, FPR:0.442099
	cross	TPR:0.93303, FPR:0.329043
	external	TPR:0.913111, FPR:0.0402838
highFreq(5*5)	internal	TPR:0.967042, FPR:0.425556
	cross	TPR:0.942129, FPR:0.312278
	external	TPR:0.925983, FPR:0.0734735
highFreq(7*7)	internal	TPR:0.959663, FPR:0.28089
	cross	TPR:0.941519, FPR:0.169856
	external	TPR:0.930311, FPR:0.294401
highFreq(9*9)	internal	TPR:0.96055, FPR:0.294124
	cross	TPR:0.939577, FPR:0.254361
	external	TPR:0.926039, FPR:0.0884216
highFreq(11*11)	internal	TPR:0.982911, FPR:0.069595
	cross	TPR:0.972313, FPR:0.131245
	external	TPR:0.971814, FPR:0.617684
highFreq(13*13)	internal	TPR:0.957721, FPR:0.272447
	cross	TPR:0.93192, FPR:0.320406
	external	TPR:0.923764, FPR:0.157841
lbp	internal	TPR:0.999889, FPR:0.034227
	cross	TPR:0.999834, FPR:0.0269263
	external	TPR:0.999889, FPR:0.904484



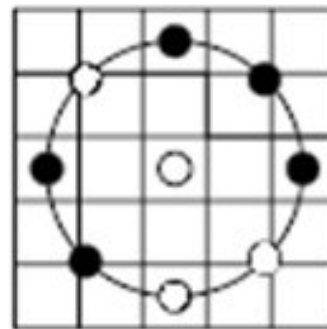
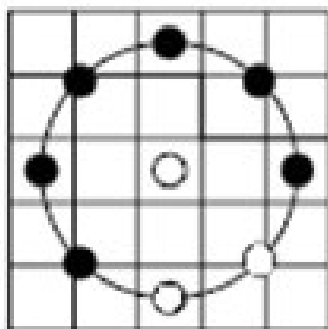
256-dimension lbp

mode	detect twice	detect once
internal	TPR:0.999889, FPR:0.034227	TPR:0.995634, FPR:0.121698
external_1	TPR:0.997559, FPR:0.0215353	TPR:0.989731, FPR:0.0192538
external_2	TPR:0.99767, FPR:0.0221234	TPR:0.990326, FPR:0.0237427
external_3	TPR:0.997725, FPR:0.00871018	TPR:0.98983, FPR:0.0214895
external_4	TPR:0.998391, FPR:0.15935	TPR:0.991021, FPR:0.0965287
external_5	TPR:0.997614, FPR:0.0666823	TPR:0.991914, FPR:0.0678941
cross_1	TPR:0.997559, FPR:0.0147333	TPR:0.98983, FPR:0.0273918
cross_2	TPR:0.998446, FPR:0.0193395	TPR:0.99117, FPR:0.0226375
cross_3	TPR:0.99767, FPR:0.00701924	TPR:0.989781, FPR:0.0256699
cross_4	TPR:0.997947, FPR:0.00203069	TPR:0.990674, FPR:0.00842884
cross_5	TPR:0.998224, FPR:0.0404957	TPR:0.992311, FPR:0.0291042



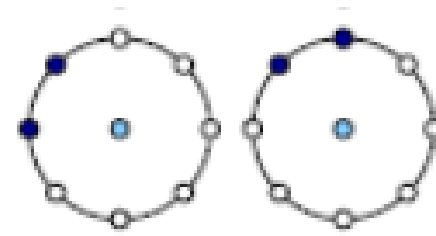
59-dimension lbp

mode	detect twice	detect once
internal	TPR:0.999889, FPR:0.034227	TPR:0.995634, FPR:0.121698
external_1	TPR:0.997559, FPR:0.0215353	TPR:0.989731, FPR:0.0192538
external_2	TPR:0.99767, FPR:0.0221234	TPR:0.990326, FPR:0.0237427
external_3	TPR:0.997725, FPR:0.00871018	TPR:0.98983, FPR:0.0214895
external_4	TPR:0.998391, FPR:0.15935	TPR:0.991021, FPR:0.0965287
external_5	TPR:0.997614, FPR:0.0666823	TPR:0.991914, FPR:0.0678941
cross_1	TPR:0.997559, FPR:0.0147333	TPR:0.98983, FPR:0.0273918
cross_2	TPR:0.998446, FPR:0.0193395	TPR:0.99117, FPR:0.0226375
cross_3	TPR:0.99767, FPR:0.00701924	TPR:0.989781, FPR:0.0256699
cross_4	TPR:0.997947, FPR:0.00203069	TPR:0.990674, FPR:0.00842884
cross_5	TPR:0.998224, FPR:0.0404957	TPR:0.992311, FPR:0.0291042





- Distance
- Background
- Lighting



Full + Hist + SVM: TP:19950, FP:2698, TN:15709, FN:968, TPR:0.953724, FPR:0.146575

Half +Hist + SVM: TP:19272, FP:3598, TN:14809, FN:1646, TPR:0.921312, FPR:0.195469

HOG + SVM: TP:20918, FP:18407, TN:0, FN:0, TPR:1, FPR:1



Input: 1*3*168*128(NCHW)

Conv1: inputChannel:3, outputChannel:16, kernel:3, stride=1, pad=0

Conv1_dw: inputChannel:16, outputChannel:16, kernel:3, stride=1, pad=0

Conv2: inputChannel:16, outputChannel:32, kernel:3, stride=1, pad=0

Conv2_dw: inputChannel:32, outputChannel:32, kernel:3, stride=1, pad=0

Conv3: inputChannel:32, outputChannel:64, kernel:3, stride=1, pad=0

Conv3_dw: inputChannel:64, outputChannel:64, kernel:3, stride=1, pad=0

Conv4: inputChannel:64, outputChannel:128, kernel:3, stride=1, pad=0

Conv4_dw: inputChannel:128, outputChannel:128, kernel:3, stride=1, pad=0

Conv5: inputChannel:128, outputChannel:256, kernel:3, stride=1, pad=0

Conv5_dw: inputChannel:256, outputChannel:256, kernel:3, stride=1, pad=0

fc1: inputChannel:256, outputChannel:10

dropout: ratio:0.5

fc2: inputChannel:10, outputChannel:2

SoftmaxLoss: inputChannel:2, outputChannel:1



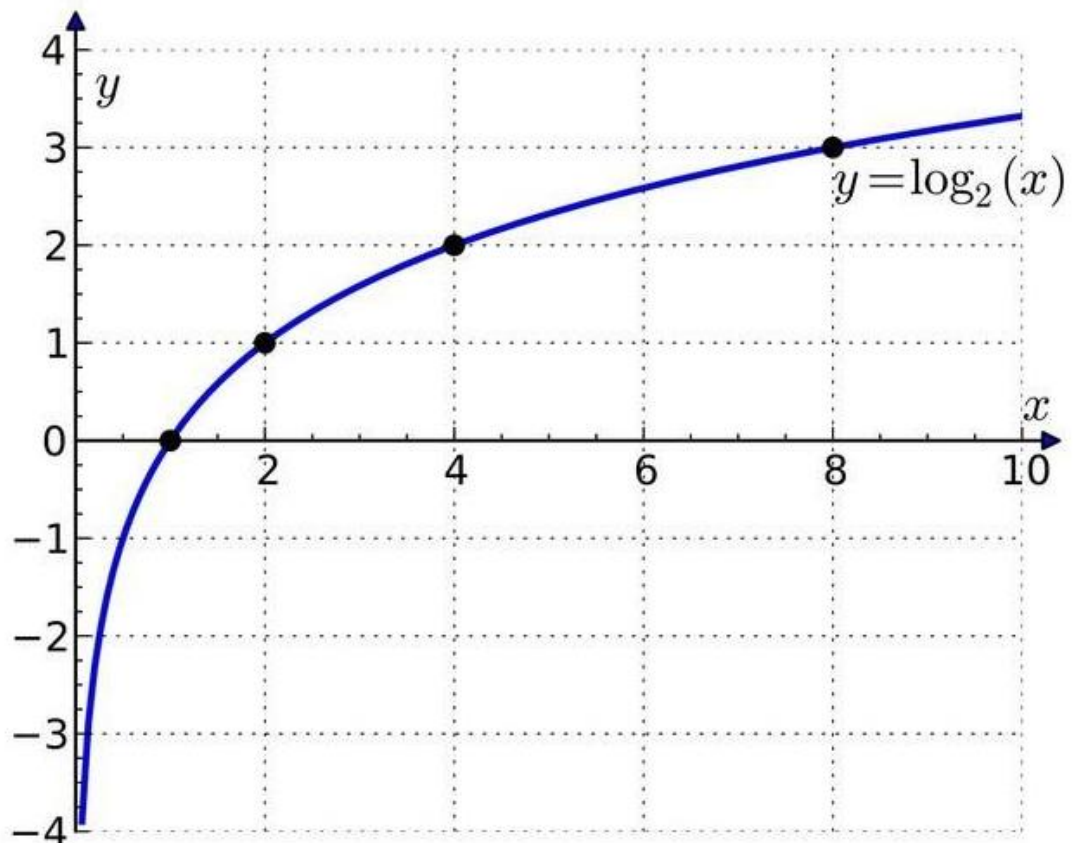
Train:91751,validate:39327

$$L = - \sum_{j=1}^T y_j \log s_j$$

Train Loss: 0.693147 \rightarrow 5.95862e-7
Validate Loss: 36.6123

Adjust:

- input data;
- net structure;
- learning_rate;
- weight_decay;
- dropout_ratio.

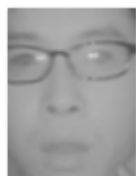


Train:91751,validate:39327

- High similarity in consecute frames;
- Repeat action.



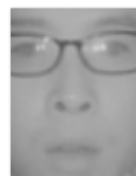
baoshidong_inf
rared_indoor_c
ontrolled_1_70.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_71.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_72.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_73.j
pg



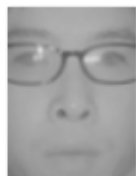
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rared_indoor_c
ontrolled_1_74.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_75.j
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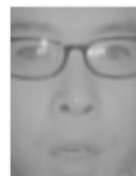
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rared_indoor_c
ontrolled_1_76.j
pg



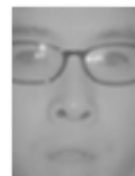
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rared_indoor_c
ontrolled_1_77.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_78.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_79.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_80.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_81.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_82.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_83.j
pg



baoshidong_inf
rared_indoor_c
ontrolled_1_84.j
pg



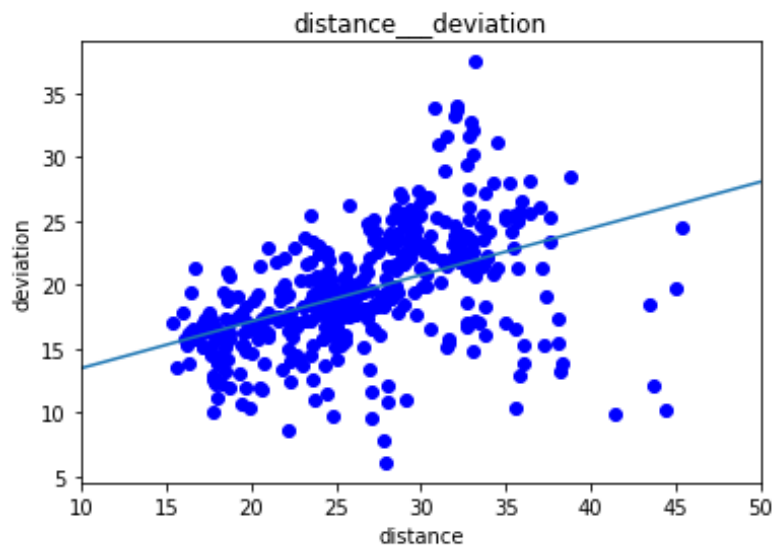
baoshidong_inf
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ontrolled_1_85.j
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baoshidong_inf
rared_indoor_c
ontrolled_1_86.j
pg

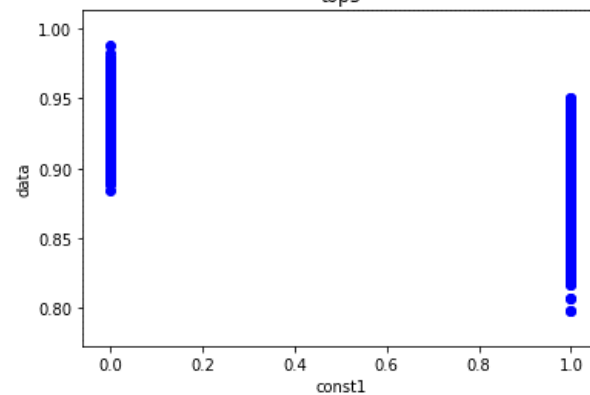
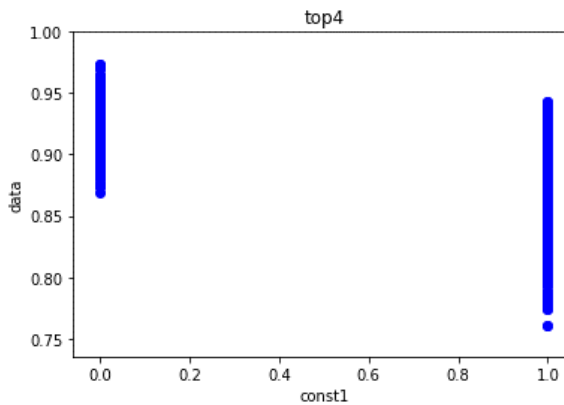
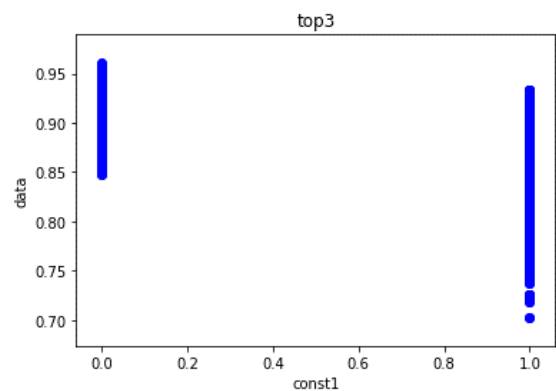
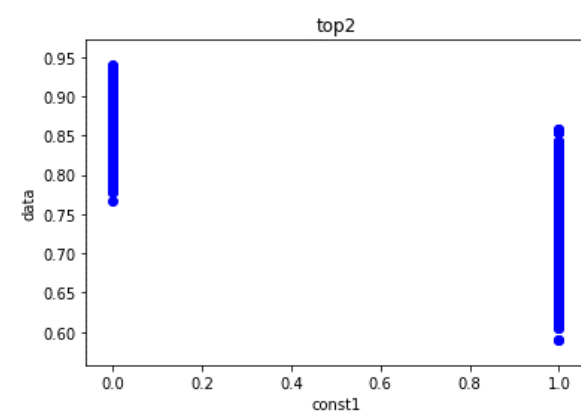
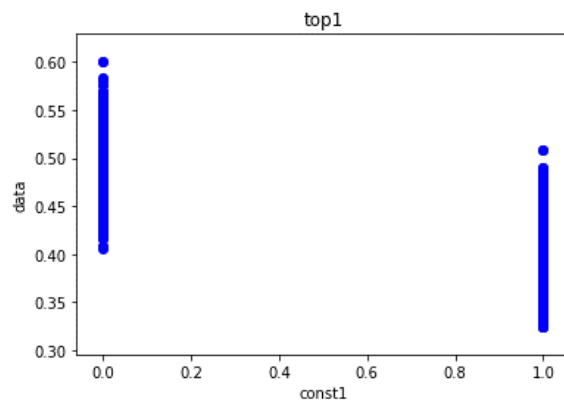
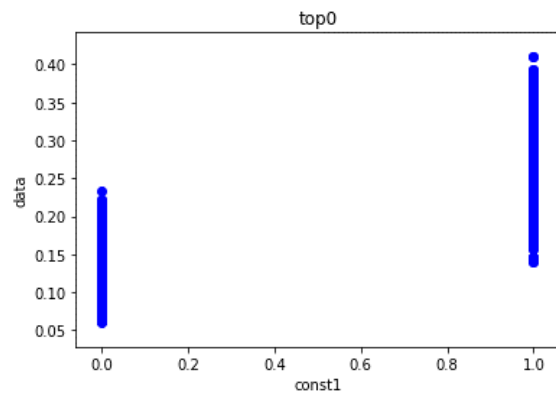


baoshidong_inf
rared_indoor_c
ontrolled_1_87.j
pg

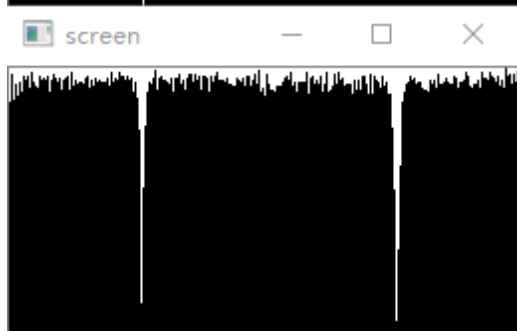
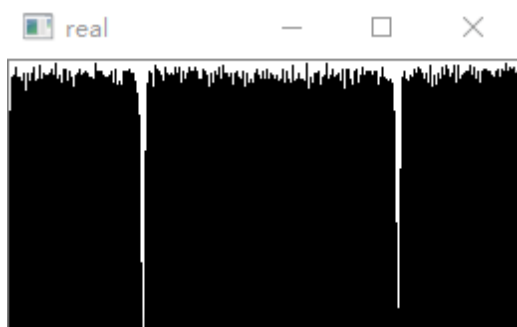
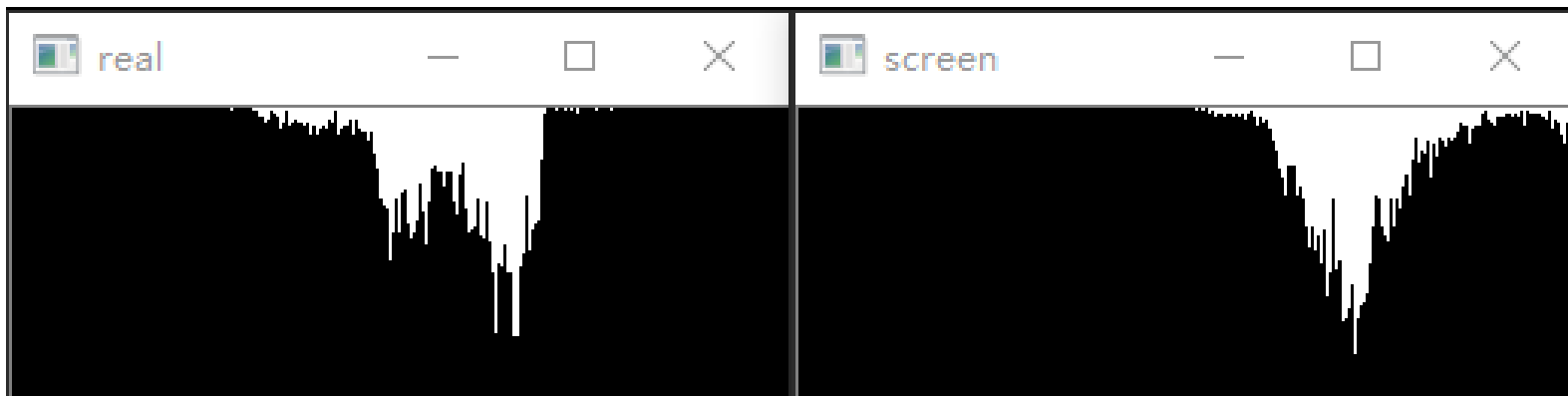


$$x_diff = 0.381198 * distance + 9.29973$$

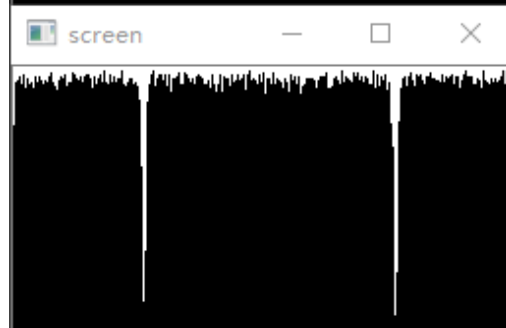
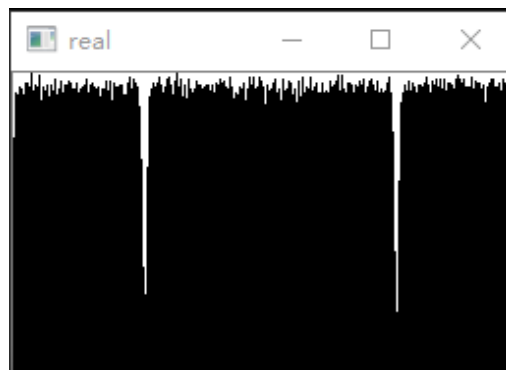
Hue,
Saturate,
Chrominance Red,
Chrominance Blue.



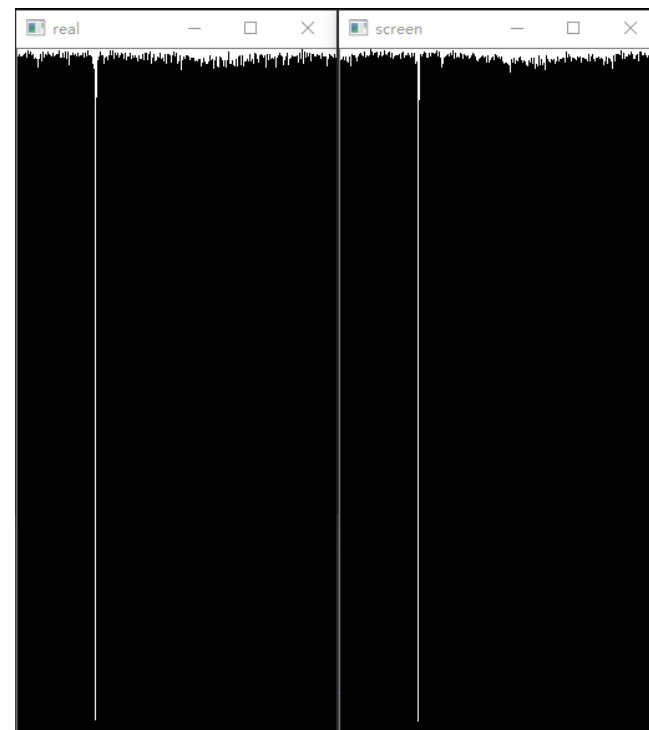
Gray



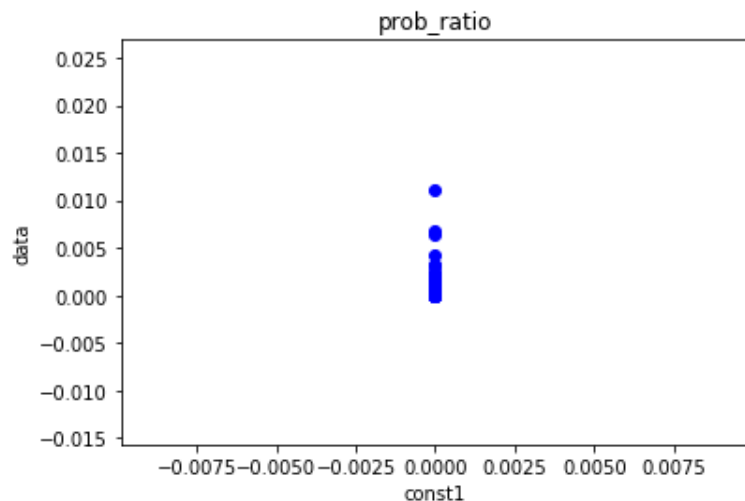
Image



Real

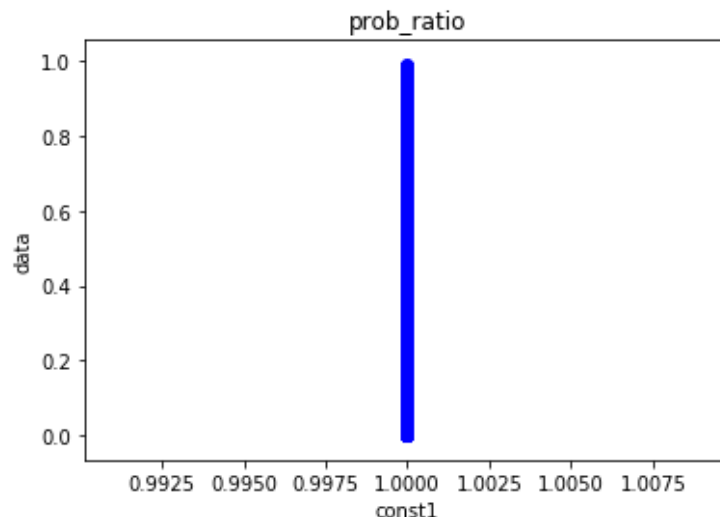


Complex



Largest 10 probabilities:

0.0111772
0.00678334
0.00639961
0.00422563
0.00326457
0.00297345
0.00252713
0.00215919
0.00213708
0.00167701



Smallest 10 probabilities:

3.65649e-05
4.01126e-05
4.23897e-05
4.36003e-05
4.80961e-05
4.84037e-05
4.86624e-05
5.2528e-05
5.52755e-05
5.69162e-05

human_prob_thresh=0.001: TPR:95%, FPR:1%

light_blob: gray_value > 250,
light_blob_ratio_thresh=0.02



TP:21791, FN:0, TPR:100%



TP:9273, FN:86, TPR:99%

Screen detect: FP:1638, TN:989, FPR:62%.

Light_blob can exclude 38% screen attack.

light_blob_ratio > 0.02 or human_prob < 0.001:

TP:66196, FN:3806, FP:19, TN:6581, TPR:94.56%, FPR:0.29%