FaceRecognition

Performance Report

2018-01-26

OPEN AI LAB

Revision Record

Date	Rev	Change Description	Author
2017-10-23	0.1.0	QA Testing	Luo Hao /Huifang
2017-12-29	0.1.1	QA Testing	Luo Hao
2017-01-26	0.1.2	QA Testing	Luo Hao

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1 Purpose

This Report is tested on Rock960 platform and the CaffeOnACL version is 0.4.0 with Arm Compute Library(ACL) 17.12/OpenBLAS. The report only includes CPU data.

2 Test Environment

Hardware SoC: firefly

http://www.t-firefly.com/product/rk3399.html

- GPU: Mali T864 (800MHz)
- RAM: 4G
- CPU: Dual-core Cortex-A72 up to 2.0GHz (real frequency is 1.8GHz); Quad-core Cortex-A53 up to 1.5GHz (real frequency is 1.4GHz)

Operating System : Ubuntu 16.04

FaceRecognition vision: 0.1.2

All performance data is 100 frames average processing time.

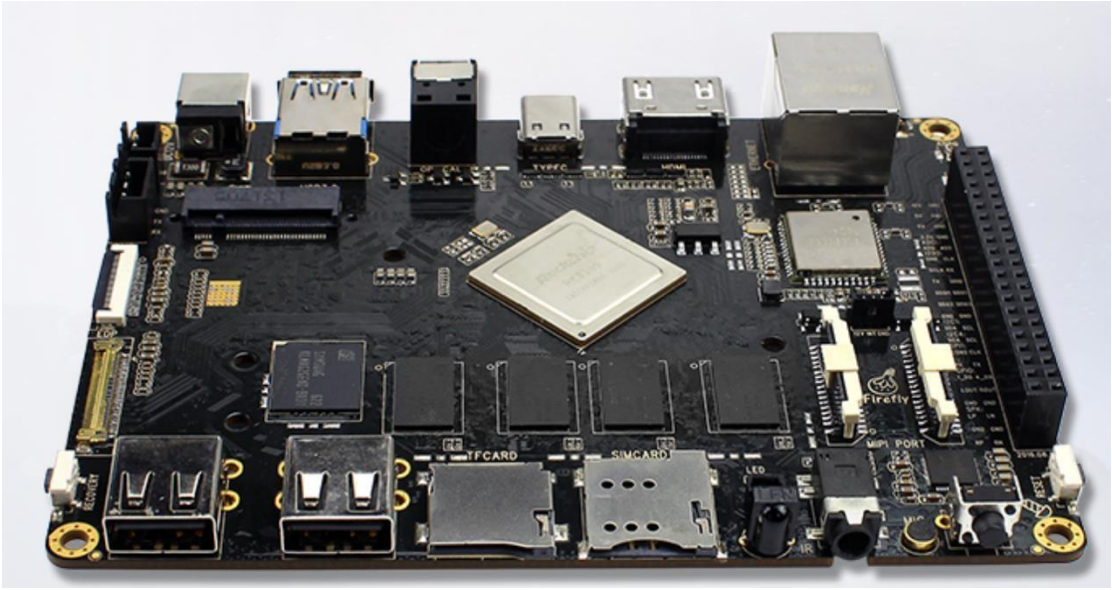
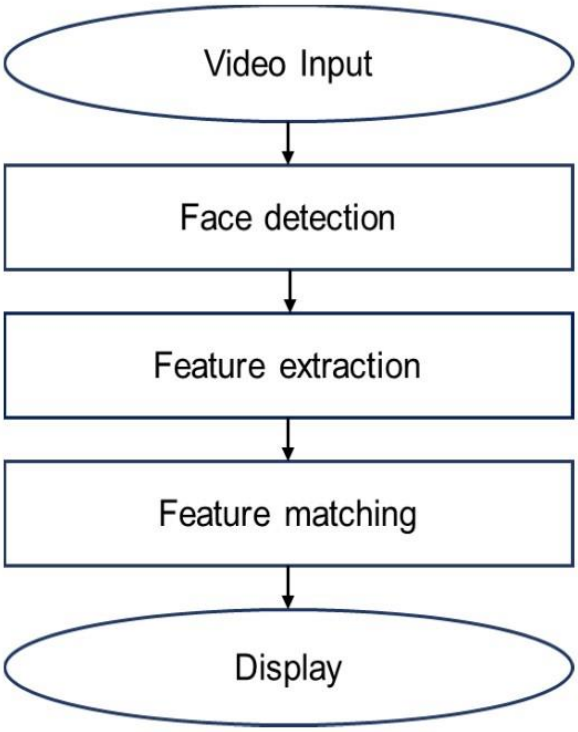


Fig 2.1 Rockchip 96board

3 Face Recognition Flow



Face detection : Detect the face from input frame
Feature extraction : Extrace features from detected face
Feature matching : search the Database according the extracted feature, find the matching face

Fig 3.1 The process of face recognition

4 Performance with Arm Compute Library(ACL) BYPASSACL=0

Face recognition performance is influenced by many factors, only faces, cores, minimum size of face are test. Note: the alignment is not included. The performances with ACL are as fellow.

4.1 Single A53 CPU @1.42GHz

Table 4.1 Performance of different part on Single A53

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	510	1187	0	1699
480P 48*48 single face	259	1232	0	1493
480P 64*64 single face	174	1197	0	1374
480P 32*32 two faces	548	2435	0	2986
480P 48*48 two faces	347	2389	0	2739
480P 64*64 two faces	348	2460	0	2811

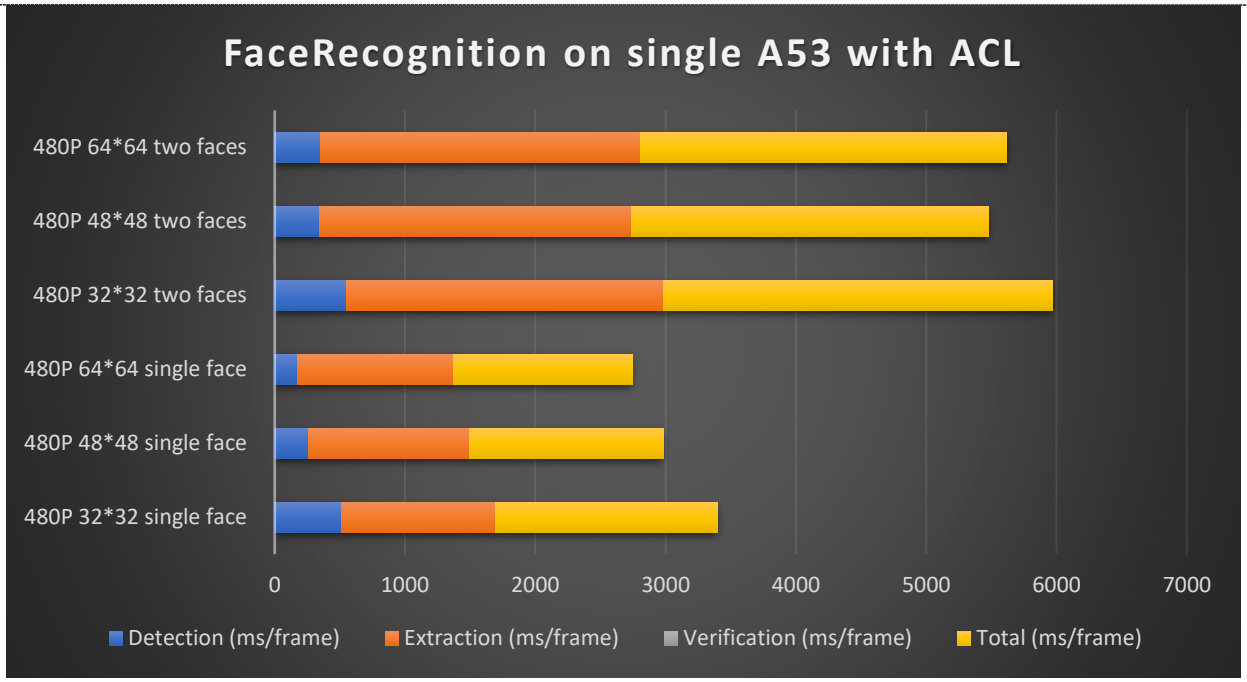


Fig 4.1 Performance Compare on Single A53

4.2 Single A72 CPU @1.8GHz

Table 4.2 Performance of different part on Single A72

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	286	750	0	1036
480P 48*48 single face	138	769	0	908
480P 64*64 single face	83	775	0	860
480P 32*32 two faces	316	1430	0	1747
480P 48*48 two faces	163	1625	0	1789
480P 64*64 two faces	165	1557	0	1723

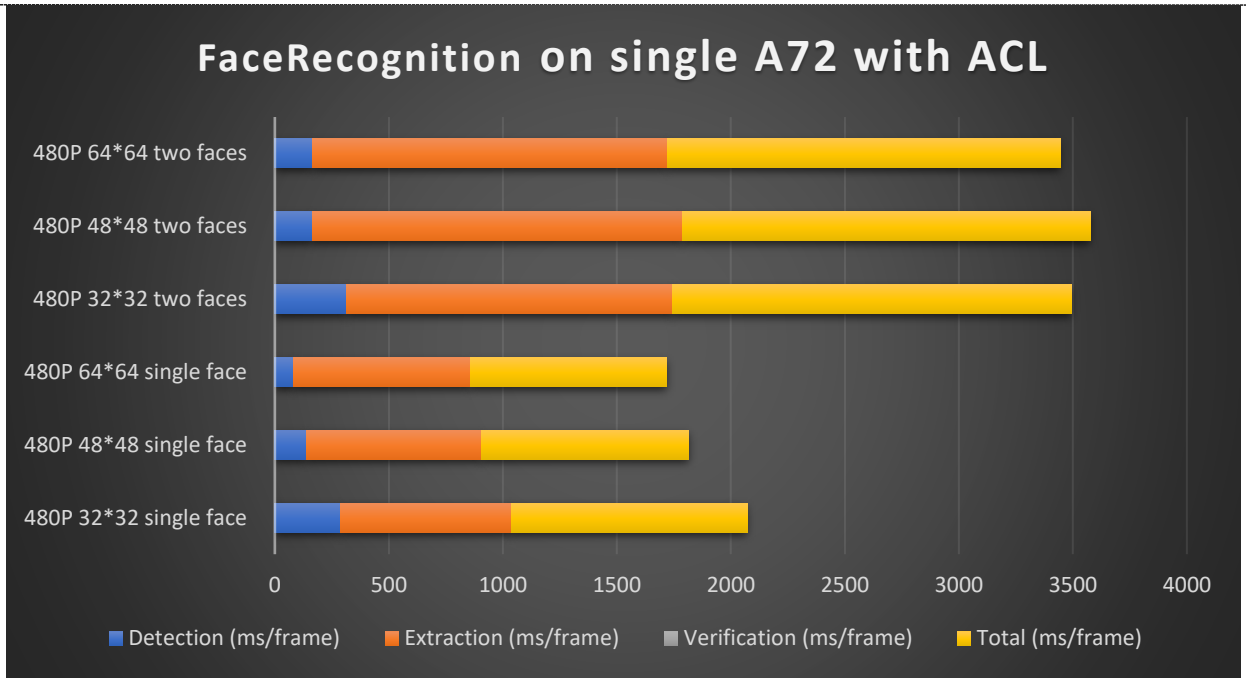


Fig 4.2 Performance Compare on Single A72

4.3 Multi CPUs(2xA72@1.8GHz)

Table 4.3 Performance of different part on Multi CPUs

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	271	443	0	715
480P 48*48 single face	140	461	0	602
480P 64*64 single face	77	455	0	533
480P 32*32 two faces	302	925	0	1228
480P 48*48 two faces	171	922	0	1095
480P 64*64 two faces	162	911	0	1075

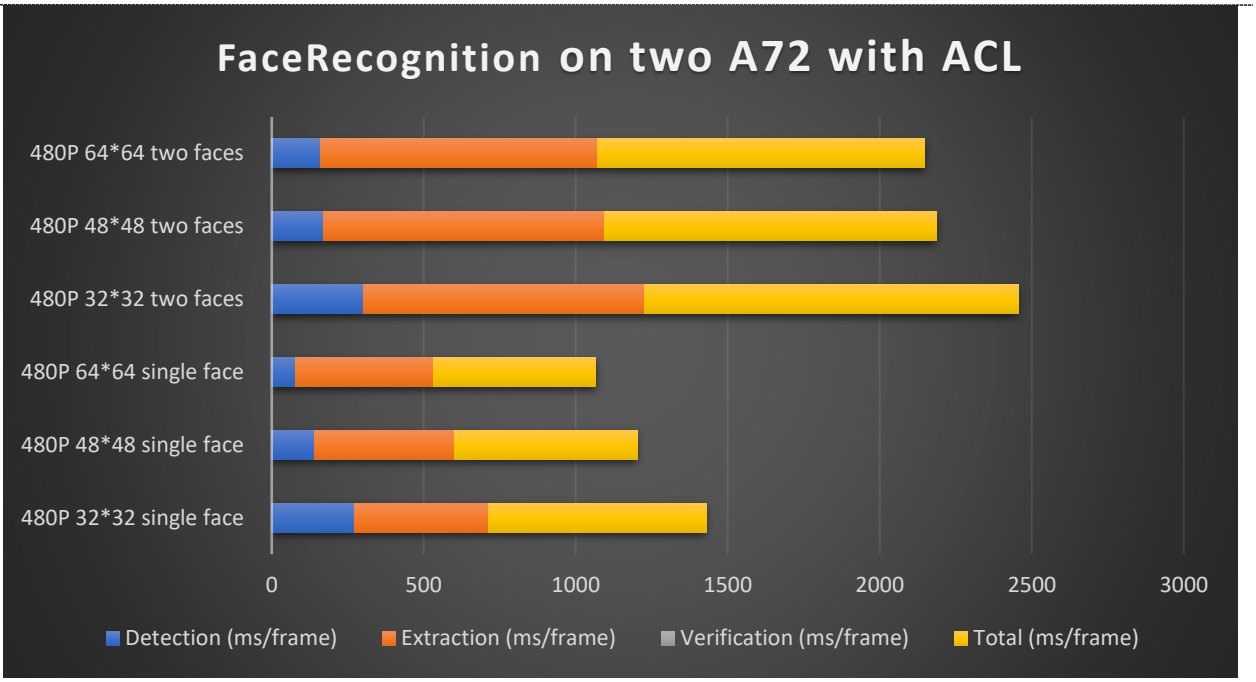


Fig 4.3 Performance Compare on two A72

5 Performance with OpenBLAS **(BYPASSACL=0Xffff)**

Face recognition performance is influenced by many factors, only faces, cores, minimum size of face are test. Note: the alignment is not included. The performances with OpenBLAS are as fellow.

5.1 Single A53 CPU @1.42GHz

Table 5.1 Performance of different part on Single A53

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	311	777	0	1090
480P 48*48 single face	158	781	0	942
480P 64*64 single face	116	782	0	900
480P 32*32 two faces	328	1566	0	1898
480P 48*48 two faces	222	1569	0	1795

480P 64*64 two faces	188	1562	0	1754

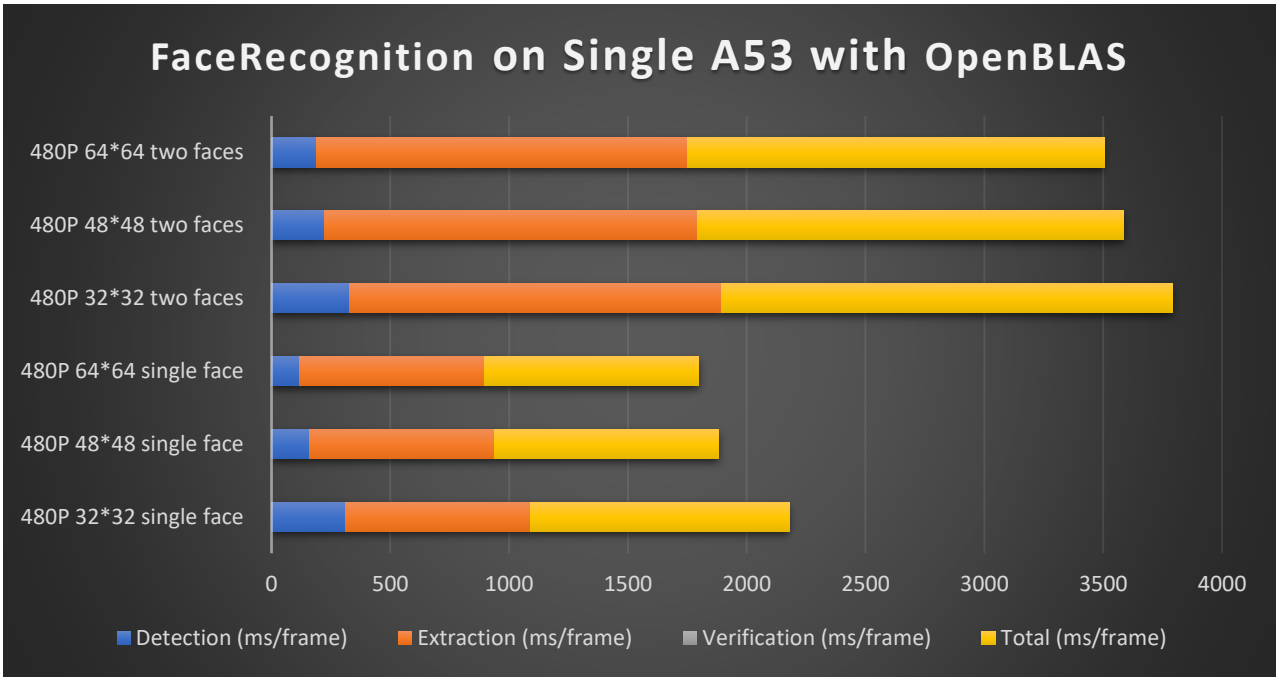


Fig 5.1 Performance Compare on Single A53

5.2 Single A72 CPU @1.8GHz

Table 5.2 Performance of different part on Single A72

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	126	331	0	458
480P 48*48 single face	64	331	0	396
480P 64*64 single face	46	330	0	377
480P 32*32 two faces	136	673	0	812
480P 48*48 two faces	90	673	0	765
480P 64*64 two faces	97	644	0	743

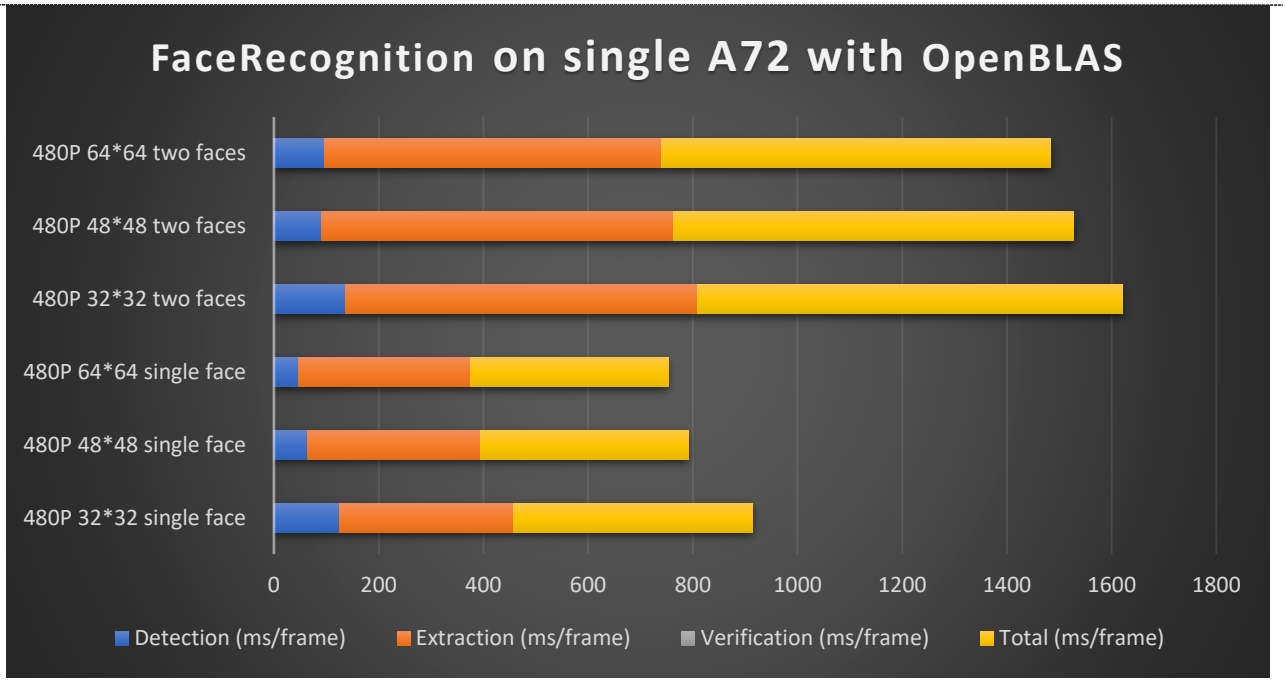


Fig 5.2 Performance Compare on Single A72

5.3 Multi CPUs(2xA72@1.8GHz)

Table 5.3 Performance of different part on Multi CPUs

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	99	206	0	306
480P 48*48 single face	52	216	0	270
480P 64*64 single face	39	217	0	257
480P 32*32 two faces	118	458	0	577
480P 48*48 two faces	68	459	0	529
480P 64*64 two faces	80	434	0	515

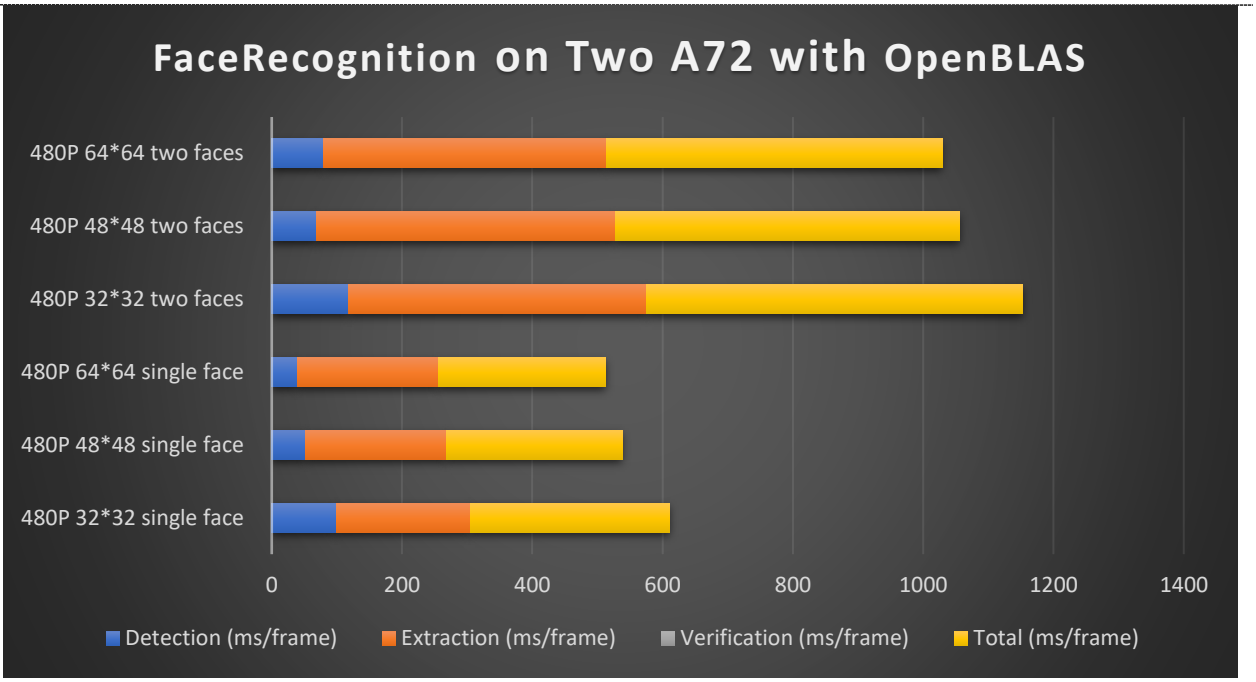


Fig 5.3 Performance Compare on two A72

6 Performance with Mixed Libraries (BYPASSACL=0Xffc7)

Face recognition performance is influenced by many factors, only faces, cores, minimum size of face are test. Note: the alignment is not included. The performances are tested on mixed libraries mode, in which FC(full connecting)/pooling/LRN(local response normalization) layers are computed on ACL and others layers are computed on OpenBLAS. The results are as fellow.

6.1 Single A53 CPU @1.42GHz

Table 6.1 Performance of different part on Single A53

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	309	863	0	1174
480P 48*48 single face	161	879	0	1042
480P 64*64 single face	121	886	0	1009
480P 32*32 two faces	357	1671	0	2031

480P 48*48 two faces	220	1657	0	1880
480P 64*64 two faces	214	1763	0	1980

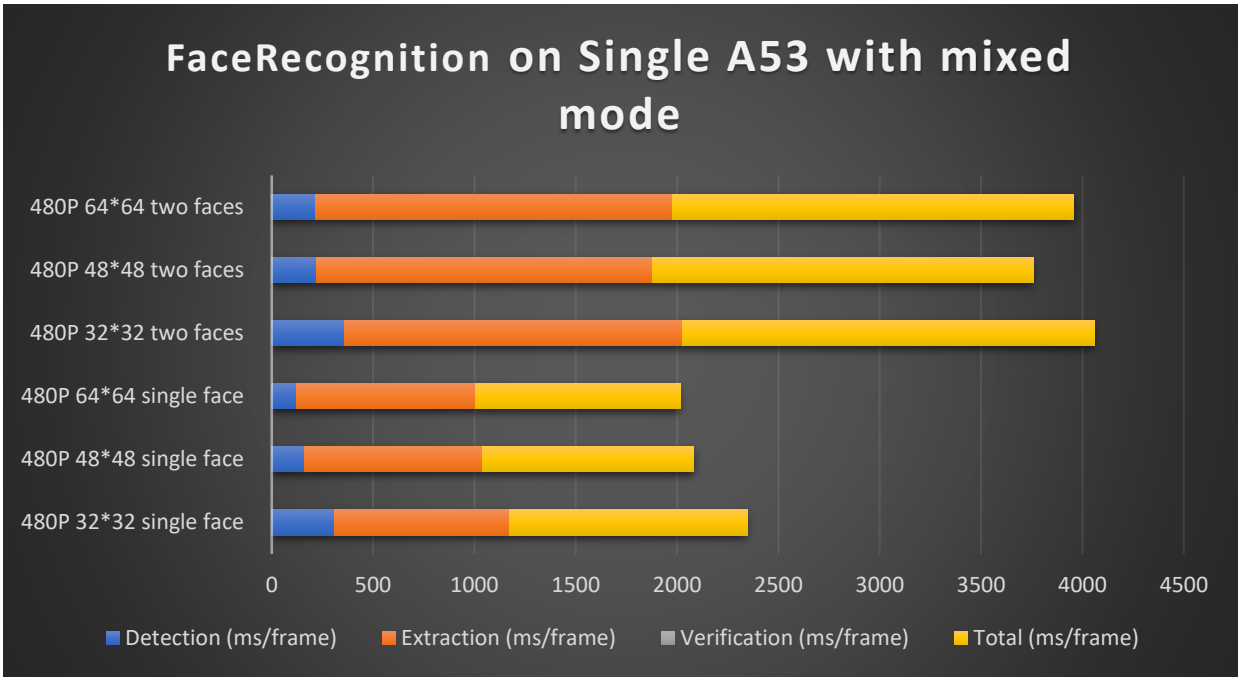


Fig 6.1 Performance Compare on Single A53

6.2 Single A72 CPU @1.8GHz

Table 6.2 Performance of different part on Single A72

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	120	312	0	433
480P 48*48 single face	62	313	0	375
480P 64*64 single face	45	312	0	358
480P 32*32 two faces	141	634	0	776
480P 48*48 two faces	87	642	0	730

480P 64*64 two faces	85	623	0	710

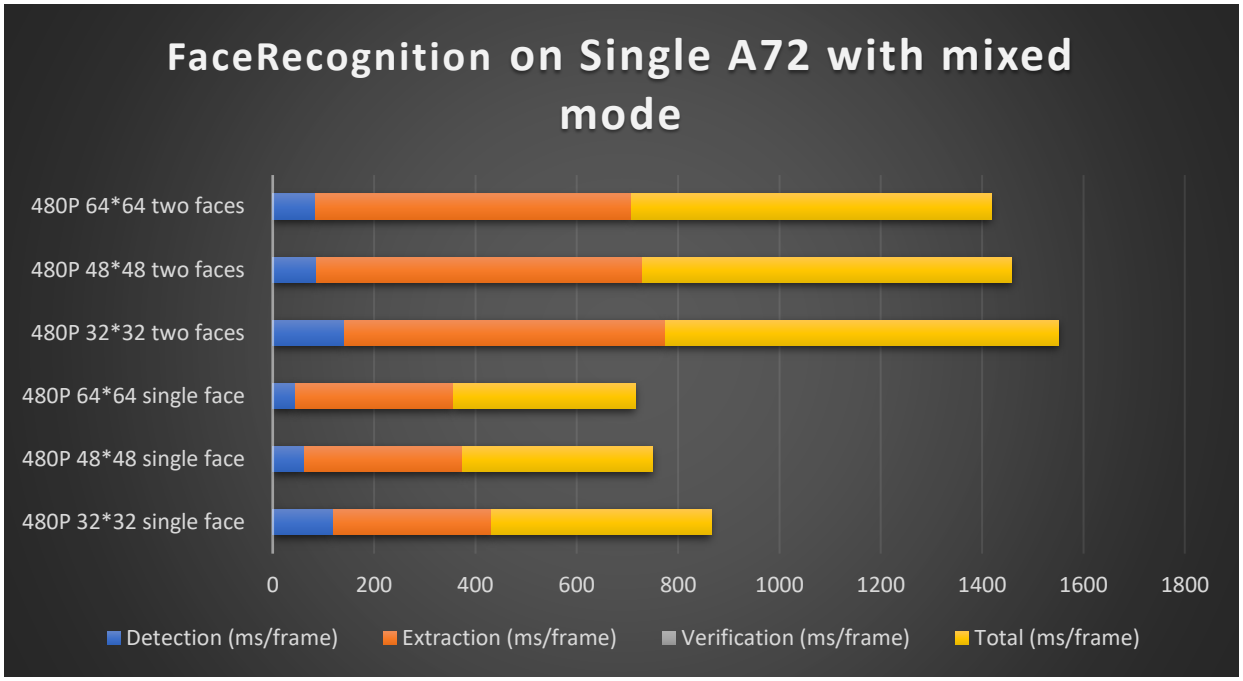


Fig 6.2 Performance Compare on Single A72

6.3 Multi CPUs(2xA72@1.8GHz)

Table 6.3 Performance of different part on Multi CPUs

Test Case	Detection (ms/frame)	Extraction (ms/frame)	Verification (ms/frame)	Total (ms/frame)
480P 32*32 single face	98	195	0	294
480P 48*48 single face	52	197	0	250
480P 64*64 single face	37	197	0	236
480P 32*32 two faces	114	411	0	527
480P 48*48 two faces	72	398	0	472
480P 64*64 two faces	70	404	0	475

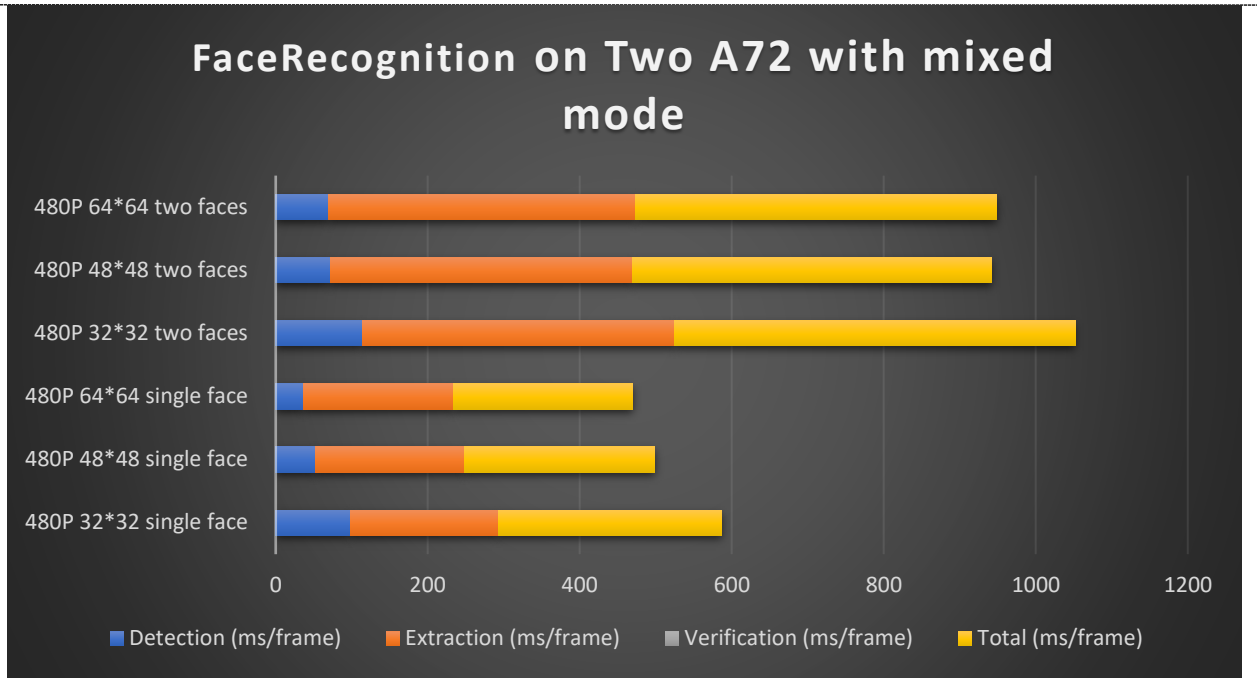


Fig 6.3 Performance Compare on Two A72

7 Accuracy Test

To test accuracy of the model, images with labelled ground true is needed. For detection test, we use a subset of CelebA dataset containing 10000 images. For recognition test, we use the full LFW dataset.

7.1 Detection test

To evaluate detection accuracy, following indices are used:

- Recall: Correctly detected faces / all faces in test dataset
- Precision: Correctly detected faces / all detected faces
- Stability: The average IOU of detected face and labelled face.
- IOU: Intersection over Union, intersection means the overlap area of detection and ground truth, union mean the union area of detection and ground truth

A correct face is defined when IOU >= 0.5. The accuracy results of detection are given below:

Table 7.1 Accuracy results of detection.

Recall	Precision	Stability
0.78	0.75	0.64

7.2 Recognition test

To evaluate recognition accuracy, following indices are used:

- ROC curve: The ROC curve is created by plotting the true positive rate (TPR) against the false positive rate (FPR) at various threshold settings
- TPR/FPR: TPR(true-positive rate) is also known as sensitivity or probability of detection. FPR(false-positive rate) is also known as the fall-out or probability of false alarm. Calculation defined in the below.
- PR curve: P(Precision), R(Recall).

		True condition	
	Total population	Condition positive	Condition negative
Predicted condition	Predicted condition positive	**True positive**, Power	**False positive**, Type I error
	Predicted condition negative	**False negative**, Type II error	**True negative**
		True positive rate (TPR), Recall, Sensitivity, probability of detection = $\frac{\Sigma \text{ True positive}}{\Sigma \text{ Condition positive}}$	False positive rate (FPR), Fall-out, probability of false alarm = $\frac{\Sigma \text{ False positive}}{\Sigma \text{ Condition negative}}$
		False negative rate (FNR), Miss rate = $\frac{\Sigma \text{ False negative}}{\Sigma \text{ Condition positive}}$	True negative rate (TNR), Specificity (SPC) = $\frac{\Sigma \text{ True negative}}{\Sigma \text{ Condition negative}}$

Fig 7.1 TP/FP/FN/TN

For security application, we used a relatively higher threshold, the average accuracy in the LFW dataset is: 0.7.

For different thresholds, the ROC curve and PR curve are given below:

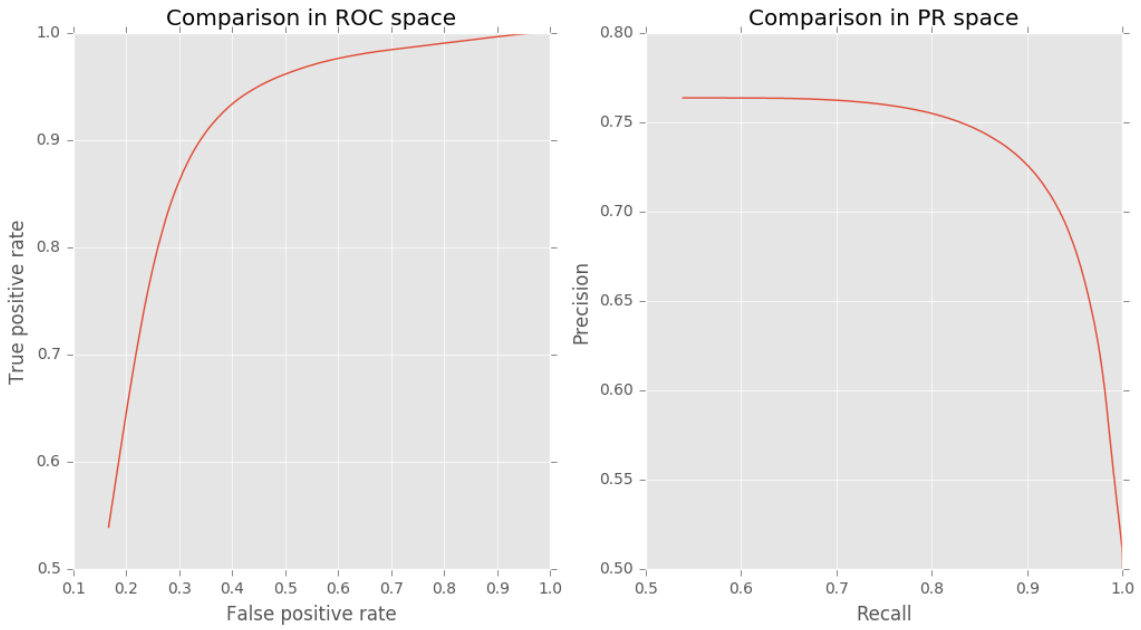


Fig 7.2 ROC curve and PR curve

8 Conclusion

From the above test cases, we can deduce that:

- Detection time is influenced by minimum face size, in general, detection speed of min face size set to 64x64 is faster than 32x32 and 48x48, so if you don't need the small face detect you can increase face size to speed up.
- The feature extraction time increases with the number of faces.
- The performance on two A72 is better than on single A53 and all six cores.
- In certain cases, the performance with mixed libraries mode is better than with OpenBLAS.