Unsupervised Domain Adaptation for Cross-Device Iris Liveness Detection Model Transfer

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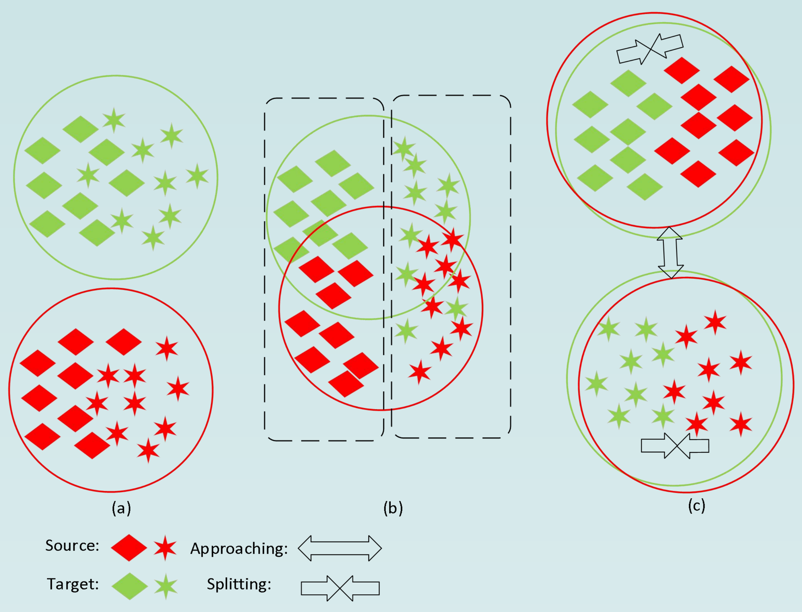
INTRODUCTION

- In traditional iris classification research, we often assume that the distribution of the training set and the test set is consistent. We train the model on the training set and test it on the test set. However, in practical scenarios, the test environment is often uncontrollable, leading to significant differences in the distribution between the test set and the training set. This discrepancy can cause overfitting and result in poor model performance on the test set.
- When the distributions of the training set and the test set are inconsistent—due to factors like changing devices, end users, or the presence of many unobserved contact lens types—agile deployment can be achieved through transfer learning technology.
- An approach to feature space alignment was devised, leveraging the measures of Maximum Mean Discrepancy (MMD) and Contrastive Domain Discrepancy (CDD), thereby facilitating un_x0002_supervised model transfer learning within the target domain, consequently enhancing the efficacy of model transfer significantly.

METHODOLOGY

- (a) Before domain adaptation, it is evident that there exists a significant domain shift between the source and target data. (b) After conventional domain adaptation, the situation of ignoring class labels of samples often leads to poor generalization performance. (c) Our proposed method aims to minimize the intra-domain differences while maximizing the inter-domain variances, thereby significantly enhancing the classification accuracy.

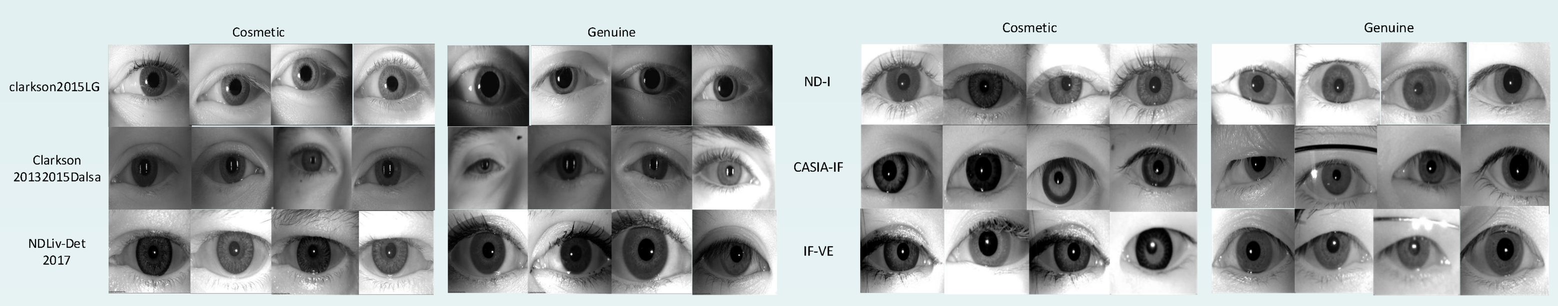


MMD primarily focuses on source-target domain similarity, while CDD primarily focuses on contrastiveness.

This figure shows the comparison of the distribution of domain difference minimization methods, which minimizes the intra-class difference and maximizes the inter-class difference in our iris detection task.

RESULTS

- **Dataset:** We designed two sets of experiments to validate the effectiveness of the method. For the first set of experiments, we selected Clarkson2015LG, Clarkson20132015Dalsa and NDLiv-Det2017 datasets as dataset-1. For the second set of experiments, we selected ND-I, CASIA-IF and IF-VE datasets as dataset-2.



The details of Dataset 1 and Dataset 2 are as follows:

Datasets		Train		Test	
		Genuine	Cosmetic	Genuine	Cosmetic
Dataset-1	NDLiv-Det2017	600	600	900	900
	Clarkson2015LG	450	540	379	577
	Clarkson20132015Dalsa	970	1275	625	1000
Dataset-2	ND-I	2000	1000	800	400
	CASIA-IF	4800	592	1200	148
	IF-VE	20000	20000	5000	5000

We experimented on the model using datasets dataset-1 and dataset-2. Six arrangements of source domain and target domain were set up, and two backbone networks ResNet-50 and RestNet-101 were used to carry out experiments on MMD and CDD models. It can be clearly seen that the classification accuracy of CDD is better than that of MMD than that of non-migration method.

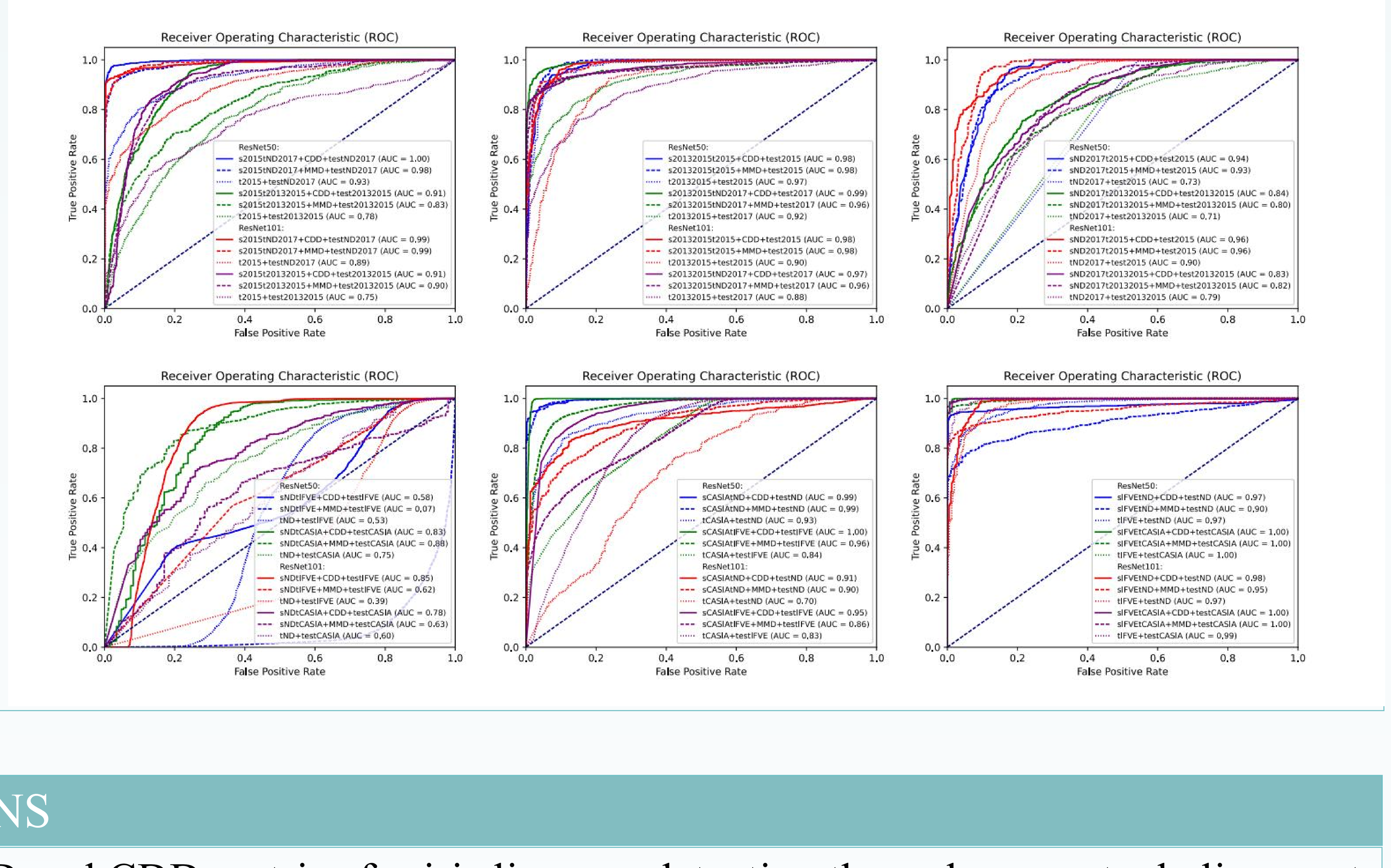
- **Experiment-1:** This table shows the sample instances of genuine iris and cosmetic contact lens iris images in the first dataset of experiments. The accuracy of our model performing on it is shown as well. RN50-NT and RN101-NT respectively denote the Non-Transfer of method with backbone Resnet-50 and Resnet-101

Source	Target/Test	Resnet50	RN50-ACC	RN50-NT	Resnet101	RN101-ACC	RN101-NT
Clarkson2015	Clarkson20132015Dalsa	MMD	71.7058	61.9943	MMD	76.0425	59.8818
		CDD	85.3540		CDD	82.1147	
Clarkson2015	NDLiv-Det2017	MMD	89.4444	85.3889	MMD	91.5556	74.0556
		CDD	97.0566		CDD	93.5556	
Clarkson20132015Dalsa	Clarkson2015	MMD	88.8104	73.9542	MMD	86.1648	84.5941
		CDD	95.1348		CDD	90.5630	
Clarkson20132015Dalsa	NDLiv-Det2017	MMD	79.3889	63.1111	MMD	77.4444	73.2778
		CDD	89.2778		CDD	83.6667	
NDLiv-Det2017	Clarkson2015	MMD	84.7222	81.7708	MMD	90.4473	80.0347
		CDD	90.7118		CDD	97.5198	
NDLiv-Det2017	Clarkson20132015Dalsa	MMD	66.6435	64.8798	MMD	69.1383	59.3186
		CDD	72.6096		CDD	71.0859	

- **Experiment-2:** This table shows the sample instances of real iris and cosmetic contact lens iris images, in the second dataset of experiments. The accuracy of our model performing on this dataset is shown as well. RN50-NT and RN101-NT respectively denote the Non-Transfer of method with backbone Resnet-50 and Resnet-101.

Source	Target/Test	Resnet50	RN50-ACC	RN50-NT	Resnet101	RN101-ACC	RN101-NT
ND-I	CASIA-IF	MMD	65.8615	51.0204	MMD	58.3856	53.4014
		CDD	78.4766		CDD	70.6764	
ND-I	IF-VE	MMD	24.6871	50.1700	MMD	58.1913	50.8200
		CDD	56.5526		CDD	77.0016	
CASIA-IF	ND-I	MMD	86.1875	85.3125	MMD	87.3750	59.1875
		CDD	98.0625		CDD	93.6875	
CASIA-IF	IF-VE	MMD	67.2000	62.7700	MMD	67.1305	59.4700
		CDD	98.5200		CDD	86.5261	
IF-VE	ND-I	MMD	84.0625	77.1875	MMD	81.1875	80.6875
		CDD	91.8125		CDD	91.8125	
IF-VE	CASIA-IF	MMD	96.2310	95.9184	MMD	95.5782	94.8563
		CDD	99.1948		CDD	98.6536	

- **ROC:** Tree sets of diagrams on the first line: ROC curve obtained according to Clarkson2015, Clarkson20132015Dalsa and NDLiv-Det2017 training sample. According to the experimental grouping in Table 2, the MMD,CDD, and the Non-Transfer of method were visually compared using the ROC curve. The advantages of the CDD approach are clearly visible. Tree sets of diagrams on the second line: ROC curve obtained according to ND-I, CASIA-IF and IF-VE training sample. According to the experimental grouping in Table 3, the MMD,CDD, and the Non-Transfer of method were visually compared according to the ROC curve. The results are affected by the large gap in the number of data sets, but the advantages of the CDD method can still be clearly seen.



CONCLUSIONS

- we propose an unsupervised domain adaptation transfer learning model based on MMD and CDD metrics for iris liveness detection through perceptual alignment. Modeling and optimizing intra-domain and inter-domain discrepancies, the CDD metric and MMD metric significantly improve the accuracy of our model when detecting. In addition, CDD is with a noticeable superiority in terms of classification accuracy and overall model improvement.
- The security of iris recognition technology is pertinent to every individual's life. The forgery of an individual's iris can have profound implications for personal, corporate, and national interests. The two transfer model methods we propose facilitate agile and cost-effective deployment when integrating new devices, thereby significantly advancing iris recognition technology.