SATGAN: Augmenting Age Biased Dataset For Cross-age Face Recognition

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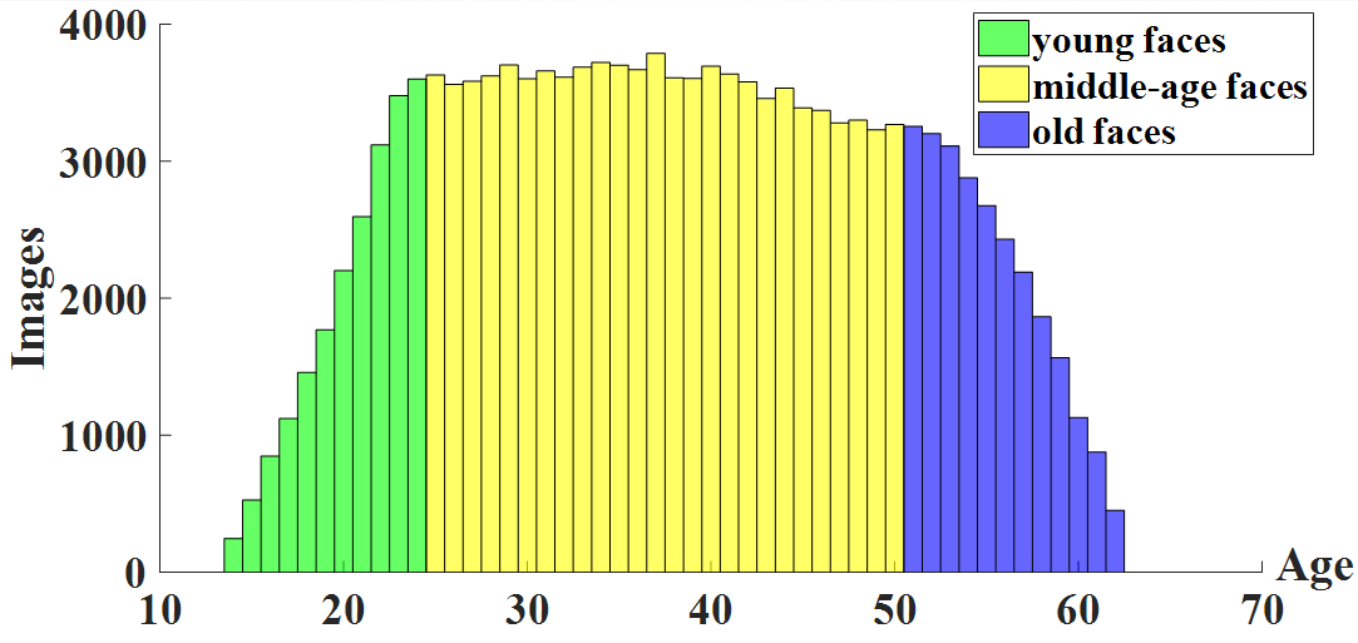
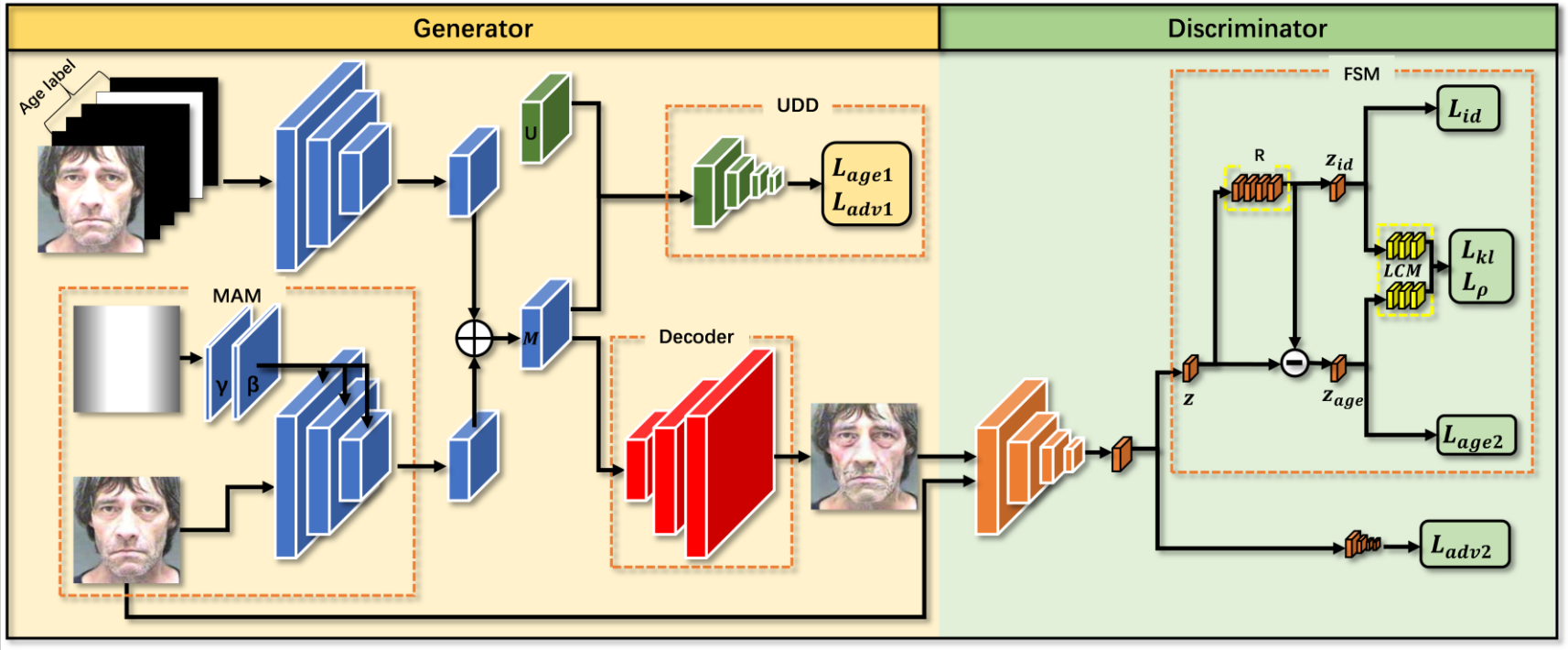
Background—Face Recognition

- There is a significant age bias in the open face dataset. (The figure below shows the age distribution of CACD dataset)



SATGAN

- Framework

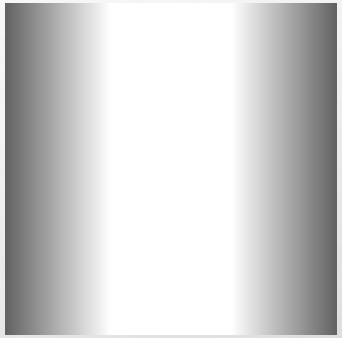


SATGAN

Mask Attention Module (MAM)

- The size of the mask is 128×128, and each column pixel value can be defined by the following formula:

$$Pixel = \begin{cases} 100 + \left(\frac{255-100}{40-0}\right)x & 0 \ll x \ll 40 \\ 255 & 40 < x < 88 \\ 255 - \left(\frac{255-100}{40-0}\right)(x-88) & 88 \ll x \ll 128 \end{cases}$$



SATGAN

Uniform Distribution Discriminator (UDD)

- The potential feature map M is uniformly distributed.
- The potential feature map M contains age classification information.

Adversarial Loss:

$$L_{adv1} = E_M[D_1(M)] - E_U[D_1(U)]$$

Age Loss:

$$L_{age1} = E_{M,c_{trg}}\left[-logD_1\left(c_{trg}\middle|M\right)\right]$$

SATGAN

Feature Separation Module (FSM)

- Increase the probability distribution distance of identity and age features.
- Eliminate the linear correlation between identity and age.

KL Divergence Loss:

$$L_{kl} = \frac{1}{N}\sum_{i}\sum_{j} l_{age}(j)\, log\left(\frac{l_{age}(j)}{l_{id}(j)}\right)$$

Canonical Correlation Loss:

$$L_{\rho} = -\frac{1}{N}\sum_{i}\frac{Cov(l_{age}, l_{id})}{\sqrt{Var(l_{age})Var(l_{id})}}$$

Experiments

- Results of age progression and regression on Morph.

Experiments

- Results of the GAN based models on morph.

TABLE I
RESULTS OF THE GAN BASED MODELS ON MORPH.

Method	Accuracy(%)	FID score
StarGAN	59.70	13.83
AttGAN	57.21	10.34
SwitchGAN	85.38	6.87
SATGAN	**90.53**	**6.22**

Experiments

- Proposed dataset **(Three Age Stages Dataset)**

We collected 35,416 images (10,015 identities) labeled with both identity and age, from CACD and WIKI-IMDB [28], to train our SATGAN to synthesize faces of different ages in VGGFace2 to train the face recognition model and evaluate it on CALFW. The dataset, called TASD, is divided into three subsets with different age groups, i.e. youth (10,091), middle age (9,098) and elder (16,236). All the images are manually cleaned..

青年

中年

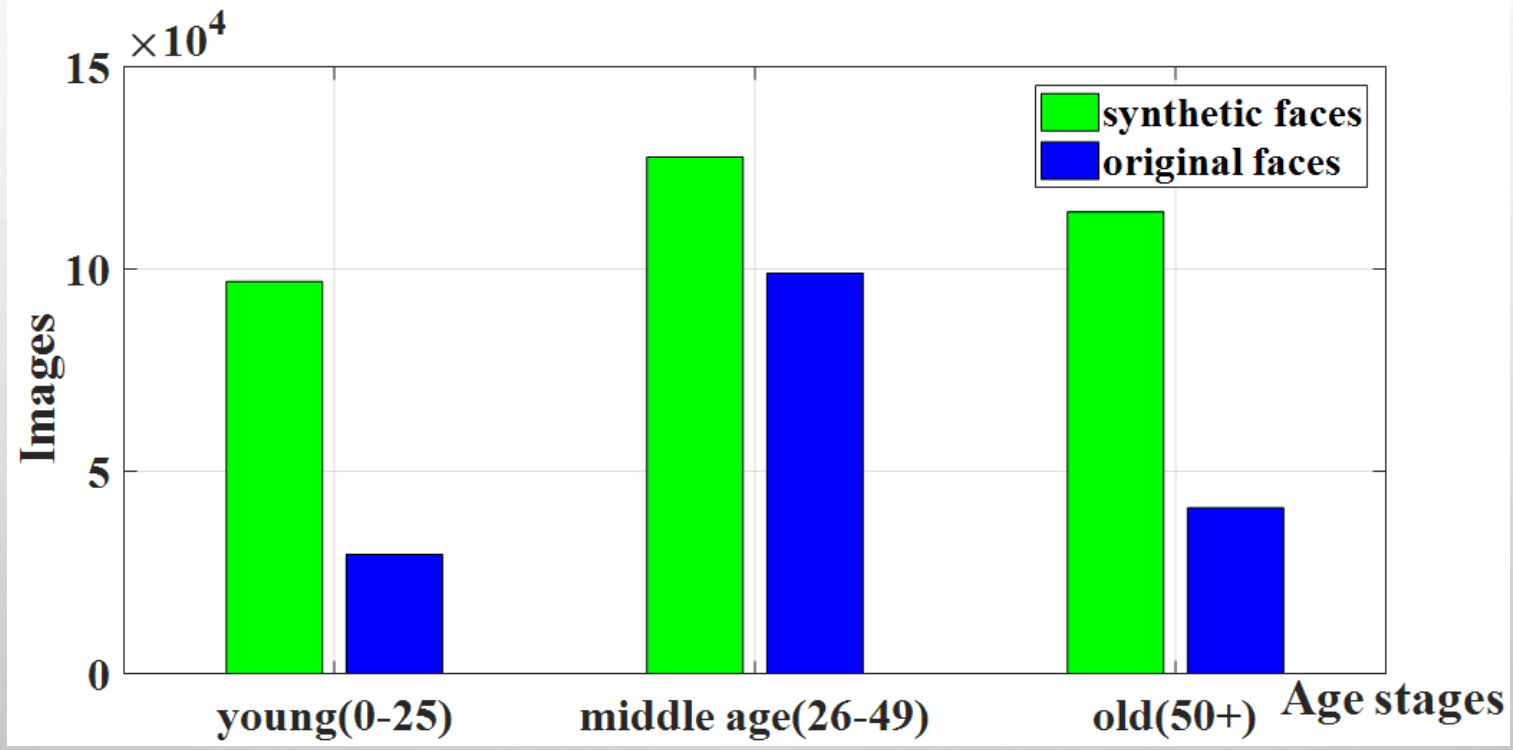
老年

Experiments

- Visual comparison of face rejuvenation and aging generated by different models on VGGFace2.

Experiments

- Evaluate the generated face age distribution of VGGFace2.



Experiments

- Evaluating Face Recognition（CALFW）

TABLE IV
ACCURACY(%) ON CALFW.

Size	Subset	Model	Result
Small	Original	-	68.15
	Augmented	CAAE	63.40
		StarGAN	67.85
		AttGAN	68.12
		SwitchGAN	68.38
		SATGAN	**70.20**
Medium	Original	-	77.22
	Augmented	CAAE	68.45
		StarGAN	77.38
		AttGAN	78.13
		SwitchGAN	78.03
		SATGAN	**79.08**
Large	Original	-	81.82
	Augmented	CAAE	75.08
		StarGAN	82.27
		AttGAN	82.15
		SwitchGAN	82.75
		SATGAN	**83.40**

Experiments

- Ablation Study（CALFW）

TABLE III
RESULT FOR ABLATION STUDIES.

Model	Accuracy(%)
StarGAN	67.85
Architecture ablation of SATGAN	
w/o MAM	68.47
w/o UDD	69.33
w/o FSM	69.00
SATGAN	**70.20**

Experiments

- Comparisons with state-of-the-art methods

TABLE V

COMPARISON OF VERIFICATION ACCURACY (%) ON CALFW AND AGEDB-30 WITH FOUR SOTA DEEP FACE RECOGNITION MODELS.

Method	CALFW	AgeDB-30
SphereFace [4]	90.30	97.56
VGGFace2 [24]	90.57	-
ConsineFace [5]	-	97.91
ArcFace [6]	95.87	98.08
PyTorch Implementation of ArcFace		
Original MS1M	95.78	98.10
Augmented MS1M	**95.92**	**98.43**

Conclusion

In this paper, we propose a new framework, namely SATGAN, to synthesize the young and old faces in face datasets and effectively solve the age bias of dataset. Our framework contains three novel modules, i.e., MAM, UDD and FSM. SATGAN can not only synthesize high quality images of different ages, but also improve the performance of face recognition models by augmenting the training dataset.

Thank you !