Improving Detection and Recognition of Degraded Faces by Discriminative Feature Restoration Using GAN

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Introduction

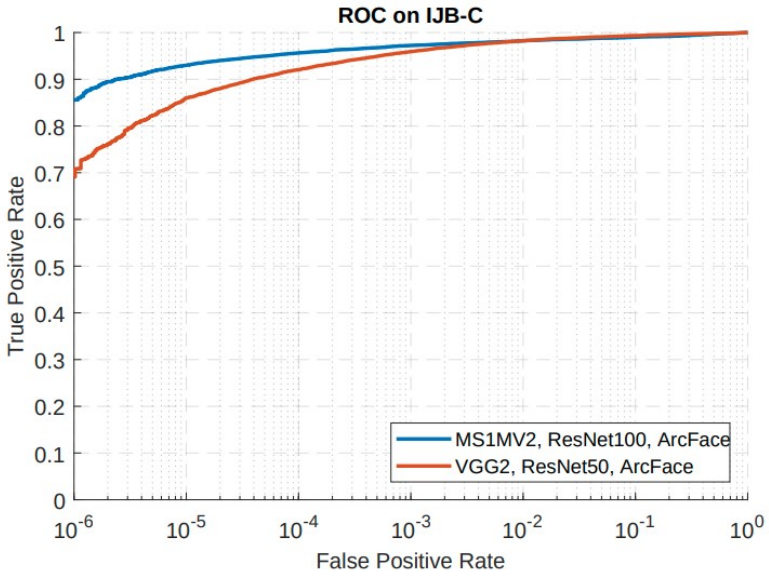
- Face detection and recognition from low-quality images common problem.
- It is quite challenging but highly demanded in real-world applications.
- Several effective solutions have been proposed for face recognition.
- Their performance drops significantly with degraded images.

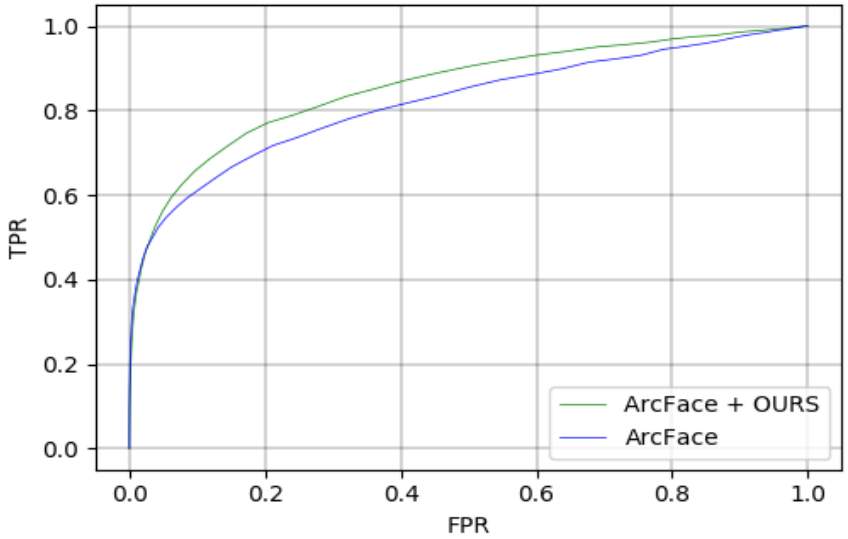
Drawbacks of Previous Methods

Image samples from **IJB-C**

Image samples from **SCFace**

Drawbacks of Previous Methods





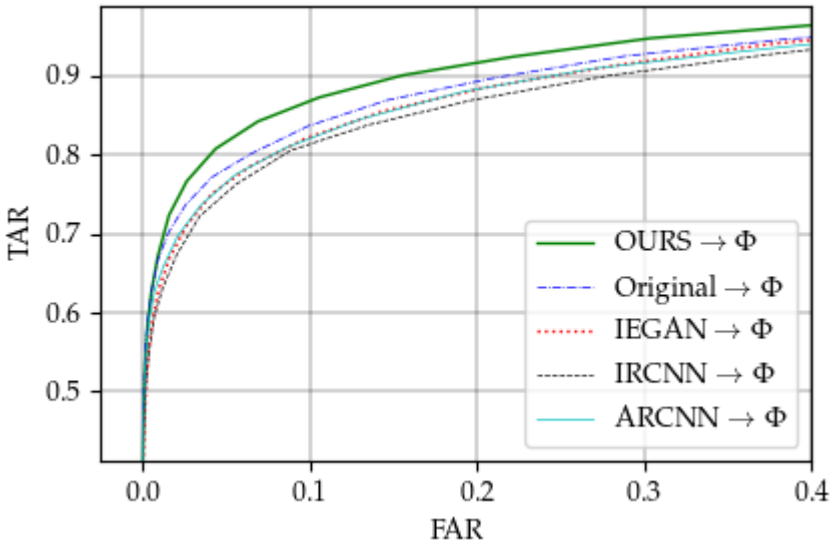
ROC for ArcFace** on **IJB-C**

ROC for ArcFace on **SCFace**

** Jiankang Deng, Jia Guo, Niannan Xue, and StefanosZafeiriou, "Arcface: Additive angular margin loss fordeep face recognition," inCVPR, 2019.

Drawbacks of Previous Methods

- Artifact or noise removal methods actually degrade FR/FD performance.
- Methods like IRCNN, ARCNN, IEGAN etc. doesn't improve FR/FD performance.
- We are looking for something that enhances FR/FD performance.



Aim of Research

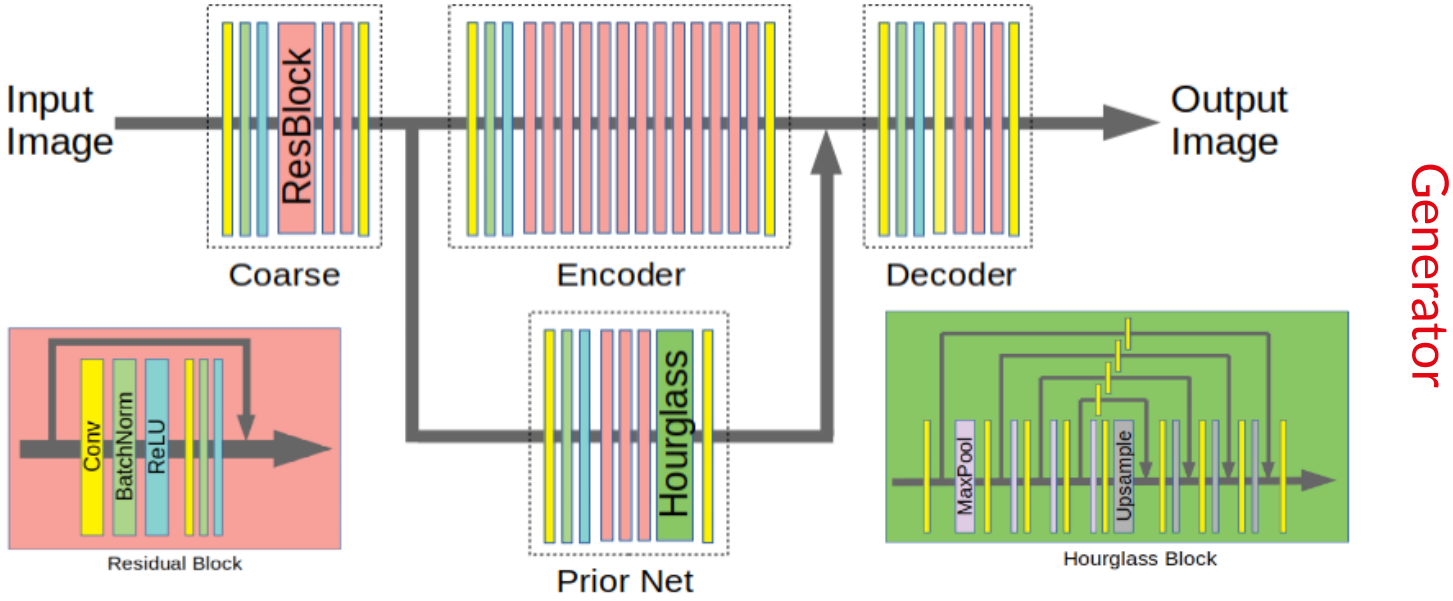
- Develop a framework which can enhance the facial features of the images
- Develop a loss function which can better discriminate between images
- Improve face detection performance
- Improve face recognition performance

Achievements

- Proposed a constrained angular metric learning method that learns to discriminate facial features.
- Proposed an effective loss function to recover discriminative facial features.
- Improved detection rate by 3.08% compared to S3FD*.
- Improved recognition rate by 2.55% for ArcFace**.

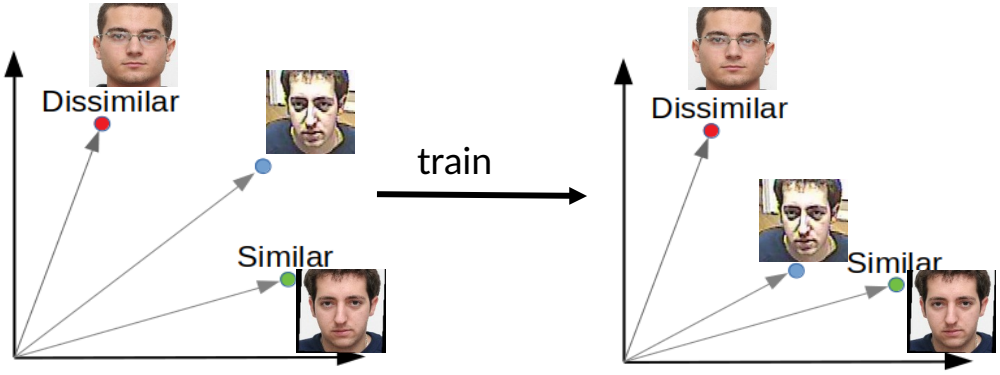
* Shifeng Zhang, Xiangyu Zhu, Zhen Lei, Hailin Shi, Xiaobo Wang, and Stan Z. Li, "S3fd: Single shot scale-invariant face detector," in ICCV, 2017.

Network Architecture



- Discriminator is in line with the architectural guidelines of DCGAN

Constrained Angular Metric Learning



- There are two high quality anchors and they are fixed
  - The ground truth representative mugshot feature from the similar class
  - The ground truth representative mugshot feature from the dissimilar class

Loss Function

- Constrained Angular metric Loss
- Identity feature Loss
- Pixelwise Loss
- Perceptual Loss
- Discriminator loss

Loss function = Weighted sum of the above terms

Training Setup

- Network trained with **~1.3M** images (128x128 pixels) of **14,528** identities.
- Images were aligned and cropped using MTCNN.
- Random degradations like MPEG/JPEG compression, changing brightness/contrast, interlacing artifacts, blurring etc. applied.
- Trained on Nvidia DGX Station.
- Implementation based on Tensorflow.

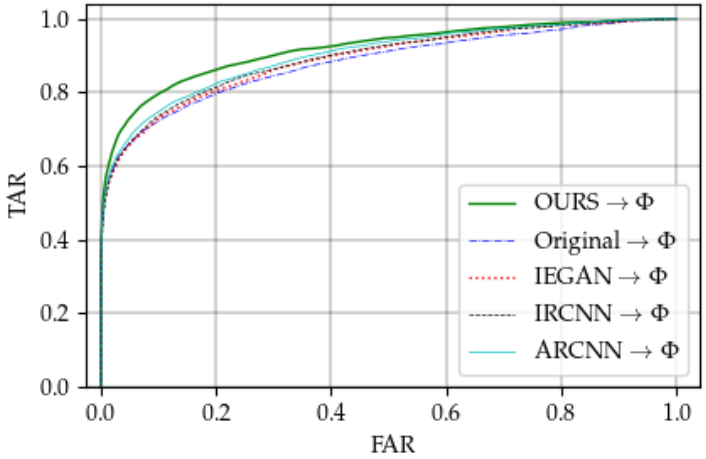
Face Detection Performance

Algorithm	dlib	SSD	MTCNN	S3FD
Original	90.35%	59.27%	91.96%	96.01%
ARCNN	87.38%	55.91%	90.94%	96.01%
IRCNN	87.66%	59.09%	90.56%	95.84%
IEGAN	89.02%	50.91%	87.76%	92.69%
Ours	**95.31%**	**86.36%**	**95.36%**	**99.09%**

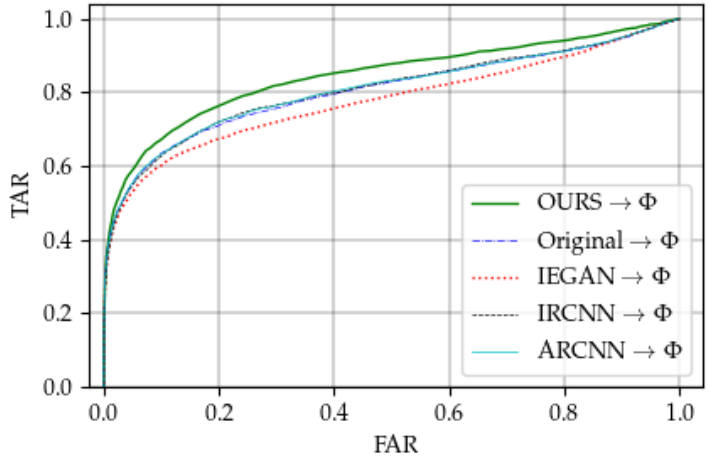
Face Recognition Performance

Algorithm	TAR%@FAR				
	5%	1%	0.1%	0.01%	0.001%
ARCNN	77.39	62.25	50.62	38.39	29.72
IRCNN	75.78	61.29	47.41	33.64	21.15
IEGAN	76.82	63.09	48.82	34.71	20.21
Ours	**82.06**	**67.90**	**51.01**	**39.19**	**33.35**

Face Recognition Performance: ROC



ArcFace



CosFace

Conclusion

- We presented a deep GAN for face enhancement that sets a improves detection and recognition of low-quality images
- This is done by targeting discriminative facial features.
- Improved perceptual quality does not guarantee improved recognition performance.
- This algorithm can be used in conjunction with any face recognition algorithm as a preprocessing step.