Multi-Laplacian GAN with Edge Enhancement for Face Super Resolution

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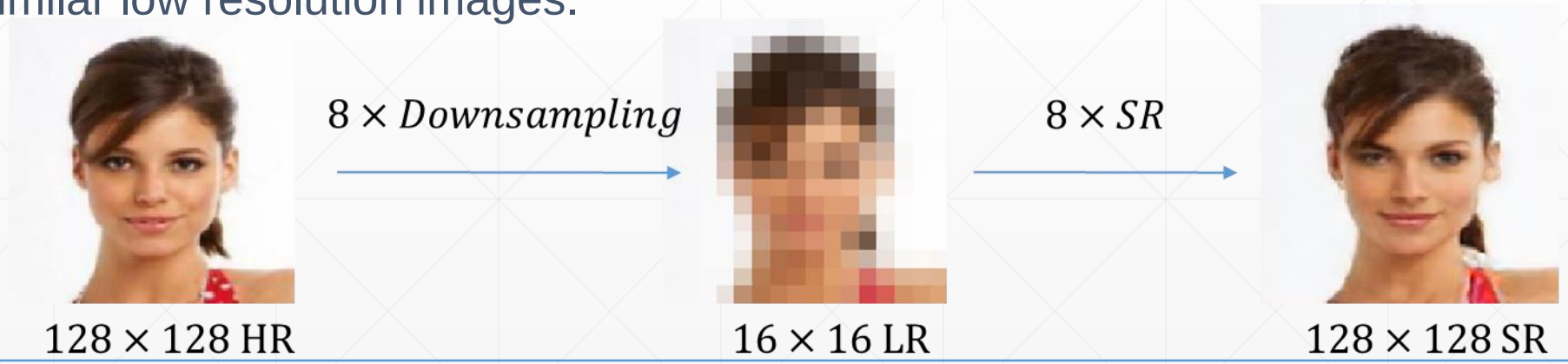
Outline

- Introduction
- Proposed Method
- Experiments
- Conclusions and Future Works

Introduction

- **Super Resolution (SR) Problem**
  - Generate a high-resolution (HR) face image from an LR one
  - Why is it important?
    - Applications: Remote sensing, medical diagnostic, intelligent surveillance etc.
    - Recover details of HR from LR
  - Face SR Major challenges
    - Missing information: Identities, five senses, facial attributes, etc
    - Ill-posed problems: two different high resolution images are possible to be downsampled to two similar low resolution images.



Contribution

- **Propose the Multi-Laplacian GAN with Edge enhancement (MLGE)**
- **MLGE**
  - Model Generalization
    - No additional prior facial information is required in both training and testing phases for our model
  - Enhance the quality
    - MLGE achieves higher quantitative and qualitative performance.

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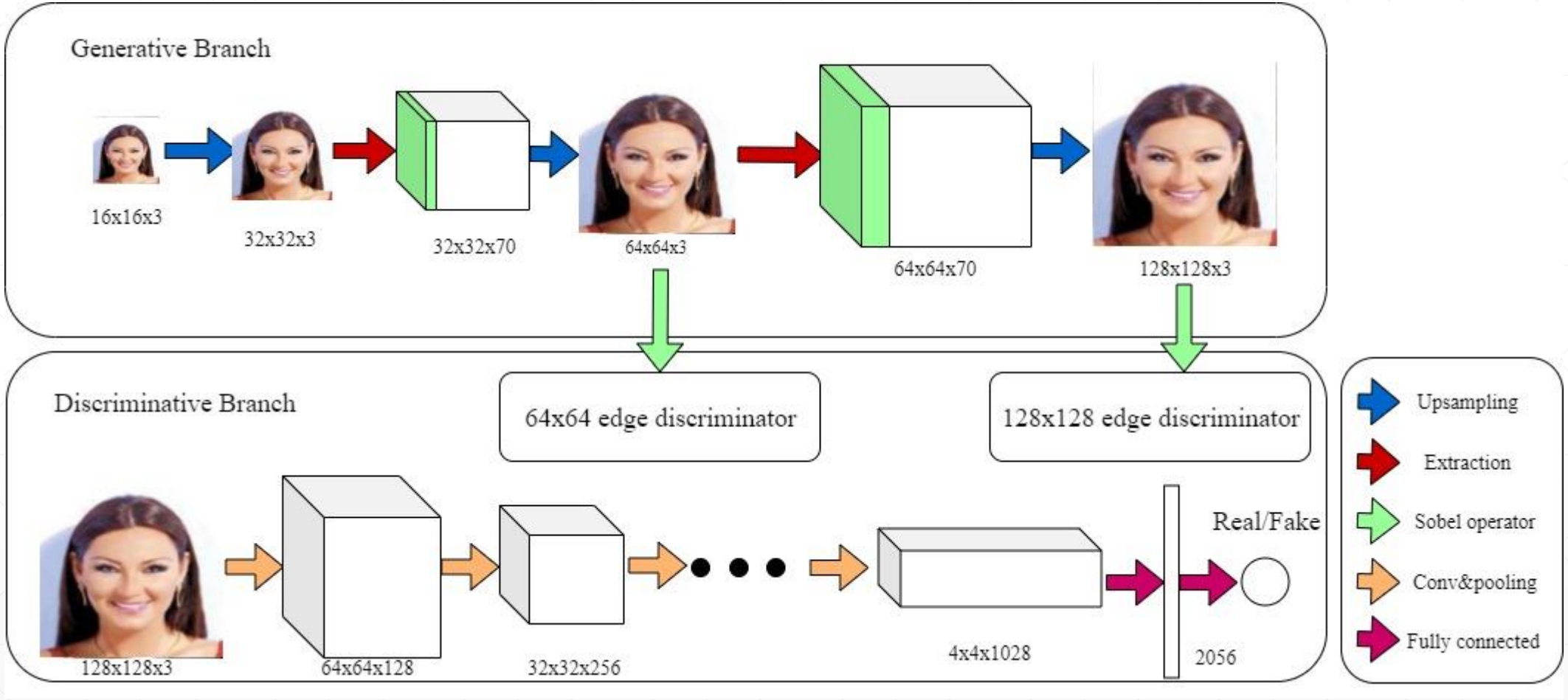
MLGE Architecture



MLGE Architecture-Discriminative Branch

- The general discriminator D_{h^8} determines whether
  - the 8× SR $\hat{h}^8$ is similar to HR face images h^8
- The objective function for the general discriminator is expressed as:
  - $L_{D_{h^8}} = -E[logD_{h^8}(h^8) + log(1 - D_{h^8}(\hat{h}^8)]$

128 × 128 HR

General Discriminator

0.8	0.8	0.8	0.8
0.8	1	1	0.8
0.8	1	1	0.8
1	1	1	1

MLGE Architecture-Discriminative Branch

- Two edge discriminators D_{e^s} determine whether
  - the gradients of SR images $\hat{e}^s$ are similar to the gradient of HR face images e^s in each scale S.
- The objective function for general discriminator is expressed as:
  - $L_{D_{e^s}} = -E[logD_{e^s}(e^s) + log(1 - D_{e^s}(\hat{e}^s)], s = 4, 8$

Gradients

Edge Discriminator

0.8	0.8	0.8	0.8
0.8	1	1	0.8
0.8	1	1	0.8
1	1	1	1

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- Introduction
- Related Works
- Proposed Method
- **Experiments**
- Conclusions and Future Works

Experiment Settings

- **Datasets:**
  - Celebrity Face Attributes (CelebA) dataset
    - 202,599 human face images with labeled 40 facial attributes, landmarks.
  - Training data and testing data:
    - 22K face images as training
    - 2.6K face images as testing
    - Resize to 128×128 as our HR images
    - Downsample HR images to 16×16 as our LR images

Experiment Settings (cont.)

- **Comparison methods**
  - Bicubic (IEEE Trans. Signal Process.1981)
    - Traditional upsampling method
  - VDSR (CVPR 2016)
    - CNN based method
  - SRGAN (CVPR2017)
    - GAN-based method
  - Yu et al (CVPR 2018) (attributes)
    - Conditional GAN based
    - Training images only include face region
- **Evaluate metrics**
  - PSNR (The average Peak Signal to Noise Ratio)
  - SSIM (The Structure Similarity Score)

Method comparison

- **Quantitative Comparison**
  - MLGE outperforms other methods with large margins in PSNR and SSIM

Method	Bicubic [23]	VDSR [12]	SRGAN [21]	Yu *et al* [8]	MLGE
PSNR	21.76	23.12	23.76	22.85	**25.07**
SSIM	0.72	0.80	0.78	0.753	**0.83**

- **Qualitative Comparison**

LR Bicubic VDSR SRGAN Yu *et al* MLGE HR

Method comparison

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- **Qualitative Comparison**

LR Bicubic VDSR SRGAN Yu *et al* MLGE HR

Conclusions and Future Works

- **MLGE algorithm**
  - Generalization
    - No additional prior facial information is required in both training and testing phases
  - Enhance the quality
    - Outperform the state-of-the-arts both in quantitatively and qualitatively
    - Generates SR images which have almost the same facial attributes as HR images
- **Future works**
  - Explore better information extraction methods
    - Principal component analysis (PCA) and fast fourier transform
    - Extend MLGE to large scale SR task, such as 256 × 256 LR images

Thank you