Attention 2 Angio GAN

Synthesizing Fluorescein Angiography from Retinal Fundus Images using Generative Adversarial Networks

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Introduction to Attention 2 Angio

Problem

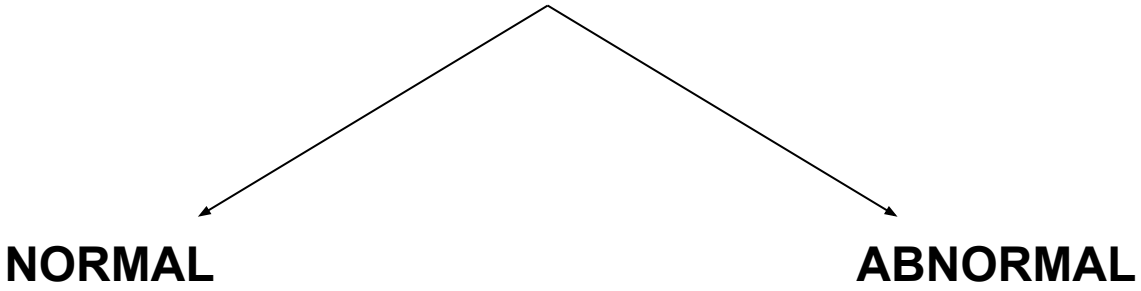
With Fluorescein Angiography nonfatal complications can arise

Solution

attention based generative adversarial network (GAN)

Dataset

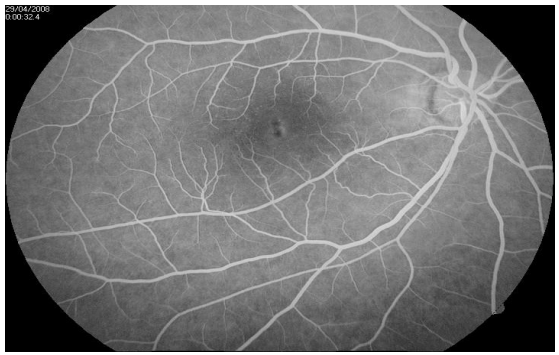
- The chosen dataset is taken from the research paper *"Diabetic retinopathy grading by digital curvelet transform," Computational and mathematical methods in medicine, vol. 2012, 2012*.



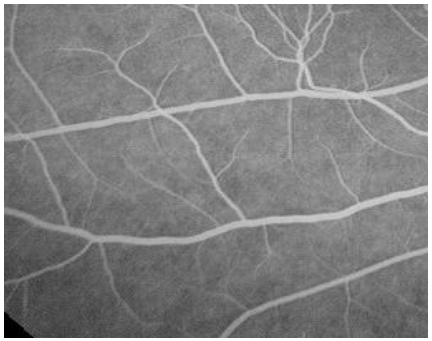
Preprocessing

NORMAL	ABNORMAL
30 pair images	30 pair images
↓	↓
10 pair images	7 pair images

- 20 Random crops 256 x 256 from 720 x 576



Original Image



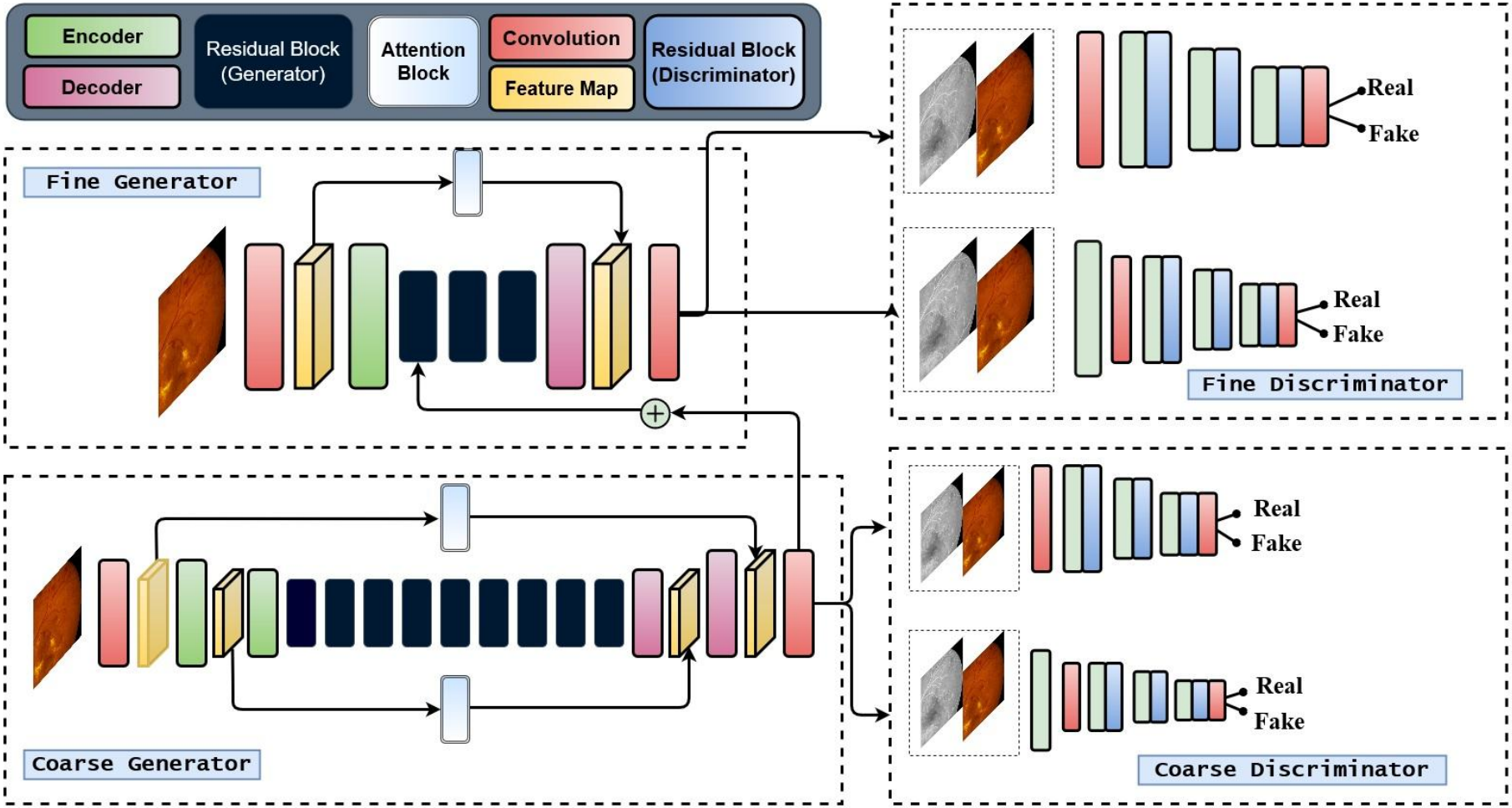
Random Crop

Network

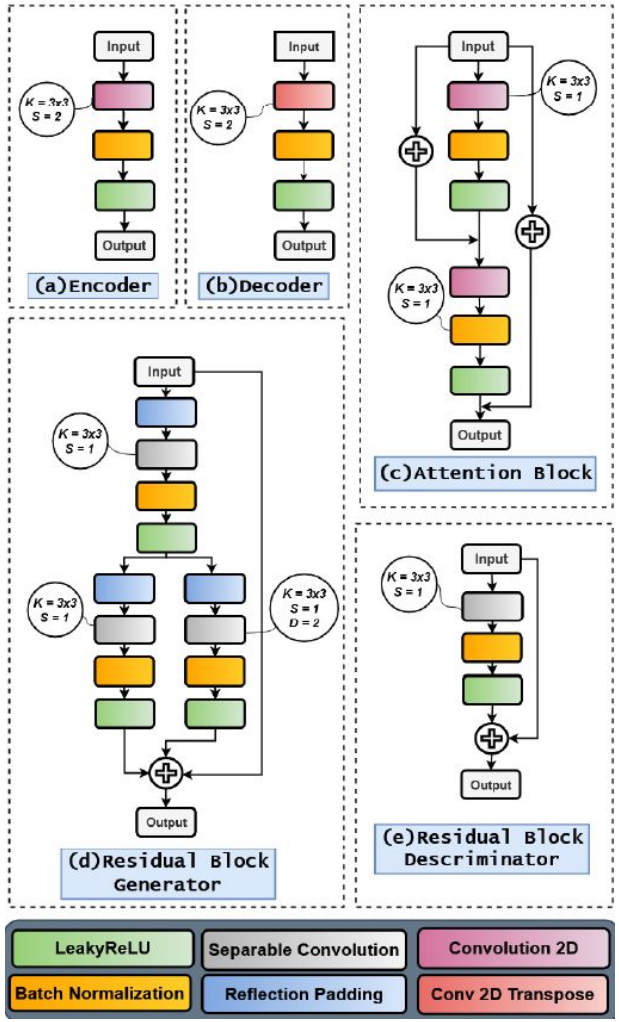
The GAN architecture is composed of two generators and four discriminators:

- **Fine Generator** → synthesizes FA from fundus images by learning local information
- **Coarse Generator** → aims to extract and preserve global information
- **Fine Discriminator** → dictate the fine generator to produce more detailed local features. It takes as input the sample size
- **Coarse Discriminator** → tries to convince the coarse generator to retain more global features. It takes as input half of the sample size

Network


Encoder
Decoder
Residual Block (Generator)
Attention Block
Convolution
Feature Map
Residual Block (Discriminator)
Fine Generator
Real
Fake
Real
Fake
Fine Discriminator
Coarse Generator
Real
Fake
Real
Fake
Coarse Discriminator

Network


Input
K = 3x3
S = 2
Output
(a)Encoder
Input
K = 3x3
S = 2
Output
(b)Decoder
Input
K = 3x3
S = 1
K = 3x3
S = 1
Output
(c)Attention Block
Input
K = 3x3
S = 1
K = 3x3
S = 1
K = 3x3
S = 1
D = 2
Output
(d)Residual Block
Generator
Input
K = 3x3
S = 1
Output
(e)Residual Block
Descriminator
LeakyReLU
Separable Convolution
Convolution 2D
Batch Normalization
Reflection Padding
Conv 2D Transpose

Our Work

- ***Performance Visualizers***

  Fréchet Inception Distance (FID) - calculates the distance between feature vectors calculated for real and generated images.

  Kernel Inception Distance (KID) - measures the dissimilarity between two probability distributions using samples drawn independently from each distribution.

- ***Loss Function***

  ➔ **Perceptual Loss**

  ➔ **Mean Squared Error**

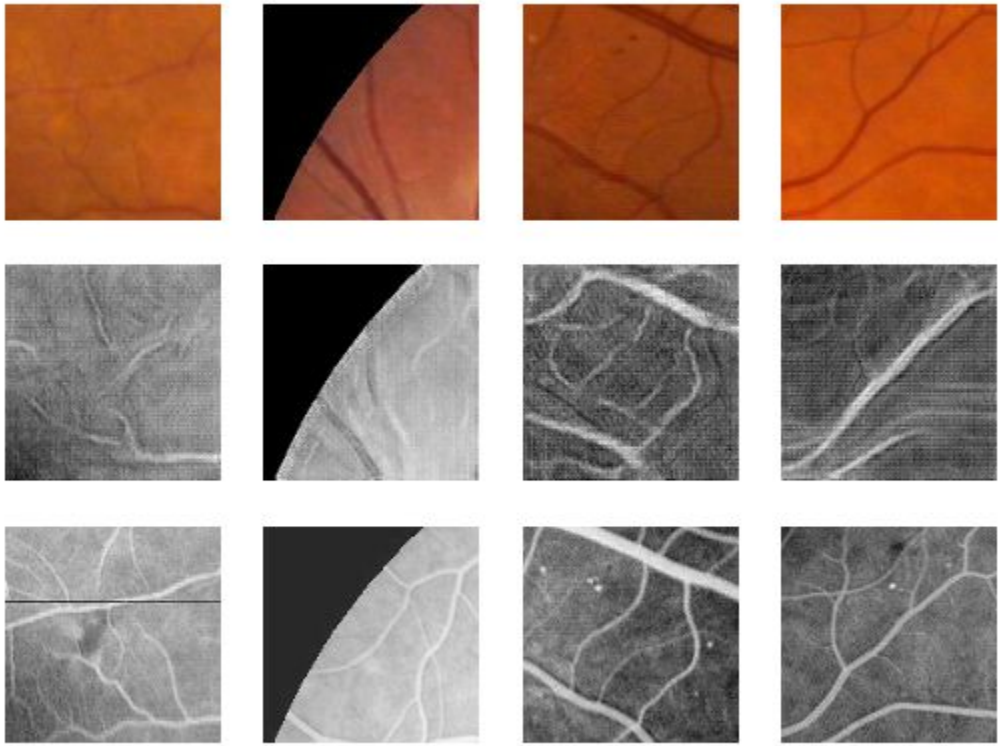
Tests

- –input_dim=256 –batch=8 –epochs=100 –n_crops=20 –mod=0
- –input_dim=256 –batch=4 –epochs=100 –n_crops=20 –mod=0
- –input_dim=256 –batch=4 –epochs=100 –n_crops=20 –mod=1
- **–input_dim=256 –batch=2 –epochs=200 –n_crops=20 –mod=0**
- **–input_dim=256 –batch=2 –epochs=200 –n_crops=20 –mod=1**

➔ **Perceptual Loss** → 8 hours for 100 epochs and 12 hours for 200 epochs

➔ **Mean Squared Error** → 6 hours for 100 epochs and 10 hours for 200 epochs

Results



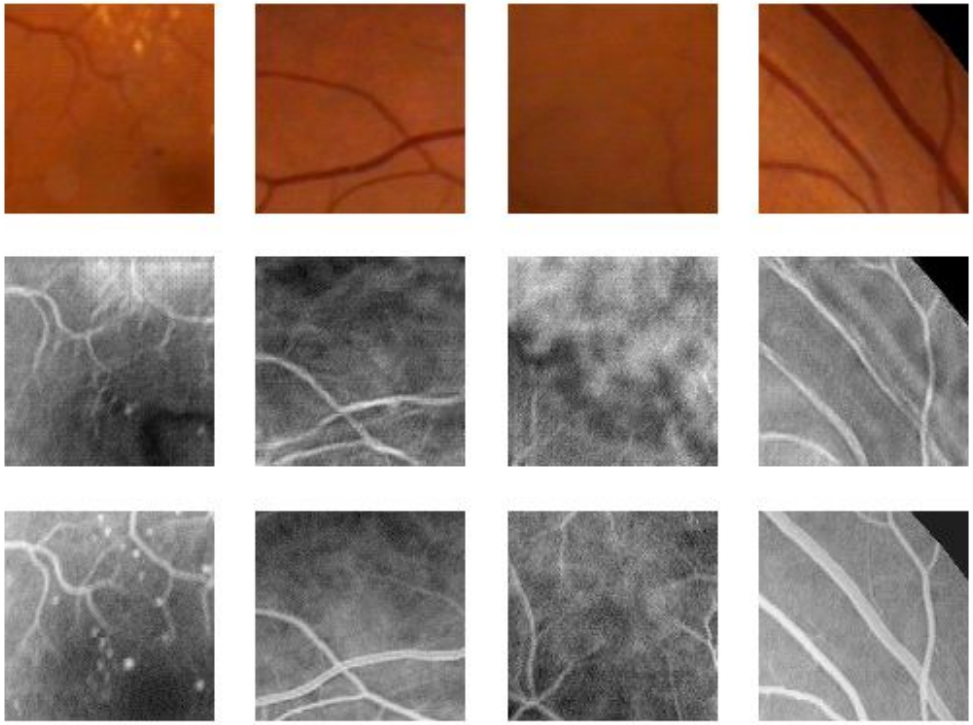
–input_dim=256 –batch=2 –epochs=200 –n_crops=20 –mod=0

Results

```
Found 4 images in the folder /content/drive/MyDrive/C
FID real_target : 100% 1/1 [00:02<00:00,  2.83s/it]
Found 4 images in the folder /content/drive/MyDrive/C
FID fake : 100% 1/1 [00:15<00:00, 15.09s/it]
269.883008789561
compute KID between two folders
Found 4 images in the folder /content/drive/MyDrive/C
KID real_target : 100% 1/1 [00:02<00:00,  2.79s/it]
Found 4 images in the folder /content/drive/MyDrive/C
KID fake : 100% 1/1 [00:02<00:00,  2.85s/it]
0.09226782639821335
```

–input_dim=256 –batch=2 –epochs=200 –n_crops=20 –mod=0

Results



–input_dim=256 –batch=2 –epochs=200 –n_crops=20 –mod=1

Results

```
Found 4 images in the folder /content/drive/MyDrive
FID real_target : 100% 1/1 [00:03<00:00,  3.07s/it]
Found 4 images in the folder /content/drive/MyDrive
FID fake : 100% 1/1 [00:15<00:00, 15.03s/it]
426.364288061312
compute KID between two folders
Found 4 images in the folder /content/drive/MyDrive
KID real_target : 100% 1/1 [00:03<00:00,  3.01s/it]
Found 4 images in the folder /content/drive/MyDrive
KID fake : 100% 1/1 [00:02<00:00,  2.90s/it]
0.15219275156656853
```

–input_dim=256 –batch=2 –epochs=200 –n_crops=20 –mod=1

Conclusions

- Mean Squared Error
  - Lower training time with still appreciable results
- Perceptual Loss
  - Has a lower FID and KID in all tests
  - Better contrast detection → less distorted pictures
- **Perceptual Loss > Mean Squared Error**
  - **but the training time is 33% longer**

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Thank you!