

# Restoration Of Degraded Images Using VAE and GAN

Final Year Project

Batch :- C16 [ R17 ]

Project Guide : Sri. BNV NARASIMHA RAJU

By:

- ASHUTOSH MISHRA [17B91A05P4]
- AAYUSH KARNA [17B91A05P2]
- RAVI SHANKER YADAV [17B91A05P8]

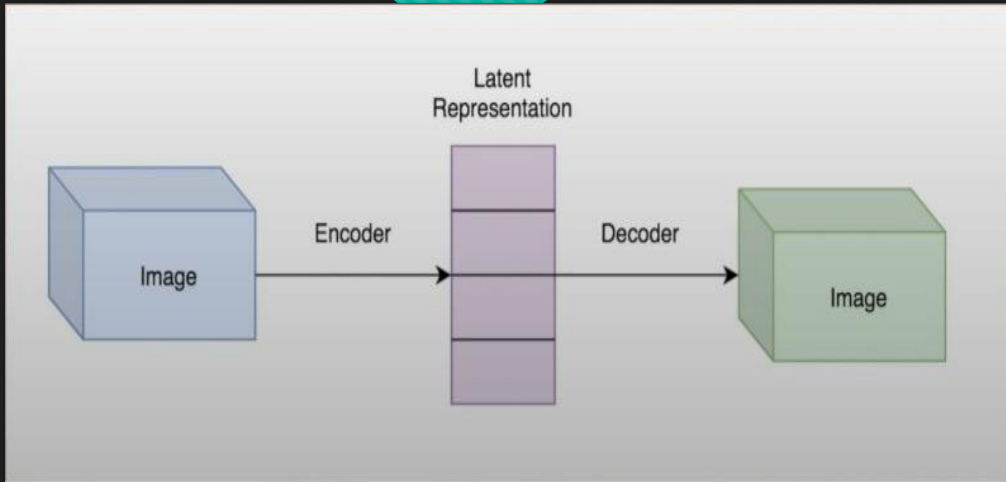
# ABSTRACT

Old and deteriorated photos suffer from severe degradation because of multiple reasons. This degradation is restored algorithmically through a deep learning approach. Unlike conventional restoration tasks that can be solved through supervised learning, the degradation in real photos is complex and the domain gap between synthetic images and real old photos makes the network fail to generalize. Therefore, a customized generative adversarial network (GAN) is proposed by leveraging real photos along with numerous generated image pairs. Two variational autoencoders (VAEs) are trained to respectively transform old photos and legit photos into two distinct latent spaces.

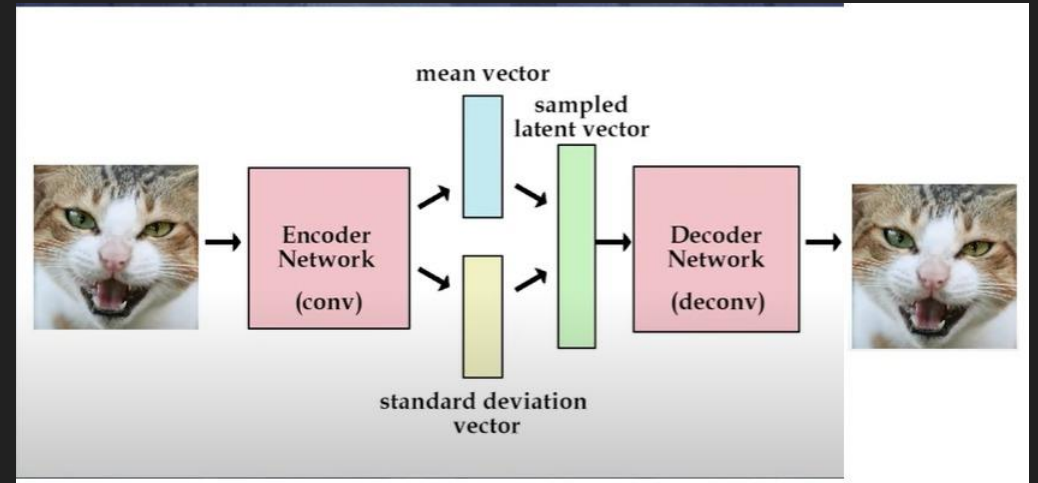
# PROBLEM STATEMENT

Degradations in images like optical blur, Black & White colorization, motion blur, quantization, additive noises, grains and low-resolution are to be corrected and restored. The proposed technique should increase efficiency of the algorithms, as well as make it possible to restore more severe degradations, which cannot be elegantly done by the existing approached.

# RELATED IMAGE



Traditional Auto-Encoder



Variational Auto-Encoder



# LITERATURE SURVEY

**Image Restoration** : Tony Xavier and Prof. Banshidhar Majhi had released a journal on “DEVELOPMENT OF IMAGE RESTORATION TECHNIQUES “ which discusses different reasons behind image degradation such as blind de-convolution, motion blur and noising, along with its remedies such as de-noising and impulse clarification pixel wise.

Link : <https://core.ac.uk/download/pdf/53188951.pdf>

**VAE ( Variational Auto Encoder)** : Another journal named "Old Photo Restoration via Deep Latent Space Translation" released by Microsoft and its R&D team on 2015 discusses elaborately on techniques of latent space content prediction using VAE.

Link : <https://arxiv.org/pdf/2009.07047v1.pdf>

# LIMITATIONS

- Processing of images is slow ( depending on different parameters like hardware specification and image size )
- Large size images ( > 350KB ) cannot be processed using our model.
- As we have a pre-trained model of large size it requires fast internet connectivity ( > 1mbps ) .

# PROPOSED SYSTEM

- Two stage joint training to achieve higher effectiveness for face enhancement.
- Adoption of progressive generator with spatial condition rather than image level concatenation.
- Training with the two-stage manner isolates the two VAEs, and the latent adversarial loss further closes the domain gap.



Original



Existing

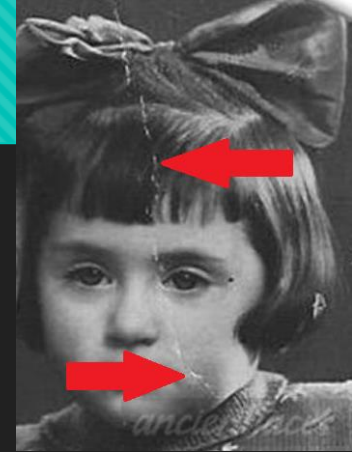


Proposed





# METHODOLOGY

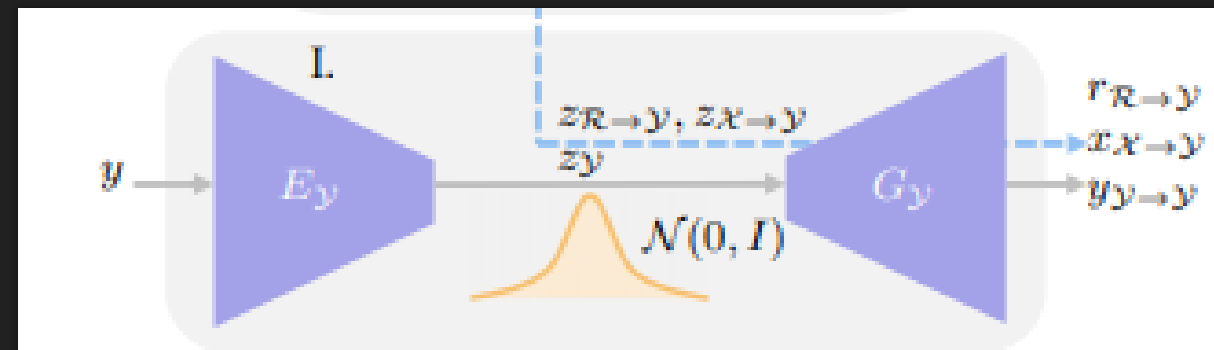
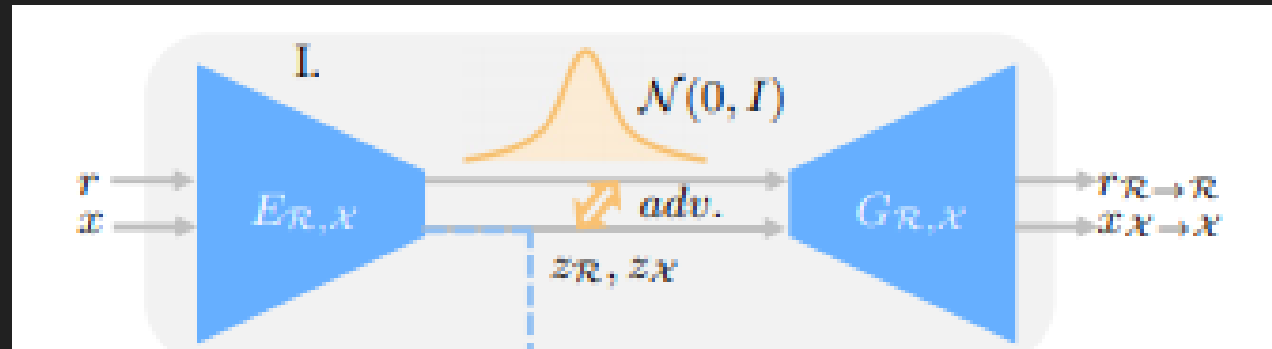


1. Restoration via Latent Space Translation
  - Latent space = Hidden space, or the space hidden behind the degradation

- Translation in two stages

**STAGE 1 :** Train 2 VAEs.  
(As shown below)

- VAE(1) for images in real photos( $\mathcal{R}$ ) and synthetic images( $\mathcal{X}$ ), by training an adversarial discriminator.
- VAE(2) is trained for clean images( $\mathcal{Y}$ ).





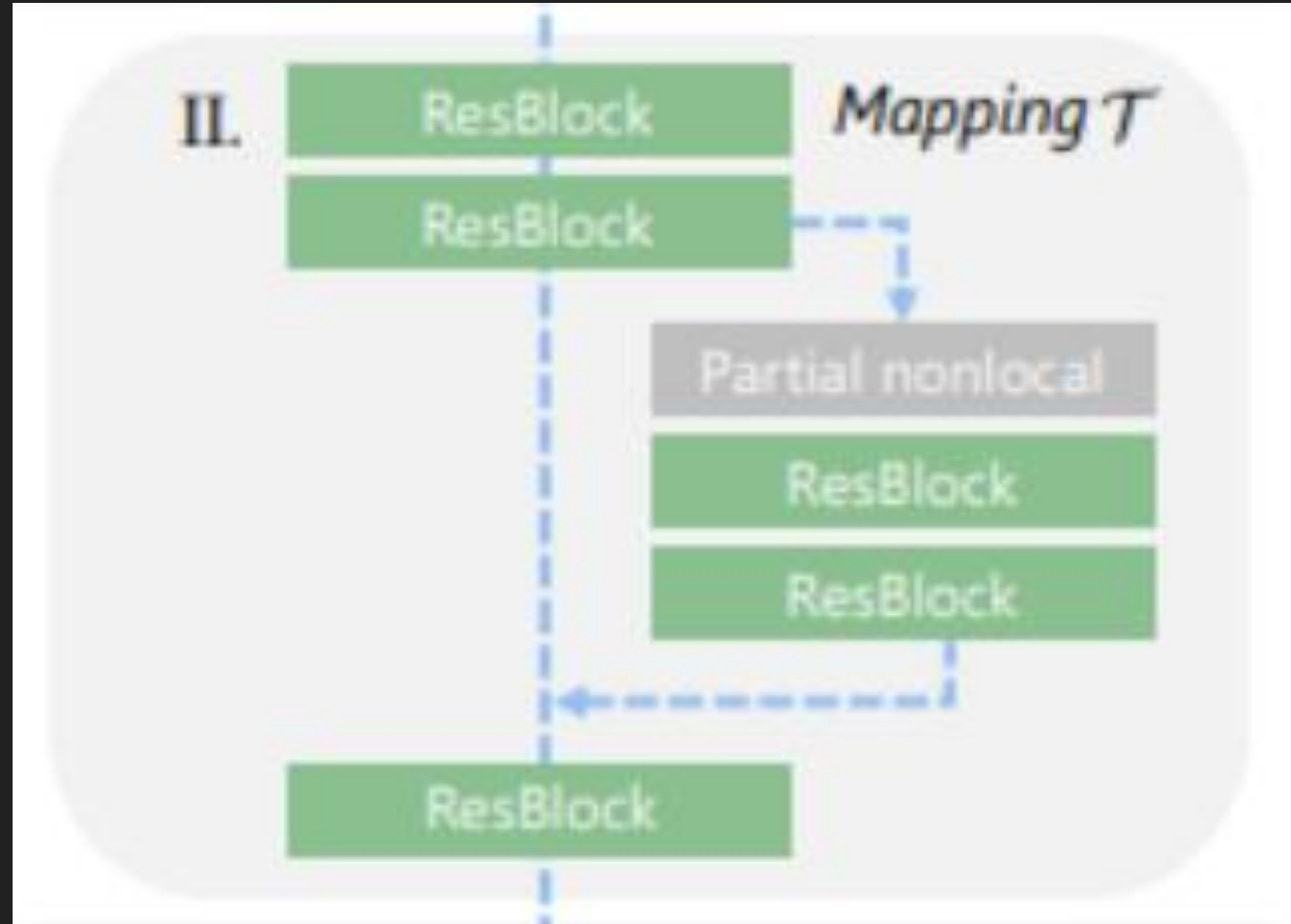
# METHODOLOGY (Contd.)

**STAGE 2 :** Learn the mapping that restores the corrupted images to clean ones in the latent space.

Thus, the real old photos  $r$  can be restored by sequentially performing the mappings.

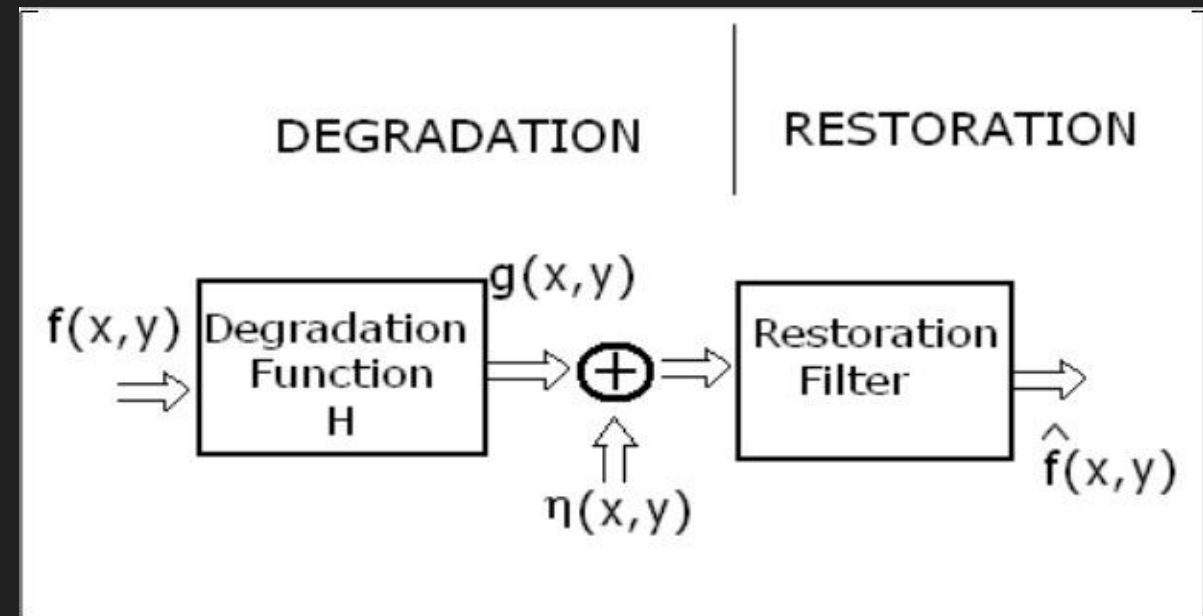
$$rR \rightarrow Y = GY \circ TZ \circ ER(r).$$

Partial non-local and ResBlocks are generated to fill up the latent space.

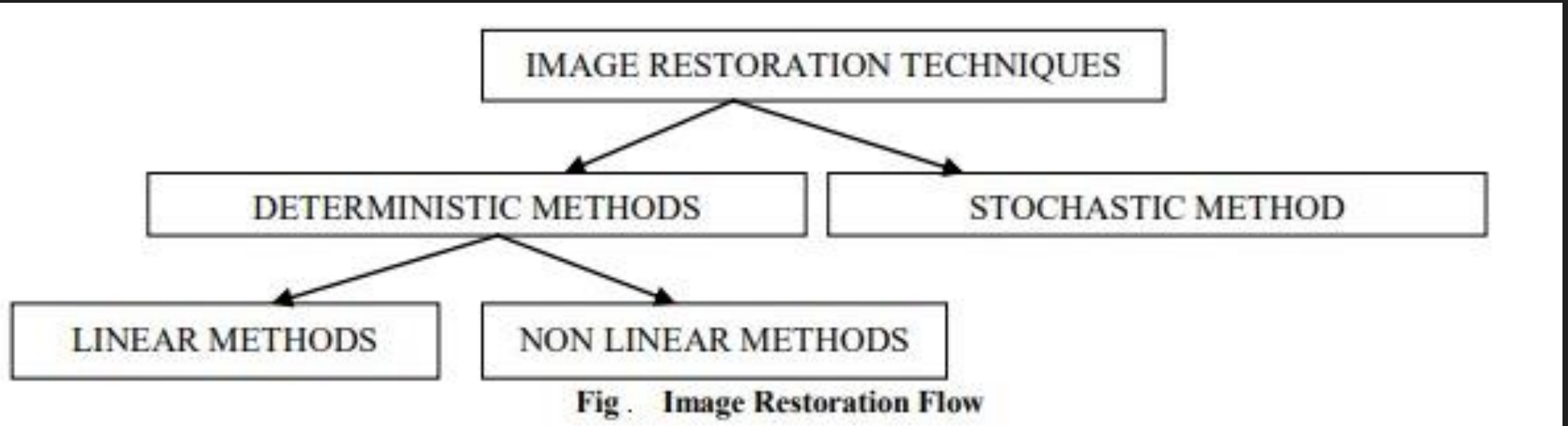


# METHODOLOGY

- Pixel wise distribution of images
- Integration of repeated degradations and restorations helps the method to restore complex and unstructured degradations.
- Output of degradation function is subjected to XOR function with a constant proportion.
- This resultant function ( $g$ ) acts as an input to the restoration filter.
- It produces the output clean image.

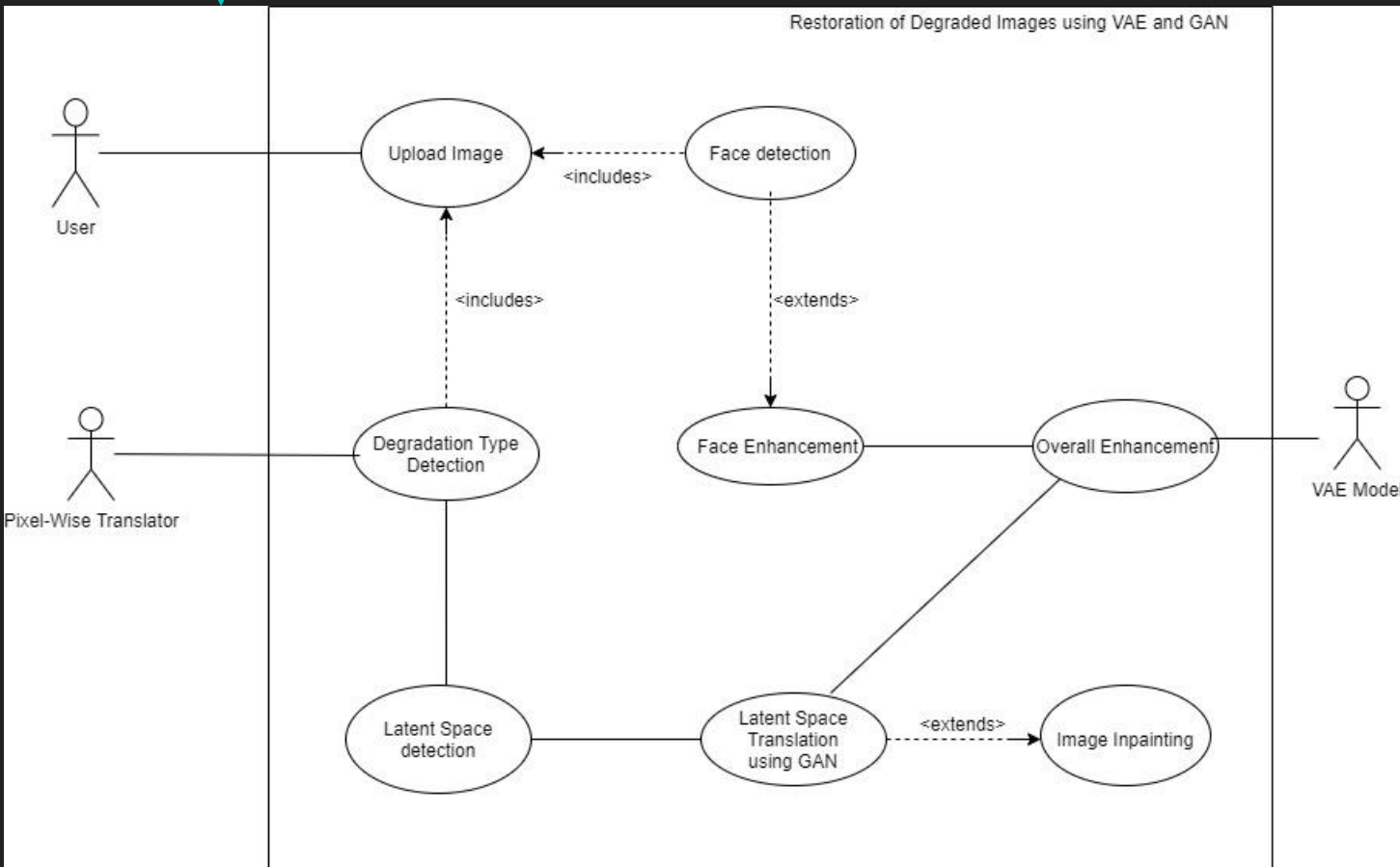


# TYPES OF METHODS

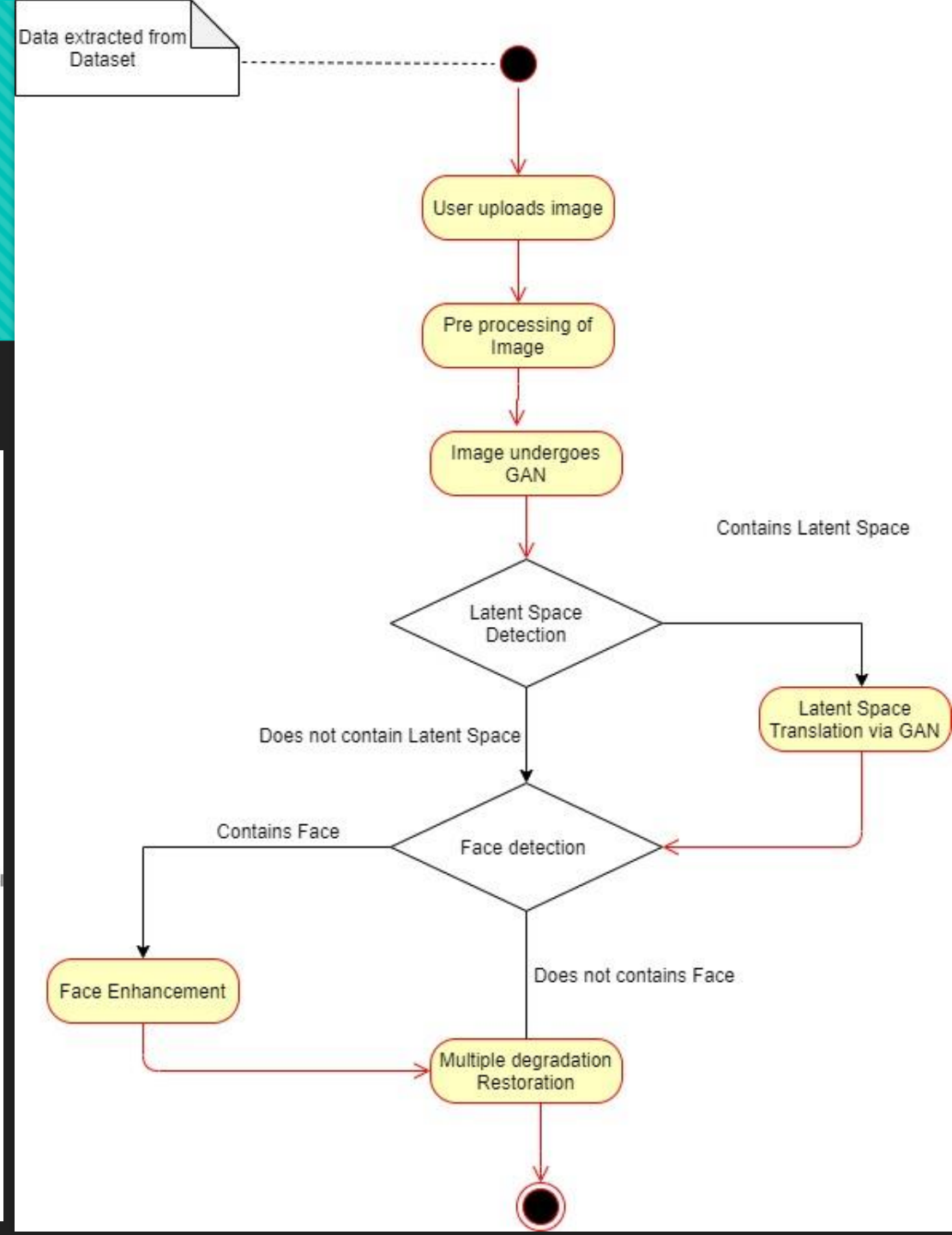


# UML DIAGRAM

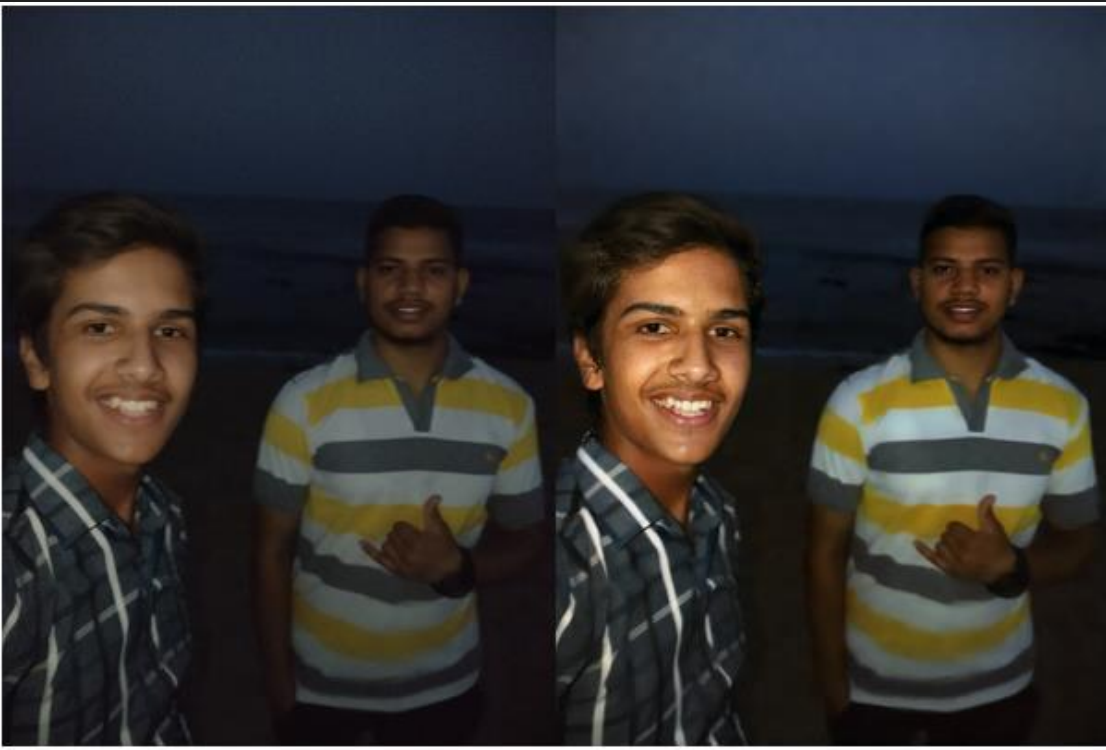
Use Case Diagram



Activity Diagram



# RESULT (Demo)



+ Code + Text

```
▶ filenames_upload = os.listdir(os.path.join(upload_path))
   filenames_upload.sort()

   filenames_upload_output = os.listdir(os.path.join(upload_output_path, "final_output"))
   filenames_upload_output.sort()

   for filename, filename_output in zip(filenames_upload, filenames_upload_output):
       image_original = PIL.Image.open(os.path.join(upload_path, filename))
       image_restore = PIL.Image.open(os.path.join(upload_output_path, "final_output", filename_output))
       |
       display(make_grid(image_original, image_restore))
       print("")
```





# RESULT (Contd.)

co

Restoration Of Degraded Images.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Table of contents

Restoration of Degraded Images Using VAE and GAN

Verify Runtime Settings

Git clone

Set up the environment

Run the code

Restore photos (normal mode)

Restore the photos with scratches

Try it on your own photos!

Visualize

Download your results


Section

+ Code + Text


```
filenames = os.listdir(os.path.join(input_path))
filenames.sort()

for filename in filenames:
    print(filename)
    image_original = PIL.Image.open(os.path.join(input_path, filename))
    image_restore = PIL.Image.open(os.path.join(output_path, 'final_output', filename))

    display(make_grid(image_original, image_restore))
```



e.png



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# CONCLUSION

In this project, degraded images are synthesized and restored so as to produce a relatively fresh image.

The degradations that are dealt with are as follows:

- Noise
- Optical Blur
- Motion Blur
- Black and white Images (Lack of color)
- Granular defects
- Scratches and deliberate latent spaces
- Low resolution

Our project can be used in a few fields such as restoring images taken by minute cameras for scientific research purposes, restoration of household and personal images degraded over time, images taken in faulty conditions, images taken by cameras with low capacity, etc.



The background is split horizontally. The top half is teal with a fine, light-colored diagonal line pattern. The bottom half is solid black. A white, jagged line separates the two, resembling a torn piece of paper or a stylized horizon.

**Thank you**