SUPERVISOR: DR MARIA SIDDIQUA

# IMAGE RESTORATION USING TRANSFORMERS

By Moiz Farooqui

ROLL NO: 23K-804

# Abstract

Sand image restoration is vital in deep learning and computer vision, especially for autonomous vehicles and satellite applications like environmental planning and disaster response. Traditional methods using CNNs and GANs perform well but struggle with capturing global context. This thesis explores transformer-based models for sand image restoration, leveraging their self-attention mechanism for improved feature learning. A synthetic dataset simulating sand degradation is created, and a Pix2Pix GAN baseline model is implemented.

# Introduction

With the rise of autonomous vehicles and satellite imaging, the need for effective image restoration is growing rapidly. Environmental factors like sand and dust degrade image quality, impacting systems that rely on visual data for decision-making. This research aims to develop an efficient model to restore sand-degraded images, enhancing the reliability of autonomous systems

# Research Problem

The growing demand for high-quality image restoration in real-world applications, especially autonomous vehicle systems.

Weather conditions like rain, fog, and motion blur degrade image quality, leading to potential navigation errors.

This degraded images effects the performance of autonomous systems, therefore image restoration is a very pivotal task to maintain continuous and reliable operation.

# Scope of Work

## Y

Synthetic datasets are prepared by adding sand like noise to make real world images as sand degraded images to simulate the real-world degradation

## $X^1$

a baseline model consisting of GANs (Pix2Pix and CycleGAN) based architecture is implemented for image restoration.

## $X^2$

we will implement the vision transformer-based image restoration model to address the limitations of GANs.

# Methodology

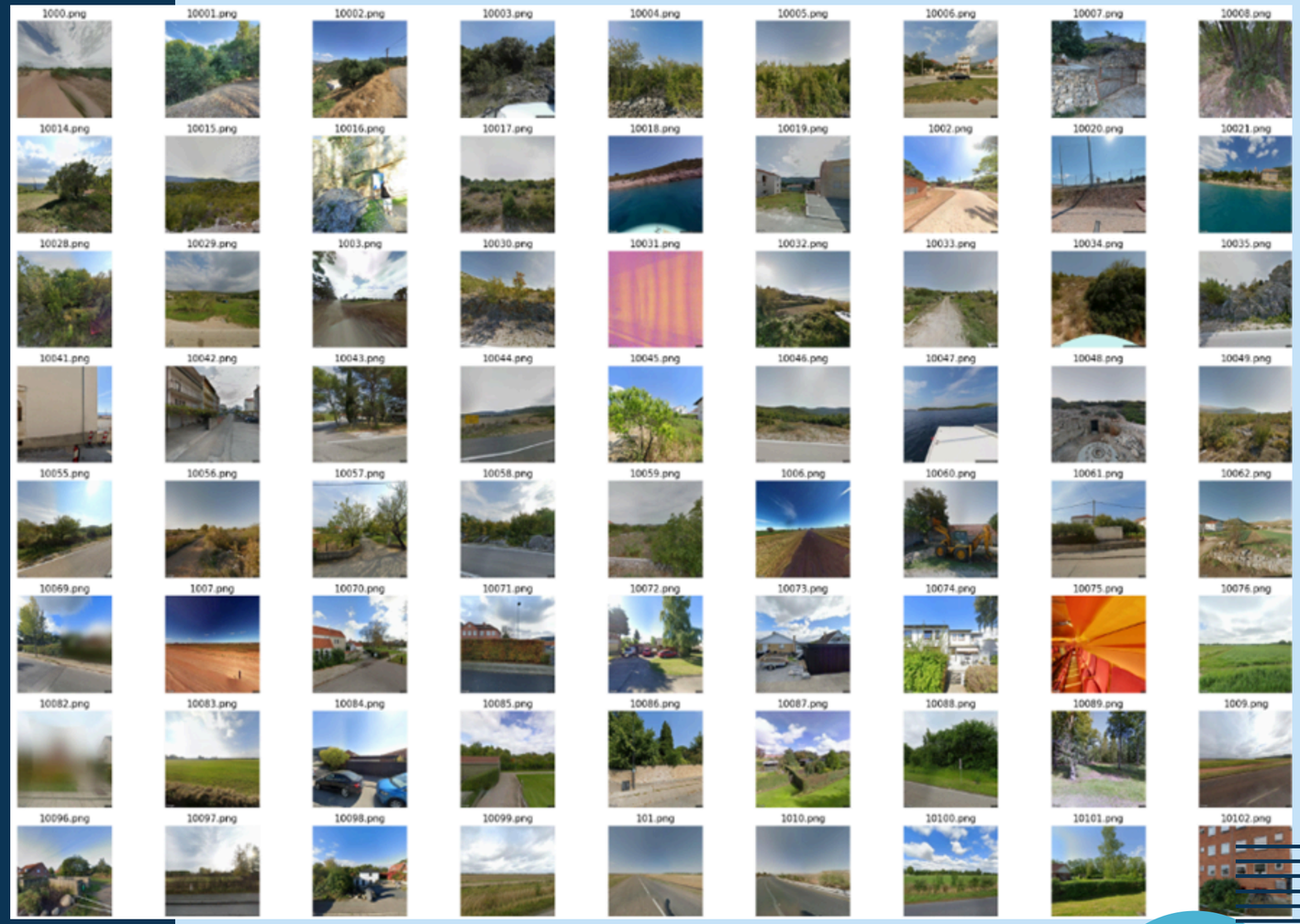
**Data Collection**

Google Streetview Dataset has been used for implementation of our models . It consists of around 23000 images.  . The data has been synthesized by adding sand effect to make the images look like sand degraded images

**Model Implementation**

In this model we have trained conditional generative adversarial network (cGAN) called pix2pix that learns a mapping from input images to output images

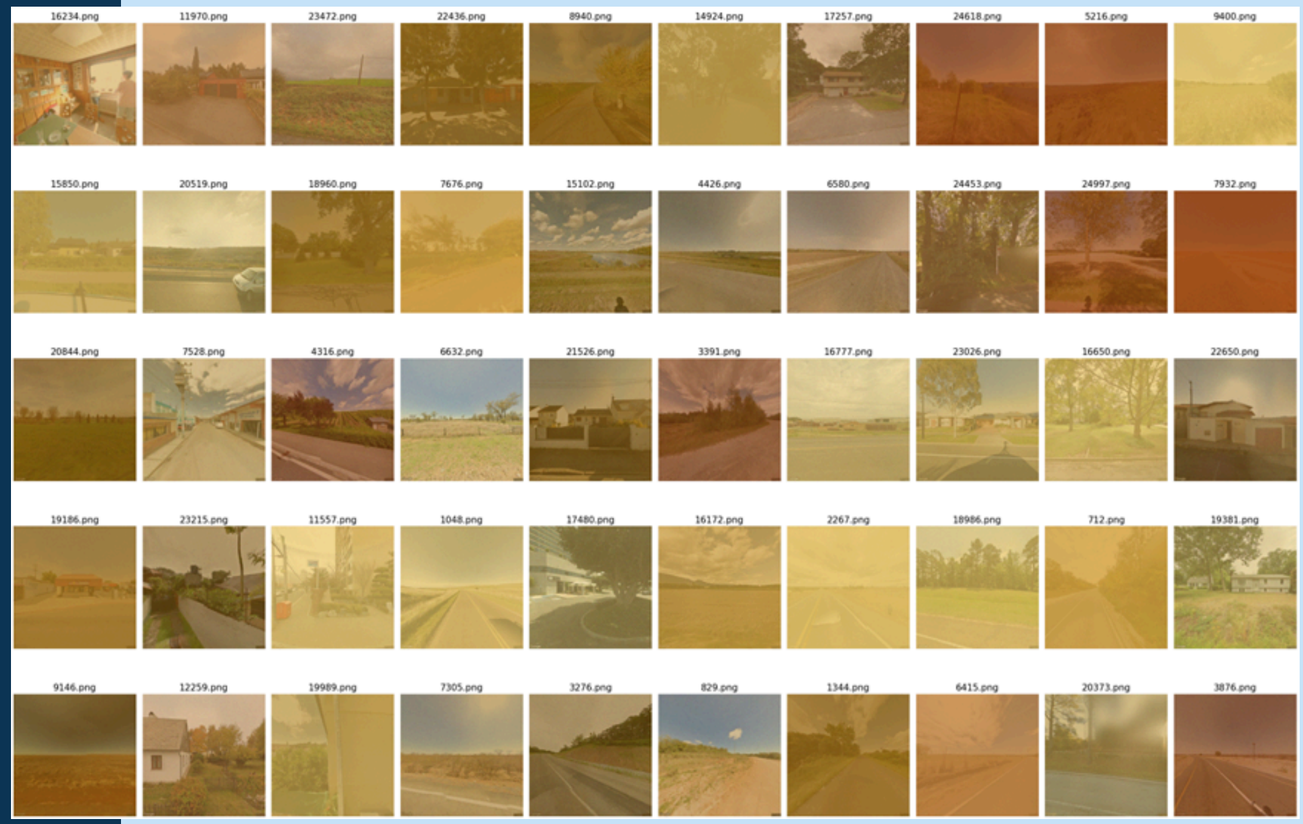
# Data Collection



A sand like effect is added to the images by applying gaussian noise, gaussian blur and different shades of tints given in the below table.

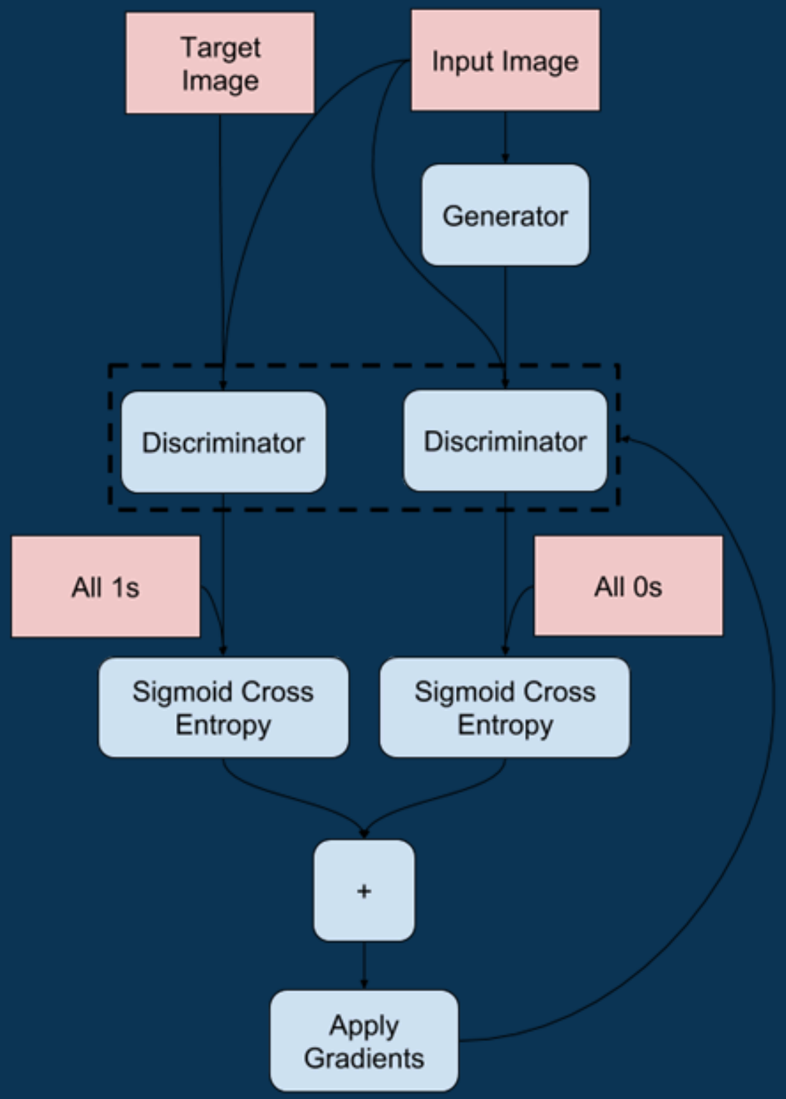
| S.no | RGB Array | HEX Code | Shade | Color |
|---|---|---|---|---|
| 1 | (204, 166, 122) | #CCA67A | Sand yellow / Light dusty sand | |
| 2 | (161, 74, 26) | #A14A1A | Rusty sand / Dusty reddish brown | |
| 3 | (198, 133, 61) | #C6853D | Dusty tan / Sandstone | |
| 4 | (242, 204, 102) | #F2CC66 | Pale sand / Light sandy beige | |
| 5 | (217, 166, 64) | #D9A640 | Golden sand / Rich sandy gold | |
| 6 | (166, 115, 26) | #A6731A | Earthy sand / Brownish dust | |
| 7 | (153, 102, 13) | #99660D | Dark sand / Dusty ochre | |

# Sand Degraded Images



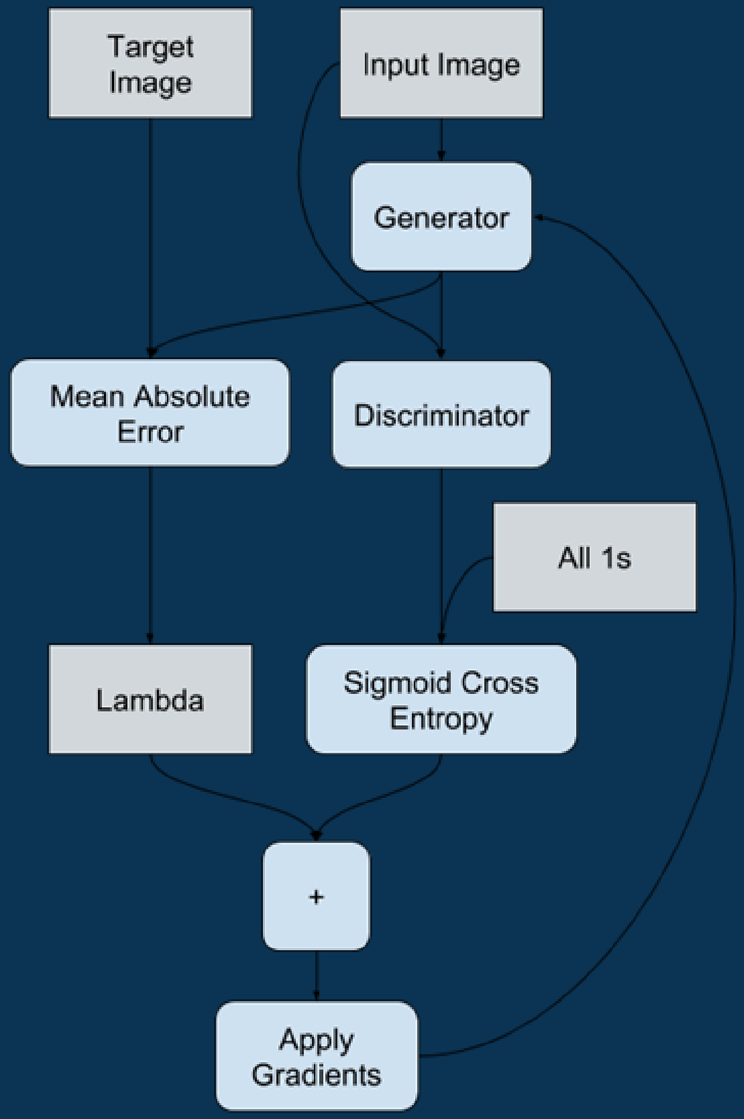
# Implementing Baseline Model (Pix2Pix)

- Creating Input Pipeline
- Build the Generator
- Build the Discriminator
- Training




## Generator

## Discriminator



# Findings

**PSNR(Peak Signal to Noise Ratio**

54.55 dB
Excellent

Very low noise and high pixel accuracy

**SSIM(Structural Similarity Index Metric)**

0.9756
Near to real

Strong preservation of structure and details

**Restored Images**

Significant Dust Removal

Preservation of Structural Details

Remaining Grain Artifacts and Sharpness Issues

# Restored Images

# Conclusion

It has been seen that GANs are effective in image restoration tasks and when we applied the baseline model to our sand effected images it restores and were efficient on our test dataset and gave us promising results but still have some limitations . We look forward to implementing transformer based models comprising vision transformers to see the difference of restored images

Salford University

# Thank You

By Samira Hadid

Faculty Of Engineering - 2030