

Super Resolution Image Processing using GenAI

Mrunmayee Ruchi Udit

WE Cohort V

June 2, 2024

About

- ▶ Image Super-Resolution enhances image resolution by 4x+. Its various applications include improving image quality, enhancing visual detail, and increasing the accuracy of computer vision algorithms.

Data Processing Inequality

- ▶ According to Information Theory , whatever way we process data we cannot add information that is not already present.
- ▶ This implies that missing data cannot be recovered from further data processing.

Use of AI

- ▶ This is where Neural Networks enter the picture. These are trained on a large set of images and learn to hallucinate details based on this prior information.
- ▶ The details thus added do not violate the data processing inequality.

What are Neural Networks

- ▶ An artificial neural network is made of artificial neurons that work together to solve a problem. Artificial neurons are software modules, called nodes, and artificial neural networks are software algorithms that use computing systems to solve mathematical calculations at core.



Layer	Description
Input Layer	Receives external information
Hidden Layer(s)	(Optional) Processes information from previous layers
Output Layer	Provides final result

Convolutional Neural Networks

- ▶ The hidden layers in convolutional neural networks perform specific mathematical functions, like summarizing or filtering, called convolutions.
- ▶ They are very useful for image classification because they can extract relevant features from images that are useful for image recognition and classification.
- ▶ This new form is easier to process without losing features that are critical for making a good prediction. Each hidden layer extracts and processes different image features, like edges, color, and depth.

SRCNN

- ▶ Super-Resolution Convolutional Neural Network : a pioneering deep learning model designed for image super-resolution
- ▶ Enhances the resolution of images by learning end-to-end mappings from low-resolution to high-resolution images using convolutional neural networks
- ▶ comprises three key steps: patch extraction and representation, non-linear mapping, and reconstruction

Loss Functions

- ▶ It's a mathematical function that quantifies the difference between a model's predictions and the actual target values.
- ▶ Lower scores indicate the model's doing well. The loss function uses this difference to tell the model how to adjust itself. By minimizing the loss, the model learns to make more accurate predictions.

Choosing the right loss function

- ▶ MSE: Focuses on pixel-level differences between the generated image and the ground truth (actual high-resolution image). It calculates the average squared difference between corresponding pixels.
- ▶ SSIM: Goes beyond pixel values and considers structural similarity. It analyzes the image in terms of luminance (brightness), contrast, and structure, providing a more human-centric evaluation of image quality.
- ▶ A new, differentiable error function specifically designed for image restoration tasks which aims to combine the benefits of both MSE and perceptual losses lead to significantly better image restoration results.

GANs

- ▶ Its a powerful architecture which works on the principle of constant competition between two neural networks
- ▶ Generator: This network acts like an artist, constantly trying to create new, realistic images that could be mistaken for real examples.
- ▶ Discriminator: This network acts like a critic, meticulously analyzing the data generated by the generator and trying to distinguish it from real data.

Demo

Intersting Usecase

- ▶ Pixel 3 uses Super resolution for better Zoom effect
- ▶ Statement from an article,"The Super Res Zoom technology in Pixel 3 is different and better than any previous digital zoom technique based on upscaling a crop of a single image, because we merge many frames directly onto a higher resolution picture"
- ▶ thus zoom option becomes better than cropping the image afterwards

Algorithm used

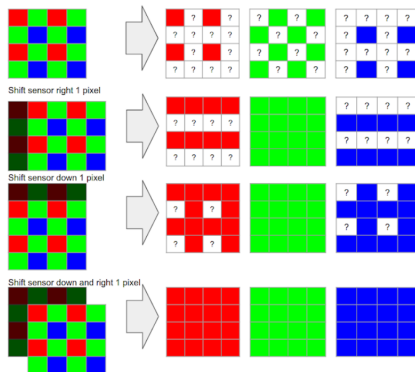


Figure: This algorithm is used to completely fill the pixels.

Any questions?