Khalil TABAKH

Report

Image Super-Resolution via Iterative Refinement

https://ieeexplore.ieee.org/document/9887996

Importance of the Paper

The paper "Image Super Resolution via Iterative Refinement" presents a method called SR3 for enhancing image quality. A key innovation of this paper is the use of denoising diffusion models (DDPM) in image super resolution. The approach involves adapting DDPMs for translating images by employing a U-Net structure trained on denoising tasks at different noise levels. The model refines images step by step starting from Gaussian noise to generate high resolution outputs based on low resolution inputs. This paper is important as it can create high resolution images with better performance compared to traditional GAN based techniques, making it a significant advancement in image enhancement and generation.

What was implemented

In the code provided (refer to main.py), a Conditional Denoising Diffusion Model (DDPM) is implemented for image super resolution following the principles outlined in the SR3 method discussed in the paper. The implementation includes components such as;

- **U-Net Architecture**: A structured model, with an encoder decoder design, is used to handle denoising tasks. The U Net architecture plays a role in processing images at different noise levels during the refinement process.
- **Conditional DDPM Model**: The ConditionalDDPM class, which extends tf.keras.Model, includes functions, for both forward and reverse diffusion processes. It utilizes the model U-Net along with diffusion parameters such as beta schedules and cumulative product of alpha values which are essential for the denoising process.
- **Forward Diffusion Process**: The method forward_diffusion introduces Gaussian noise to the high resolution image across multiple time steps to mimic the degradation process.
- **Reverse Diffusion Process**: The reverse_diffusion function leverages the U-Net to predict and eliminate noise from the image progressively refining it back to its high resolution form.
- **Data Preparation**: The CIFAR 10 dataset is prepared by normalizing images and organizing them into batches for the training. The model undergoes compilation with an optimizer and is trained on the preprocessed dataset.
- **Training Procedure**: The train_step function executes a training step, computing loss based on the variance between predicted noise and actual noise introduced during diffusion.
- **Generating Images**: Through the generate_high_res_images function, high resolution images are generated from low resolution inputs using the trained model. The process commences with an image and iteratively enhances it to produce high quality outputs.