Image Deblurring Using Autoencoders

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Abstract

Image deblurring is a significant challenge in the field of computer vision, aiming to recover sharp images from their blurred counterparts. This project explores the application of autoencoders[3], a class of neural networks known for feature learning, in addressing this challenge. By encoding an image to a lower-dimensional space and subsequently decoding it, our approach seeks to reconstruct the original image with reduced blur, thereby enhancing its quality and usability.

1 Introduction

The problem of image blurring occurs in various real-world scenarios, often resulting from motion during capture or focus issues. Such degradation not only diminishes the visual appeal of images but can also impair their analysis for both human observers and computer vision algorithms. Motivated by the potential of autoencoders to learn and replicate complex data distributions, this project investigates their efficacy in deblurring images.

2 Methodology

The core of our solution lies in an autoencoder model that learns to reconstruct sharp images from their blurred versions. The model architecture includes four convolutional layers for encoding and corresponding deconvolutional layers for decoding[4]. Training utilizes the Mean Squared Error (MSE) loss to quantify pixel-wise discrepancies between the reconstructed and original images, optimized using the Adam optimizer.

2.1 Datasets

Our model underwent training on diverse datasets, including CelebA, HIDE, and Wide-face, employing incremental learning techniques to enhance its generalizability across different image types and blurring patterns.

2.2 Evaluation Metrics

The model's performance was evaluated using several metrics[1]:

- Mean Squared Error (MSE) for pixel-wise accuracy.
- Peak Signal to Noise Ratio (PSNR) to assess contrast fidelity.[2]

- Structural Similarity Index (SSIM) for perceived image quality, focusing on changes in structural information, luminance, and contrast.

3 Results

Evaluation on the test split of our datasets revealed promising outcomes, with PSNR and SSIM values indicating a notable improvement in image clarity and quality. The model demonstrated an ability to significantly reduce blurring, as evidenced by quantitative metrics and qualitative assessments of reconstructed images.

Dataset	PSNR	SSIM	MSE
CelebA	19.9094	0.7404	0.002
GoPro	23.7087	0.8146	0.001
TextOcr	23.9223	0.8338	0.001
Helen	27.1433	0.8933	0.001

Figure 1: Table of results of our experiments on different datasets

4 Applications

The deblurring technique presented holds potential for wide-ranging applications, from enhancing photographic images and medical imaging to improving astronomical imagery. By facilitating clearer images, our approach can aid in more accurate analysis and interpretation across these fields.

5 Conclusion

This project underscores the potential of autoencoders in the domain of image deblurring, offering a promising avenue for enhancing image quality across various applications. Future work may explore the integration of more sophisticated autoencoder architectures and training strategies to further refine the deblurring performance.

References

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