REPORT ON

Denoising Images

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Introduction

Background and Objective

Image denoising is a crucial preprocessing step in various computer vision applications, aimed at enhancing the quality of images by removing noise. This project focuses on developing a convolutional neural network (CNN) model from scratch for image denoising, avoiding the use of pre-trained models. The primary goal is to train the model on a dataset of noisy and clean images, evaluate its performance using metrics such as Mean Squared Error (MSE), Peak Signal-to-Noise Ratio (PSNR), , and produce denoised images for a test set.

Architecture Used

The architecture used in this project is a simple yet effective CNN designed specifically for denoising tasks. The model consists of several convolutional layers followed by max-pooling and up-sampling layers to capture both the local and global features of the image. The key specifications of the architecture are:

- **Input Layer:** Takes a grayscale image of size 128x128.
- **Convolutional Layers:** Three convolutional layers with 64, 32, and 32 filters, respectively, all using a 3x3 kernel size and ReLU activation.
- **Max-Pooling Layers:** Two max-pooling layers to down-sample the feature maps, reducing the spatial dimensions by half.
- **Up-Sampling Layers:** Two up-sampling layers to restore the original image dimensions.
- **Output Layer:** A convolutional layer with a single filter and sigmoid activation to produce the final denoised image.

Performance Metrics

The performance of the model is evaluated using the following metrics:

- **MSE (Mean Squared Error):** Measures the average of the squares of the errors between the denoised and original images.
- **PSNR (Peak Signal-to-Noise Ratio):** Measures the ratio between the maximum possible power of a signal and the power of corrupting noise. Higher PSNR indicates better quality.

The PSNR value achieved by the model on the training dataset is a key indicator of its performance.

Implemented Paper

This project is inspired by various research papers in the field of image denoising. One notable paper is "Image Denoising by Sparse 3D Transform-Domain Collaborative Filtering" by K. Dabov, A. Foi, V. Katkovnik, and K. Egiazarian. The paper presents an advanced denoising algorithm based on collaborative filtering in a 3D transform domain, known as BM3D. While our model does not directly implement BM3D, it leverages similar principles of capturing spatial correlations in images. The paper can be accessed here.

Project Details

Data Preparation

The first step in the project involves loading and preparing the dataset. We load grayscale images from a specified folder, resize them to 128x128 pixels, and normalize their pixel values to the range [0, 1]. We then add Gaussian noise to these images to create the noisy versions used for training.

Model Architecture

The CNN model for denoising is constructed using Keras. It consists of multiple convolutional layers with ReLU activation functions, followed by max-pooling and up-sampling layers. The model's architecture is designed to effectively capture and restore the spatial details of the images.

Training the Model

The model is trained on the noisy and clean image pairs. We use a training set split of 80% for training and 20% for validation. The model is trained for 50 epochs with a batch size of 32.

Evaluation and Results

After training, we evaluate the model's performance on the training set using MSE, PSNR, and MAE. The evaluation metrics provide insights into the model's effectiveness in removing noise and restoring image quality.

Predicting on Test Set

We use the trained model to predict denoised images for the test set. The denoised images are saved in the specified output folder.

Summary

Findings

- **MSE, PSNR, and MAE**: The model achieved respectable scores for MSE, PSNR, and MAE on the training dataset, indicating effective denoising performance. Specifically, the PSNR value was found to be sufficiently high, reflecting good image quality restoration.

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  MSE: 0.007677697876355885
  ```

  ```
  PSNR: 21.14768981722792
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- **Architecture Performance**: The simple CNN architecture with convolutional, max-pooling, and up-sampling layers proved effective for the denoising task