Analysis and Verification of MemNet for Image Restoration

Parul Gupta, Apurbaa Bhattacharjee, Bastin Joseph
{pgupta52,bhattachar26,bjoseph5}@wisc.edu
University of Wisconsin-Madison

Abstract

We present a study of the MemNet model which performs 3 tasks: image denoising, JPEG deblocking and super resolution image generation. This model tackles the image restoration problem by using a recursive block which has both long term and short term memory blocks. These blocks help in achieving persistent memory in the model. We also perform stress testing on the model. We will also test the model on different dataset to understand how well the model will generalize with data from other types of datasets.

1. Introduction

Image restoration[6] is a classical computer vision problem. It is the process of recovering original noise-free image from a corrupted one. Often when we capture an image, the image acquisition process can be affected by several external factors like motion-blur due to camera shake, motion due to scene objects, artifacts in low light scenes, noise, blur etc. This leads to corruption in the acquired image. With huge advancements in digital photography and rise in the number of digital images, there is an increasing need to have efficient techniques to obtain noise free and high resolution images. With extensive literature survey, it has been established that the process of image restoration can be divided into separate problem statements like image denoising, image super-resolution and JPEG deblocking.

Image denoising is the technique of removal of white Gaussian noise of standard deviation σ from a noise-corrupted image to obtain a latent clean image. Image super-resolution is the process of conversion of a low-resolution image to a high-resolution image. JPEG compression is a lossy image compression technique which results in loss of image information. When the compression factor is high, the information loss in the images will appear as blocking artifacts in the compressed image. JPEG deblocking is an algorithm used to remove these artifacts.

MemNet [1] model by Tai et al. presents a model that looks at all the three image restoration problems all at once. In the project we intend to understand and analyze this model in depth and look into future applications of this image restoration model.

2. Problem Statement

The problem statement for this project is to restore an image using using three image restoration tasks - image denoising, super-resolution and JPEG deblocking. Given a low quality corrupted image the proposed solution will perform a feature extraction on it, then pass on the extracted features to a densely connected structure to convert the image to a high resolution image. Then a reconstruction network based on a residual network is used to get the uncorrupted image.

3. Motivation

Images are captured from areas ranging from professional photography to astronomy, surveillance, remote sensing, biomedical imaging etc. Interference in camera, varying lighting conditions like low light, extreme low light, different exposure ranges and external factors can often cause blurring and corruption of captured images. Image reconstruction has been a widely explored and researched topic in the field of computer vision. This problem statement is critical because this forms the premise for any aforementioned applications which need to make use of these images. It is highly essential that we remove the image corruption and improve the resolution of these images so that they can be efficiently used in ongoing research, academia and industrial applications.

4. Current State-of-the-Art

Image Denoising : In [2], Cheng et al. proposed to use patch guided internal clustering algorithm for image denoising. It utilizes Gaussian mixture model learning to guide the clustering of noisy images followed by an approximation process to estimate the subspace for image recovery. Zhang et al. [3] introduced the concepts of short-term and restricted long-term memory by making use of skip connections to pass information through the layers of the network.

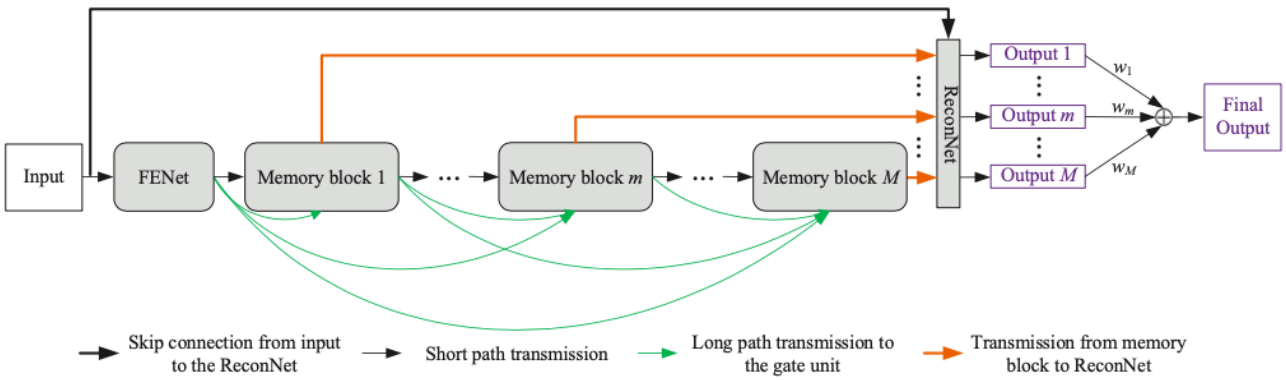

Figure 1. MemNet [2] architecture diagram

Single Image Super Resolution : Mao et al. [4] introduced symmetric skip connections into a 30-layer convolutional auto-encoder network for image denoising and single image super resolution.

JPEG Deblocking : In [5], Dong et al. introduced an extended convolution network called Artifacts Reduction Convolutional Neural Networks (ARCNN) for removing the JPEG compression artifacts effectively.

5. Are you planning on re-implementing an existing solution, or propose a new approach?

Our aim is to implement and understand the functioning of the MemNet model in depth.
We also plan to understand the application of this model results on other applications which require higher resolution images. For example, autonomous driving application which would capture low quality image but accurate detection of objects is crucial for this application.
We intend to analyze the generalization of the MemNet model to other generic datasets. This will help us understand how well the model is able to learn scaling up generic features in an image.
We will also perform stress test on the model to identify the weak points from within the train/test dataset where the model will break. This will help in in-depth understanding of model drawback that we need to work on improving.

6. If you are proposing your own approach, why do you think existing approaches cannot adequately solve this problem? Why do you think you solution will work better?

Our initial aim is to learn and implement the baseline MemNet [1] architecture for these image restoration tasks. Although we are not proposing our own architecture at this time, but we wish to couple this architecture with existing state-of-the-art object detection models like YOLO [7] and compare the result of detection with and without this image restoration block. Our goal is to evaluate the performance of MemNet as an image pre-processing block in computer vision models.

7. Project Timeline

Milestone 1
Mar 13, 2020 : Complete implementation/bring up of the model
Milestone 2
April 10 : Complete stress testing of MemNet model
Milestone 3
May 4 : Complete testing other datasets on MemNet model

8. Evaluation Metric

We are trying to make a qualitative analysis of how well the model generalizes to other datasets and existing deep learning models.

References

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