Machine Learning Engineer Nanodegree

Capstone Proposal

Emile Papillon,

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Domain Background

One aspect of machine learning that I find fascinating is that contrary to most algorithms, ML algorithm are able to add missing information to some input. For example, when we use a classifier on an image we are adding a label, which provides additional information. A less common area where we can apply this principle is the reconstruction of deteriorated signals. In signal processing theory, the signal-to-noise ratio defines how much information can be retrieved from a given signal. By learning some patterns in signals, ML models are able to improve the SNR.

Typically, when information is lost it can no longer be recovered. ML algorithms can achieve signal recovery by learning patterns in certain signals. In this Capstone project I want to apply this to degraded images like blurred photographs. Improving the quality of degraded images has a wide spectrum of applications like recovery of lower quality images transmitted over the network in-situ on ultra high definition monitors equipped with computing devices capable of performing the recovery, or improving the quality of images taken by security systems.

Problem Statement

As photographers, sometimes we get disappointed when we view our photos or video footage on a large screen. An image that we were convinced was crisp isn't so sharp when enlarged. To solve this, some people are using machine learning to recreate the image to add back the information lost by the blurr. There are applications available to correct photos using machine learning but since these applications were launched, significant progress has been made in the field of image restoration.

Datasets and Inputs

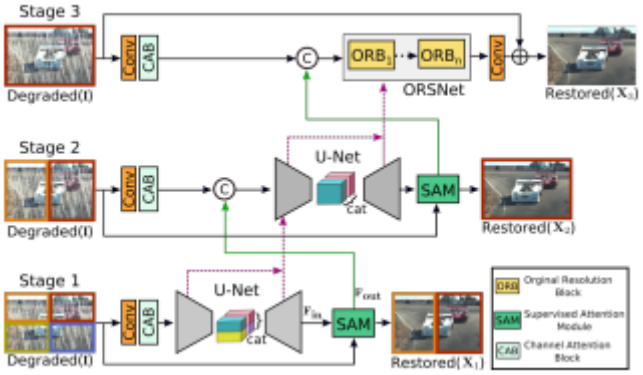
To train the model, the GoPro dataset is used. The data contains 2103 training pairs (clean - blurr).

The inputs to test our model will be images taken from blurry video and blurry photos taken with a DSLR camera. They will be resized to a size of 720 × 576 pixels, so that it will be easier to transfer them to an AWS endpoint. On the endpoint, additional preprocessing is done to match the dimensions expected by the model. Then, the images will be enhanced and returned back to the user.

Solution Statement

Image recovery benefits from contextualized information as well as special details. These two levels of information must be brought into a single model which leverages CNNs as a means to capture localised details and original resolution blocks (ORBs) to capture contextualised high resolution information. In this model, the information processing is not only sequential but there is also exchange of information in parallel between the different stages, as illustrated below in figure 1.

The architecture shown in [1] and reproduced in figure 1. will be used for the model.



We propose to use this multi-stage state-of-the-art model capable of capturing features at a high level, but also at a localised scale, to de-blur photographs, and possibly videos. The model will be uploaded to Amazon S3 and an endpoint will be created. A Web application will allow a user to upload data and retrieve an enhanced version of their photos or videos.

Benchmark Model

The benchmark will be the demo script in https://github.com/swz30/MPRNet on the same image, and ensuring that we can obtain a similar variance of the Laplacian. This will be compared with the result we are getting from the web app.

Evaluation Metrics

We will quantify blurr with the variance of a Laplacian as explained in https://www.pyimagesearch.com/2015/09/07/blur-detection-with-opencv/ The results of implementing the web-app will be compared between original images and de-blurred ones.

Project Design

is implemented in PyTorch and what we propose to do is to deploy this model to a Web Application, allowing a user to input a photo or perhaps a video and improve its quality.

References

[1]: Multi-Stage Progressive Image Restoration, Syed Waqas Zamir and Aditya Arora and Salman Khan and Munawar Hayat and Fahad Shahbaz Khan and Ming-Hsuan Yang and Ling Shao, CVPR, 2021