Reflection Remover

CS 2364 Final Project By Jivansh Sharma

https://github.com/parzuko/deflect

Summary:

Deflect intends to be a tool for removing reflection from uploaded images.This project leverages both traditional image processing techniques, such as averaging and filtering, and advanced deep learning models to identify and subtract reflection components from images.

The final product will (hopefully) be a website where users can upload photos with unwanted reflections (e.g., through windows), and the system will process and return the cleaned images.

Task List:

Core Objectives:

1. **Literature Review and Algorithm Selection**: Study existing methods for reflection removal, focusing on averaging techniques for simple scenarios and deep learning models for complex cases.
2. **Development of Image Processing Backend**: Implement a basic image processing algorithm for reflection removal using averaging and filtering techniques in Python, using libraries like OpenCV.

Nice-to-Haves (If Time Permits):

1. **Integration of Deep Learning Model**: Select and train a deep learning model suitable for reflection removal on more complex images. Consider pre-trained models or datasets available for fine-tuning.
2. **Web Application Development**: Develop webapp (NextJS frontend, Flask Backend) that allows users to upload images and view the results.

Fast Single Image Reflection Suppression via Convex Optimization

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Abstract

Removing undesired reflections from images taken through the glass is of great importance in computer vision. It serves as a means to enhance the image quality for aesthetic purposes as well as to preprocess images in machine learning and pattern recognition applications. We propose a convex model to suppress the reflection from a single input image. Our model implies a partial differential equation with gradient thresholding, which is solved efficiently using Discrete Cosine Transform. Extensive experiments on synthetic and real-world images demonstrate that our approach achieves desirable reflection suppression results and dramatically reduces the execution time.

1. Introduction

Images taken through glass usually contain unpleasant

(1a) Original Image (1b) Dereflected Image

Figure 1: (1a): A real-world image taken through the window on a train. Notice the reflection of the seat and the lights in the train. (1b): The result after the reflection suppression by our proposed method. Image size: 1080 × 1440. Execution time: 1.15s. https://github.com/yyhz76/reflectSuppress

layers, *suppressing* the reflection in a single input image,

what we are solving

Removing undesired reflections from images taken through the glass.

It serves as a means to enhance the image quality for aesthetic purposes as well as to preprocess images in machine learning and pattern recognition applications

The model implies a partial differential equation with gradient thresholding, which is solved efficiently using Discrete Cosine Transform. Extensive experiments on synthetic and real-world images demonstrate that our approach achieves desirable reflection suppression results and dramatically reduces the execution time

Reflection Remover

This project was built for CS-2364 as the final project submission. It is a code based implementation of Fast Single Image Reflection Suppression via Convex Optimization. Upload an image below and try it!

Upload Image

Set the params and remove reflections!

H Value

Enter a threshold value between 0 and 1

Picture

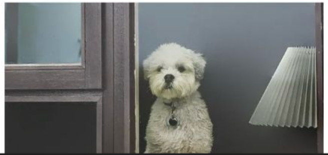
Choose file No file chosen

✨ Remove Reflections

Example Images

Below are a few examples of images from the white paper, depicting synthetically generated reflections on images and the corresponding h value which was used to remove them



the problem

Images taken through glass usually contain unpleasant reflections. It is highly desirable if such reflections can be removed. In particular, with the advent of the popularity of portable digital devices such as smartphones and tablets, a lot of such images are taken in everyday life.

A fast-response and user-friendly image reflection suppression technology is of great practical significance so that such images can be processed on portable devices in seconds with the best dereflected results produced in real-time according to a user's visual perception

other work

Reflection removal using multiple images generally achieves better performance than that using a single image since information across images can be exploited to improve layer separation results. However, these approaches usually requires special settings such as images taken from certain angles and locations, or special devices such as polarizers and flashes, which significantly limit their practicality

Instead of separating layers propose to suppress the reflection in a single input image using Laplacian-based data fidelity term and gradient sparsity prior, which achieves desirable quality of dereflection but is not quite efficient due to the fact that their model is non

Other latest methods include deep learning strategies (Fan et al. [4]), and nonlocal similar patch search (Wan et al. [20]). However, either extra network training time or external image datasets are required

- Our proposed model is convex. The solution is guaranteed to be the global optimal of the model.
- The optimal solution is in closed form and doesn't rely on iterative algorithms. It is obtained through solving a partial differential equation, which can be done efficiently using Discrete Cosine Transform.
- Our method doesn't require any external dataset ortraining time as in the aforementioned neural network approaches.

$$Y = T + R$$

The input reflection-contaminated image Y,

The transmission layer T (the true background) and the reflection layer R (both are unknown)

Multiple ways of separation are possible. Different priors and assumptions have been introduced to narrow down the range of valid solutions, despite specific limitations therein. Instead of separating the image into two layers, suppressing the reflection in a single input image

Also, perfect layer separation of a single image is in general difficult

We propose an image reflection suppression approach that is highly efficient, which is able to process large smartphone images in seconds, yet can achieve competitive dereflection quality compared to state-of-the-art approaches

(1a) Original Image

(1b) Dereflected Image

proposal

Our proposed model relies on the assumption that the camera focuses on the transmission layer (i.e., the objects behind the glass) so that sharp edges appear mostly in this layer. On the other hand, the reflection layer (i.e., the reflection off the surface of the glass) is less in focus so that edges in this layer are mostly weaker than those in the transmission layer

$$Y = wT + (1 - w)(k * R)$$

Y = input image

T = Transmission Layer

R = Reflection Layer

w is parameter which measures weigh between 2 layers

k is guassian blurring kernel (A Gaussian blurring kernel is **a square array of pixels that is used to blur an image with a Gaussian blur effect**. The pixel values in the kernel correspond to the values of a Gaussian curve, also known as a normal distribution or bell curve.)

$$\min_T \left(\frac{1}{2} \| L(T) - \mathrm{div}(\delta_h(\nabla Y)) \|_2^2 + \frac{\epsilon}{2} \| T - Y \|_2^2 \right)$$

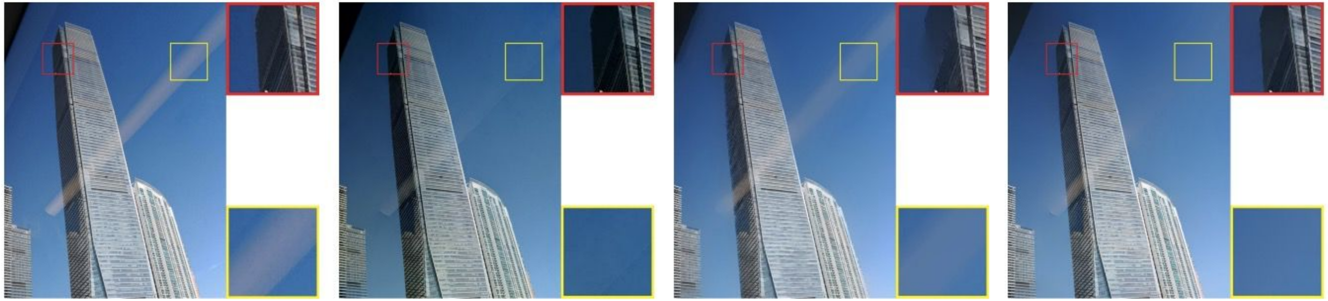
Algorithm 1 **Image Reflection Suppression via Gradient Thresholding and Solving PDE**

Input: $\mathbf{Y}, h, \varepsilon$

return $T_{m,n} = \mathcal{F}_c^{-1}\left(\frac{[\mathcal{F}_c(\mathbf{P})]_{m,n}}{K_{m,n}^2 + \varepsilon}\right).$

Output: $\mathbf{T}$

(6i) Input 3 (6j) [12] (6k) [2], $\lambda = 0.01$ (6l) Proposed, $h = 0.1$



(6a) Input 1 (6b) [12] (6c) [2], $\lambda = 0.01$ (6d) Proposed, $h = 0.04$

time for website demo