DIP Project Proposal

Depth of Field Guided Reflection Removal

Team 001

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Github: https://github.com/ayush003/DoF-guided-reflection-removal/

Main Goals-
The main goal is to implement an algorithm which removes the undesired reflection component(s) from a given image, which may arise in situations where the image is captured through a transparent surface.

Problem Definition-
When taking photos through transparent surfaces, the captured pictures are usually a mixture of both the desired scene and undesired reflections. Our project aims at separating the desired scene from the undesired reflections using reflection removal techniques. Various methods have been proposed for achieving this target. In this project we focus on removing the reflection using a single image based on Depth of Field (DoF) confidence maps.

Our underlying assumption is the fact that the photographers always focus on the background in a particular depth when they take photos. Reflections in different depth layers would be blurred in the images. Thus, DoF, the distance between the nearest and farthest objects in a scene that appears reasonably sharp and can be used as an important feature to distinguish background and reflection edges.

We also observe that images with different resolution can exhibit different levels of details in the DoF map. Combining the assumption and observation, we develop a multi-scale inference scheme to select background and reflection edges to guide the reflection removal process.

<u>Results Of The Project-</u>

Our project has three main phases:

1. *Background Edge map generation*
2. *Reflection Edge map generation*
3. *Layer Reconstruction*

1. Background Edge map generation: The input image is first converted to the Lab color space. For each channel, we build one reference pyramid(b_r) with the same resolution as that of input image and three blurred pyramids(b_k) which are obtained by convolving the reference pyramid with kxk blurring filters(k = {3,5,7}). We find the KL divergence between the corresponding layers of b_r and b_k which is denoted as $D^n{}_k$ this is then used to calculate the DoF confidence maps corresponding to each channel as follows:

$$D^n(i,j) = \sum_{k=\{3,5,7\}} D^n_k(i,j), n = \{1,2,3\}.$$

The DoF confidence maps D^2 and D^3 are upscaled to the same size as D^1. The final DoF confidence map is obtained by combining the three DoF maps as follows:

$$D = (\lambda \cdot D^2 \uparrow + (1-\lambda) \cdot D^3 \uparrow) \odot (D^1),$$

Then, we rule out the pixels belonging to reflection components in the DoF maps and the salient edges for layer reconstruction are determined by:

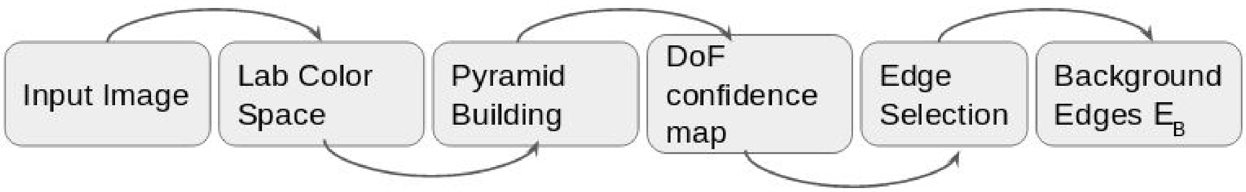
$$E_b = H(D - \tau_s)$$

where H is the Heaviside step function and τ_s is a threshold to determine the salient edges belonging to the background components.

Finally, the edge map of the background can be generated as follows:

$$E_B = \vee^3_{m=1} E^m_b$$

where $\vee$ denotes logical or and *m* is the channel number corresponding to {L, a, b}, respectively.



2. Reflection Edge map generation: We compute the gradient of the input image to get the initial reflection edges. In the gradient domain , we can obtain an initial reflection edge map based on the following threshold:

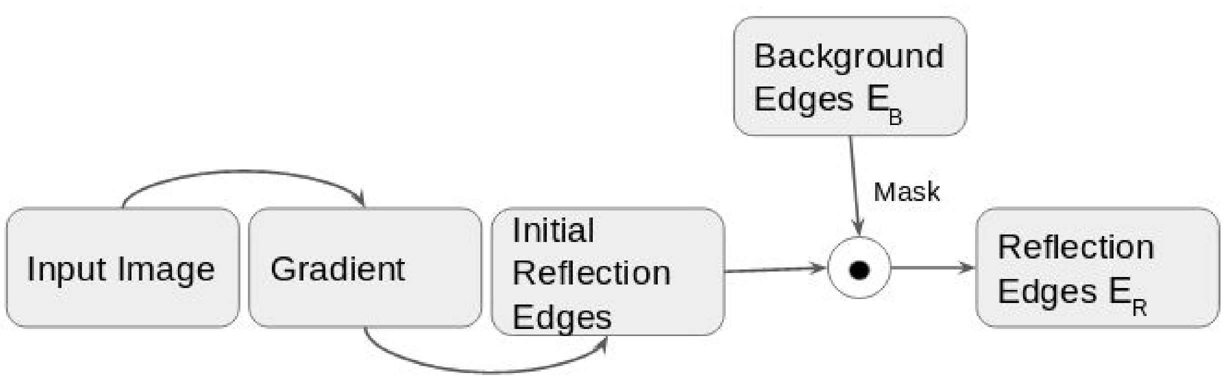
$$E'_R(i) = \begin{cases} 1, & \text{if } \tau_{r1} < g(i) < \tau_{r2} \\ 0, & \text{otherwise} \end{cases}$$

where g(i) is the gradient value of the input mixture image on pixel i.
To remove more tiny details from the background components, we create a mask by using an appropriate structuring element S to dilate the background edge map as

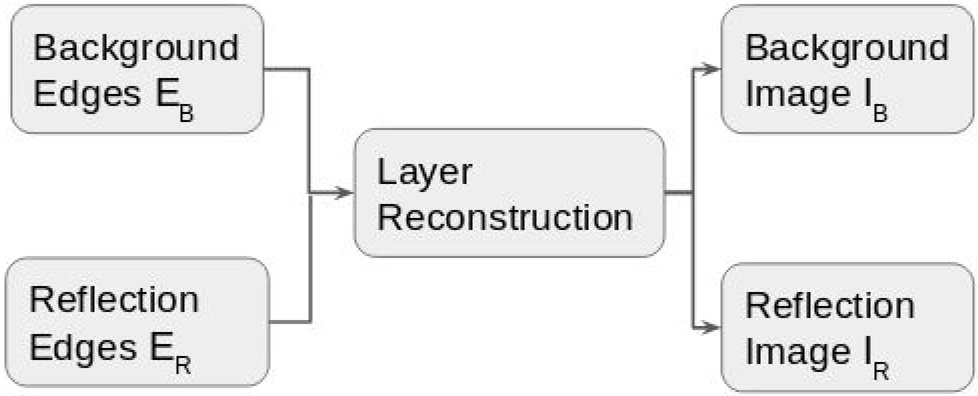
$$M = E_B \oplus S$$

Then we can reduce the artifacts in the initial reflection edge map as follows:

$$E_R = \overline{M} \odot E'_R$$



3. Layer Reconstruction: With the background and reflection edge maps generated before, the reflection and background layers can be separated based on an objective function.



Project Milestones and Expected Timeline-

Milestone	**Expected date of completion**
Proposal Submission	28/09/2019
Understanding and completing relevant research	05/10/2019
Background edge map generation (Implementation)	10/10/2019
Testing and Debugging	12/10/2019
Reflection edge map generation (Implementation)	17/10/2019
Testing and Debugging	19/10/2019
Layer Reconstruction (Implementation)	23/10/2019
Testing and Debugging	25/10/2019
Code integration and Final Testing	30/10/2019