DIP PROJECT PROPOSAL

TA Mentor: Abhishek Prusty

Team Name: Jougan

PROJECT ID AND TITLE

- ID : 25
- TITLE :

  Face Illumination Transfer through Edge-preserving Filters

  Link: (http://jinxin.me/downloads/papers/003-CVPR2011/CVPR2011-CameryReady.pdf)

GITHUB LINK AND TEAM MEMBERS

- Github Link: (https://github.com/saisoorya2000/DIP_Project)

- Name: SAI SOORYA RAO VEERAVALLI
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  Roll no: 20171105

MAIN GOAL OF THE PROJECT

- Our Main objective is to generate photo-realistic relighting of a frontal face image taken under nearly uniform illumination, with a single reference face image under another illumination. (As shown in below figure)

(a) target face (b) reference face (c) relit result

Figure 1. The objective. (a) is the target face image, and (b) is the single reference image. (c) is our relit result which has similar lighting effects to that of (b).

PROBLEM DEFINITION (1)

What is the Problem:

Image-based photo-realistic face relighting from a single reference image without any knowledge of the 3D geometry or material information of the target face.

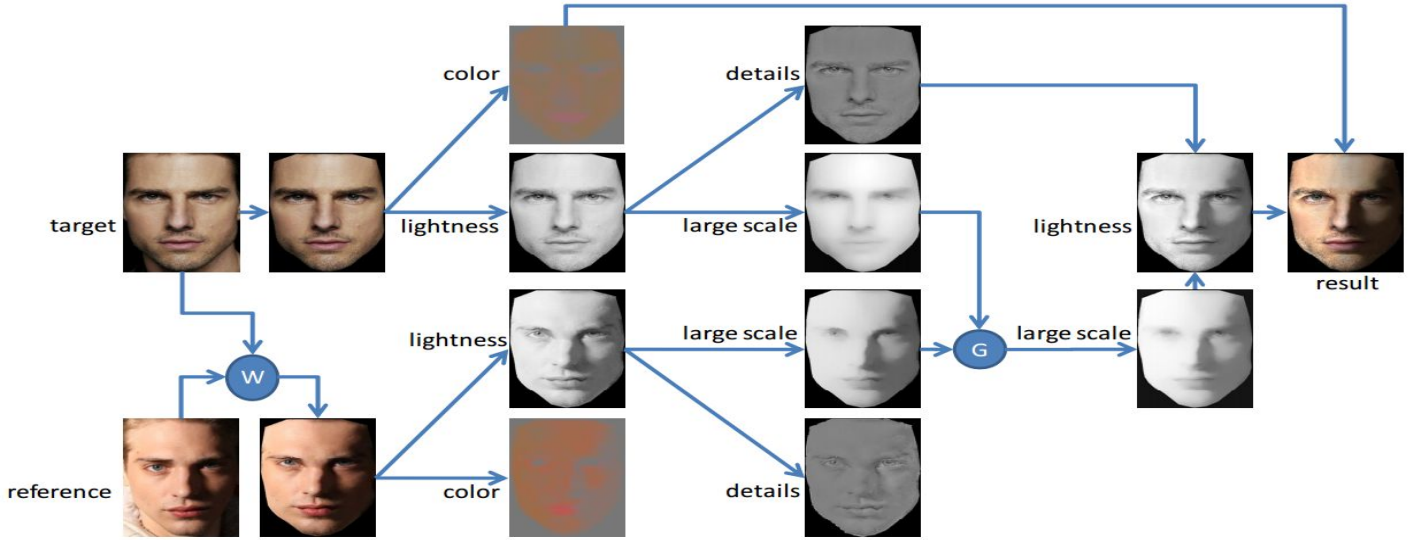
The point of the achievement of this objective is that with the interference from the material and geometry information, how to extract the illumination component from a single reference image. This makes it an ill-posed problem.

How things will be done:

- We first decompose images into two layers: color and lightness, again decompose the lightness layers of the reference and the target images into **large-scale** and **detail layers.**
- Retinex theory tells us that large-scale variance in image is caused by illumination variance, and small-scale variance is caused by reflectance variance, hence we operate only on the large-scale layer.
- We next apply **edge-preserving filters** to smooth the large-scale layer of the reference image and preserve the edges of the large-scale layer of the target image.
- Finally, we get convincing relit result while preserving good identification characteristics of target face.

PROBLEM DEFINITION (2)

WORKFLOW:



RESULTS OF THE PROJECT (1)

What will be done:

1)Face Alignment:

To transfer the illumination effects from a reference face to a target face, we need to warp the reference face image according to target face image.

- We employ Active Shape Model(ASM) with 104 mark points to identify the mark points on both images.
- We get a rough initial mark points by using ASM and then refine their accurate position in an interactive way, we then take these mark points as control points to warp the reference image according to the target image by using the affine transform.

2)Layer Decomposition:

- We decouple the image into lightness and color, and the lighting effects are considered mainly retained on lightness.
- We employ edge-preserving filters to smooth the lightness layer so as to obtain the large-scale layer and then use division to obtain the detail layer.

RESULTS OF THE PROJECT (2)

- We choose to apply WLS filter to decompose the lightness layer into the large-scale layer(illumination dependent) and the detail layer (illumination independent).

3)WLS filter with Adaptive Parameter:

In our task when WLS filter is used it is expected to perform different levels of smoothing on different regions of the image thus we set different smooth levels in different regions .

Energy function $E = |l - s|^2 + H(\nabla s, \nabla l)$

where, $|l-s|^2$ is the data term to keep s as similar as to l, and $H(\nabla s, \nabla l)$ is the regularization term to make s as smooth as possible. ('l' is lightness layer and 's' is large-scale layer)

- In $H(\nabla s, \nabla l)$, λ is balance factor between the data term and the smoothness term.
- In the flat region, a small λ is enough to produce a good separation of the large-scale and the detail layers. Most reflectance information can then be retained in the detail layer.
- However, in the regions such as facial hair and eyebrows, a larger λ is required to perform higher level of smoothing, so that reflectance can be better maintained in the detail layer.

RESULTS OF THE PROJECT (3)

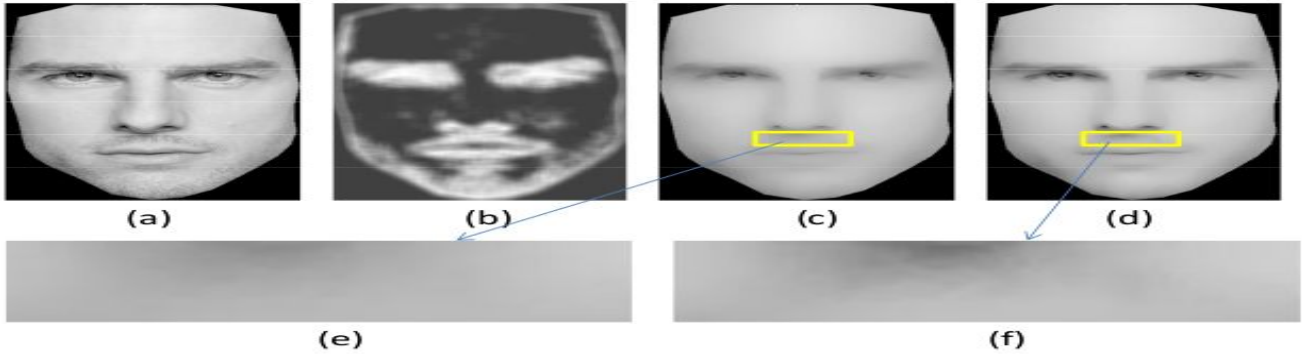


Figure 3. (a) Target lightness layer, decomposed to large-scale layer (d) by using a same λ over all the image; (b) is normalized γ, which is used to calculate spatial λ. (c) is the large-scale layer calculated by using spatial λ determined by (b). It could be observed that (c) can obtain less detail information than (d) in the regions of facial hair and eyebrows.

RESULTS OF THE PROJECT (4)

4) Guided Filter with Adaptive Parameter:

Guided filter has a key assumption that it is a local linear model between guidance I and filtered output q, as q is the linear transform of I in the window w_k centered at the pixel k:

$$q_i = a_k I_i + b_k , \forall i \in w_k$$

where, a_k and b_k are assumed to be constant in w_k . Then,the linear coefficients a_k and b_k are determined by minimizing the difference between q and filter input P.

Cost Function $E(a_k , b_k) = \Sigma((a_k I_i + b_k - P_i)^2 + a^2_k)$.

On solving above ridge regression we get a_k and b_k .

Our basic idea is to set the kernel size near the edges in the face structure region to be of larger value, and distance transform is applied to set the kernel size that gradual changes of the gradual change of the distance away from the edges in face structure region.

RESULTS OF THE PROJECT (5)

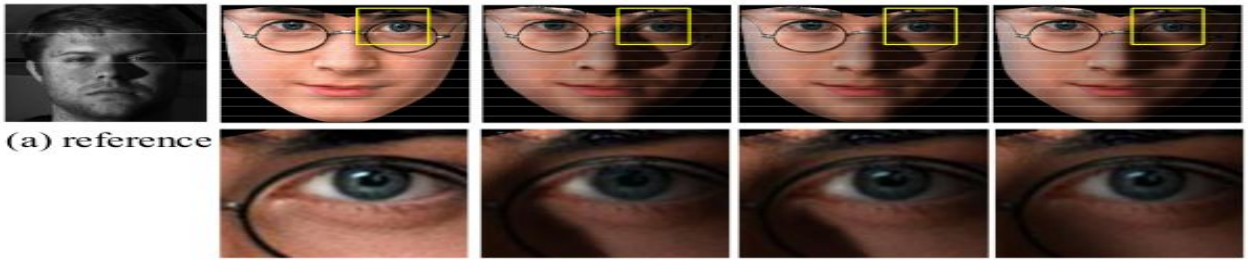


Figure 7. Our relit results with different guided filter parameters. (a) reference image, (b) target image, (c) the relit result for setting guided filter parameter $r = 3$ over all the image, (d) the relit result when the guided filter parameter r is set to be different spatially over all the image, (f) the relit result for the guided filter parameter $r = 18$ over all the image. It can be found that blurring can be seen around the eye structure in (c), shading contrast is weakened in (e), and our method in (d) can preserve the identification structure and retain the shading contrast at the same time.

RESULTS OF THE PROJECT (6)

After we filter the reference large-scale layer with the guidance of the target large-scale layer by using our modified guided filter, the desired target lightness is got by compositing the filtered reference large-scale layer and the target detail layer. Finally, we get the relit result by incorporating the color information of the target face.

Expected final Result

Relighting general objects. Our method can also be used to relight the general object when the reference object and the target object have similar geometry and reflectance.

Our method with guided filter stresses that the relit result with the target image in local window can preserve the linear model and maintain better identification characteristics of the target face.

Results of the Project(7)

PROJECT MILESTONES AND EXPECTED TIMELINES

No	Milestone	Expected date
1	Project Proposal submission	Sept 29th, 2019
2	Understand and Decide on the how the code	Oct 5th, 2019
3	Complete 1) and 2) parts	Oct 20th, 2019
4	Complete 3) WLS filter and Mid Evaluation	Expecting on Nov 15th
5	Complete the 4) Guided Filter part and write report	Nov 25th, 2019
6	Project Presentation and submission	TBD
7	Final Presentation	TBD