Topic:
Low light imagery

Team-Zion

Objective

- Perform exposure correction using dual illumination estimation with help of GPU.
  - This improves on current CPU based implementations which don't give a real time performance.
- Extend the exposure correction for videos.
  - No solution exists for videos.
- Experiment on interframe optimization.

General Methods for Image Enhancement

- Gray Transformation Methods
- Histogram Equalization
- Retinex Methods
- Frequency-domain Methods
- Image fusion methods
- Defogging model methods
- Machine Learning methods

Our Method

Dual Illumination Estimation for Robust Exposure Correction

- A Retinex based method which uses illumination map estimation without considering a reflectance component.
- Given an input image, we first invert the image.
- On each, we perform illumination estimation to obtain the forward and reverse illuminations, from which we recover the intermediate under- and over-exposure corrected images.
- The two intermediate exposure correction images together with the input image are fused into the desired image.

Algorithmic Overview

The equation we need to calculate:

$$I = I' \times L$$

I – Original Normalised image

I' - Desired Enhanced Image

L – Single channel illumination map

x - Pixel wise multiplication

The initial illumination map is calculated as follows:

$$L'_p = \max I^c_p, \quad \forall c \in \{r, g, b\}$$

Optimization Problem to be solved:

$$\arg\min_L \sum_p \left(\left(L_p - L'_p\right)^2 + \lambda \left(w_{x,p} \left(\partial_x L\right)^2_p + w_{y,p} \left(\partial_y L\right)^2_p \right) \right)$$

∂_x and ∂_y : Horizontal and vertical spatial derivatives

$w_{x,p}$ and $w_{y,p}$: Spatially varying smoothness weights

Algorithmic Overview

The same needs to be done for inverted image which is obtained by: $I_{inv} = 1 - I$

We obtain I' and I'_{inv}.

Do exposure fusion on original image, enhanced original image and enhanced inverted image.

Then, fuse the images together using the following formula:

$$\hat{V}_p^k = \begin{cases} 1, & \text{if } k = \arg\max_j V_p^j,\ \forall j \in [1,3] \\ 0, & \text{otherwise} \end{cases}$$

Timeline

- 15 March, 2021
  - Implementation for images
  - Benchmark done for existing CPU implementation and the built GPU one.
- 30 March, 2021
  - Implementation for videos with frame-by-frame processing.
- 20 April, 2021
  - Experimentation on interframe optimizations.
  - Add the optimizations that work well on all kinds of videos.

Team members

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Thank You