Digital Image Analysis (COL783)

Assignment-1 Report

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Disclaimer: All the Visual Outputs are present in the Slides which is present along with this report.

A. Demosaicing

We have performed the following operations on bayer images:

- Mosaiced image – just coded with the Bayer filter colors.
- Bilinear interpolation on the image.
- Complete Implementation of the Demosaicing Paper.
- Comparison of our output with Matlab's demosaic() algorithm.

Image id	1	2	3	4
Time taken	44.15 sec	44.69 sec	44.11 sec	44.11 sec
only bilinear interp PSNR	(36.6651, 38.7759, 36.8431)	(36.2197, 38.575, 36.5564)	(31.7031, 33.3861, 31.7276)	(33.8583, 35.6594, 33.887)
Final image PSNR	(38.4209, 40.7874, 38.2838)	(38.1996, 39.3575, 37.3814)	(32.1601, 35.0893, 32.2311)	(34.8433, 37.4291, 35.0586)
Improvement over bilinear image	(1.7558, 2.0115, 1.4407)	(1.9799, 0.7825, 0.825)	(0.457, 1.7032, 0.5035)	(0.985, 1.7697, 1.1716)
Matlab image's PSNR	(38.6859, 41.2405, 38.5204)	(38.4807, 40.5134, 37.6879)	(32.6112, 35.2309, 32.5493)	(35.1662, 37.8272, 35.3879)

B. Image Enhancement

1. Night-time images

We have performed the following operations on the nighttime images.

- Gamma Correction
- Histogram Equalization
- Adaptive Histogram Equalization.
- Gamma Correction + Adaptive Histogram Equalization.
- Dual Illumination Estimation for Robust Exposure Correction.

We have captured a few images on our mobile devices with the night mode turned off and analyzed the same.

Gamma Correction

We have applied gamma correction at different gamma values, which helped increase the image's brightness. The slides in the PPT show the result of images at different gamma values.

In most cases, the best results were obtained when the gamma value was equal to 2.

Histogram Equalization

We have applied histogram equalization, which helped increase the image's contrast. The slides in the PPT show the result of images after histogram equalization.

Histogram equalization was applied at different color spaces.

- HSV
- YUV
- LAB
- YCrCb

In most cases, the results had a very high increase in the contrast value.

Adaptive Histogram Equalization

We have applied adaptive histogram equalization with different patch sizes, which helped increase the image's contrast. The slides in the PPT show the result of images after adaptive histogram equalization.

Adaptive Histogram equalization was applied at different colour spaces.

- HSV
- YUV
- LAB
- YCrCb

In most cases, the results had an increase in the contrast value. These results are reasonable compared to that of the standard histogram equalization.

Gamma Correction + Adaptive Histogram Equalization

We have applied gamma correction + adaptive histogram equalization with different patch sizes, which helped increase the image's brightness and contrast. The slides in the PPT show images after gamma correction + adaptive histogram equalization.

gamma correction + Adaptive Histogram equalization was applied at different color spaces.

- HSV
- YUV
- LAB
- YCrCb

In most cases, the results increased the brightness and contrast value. These results are reasonable compared to standard histogram equalization and adaptive histogram equalization.

Dual Illumination Estimation for Robust Exposure Correction

We have applied Dual Illumination Estimation for Robust Exposure Correction. At different values of gamma and lambdas, which helped increase the brightness and contrast of the image and, hence, enhance the image.

The slides in the PPT show images at different gamma and lambda values.

Verdict on Night-time Image Enhancement

From the above analysis, we have come to a conclusion that

- Gamma correction + adaptive histogram equalization
- Dual Illumination Estimation for Robust Exposure Correction

Produces better results compared to other.

In all the other cases, there is the presence of noise. But in the above two cases, there is less noise, and their results are very comparable to that of the expected output.

2. Foggy images.

We have performed the following operations on the foggy images.

- Adaptive histogram equalization.
- Efficient Image Dehazing with Boundary Constraint and Contextual Regularization + Increased the sharpness + increased the illumination.

Adaptive histogram equalization

We have applied adaptive histogram equalization with different patch sizes, which helped increase the contrast of the image.

The slides in the PPT show the result of images after adaptive histogram equalization.

Adaptive Histogram equalization was applied at different color spaces.

- HSV
- LAB

In most cases, the results had an increase in the contrast value.

Efficient Image Dehazing with Boundary Constraint and Contextual Regularization

We have applied Efficient Image Dehazing with Boundary Constraint and Contextual Regularization at different values of beta, which helped in de-hazing the image.

Post the above step; we have applied unsharp masking filter and gamma correction to get a clear structure of the objects.

The slides in the PPT show the result of images at different beta values.

Sharpening the output image by different ways:

- Convolving using Sharpening kernel.
- Used Laplacian Sharpening
- Used Unsharp Masking [Best Result]

Verdict on Foggy Image Enhancement

From the above analysis, we have come to a conclusion that

- Efficient Image Dehazing with Boundary Constraint and Contextual Regularization

Produces better results compared to other.

In all the other cases, there is the presence of noise. But in the above cases, there is less noise, and the edges are sharp and clear; hence their results are very comparable to that of the expected output.

C. Video Enhancement

We have performed the following sequence of operations on the video.

1. Converted the video into a sequence of frames.
2. On each frames, we first performed de-hazing.
3. We applied nighttime image enhancement on the de-hazed images using the Dual illumination method.

4. Converted all the modified frames into a video of 30FPS.

Link to the output:

https://drive.google.com/file/d/1KiLekBdWgPJIn323J51lY1_AaRp8Gmhw/view

References

[1] H. S. Malvar, L.-w. He, and R. Cutler, “High-quality linear interpolation for demosaicing of bayer-patterned color images,” in 2004 IEEE International Conference on Acoustics, Speech, and Signal Processing, vol. 3. IEEE, 2004, pp. iii–485.

[2] Qing Zhang and Yongwei Nie and Weishi Zheng. "Dual Illumination Estimation for Robust Exposure Correction". Computer Graphics Forum, 2019, 38.

[3] G. Meng, Y. Wang, J. Duan, S. Xiang and C. Pan, "Efficient Image Dehazing with Boundary Constraint and Contextual Regularization," 2013 IEEE International Conference on Computer Vision, 2013, pp. 617-624, doi: 10.1109/ICCV.2013.82.

[4] https://github.com/Utkarsh-Deshmukh/Single-Image-Dehazing-Python

[5] https://github.com/pvnieo/Low-light-Image-Enhancement