Aliah University

Elevating Images through Advanced Enhancement Techniques

presented by

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Introduction

Haze image:

A hazy image looks unclear due to fog or pollution, making it hard to see and understand.

Dehazed image:

Enhancing clarity by removing fog or haze, revealing details for improved visibility and visual quality.

Implementation

- **Medical Image Enhancing:**

Clear medical scans for precise diagnosis and treatment planning improvement.

- **Real-time Object Detection for Road Safety:**

Improve road safety with quick object identification, preventing accidents using vision.

- **CCTV Image Detection for Security:**

Alerts in real-time, preventing breaches, ensuring quick incident response.

- **Improved Satellite Imagery:**

Apply dehazing, sharpening, and contrast techniques for improved satellite imagery.

Literature Survey

- Vyas et al.[1] has proposed "Removal of Fog from Hazy Images and Their Restoration".

- **Method:** The Dark Channel Prior (DCP) method and the Laplacian filter method are used.

- **Limitation:** It primarily focuses on fog removal and does not inherently enhance the overall visual quality of the image.

Literature Survey

- Yadav et al.[2] has proposed "Foggy Image Enhancement Using Contrast Limited Adaptive Histogram Equalization of Digitally Filtered Image:Performance Improvement”.

- **Method:** FIR filter, h-gamma, and CLAHE are applied sequentially for optimal image quality.

- **Limitation:** After applying only CLAHE the restoration quality is good but noise removal is not effective.

Literature Survey

- Kyungil et al.[3] has proposed "Effective image enhancement techniques for fog-affected indoor and outdoor images".
- **Method:** A new single-image enhancement approach is based on a mixture of dark channel prior (DCP) and (CLAHE-DWT) algorithms.
- **Limitation:** It works on only a few indoor dark foggy images.

Dataset

Image data :

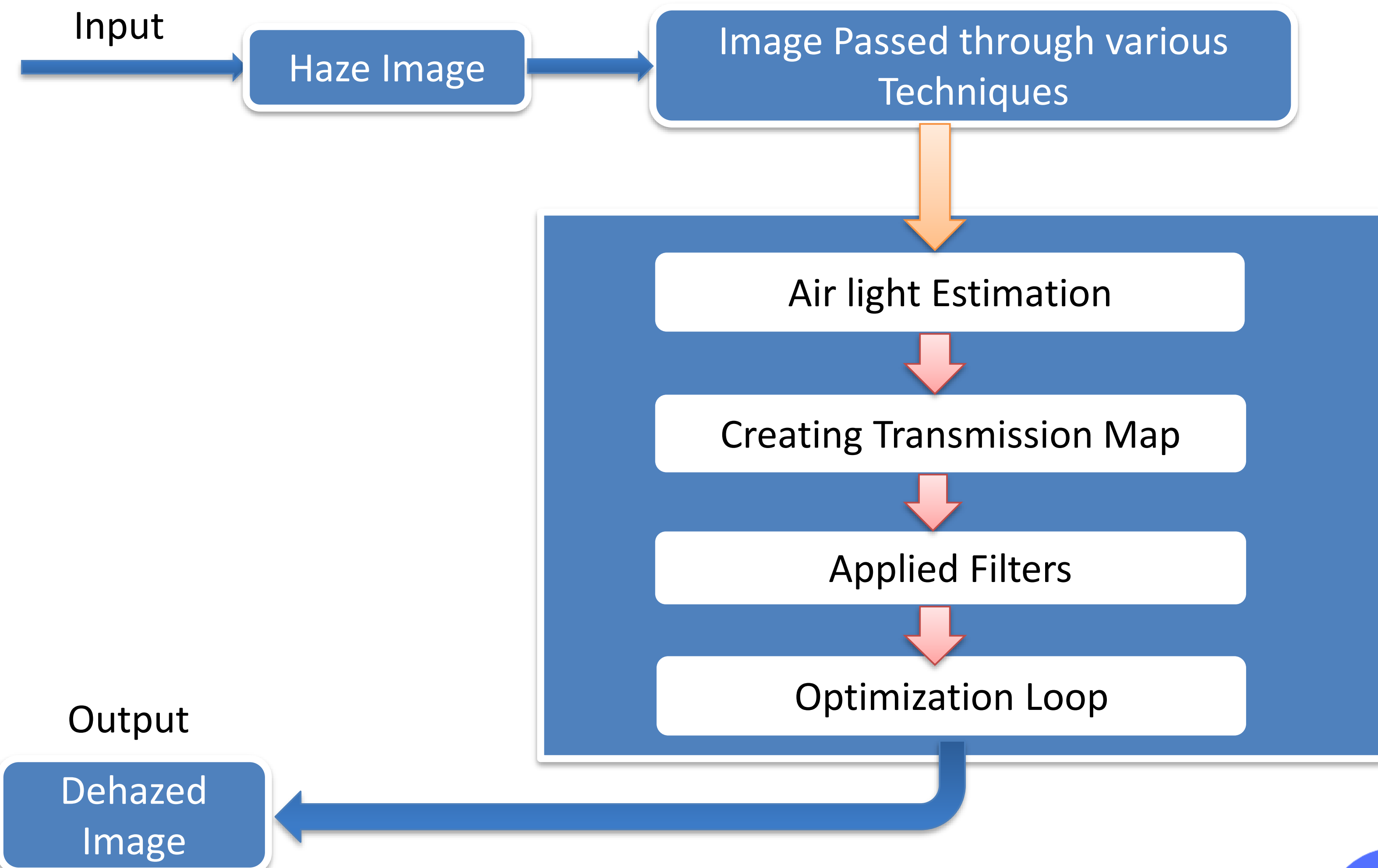
- For this case study, we have collected real foggy images in different weather conditions.
- These images may be sourced from various domains, including outdoor photography, surveillance footage, remote sensing, and more.

Proposed Work

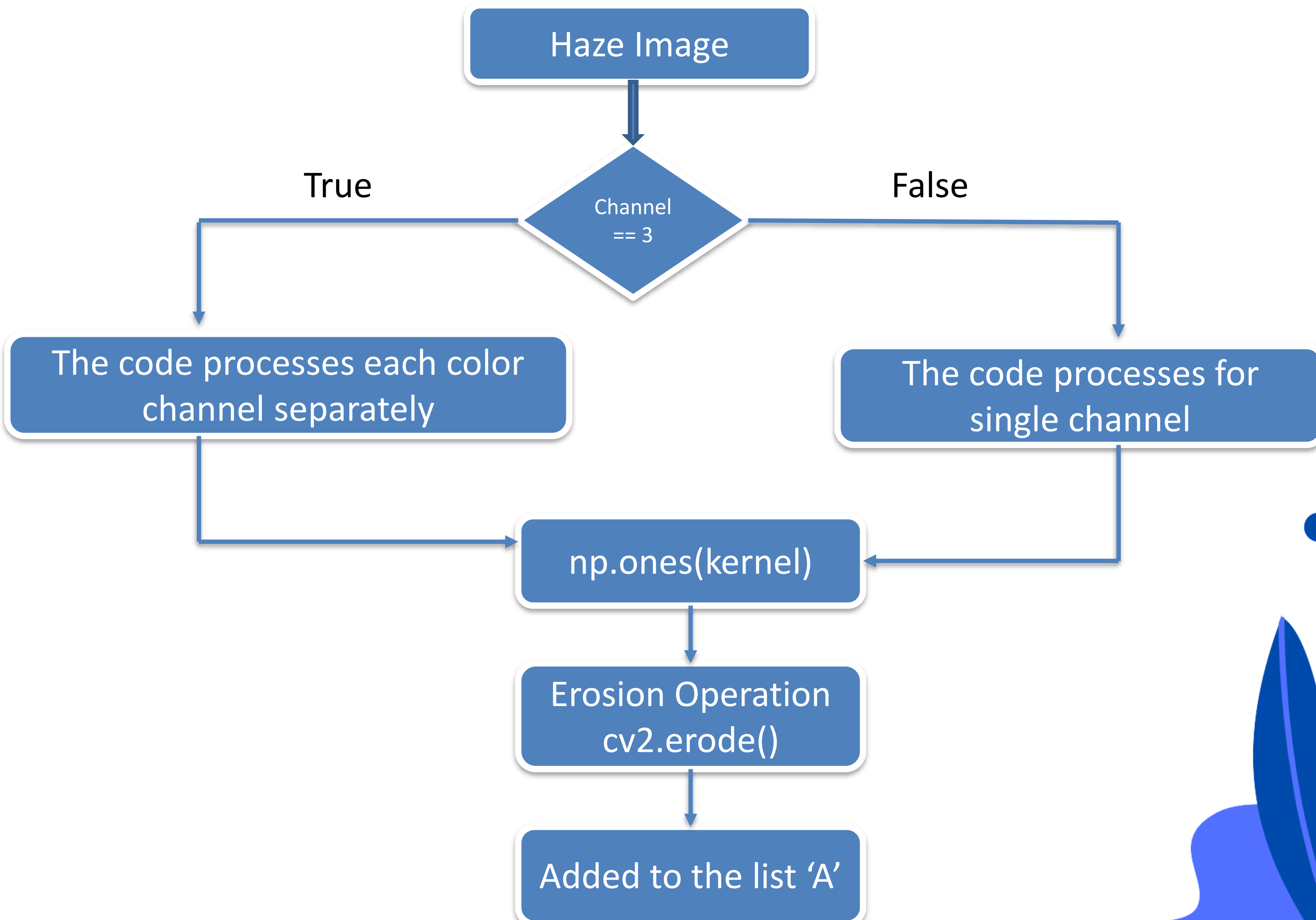
We proposed the algorithm in four parts:

- Air light Estimation
- Creating Transmission Map
- Estimate and Refine Transmission
- Perform Dehazing using the Estimated Air light and Transmission

Working Flowchart



Air light Estimation

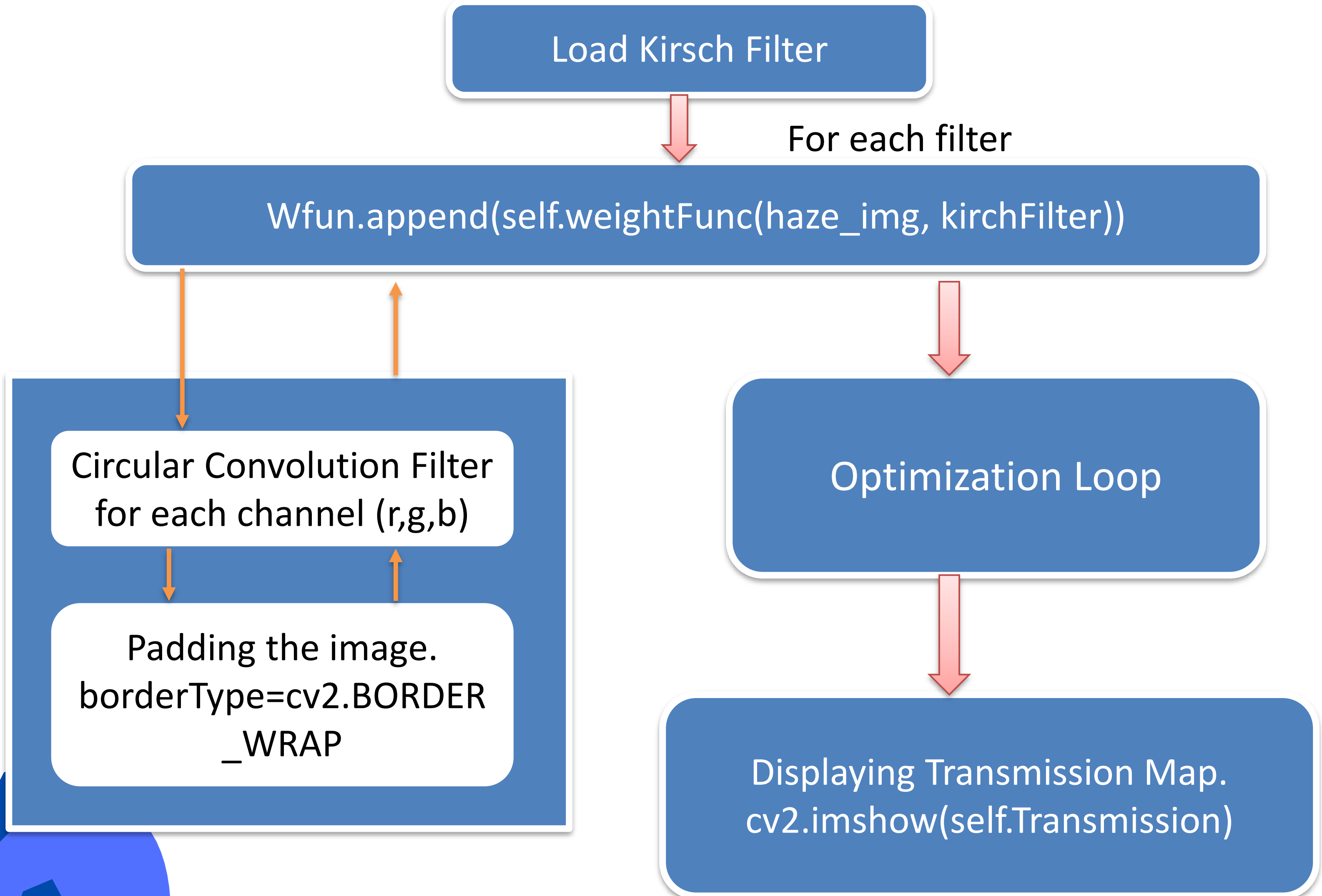


Creating Transmission

- It allowing algorithms to focus on areas with lower transmission (more haze) and adjust them accordingly

```
if len(haze_img.shape == 3):
    # For color images, process each color channel separately
    t_b = np.maximum((self._A[0] - haze_img[:, :, 0].astype(float)) / (self._A[0] - self.C0),
                     (haze_img[:, :, 0].astype(float) - self._A[0]) / (self.C1 - self._A[0]))
    t_g = np.maximum((self._A[1] - haze_img[:, :, 1].astype(float)) / (self._A[1] - self.C0),
                     (haze_img[:, :, 1].astype(float) - self._A[1]) / (self.C1 - self._A[1]))
    t_r = np.maximum((self._A[2] - haze_img[:, :, 2].astype(float)) / (self._A[2] - self.C0),
                     (haze_img[:, :, 2].astype(float) - self._A[2]) / (self.C1 - self._A[2]))
# Find the maximum value element-wise among t_b, t_g, and t_r
    max_val = np.maximum(t_b, t_g, t_r)
# Apply boundary constraints: Limit Transmission to a maximum value of 1
    self._Transmission = np.minimum(max_val, 1)
else:
    # For grayscale images, perform a simplified version of the process
    grayscale = np.maximum((self._A[0] - haze_img.astype(float)) / (self._A[0] - self.C0),
                           (haze_img.astype(float) - self._A[0]) / (self.C1 - self._A[0]))
    self._Transmission = np.minimum(grayscale, 1)
# Apply morphological closing operation to further refine the Transmission map
kernel = np.ones( shape: (self.boundaryConstraint_windowSze, self.boundaryConstraint_windowSze), float)
self._Transmission = cv2.morphologyEx(self._Transmission, cv2.MORPH_CLOSE, kernel=kernel)
```

Estimate and Refine Transmission



Kirsch Filter

- Kirsch filters are commonly used for edge detection in image processing.
- Its non-linear approach and multiple directional masks offer advantages in identifying edges and their orientations.
- Alternatives: - Sobel, Prewitt, and Robinson.
- With the help of Kirsch Compass Mask, we can find edges in the following eight directions:

    1. North
    2. North-West
    3. West
    4. South-West
    5. South
    6. South-East
    7. East
    8. North-East

Convolution Filter

- It is the process of averaging the small sets of pixels across all image.

- Convolution kernel is a matrix of numbers, used to average the value of each pixel with the value of surrounding

Ex: -

A =

2	8	6	8	8
6	8	6	6	6
8	2	8	6	6
2	2	2	8	6
8	8	6	2	8

B =

-1	-1	-1
-1	16	-1
-1	-1	-1

10

Here, B represents the Kernal.

$$\frac{(-1*2) + (-1*8) + (-1*6) + (-1*6) + (16*8) + (-1*6) + (-1*8) + (-1*2) + (-1*8)}{(-1) + (-1) + (-1) + (-1) + (16) + (-1) + (-1) + (-1) + (-1)}$$

= 10

Result

Input image

Output image

Result Discussion

- We evaluated the performance of our image enhancement algorithm using metrics such as Peak Signal-to-Noise Ratio (PSNR).

- Our enhanced images achieved a PSNR value of **44.019 dB**

- This high PSNR value signifies that our enhancement algorithm effectively preserves the essential details and clarity of our method in producing high-quality visual outputs.

Conclusion

Fig: 10-a

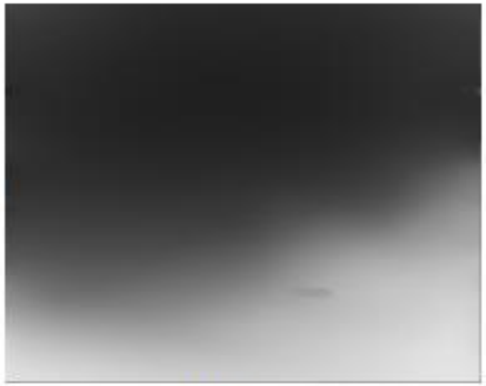


Fig: 10-b

Hazy image (10-a) is converted into refined Transmission map (10-b).

Fig: 10-b

Fig: 10-c

Haze Transmission map (10-b) is converted into dehazed image (10-c)

References

- Kyungil Kim, Soohyun Kim, Kyung-Soo Kim, “Effective image enhancement techniques for fog-affected indoor and outdoor images”, IET Image Process., 2018, Vol. 12 Iss. 4, pp. 465-471 ©The Institution of Engineering and Technology 20 17

- Garima Yadav, Saurabh Maheshwari, Anjali Agarwal, “Foggy Image Enhancement Using Contrast Limited Adaptive Histogram Equalization Of Digitally Filtered Image:Performance Improvement”, 2014 International Conference on Advances in Computing,Communications and Informatics (ICACCI)

- Vidya Nitin More, Vibha Vyas, “Removal of fog from hazy images and their restoration”, Electronics and Telecommunication Department, College of Engineering Pune, Shivaji Nagar, Pune 411005, India

- Anyao Lu 2, Yuantao Wang and Haiyang Jiang, “IDOD□YOLOV7: Image-Dehazing YOLOV7 for Object Detection in Low-Light Foggy Traffic Environments”, Sensors 2023, 23, 1347

THANK YOU