S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

Practical No. 12(Post Lab)

Aim: Use the top hat transformation to correct uneven background illumination and enhance small foreground details in grayscale images.

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Semester/Year: V/III

Academic Session: 2025-2026

Date of Performance:

Date of Submission:

Aim: Use the top hat transformation to correct uneven background illumination and enhance small foreground details in grayscale images.

OBJECTIVE/EXPECTED LEARNING OUTCOME:

After completing this experiment, you will be able to:

1. Understand the concept of morphological image processing and its operations.
2. Apply Top-hat transformation to remove uneven background illumination in grayscale images.
3. Enhance small bright features in images, such as text, spots, or fine details.
4. Analyse and compare original and processed images to observe the effect of morphological operations.
5. Gain practical skills in using OpenCV for image enhancement.

THEORY:

1. Introduction:

The Top-hat transformation is a morphological operation used in image processing to highlight small bright features in an image. It is particularly useful for images with uneven background illumination, where details might be hidden due to lighting variations.

2. Morphological Operations:

Morphological operations are techniques applied to binary or grayscale images using a structuring element (kernel). Common operations include erosion, dilation, opening, and closing.

- Opening: Erosion followed by dilation; removes small bright objects and smooths the background.
- Top-hat Transformation: Subtracts the result of opening from the original image to highlight small bright objects.

Mathematically:

$$\text{Top-hat Image} = \text{Original Image} - \text{Opened Image}$$

3. Working of Top-hat Transformation:

1. A structuring element (like a rectangle or circle) is chosen.
2. The opening operation is applied to remove small bright regions, producing a smoothed image.
3. The opened image is subtracted from the original image.
4. The resulting image shows enhanced bright features while the uneven background is minimized.

4. Applications:

- Document scanning: Enhances text on unevenly illuminated pages.
- Biomedical imaging: Highlights cells or tissue features in microscope images.
- Industrial inspection: Detects defects on surfaces, metal sheets, or fabrics.
- Object recognition: Helps in detecting small objects or features against non-uniform backgrounds.

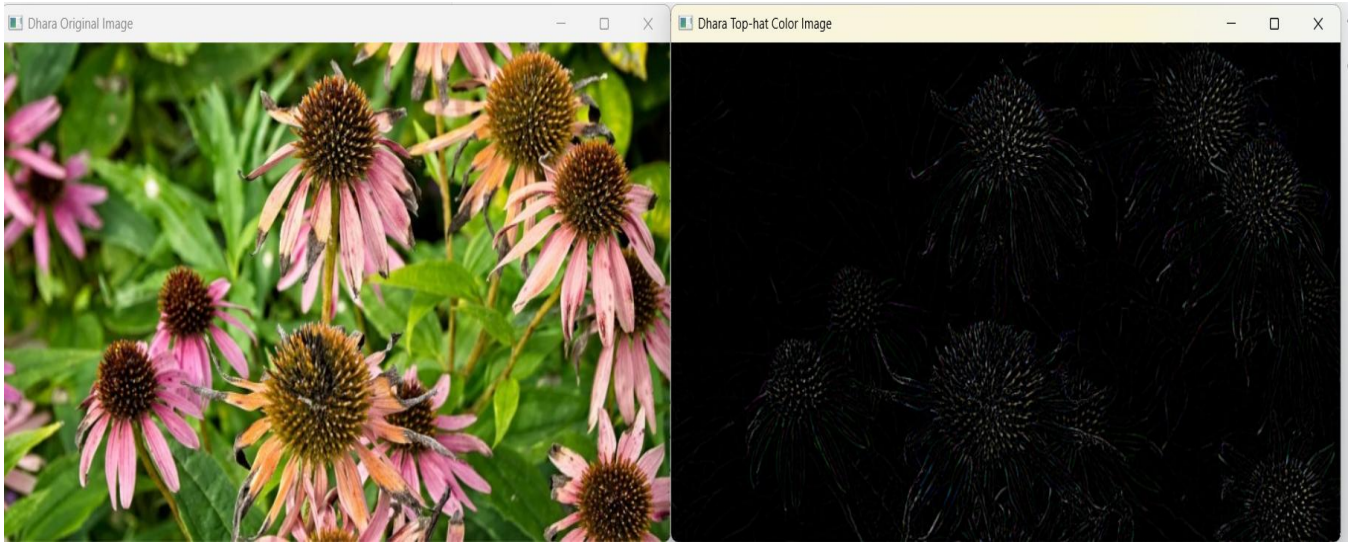
5. Advantages:

- Enhances small bright details without changing the overall image structure.
- Corrects non-uniform background illumination.
- Simple to implement with OpenCV or MATLAB.

CODE:

```
import cv2
filterSize = (3, 3)
kernel = cv2.getStructuringElement(cv2.MORPH_RECT, filterSize)
input_image = cv2.imread("image//tissue.jpg")
b, g, r = cv2.split(input_image)
b_tophat = cv2.morphologyEx(b, cv2.MORPH_TOPHAT, kernel)
g_tophat = cv2.morphologyEx(g, cv2.MORPH_TOPHAT, kernel)
r_tophat = cv2.morphologyEx(r, cv2.MORPH_TOPHAT, kernel)
tophat_img = cv2.merge([b_tophat, g_tophat, r_tophat])
cv2.imshow("Dhara Original Image", input_image)
cv2.imshow("Dhara Top-hat Color Image", tophat_img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

OUTPUT:



CONCLUSION: Hence, we have used the top hat transformation to correct uneven background illumination and enhance small foreground details in grayscale images.

DISCUSSION QUESTIONS:

1) What is the purpose of the Top-hat transformation in image processing?

2) How does the Top-hat transformation work mathematically?

3) Why is it important to choose an appropriate structuring element (kernel)?

4) What are the differences between Top-hat and Bottom-hat transformations?

5) What kind of images benefit most from Top-hat transformation?

6) How does Top-hat transformation improve image analysis or recognition?

REFERENCES:

- https://towardsdatascience.com/understanding-morphological-image-processing-and-its-operations-7bcf1ed11756/
- https://www.geeksforgeeks.org/computer-vision/different-morphological-operations-in-image-processing/
- https://docs.opencv.org/4.x/d9/d61/tutorial_py_morphological_ops.html
- https://www.mathworks.com/help/images/morphological-dilation-and-erosion.html
- https://blog.roboflow.com/morphological-operations/