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Bauhaus-Universität Weimar

ASSIGNMENT NO. 1

IMAGE ANALYSIS AND OBJECT RECOGNITION

GROUP: 13

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Task 1: Image Enhancement

Histogram Characteristics (Initial):

The initial grayscale image histogram is right-skewed, meaning more pixels are concentrated in the brighter intensity region. This indicates bright areas with fewer details in darker regions might dominate the original image.

Figure 1: Low Contrast Starting Image

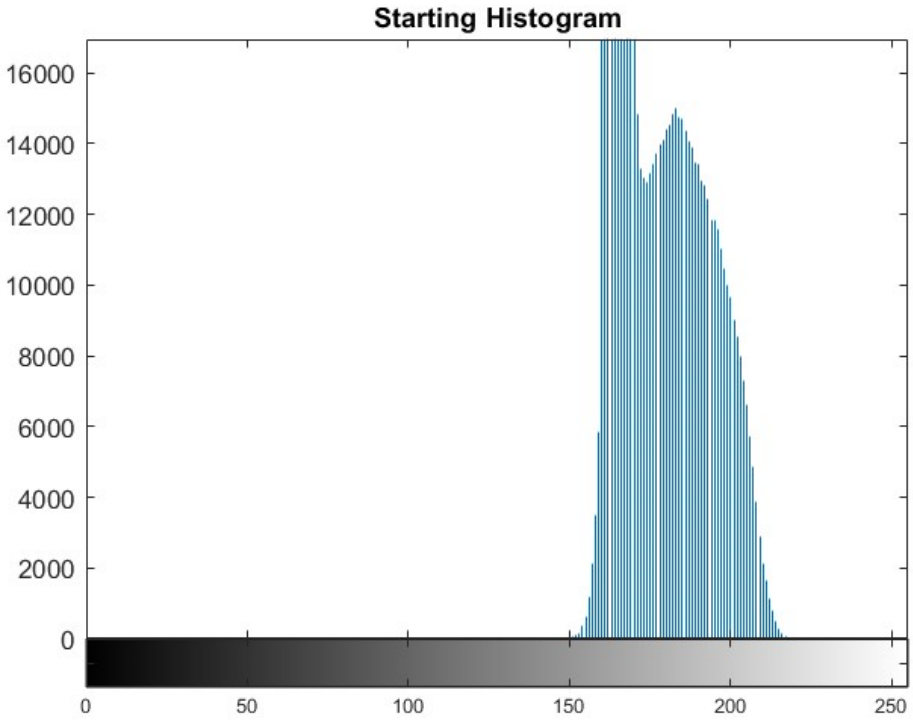


Figure 2: The right-skewed histogram of the low-contrast image

Differences in Enhanced Histogram:

After contrast enhancement, the enhanced image histogram appears more spread out, signifying a wider range of pixel intensities. In comparison to the original image, there appears to be greater contrast as seen by a higher peak and a more evenly distributed dispersion over the intensity range. In the improved image, darker details stand out more.

Figure 3: High contrast image after image enhancement

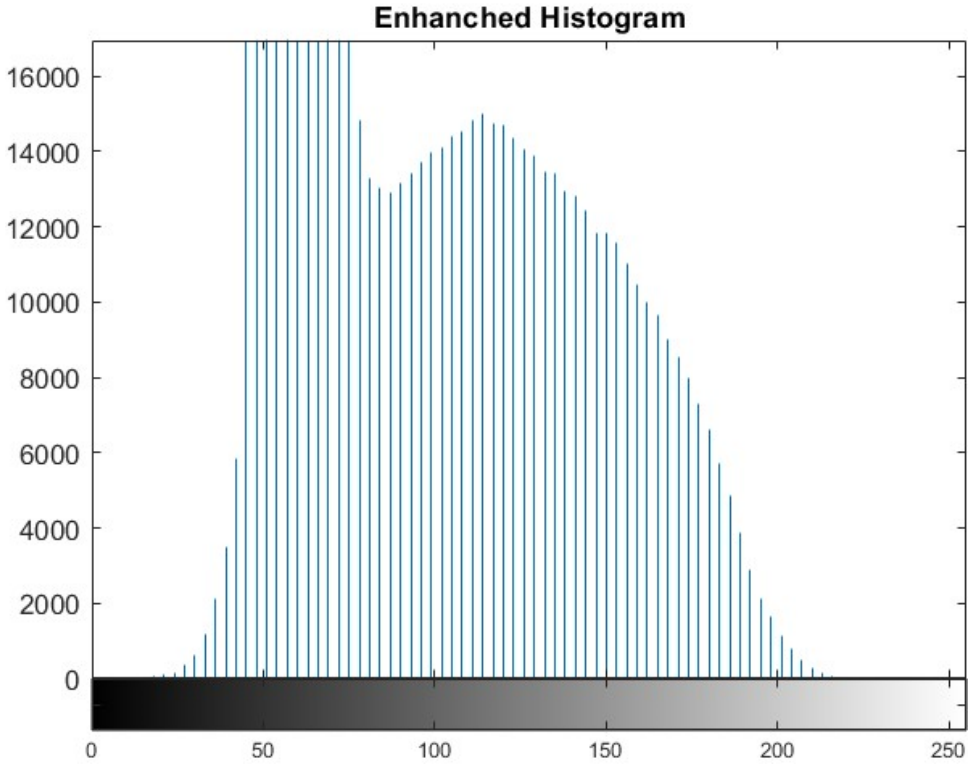


Figure 4: High contrast, evenly distributed histogram after enhancement

Task 2: Binarization

Effects of Different Threshold Values:

Whereas higher threshold areas exclude more pixels and can potentially leave out portions of the lake surface, lower threshold areas contain more foreground pixels and may contain noise and irrelevant dark regions.

Threshold 0.34 (as applied in this case): This threshold excluded certain surrounding areas but kept the majority of the water's surface as foreground (1/white). Some of the water body's darker areas went undetected its notice. More areas would be considered foreground if a lower threshold was used. This could introduce noise into the binary mask by adding unwanted noise features like dark shadows or backdrop objects along the riverside. A more conservative mask would be produced with a higher threshold, which would exclude some regions of the real water surface, particularly in places with less contrast.

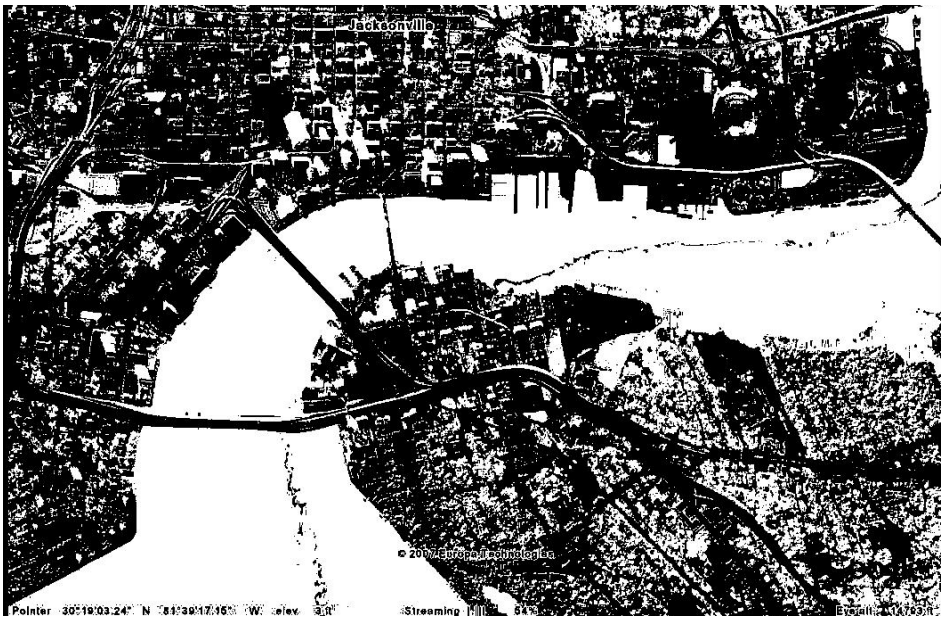


Figure 5: The inverted binary mask, where 0 is the background and 1 is the foreground i.e., the water

Difficulties in Threshold Selection:

To find a balance between including the water's surface and excluding nearby regions, the hit and trial method was used to experiment until the closest threshold (0.34) was found. This makes it difficult to choose a single threshold that is suitable for every aspect of the image, should any image be supplied for this purpose.

Task 3: Morphological Operators

A more accurate visualization of the water's surface resulted from the binary mask's combined opening and closing procedures.

Figure 6: Result after applying the morphological operators

Task 4: Results Evaluation

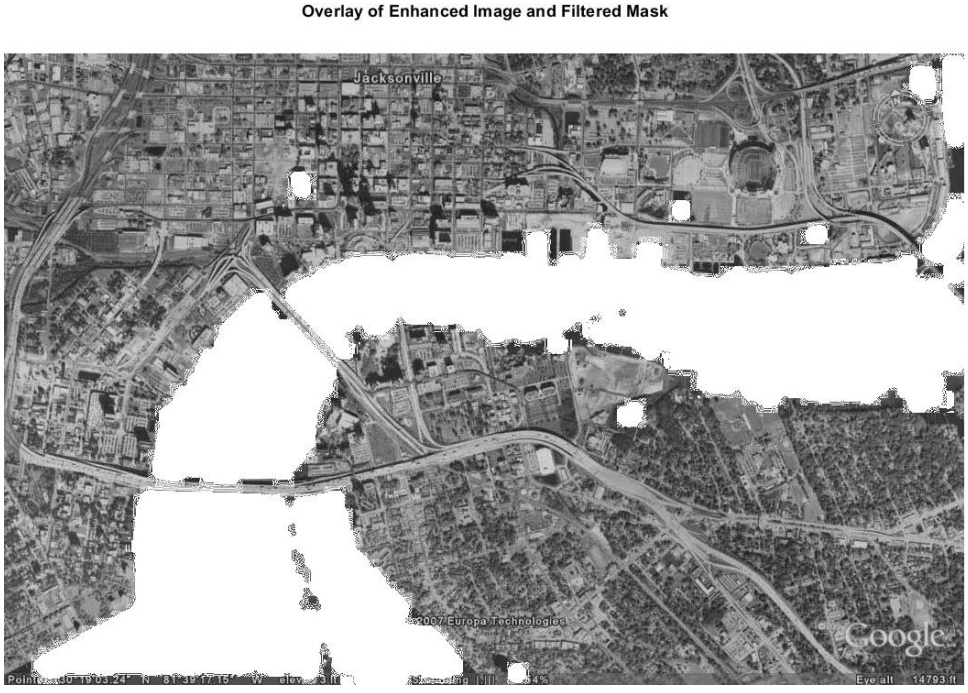
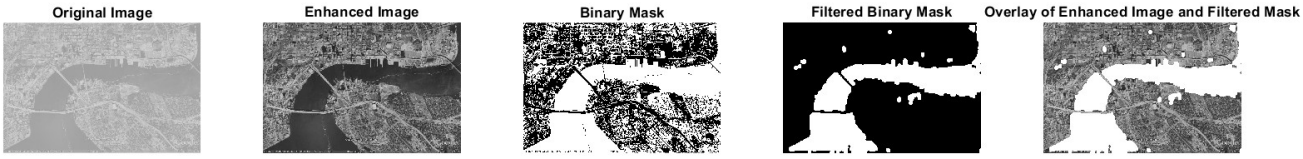


Figure 7: Final Image after the overlay of the filtered mask resulting in the isolation of the water body on the image as foreground



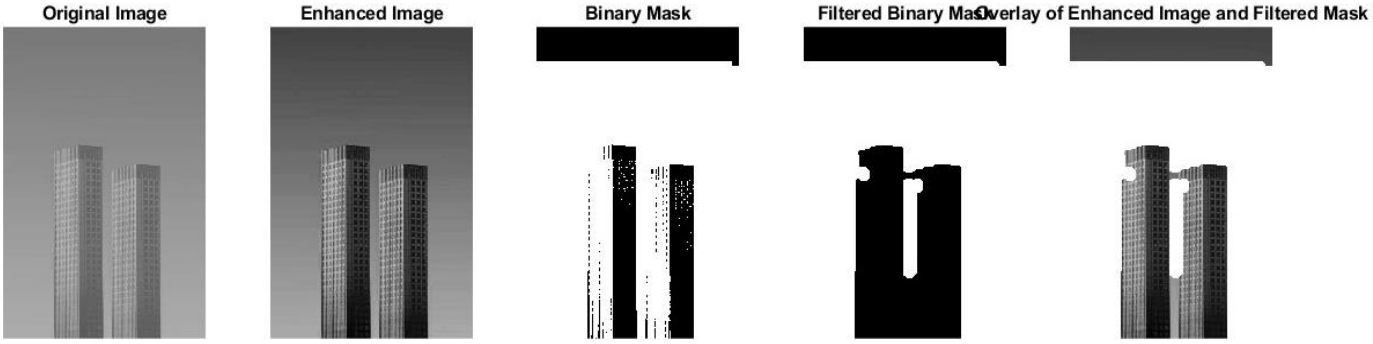
Limitations of the Approach:

The approach's limitations include:

- Image Dependency, which means that the quality of the image has a significant impact on how well this method works. Inaccurate results may arise from low-contrast photos or scenarios where the background and water have equal brightness levels.
- Threshold Sensitivity: It can be difficult to determine the ideal threshold; testing is necessary.
- Standardization Assumption: Although this relationship between water and background levels is assumed to be constant, it may not always hold.

Trial Image:

Bright architectural elements chosen to represent the sky show how difficult it is to distinguish foreground buildings) from the background using only intensity. Misclassifications may result from images including elements whose intensities are comparable to those of the intended front item. Image selected from (https://media.geeksforgeeks.org/wp-content/uploads/20211219231415/lowcontrastimg2.jpg)



Conclusion:

This approach offers a starting point for water surface extraction but has limitations. Further image analysis techniques or machine learning methods specifically trained on satellite imagery might be needed for more robust and accurate results.

References:

1. Sample Image for trial (https://media.geeksforgeeks.org/wp-content/uploads/20211219231415/lowcontrastimg2.jpg
2. Guide used for the coding; Image Processing and Computer Vision - Antworten im Hilfe-Center - MATLAB & Simulink (mathworks.com)
3. Debugging through ChatGPT and Google Gemini