Indian Institute of Science

Electronics And Engineering Department

Digital Image Processing

Assignment 1

Ansh Bansal

24250

Date: August 30, 2025

Contents

1 Histogram Computation

Figure 1.1: Input: Coins Image

- The histogram of the grayscale image shows two prominent peaks: one around low intensities (background/coins) and another at mid-high intensities (coin highlights).
- The average intensity computed from the histogram is 103.31, which matches the actual average intensity, verifying correctness.

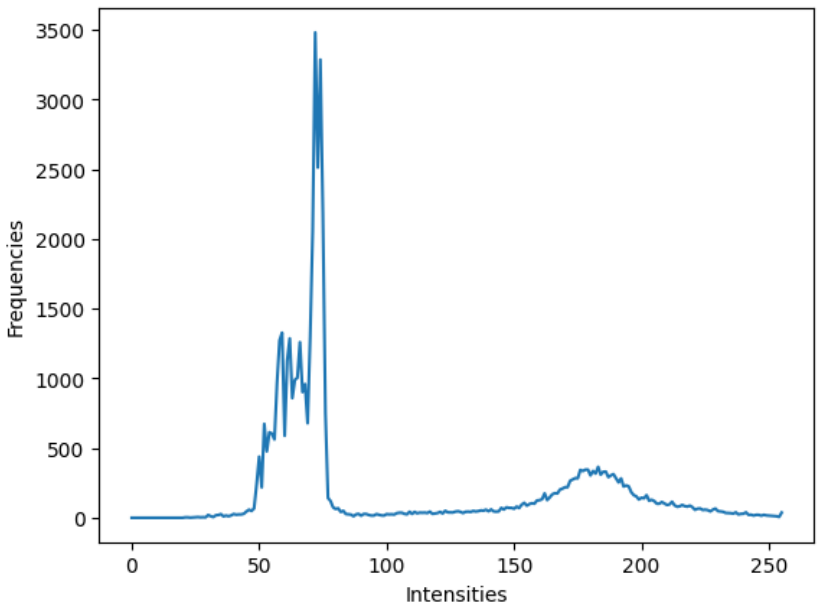

Figure 1.2: Histogram of Coins Image

2 Otsu's Binarization

Figure 2.1: Input: Coins Image

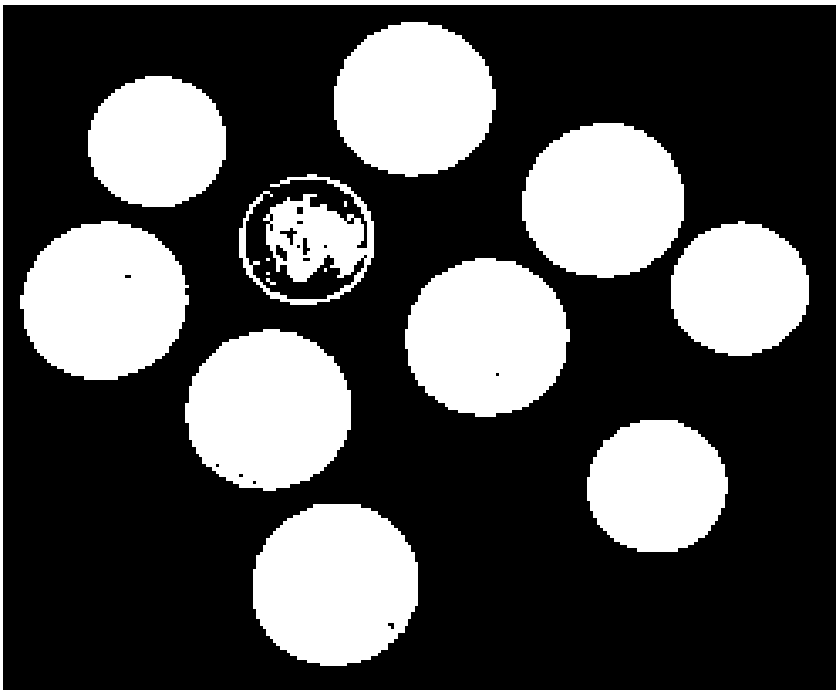

Figure 2.2: Binarized Original Image

- The optimal threshold by minimizing the within-class variance was found to be 125.
- After adding an offset of 20, the optimal threshold by maximizing the between-class variance increased to 145.

- This difference occurs because shifting the image intensities also shifts the histogram, thereby changing the threshold position accordingly.
- Since the offset is small as compared to the threshold of input image the change in the threshold after adding the offset is increased by the value offset.
- Both the binarized images are exactly same because the intensities of all pixels and the threshold increased by same amount that is offset.

Figure 2.3: Input: Coins Image With Offset 20

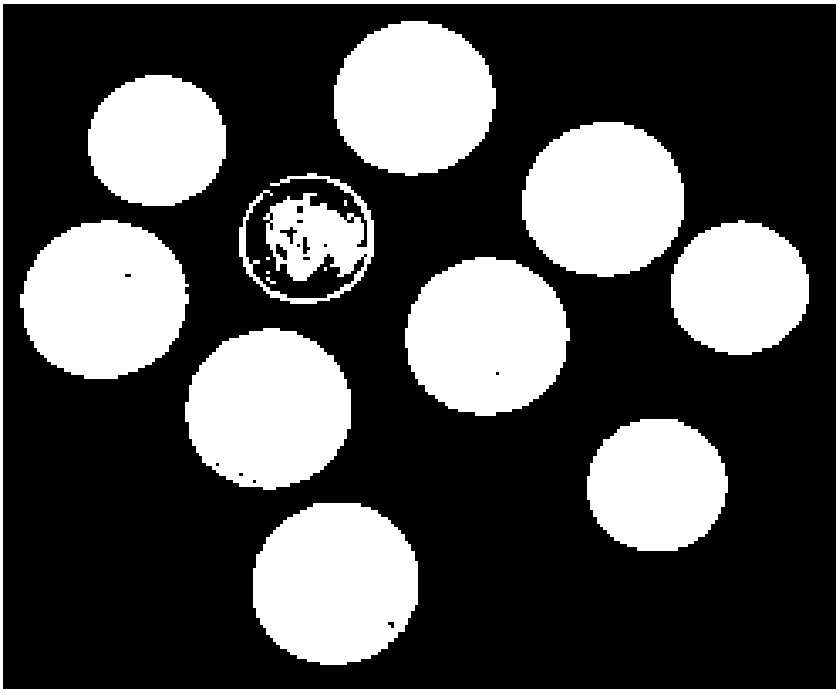

Figure 2.4: Binarized Image With Offset of 20

3 Adaptive Binarization

Figure 3.1: Input: Sudoku Image

- Adaptive binarization with small blocks (e.g., 5×5) captures local variations and fine details, but may introduce noise and uneven binarization.
- Medium block sizes (e.g., 25×25) balance detail preservation and noise reduction, producing cleaner results.
- Larger blocks (e.g., 50×50) smooth out noise but lose local contrast, which may erase finer digits in the Sudoku image.
- Global binarization is effective for uniformly illuminated images but fails when lighting is uneven.
- Overall, smaller blocks are better for images with high local variation, while larger blocks are more robust to noise in uniform regions.

Block Size	**Advantages**	**Disadvantages**
5×5	Captures fine details, adapts to local changes	Sensitive to noise, uneven binarization
10×10	Good local adaptation, less noisy than 5×5	May still introduce artifacts
25×25	Balanced performance, good detail + stability	Some fine details may be lost
50×50	Noise reduction, smooth regions	Loses local variations, digits fade
Global	Simple, efficient for uniform lighting	Poor under varying illumination

Table 1: Comparison of adaptive binarization with different block sizes.

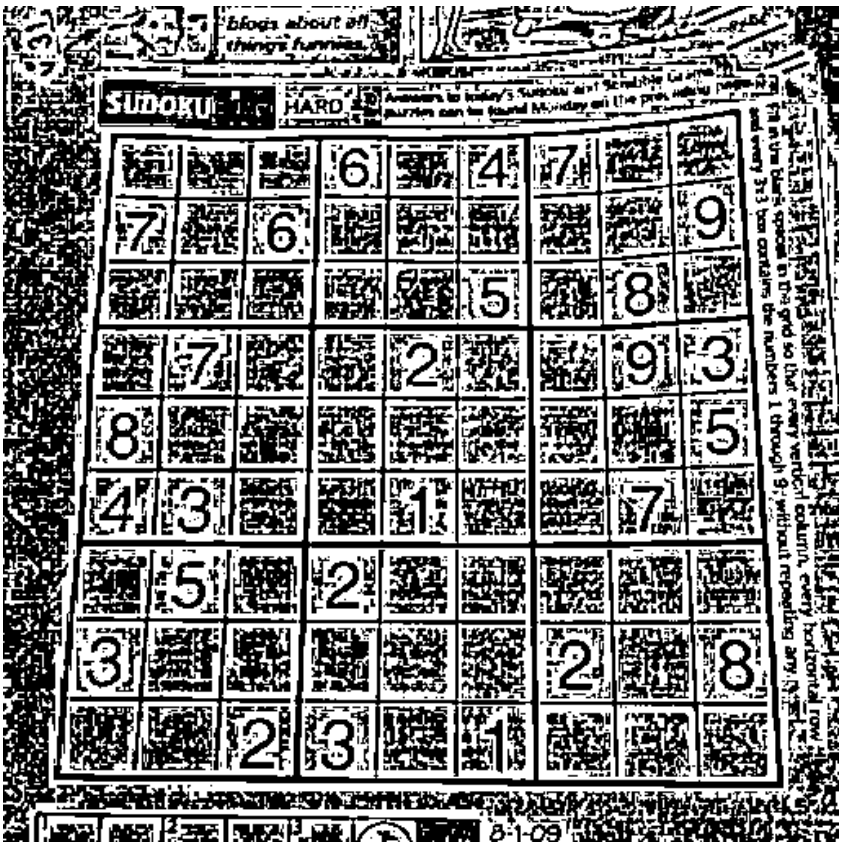

Figure 3.2: Binarized Image With Block Size 5×5

Figure 3.3: Binarized Image With Block Size 10×10

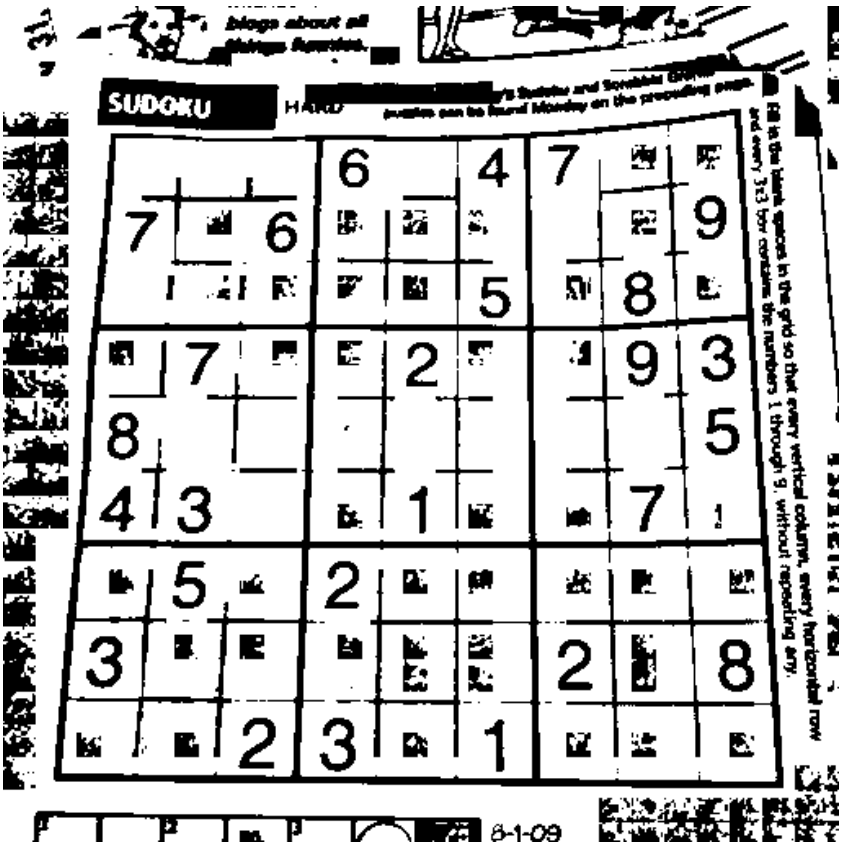

Figure 3.4: Binarized Image With Block Size 25×25

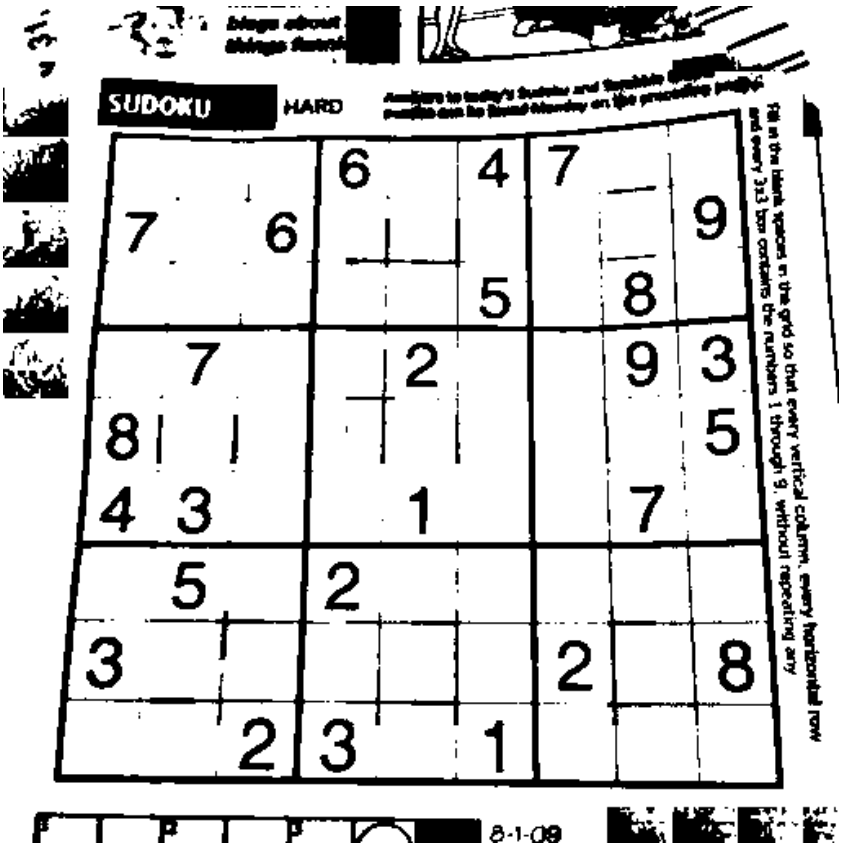

Figure 3.5: Binarized Image With Block Size 50×50

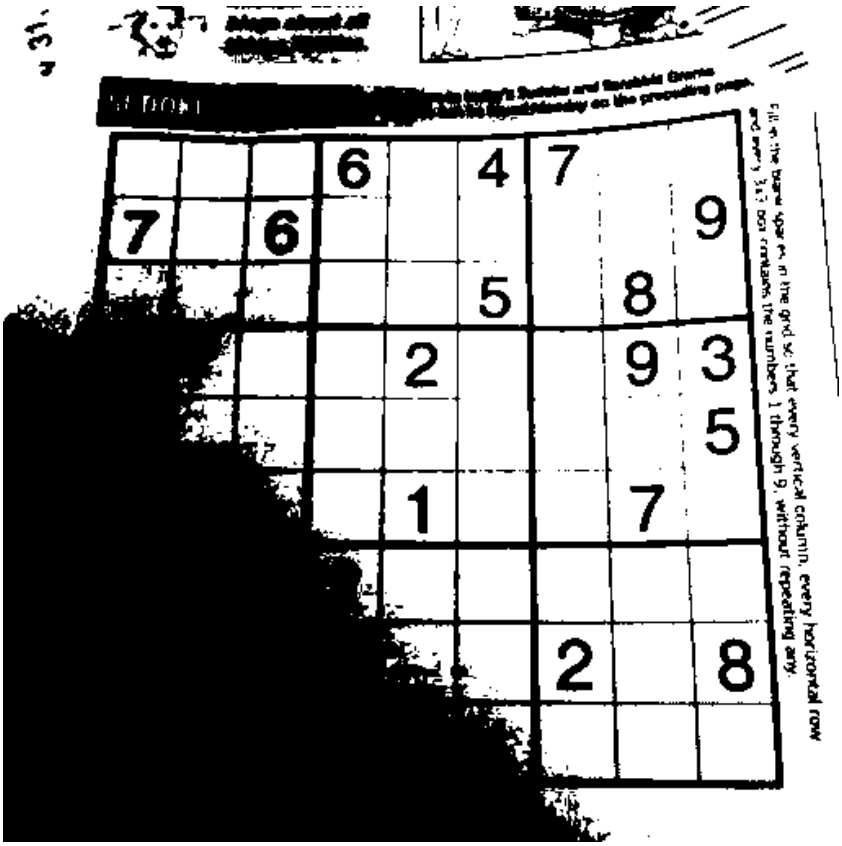

Figure 3.6: Global Binarized Image

4 Connected Components

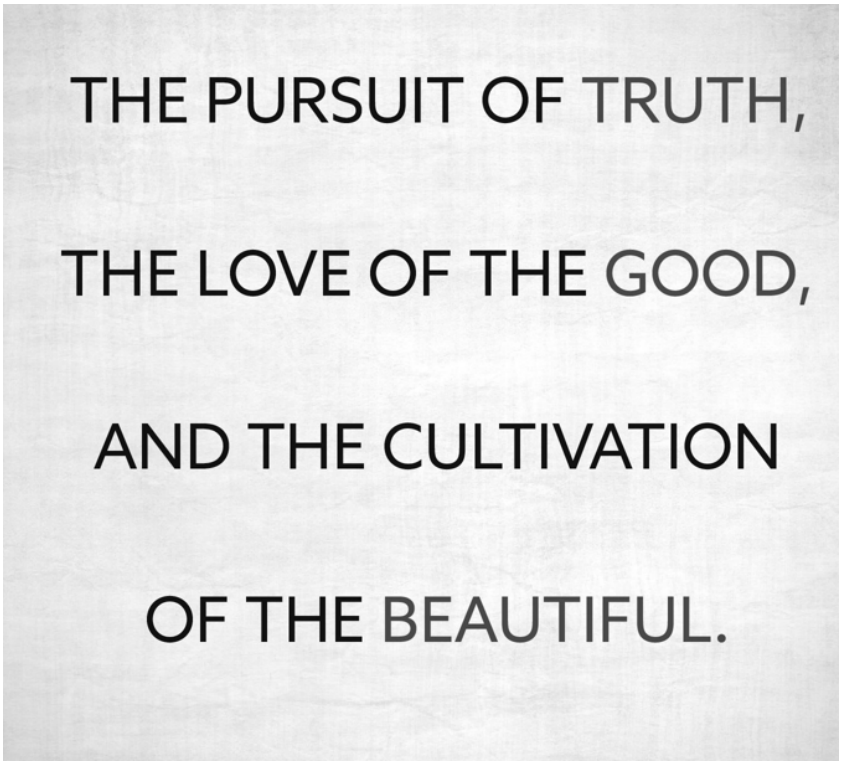

Figure 4.1: Input: Original Quote Image

- The input image `quote.png` was first converted to grayscale and binarized using Otsu's thresholding.
- Connected component analysis was performed on the binary image using the `DFS` function with 8-neighbour connectivity.
- Each connected component was extracted, and its pixel area was calculated and stored in the `connected_component` array.
- The largest connected component, corresponding to the character "N", was identified, and its pixel positions were maintained in `largest_connected_component`.
- This component was then highlighted in red and overlaid on the original image using the `color_red` function to generate the final output.

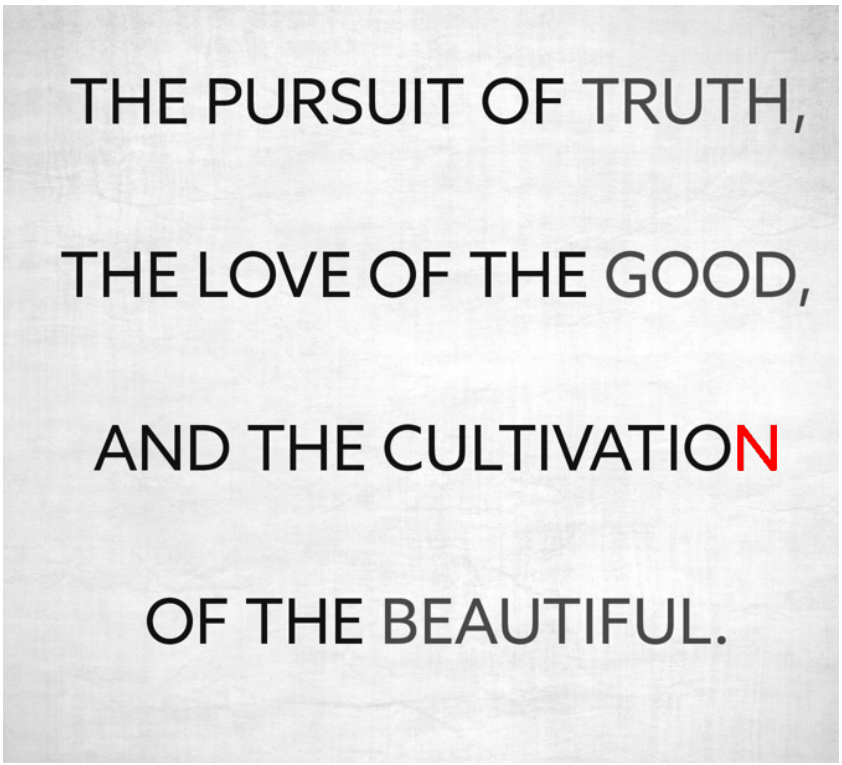

Figure 4.2: Output: Largest Character Highlighted