



INDIAN INSTITUTE OF SCIENCE
ELECTRONICS AND ENGINEERING DEPARTMENT

Digital Image Processing
Assignment 2

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1 Spatial Filtering and Binarisation

The optimal within-class variances σ_w^{2*} obtained for different filter sizes are summarized below:

Filter size m	σ_w^{2*}	threshold
5	169.61	127
29	287.25	121
129	270.25	91

The smallest variance is achieved when $m = 5$, indicating that the binarization is most effective at this scale. For larger kernels ($m = 29$ and $m = 129$), the variance increases because excessive smoothing reduces the contrast between foreground (moon) and background (sky), leading to less compact intensity distributions within each class. Hence, a small kernel is optimal for this image, as it preserves class separability while avoiding the loss of boundary information caused by heavy smoothing.

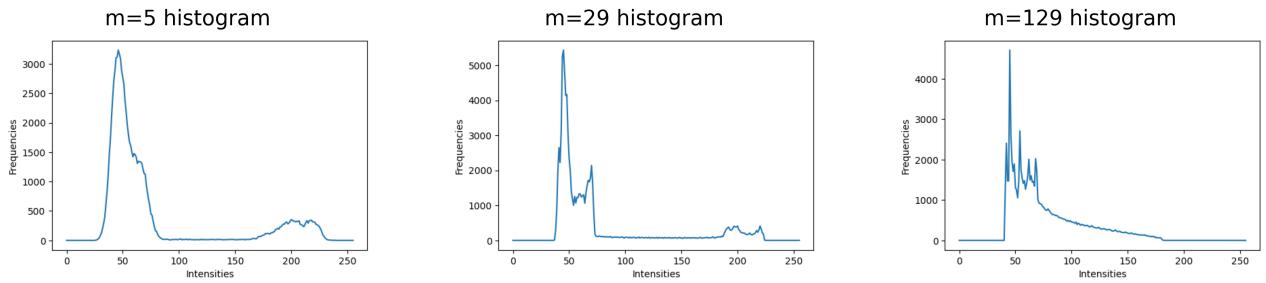


Figure 1.1: Histogram Images



Figure 1.2: Blurred Images

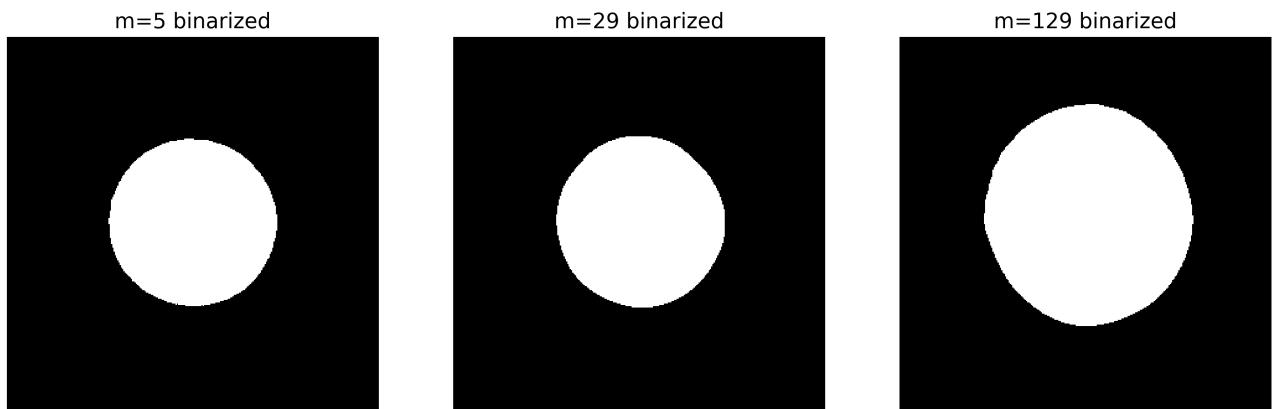


Figure 1.3: Binarized Images

2 Scaling and Rotation with Interpolation



Figure 2.1: Input: flowers Image

- When the image is **rotated first and then upsampled**, fine details are partially lost during rotation, and interpolation during scaling only smooths the already rotated structure.
- When the image is **upsampled first and then rotated**, the higher resolution preserves sharper edges and finer details during rotation.
- The **difference image** clearly highlights variations at edges, corners, and textured regions (flowers and grass), showing pixel-level discrepancies introduced by different interpolation orders.
- Hence, the two results are **not identical**: scaling and rotation are **non-commutative operations** when bilinear interpolation is used, due to resampling and rounding artifacts.

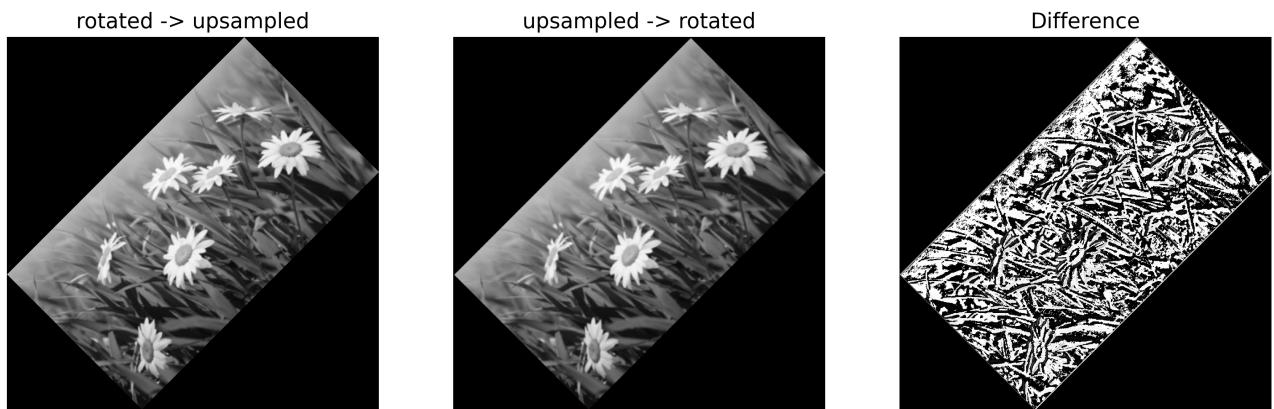


Figure 2.2: Morning sharpened for different values of p

3 Image Sharpening Concept



Figure 3.1: Input: Study Image

Observations on the input image

- Original (p=0):
 - Image is unchanged, showing natural blur/noise as in the source.
 - No halos or edge enhancement.
- p = 0.5:
 - Moderate sharpening — edges (like the laptop keyboard and notebook lines) become clearer.
 - Textures stand out more, and noise also becomes slightly amplified.
 - Good balance: details are visible without introducing strong artifacts.
- p = 1.0:
 - Strong sharpening — edges are very pronounced.

- Halos start appearing (light/dark bands around notebook edges and laptop keys).
- Noise is also significantly emphasized, making the image look grainier.

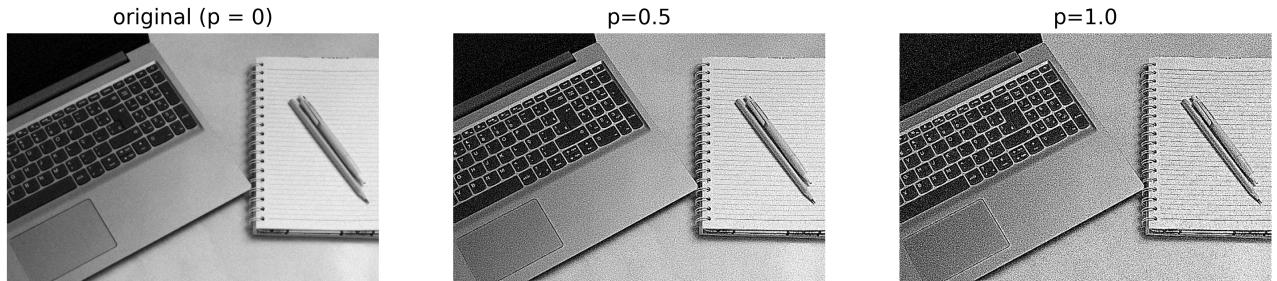


Figure 3.2: Output: Study sharpened for different values of p

Additional Experiments (Other Images)

- **Portraits:**

- Low p improves eye, hair, and skin texture.
- High p exaggerates pores and wrinkles, which can look unflattering.

- **Nature images:**

- Moderate sharpening highlights leaves and branches.
- Strong sharpening causes halos along tree edges against the sky.

- **Text/graphics images:**

- High p makes text edges crisp and readable.
- However, halos may make it look like the text is “outlined”.

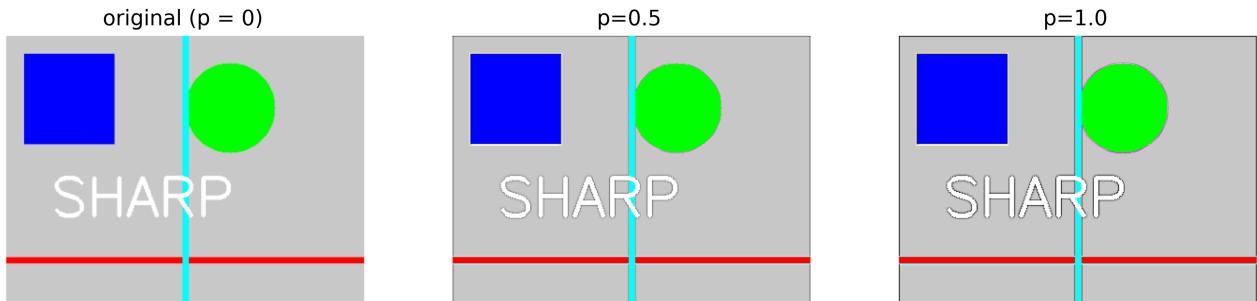


Figure 3.3: Sharp image sharpened for different values of p

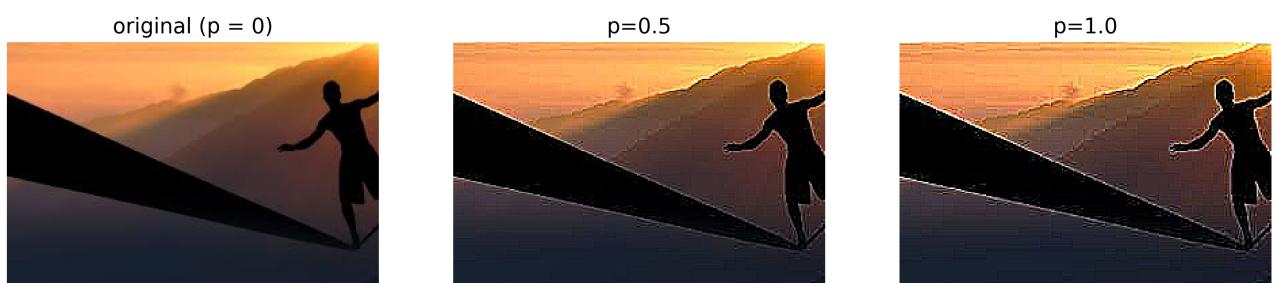


Figure 3.4: Nature image sharpened for different values of p

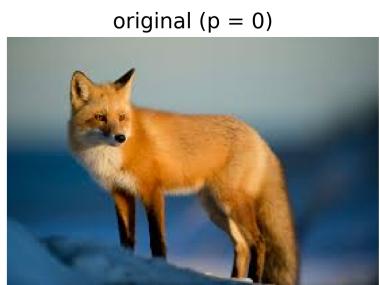


Figure 3.5: Fox image sharpened for different values of p