EXERCISE NO. 1			
Topic:	**Blurring Techniques and Edge Detection Techniques (Comparison)**	Week No.:	**3–5**
Course Code:	**CSST106**	Term:	**1st Sem.**
Course Title:	**Perception and Computer Vision**	Academic Year:	**2024-2025**
Student Name:	**Lesly-Ann B. Victoria**	Section:	**BSCS-4B**
Due Date:	**September 16, 2024**	Points:	

Exercise No. 1: Blurring Techniques and Edge Detection Techniques (Comparison)

IMAGES:

Original Image

- This is the 2x2 picture I used in making these exercises.


Scaled Image (50%)
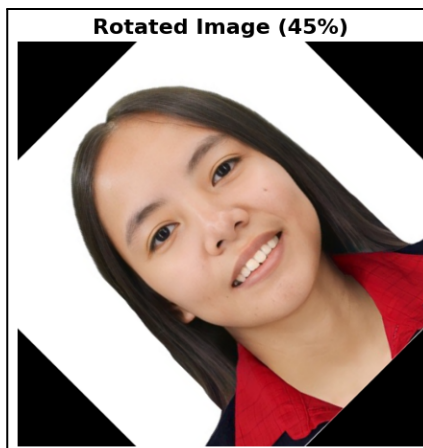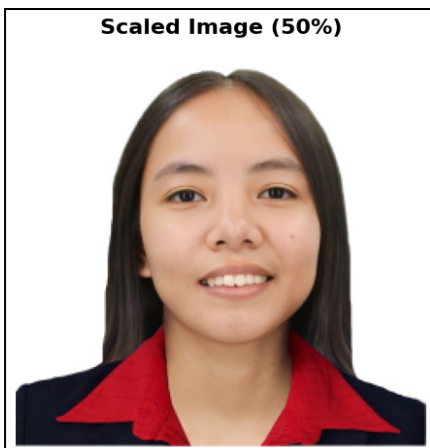
Rotated Image (45%)

- This is the scaled image and rotated image. The first image is a scaled version, reduced to 50% of its original size, which decreases the dimensions while maintaining the image's proportions. The second image has been rotated by 45 degrees, altering its orientation but preserving the content of the original image.

BLURRING TECHNIQUES:

- *Gaussian blur* is often used to reduce noise and soften edges. It's a popular choice for general purpose blurring.
- *Median blur* is particularly effective at removing salt-and-pepper noise (random black and white pixels). It preserves edges better than Gaussian blur.
- *Bilateral filter* is useful for preserving edges while reducing noise. It's a good choice for images with fine details.
- *Box filter* is a simple blurring technique that can be used to smooth out noise. However, it can also blur edges.
- *Motion blur* can be used to create artistic effects or to simulate real-world motion.
- *Unsharp mask* is often used to enhance image details and make them appear sharper.

Images:
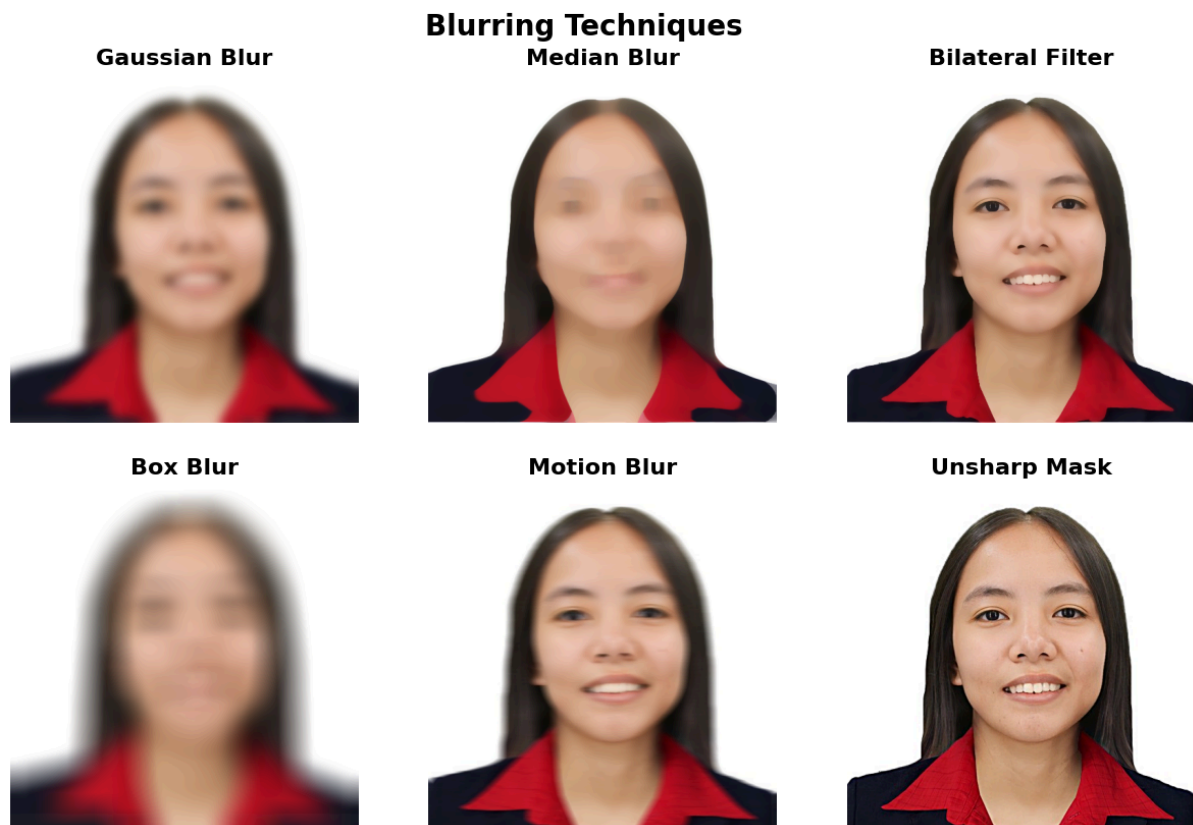
1. **Gaussian Blur -** This image shows the effect of Gaussian Blur, where the picture has been blurred by applying a Gaussian function. This technique results in a smooth blur, evenly distributing the blur effect across the image, which softens the sharp details.
2. **Median Blur -** The second image demonstrates Median Blur, which reduces noise by replacing each pixel's value with the median value of the neighboring pixels. This technique creates a soft, more blended look, but can maintain edges better than other types of blur.

3. **Bilateral Filter -** This filter preserves the edges while blurring the image, as seen in the third image. It smoothes regions of similar color or brightness but keeps the distinct boundaries of objects intact, making the subject's facial features clearer compared to other blurring techniques.

4. **Box Blur -** In the fourth image, Box Blur has been applied, resulting in a uniform and simple blur effect. The image appears as if a square filter has been averaged over each pixel in a grid pattern, creating a slightly less sophisticated blur.

5. **Motion Blur -** The fifth image demonstrates Motion Blur, simulating the effect of moving the camera or subject during the shot. This results in streaks or lines that give the impression of movement, with the blur following a specific direction.

6. **Unsharp Mask -** The final image utilizes the Unsharp Mask technique, which sharpens the image by enhancing the contrast of edges. It gives a clearer, more defined look compared to the other techniques, with the subject's facial features appearing sharper and more prominent.

Table 1: Comparison of Blurring Techniques

Blurring Techniques	Blurring	Noise Reduction	Edge Preservation	Artistic Effects	Sharpening
Gaussian Blur	✔	✔			
Median Blur	✔	✔	✔		
Bilateral Filter	✔	✔	✔	✔	
Box Blur	✔				
Motion Blur	✔			✔	
Unsharp mask			✔		✔

This Table 1 above compares different blurring techniques based on their ability to blur, reduce noise, preserve edges, create artistic effects, and sharpen images. Gaussian Blur is commonly used for blurring and noise reduction but doesn't contribute to edge preservation and artistic effects or sharpening. Median Blur excels at noise reduction and edge preservation while also providing basic blurring. Bilateral Filter is unique in that it blurs while preserving edges, noise reduction and is often used in artistic effects such as cartoonizing images. Box Blur is a simple technique that only blurs, without offering noise reduction, edge preservation, artistic effects or sharpening. Motion Blur simulates the effect of moving objects and is mainly used for artistic purposes. Finally, the Unsharp Mask is a sharpening tool rather than a blurring method, enhancing edge contrast to sharpen images.

EDGE DETECTION TECHNIQUES:

- ***Sobel edge detection*** is a simple and computationally efficient method. It's sensitive to noise and can produce double edges.
- ***Laplacian edge detection*** is less sensitive to noise than Sobel edge detection but can be more susceptible to noise. It may also produce multiple edges for a single edge.
- ***Prewitt edge detection*** is also a simple and computationally efficient method. It's like Sobel edge detection in terms of sensitivity to noise and the potential for double edges.
- ***Canny edge detection*** is considered one of the most robust edge detection algorithms. It's less sensitive to noise than Sobel and Laplacian, and it can produce thin, continuous edges.

Images:

1. **Sobel Edge Detection -** Sobel detects edges by looking at how the brightness of pixels changes from side to side and up and down. It creates thicker lines around the edges, such as the outline of the face, eyes, and mouth.
2. **Laplacian Edge Detection -** Laplacian finds edges by checking for sharp changes in brightness in all directions. It gives thinner, more detailed edges compared to Sobel, making the facial features look sharper but can be sensitive to noise.
3. **Prewitt Edge Detection -** Prewitt works similarly to Sobel but uses a simpler way to find changes in brightness. The edges it detects are also thick but a bit smoother, showing the outlines of the face and features in a slightly softer way.
4. **Canny Edge Detection -** Canny is a more advanced method that first reduces noise and then finds very clear and thin edges. It produces sharp, precise lines around the face and features, making it good for accurate edge detection.

Table 2: Comparison of Edge Detection Techniques

Edge Detection Techniques	Sensitivity to Noise	Edge Thinness	Edge Continuity	Computational Efficiency
Sobel	✔		✔	✔
Laplacian	✔	✔		✔
Prewitt	✔		✔	✔
Canny		✔	✔	

This Table 2 above compares various edge detection techniques based on sensitivity to noise, edge thinness, edge continuity, and computational efficiency. The Sobel and Prewitt operators are simple and computationally efficient but are sensitive to noise and tend to detect thicker edges with moderate edge continuity. The Laplacian method is also efficient and capable of detecting thin edges, but it is highly sensitive to noise and lacks strong edge continuity. The Canny edge detector, while computationally more intensive, excels in reducing noise sensitivity, producing thin edges, and maintaining edge continuity, making it the most accurate technique among those listed.

In conclusion, blurring and edge detection are important tools in image processing, each serving a different purpose. Blurring, such as with Gaussian blur, helps smooth out images by reducing noise and softening details. This is useful when preparing an image for further analysis. Edge detection, like the Canny Edge Detector, is used to find the edges or outlines of objects in an image. It focuses on areas where there are sharp changes in brightness. Both techniques are essential in improving image quality and helping identify important features in computer vision applications.