Recommended Assessment

Vision

Image Processing

1. In an automated sorting system where the QArm Mini needs to detect and classify objects of different colors under changing lighting conditions, which color space—HSV or RGB—would be more effective?

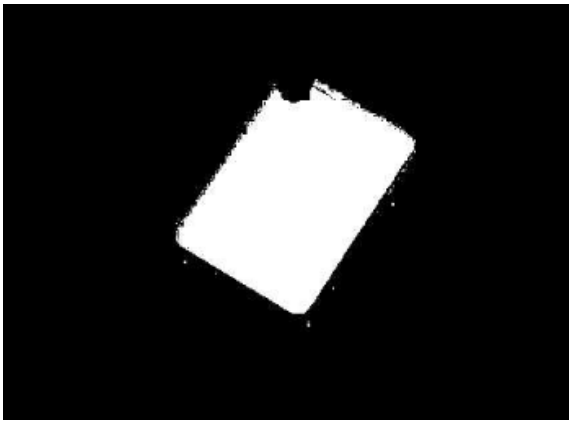
   HSV would be the more effective color space for this task because it separates color information (hue) from brightness (value), making it more robust to varying lighting conditions. To correctly classify objects, consistent color detection is crucial, and RGB can be affected by changes in illumination since it combines color and intensity in a single representation.

2. How do the hue, saturation, and value ranges affect object recognition?

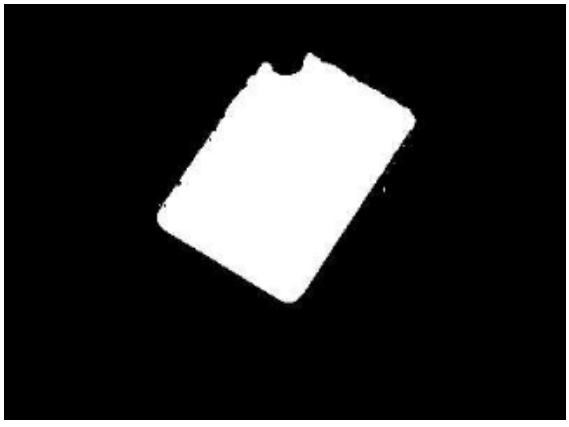
   Hue represents the color type, saturation indicates the intensity or purity of the color, and value corresponds to brightness. This separation allows for precise color thresholding. By adjusting the hue range, you can isolate specific colors, while modifying the saturation and value ranges improves detection accuracy under varying lighting conditions.

3. What is the purpose of applying Gaussian blurring before image transformation? How does changing the kernel size impact detection?

   Gaussian blurring reduces noise and smoothens the image, which helps improve the accuracy of object detection. It minimizes small variations that could otherwise be misidentified as objects. Increasing the kernel size enhances the blurring effect, which can help in reducing noise but may also cause a loss of fine details. Conversely, a smaller kernel size preserves more detail but may allow more noise to pass through, affecting segmentation accuracy.



Before Gaussian Filter



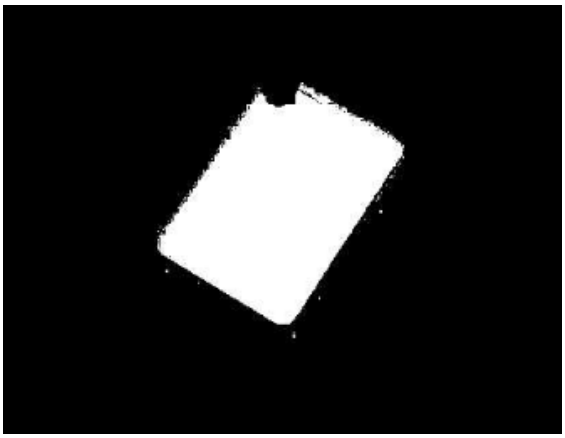
After Gaussian Filter

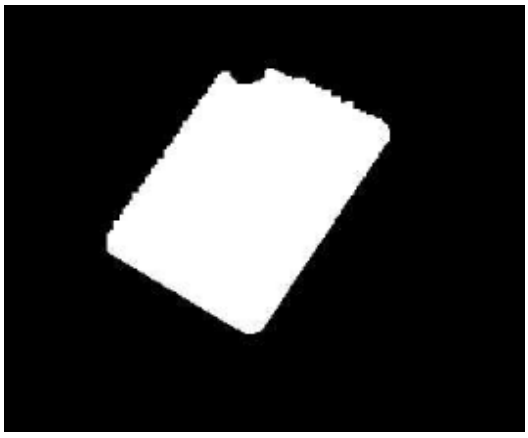
4. How do morphological operations like erosion, dilation, and opening affect image noise and object boundaries? When would you use each?

- Erosion: Shrinks object boundaries by removing pixels, which is useful for eliminating small noise and separating connected objects. It is ideal when you want to reduce false positives caused by scattered noise.

- Dilation: Enlarges object boundaries by adding pixels, helping to fill small gaps and connect fragmented objects. It is useful when objects are broken or incomplete.

- Opening: Is a combination of erosion followed by dilation, which removes small noise while preserving the shape and size of larger objects. It is commonly used to clean up noisy backgrounds without distorting the main object.





5. What does the bounding box represent in object detection, and how does changing the connectivity type (4 vs. 8 directions) influence object recognition?

   The bounding box in object detection is a rectangular region that encloses the detected object, defining its position and size within the image. It helps track and measure objects in the camera's field of view.

   Connectivity type determines how neighboring pixels are connected:

   - 4-connectivity considers only horizontal and vertical neighbors. It is more restrictive and may treat diagonally connected pixels as separate objects, which can lead to fragmented detection.

   - 8-connectivity includes diagonal neighbors, allowing for more continuous object recognition. It is useful for detecting irregularly shaped or closely spaced objects but may merge objects that are close together.

6. What challenges could arise when detecting objects in real-world environments?

   Lighting Variation: Changes in ambient light can alter object appearance and affect color detection.

   Background Complexity: Cluttered or dynamic backgrounds can cause false positives.

   Object Occlusion: Partial blocking of objects can disrupt detection.

   Color Similarity: Objects with similar hues may be misidentified.

Camera Noise: Low-resolution or noisy images can degrade performance.