Concept Review

Blob Detection

What is Blob Detection?

Blob detection is a technique which identifies and isolates regions of interest, commonly referred to as "blobs", within an image. These blobs are often characterized by their colour, enabling the detection of distinct objects. This technique is widely used in image processing applications for tasks such as object recognition, tracking, and segmentation.

Image Preprocessing

The first step of blob detection is image preprocessing, an important step aimed to enhance the quality of the image. This often involves noise reduction through appropriate filters, such as Gaussian and median filtering. Occasionally, the saturation of the image is increased make the desired region more distinguishable for blob extraction. For more detailed review on image filtering techniques, you can refer to our Image Filters Concept Review.

Now, let's proceed to the next steps, using Figure 1 as the example image for blob detection.

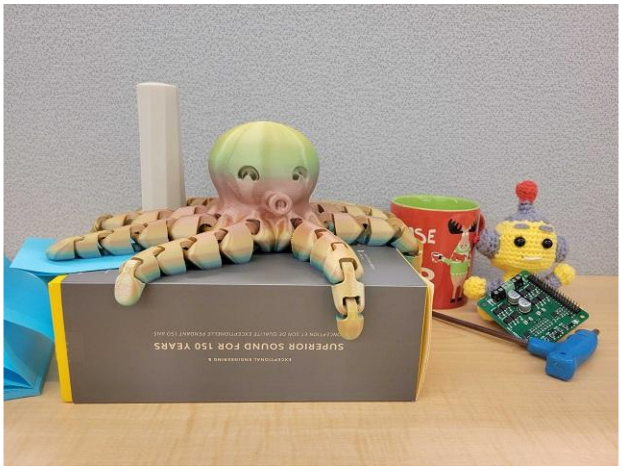

Figure 1 - octopus – original image.

Thresholding

After preprocessing, the enhanced image is then converted to a binary image through thresholding. In the global thresholding method, the same threshold values are applied to every pixel. If the pixel value falls within the range of a minimum and a maximum threshold, this pixel is set to 1. For RGB images, distinct threshold ranges are applied to each of the RGB channel to isolate the desired colour. Alternatively, for HSV images, one range of hue thresholding values is needed. For more detailed review on the difference between these two types of images, you can refer to our Colour Spaces Concept Review. However, global thresholding can be heavily affected by varying lighting conditions. To address this limitation, more advanced methods such as adaptive thresholding can be utilized, which dynamically adjusts the thresholds based on the pixel intensity in the neighbourhood.

In our image example from Figure 1, we are interested in isolating and tracking the red mug. The global thresholding method is utilized, and threshold values representing the red colour were selected. Figure 2 shows the resulting binary image overlaid on the original.

Figure 2 - Binary image after thresholding (left) and the original image with red channel replaced (right).

Blob Analysis

Blob analysis involves the segmentation of images based on connected components (blobs), and analysis of various blob properties, e.g., area and centroid of the blobs. The shape of the connected components may vary based on the type of connectivity, which is commonly a 4 or 8-connected type. A 4-connected type refers to pixels that are neighbors to every pixel that touches one of their edges. These pixels are connected horizontally and vertically. 8-connected pixels are neighbors to every pixel that touches one of their edges or corners. These pixels are connected horizontally, vertically, and diagonally. Figure 3 visualizes the 4 and 8-connectivity concepts in digital images.

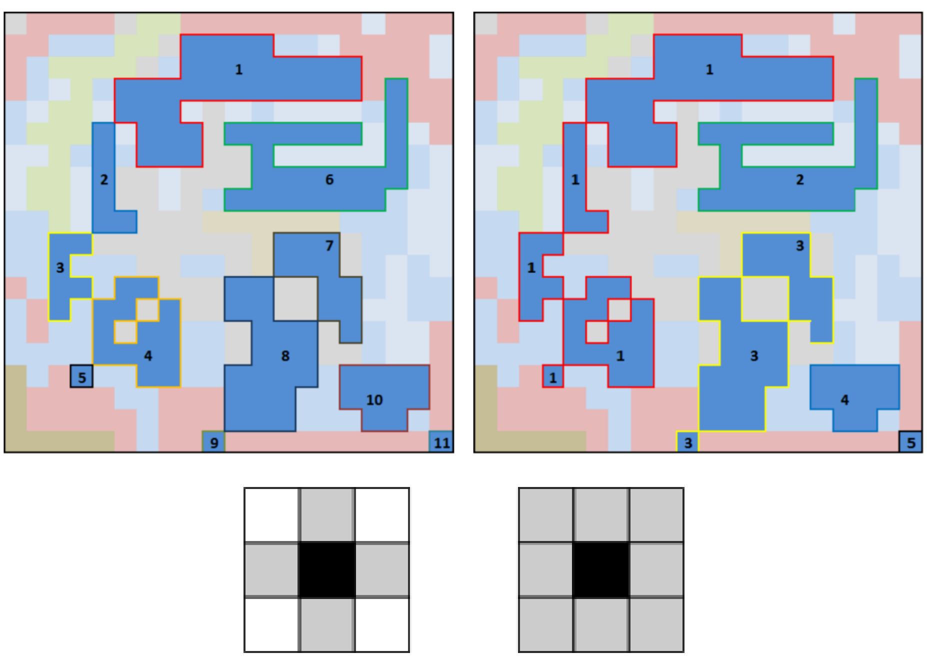

Figure 3 - 4 vs 8 Connectivity.

Figure 4 shows blob extraction results using both 4-connectivity and 8-connectivity for our example. The second largest blob in the left image is only connected to the main blob diagonally; therefore, it is recognized as a separated blob when using 4-connectivity.

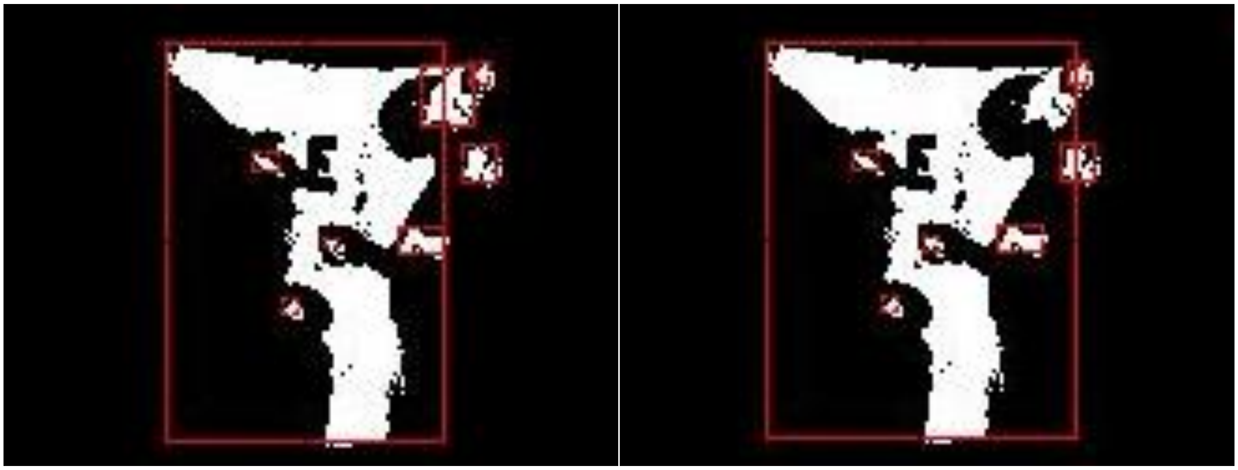

Figure 4 - 4 vs 8 connectivity applied to the example's binary image after thresholding.

In addition, Figure 4 shows many detached blobs produced by global thresholding. While the largest blob reasonably represents the mug, the binary image can be further processed to improve the quality of the blobs. We can adjust the thresholding values, hoping that it will leave out enough pixels to connect the blob. Or, alternatively, we can apply image filters such as maximum and morphology filtering (refer to the Image Filters Concept Review on more information about these). These filters can help connect the smaller blobs more consistently. In this case, we apply maximum filtering with a 7x7 kernel size. As shown in Figure 5, the maximum filtering effectively merges all small blobs in the region of the red mug, better indicating its location.

Figure 5 - Binary image after maximum filtering and the original image with red channel replaced.

The extracted blob could be further analysed and filtered based on its properties such as area, circularity, and compactness. Blob area is defined as the number of pixels in the extracted blob. Circularity measures how close to a perfect circle the blob is. For a perfect circle, the circularity equals to 1. Compactness is defined by ratio of the blob area to the area of the bounding box. These properties allow for further filtering of the blob. In our example, we can set a minimum blob area threshold to easily isolated the mug blob. Through the blob detection method, the red mug is successfully localized, as shown in Figure 6.

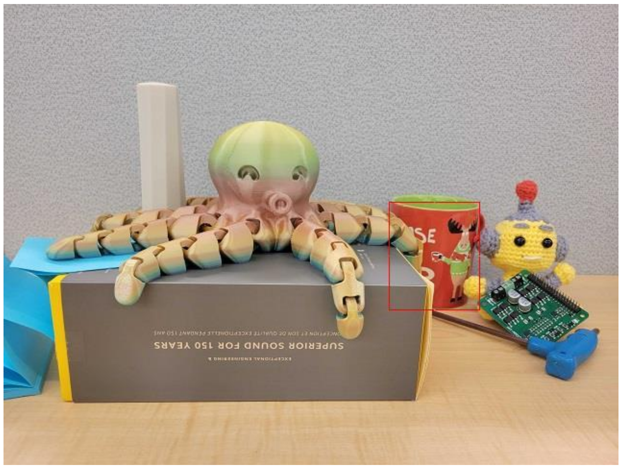

Figure 6 - Red mug localized.

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