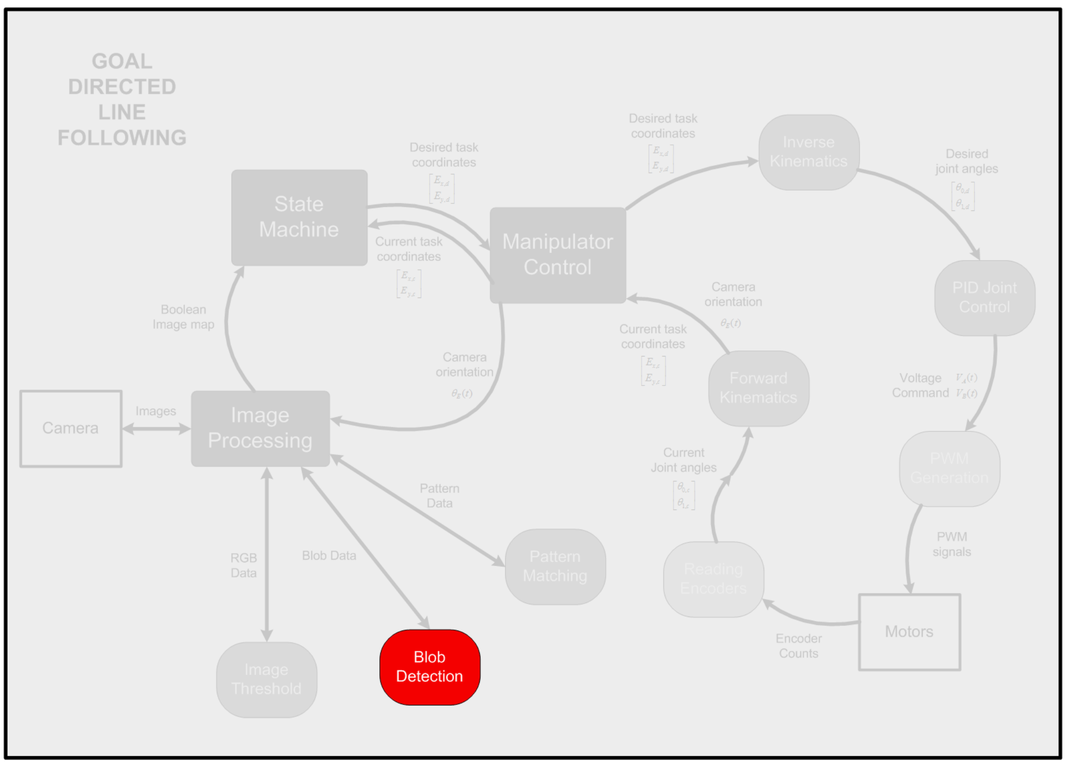
Blob Detection

Topics Covered

- Blob Detection in LabVIEW™
- Using Blob Detection to extract road information

Prerequisites

- The QNET Mechatronic Systems is set up according to the Quick Start Guide.
- Image Threshold laboratory experiment



1 Background

Blob detection (or particle analysis) is another method of image segmentation that can provides the user with various particle properties. For example, in Figure 1.1, image thresholding for the red particles will keep the red bullseye, as well as multiple red markers in the inner and outer rings. Blob detection will provide further information on these particles within the image, such as their area, location, circularity, boundary, etc. This can be used to find the circular bullseye, and ignore the markers in the rings.

Figure 1.1: A dart board

Blob detection has a variety of applications from texture recognition and analysis, to detecting tumours in MRI. Recall from the Image Threshold laboratory experiment that an image is a 2D map represented by a function $f(x, y)$. Blob detection can be represented by the following function,

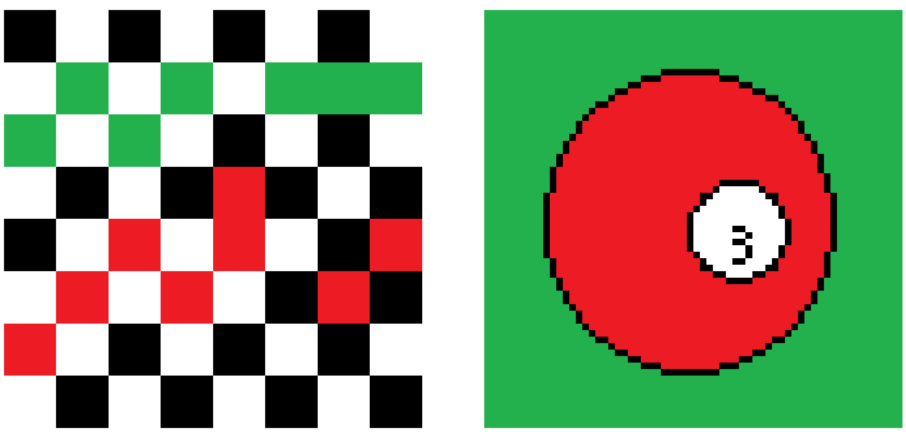
$$\big(N, X, Y, A, w, h\big) = Q\big(f(x, y)\big), \tag{1.1}$$

x and y refer to the row and column pixel index, Q is the blob detection algorithm/operation, N is the number of particles found in $f(x, y)$, X and Y refer to the centroids of those particles, A refers to the area of the particles, w refers to the particle width and h refers to the particle height. Blob detection is usually carried out on thresholded images to extract specific information. For example, to extract the location of the yellow cereal in the image shown in Figure 1.2a, the image can first be color thresholded to Figure 1.2b, followed by blob detection which would provide the centroid of each cluster of similar pixels.

(a) Original image (b) Thresholded image

Figure 1.2: Example of thresholding before blob analysis to find yellow cereal balls.

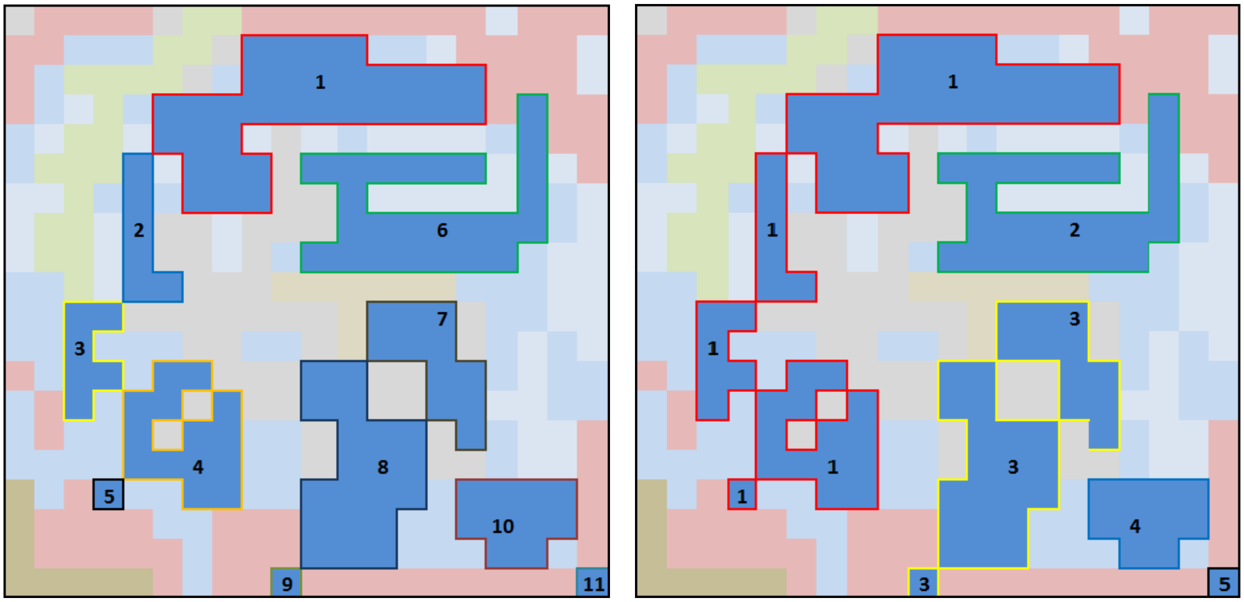
The segmentation or clustering of the particles depends on how they are connected (connectivity), which is commonly a 4 or 8-connected type. A 4-connected type refers to pixels that are neighbours to every pixel that touches one of their edges. These pixels are connected horizontally and vertically. This is useful for scenarios where information may be required at a finer scale, such as the location of pawns on a chequered board image (Figure 1.3a). On the other hand, 8-connected pixels are neighbours to every pixel that touches one of their edges or corners. These pixels are connected horizontally, vertically, and diagonally. This is useful when a generalized cluster is required, for example, to find the outer edge of the red ball in Figure 1.3b, or the centroid of the cereal in Figure 1.2b.



(a) Chequered board (b) Pool ball

Figure 1.3: Different connectivity types are useful for certain image types

When analysing high quality images that are being thresholded in real-time, an 8-connectivity might prevent particle scattering along edges. Figure 1.4 visualizes the 4 and 8-connectivity concepts in digital images. Blob detection would claim different number of particles depending on the connectivity used.



(a) 4-Connectivity (b) 8-Connectivity

Figure 1.4: Example of blob detection connectivity types when finding blue coloured blobs.

2 In-Lab Exercises

In this exercise, Blob detection is used on a Gray-scale 8-bit images $f(x, y)$ captured by the QNET Mechatronic Systems camera.

1. In the project `Mechatronic Systems.lvproj`, under `Quanser ELVIS RIO | Subsystems`, open `Blob Detection.vi`. Select the Static Image page. What change do you expect in the number of particles in the image shown with the Connectivity switch turned *OFF* or *ON*? Run the VI with the Connectivity switch *OFF* and then turn it *ON*. Do the results match your expectations?

2. Stop the VI. Switch to the Mechatronic Systems page, and run the VI. Wait till the Calibration bar is full. Depending on the threshold histogram, move the Upper Threshold Range slider to a value just below the largest peak, approximately 120 (note that this value might be different depending on the lighting conditions in your environment). Move the manipulator such that the star is roughly in the centre of the image. How many particles do you see in the thresholded image, and how many does the particle analysis report for both Connectivity types?

   Note: For more information on thresholding, refer to the Image Threshold laboratory experiment.

3. Reduce the Upper Threshold Range slider to 55. How many particles does the analysis report for both Connectivity types? Is this expected? What connectivity type should you use for extracting road information?

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