Machine Vision

Home assignment:
Counting empty bottles in bottle crates

1 General Instructions

The main goal of the following project is to learn image manipulation and to develop a sense of how image processing solutions are prototyped in software. The exercise is about thresholding and morphological processing. You will implement a program for counting empty bottles in bottle crates. The exercise will be done solo. Return your written report and commented code via e-mail. The report can be written either in English or in Finnish. Matlab is the required tool for implementing the program.

1.1 Format for Project Reports

Page 1. Cover Page.

- Project title
- Course name
- Student's name and number
- Abstract (not to exceed half a page)

Technical discussion. This section should discuss the techniques used in the solution.

Results. Includes all the results generated in the project. Number figures/tables individually so they can be referenced in the preceding discussions.

Discussion of results. A discussion of results should include major findings in terms of the project objectives. Describe also the situations when your system might fail to recognize the bottles correctly.

Appendix. Program listings. Includes listings of all programs written by the student. Standard routines and other material obtained from other sources should be acknowledged by name, but their listings do not have to be included.

2 Exercise Instructions

2.1 Test Data

The test image data set contains 24 images of bottle crates.

2.2 Desired Results

Using diffuse front light, correctly inserted bottles can be segmented using simple thresholding operations followed by some basic morphological operations. Use threshold operation to segment the background and the bottles from the original image. For the background image, use morphological opening operation to remove all fine details that are not part of the background image. An example can be seen in Figures 1 and 2. Remove all the points in image 2 from a threshold image of bottle reflections (Figure 3).

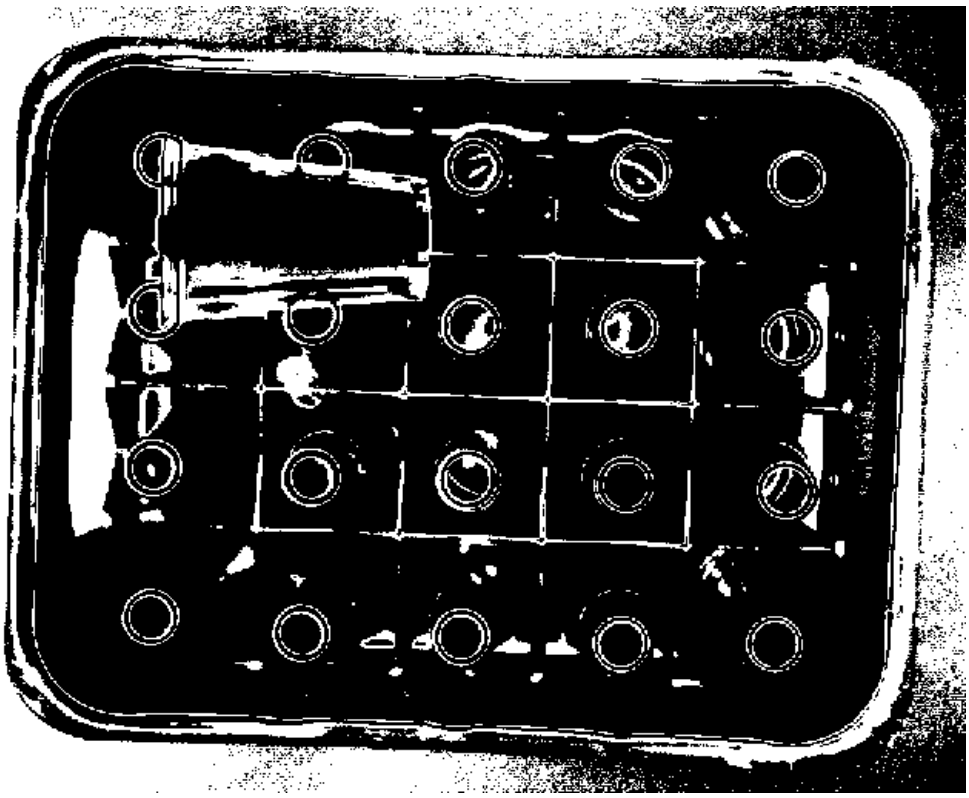

Figure 1: Threshold image of the background

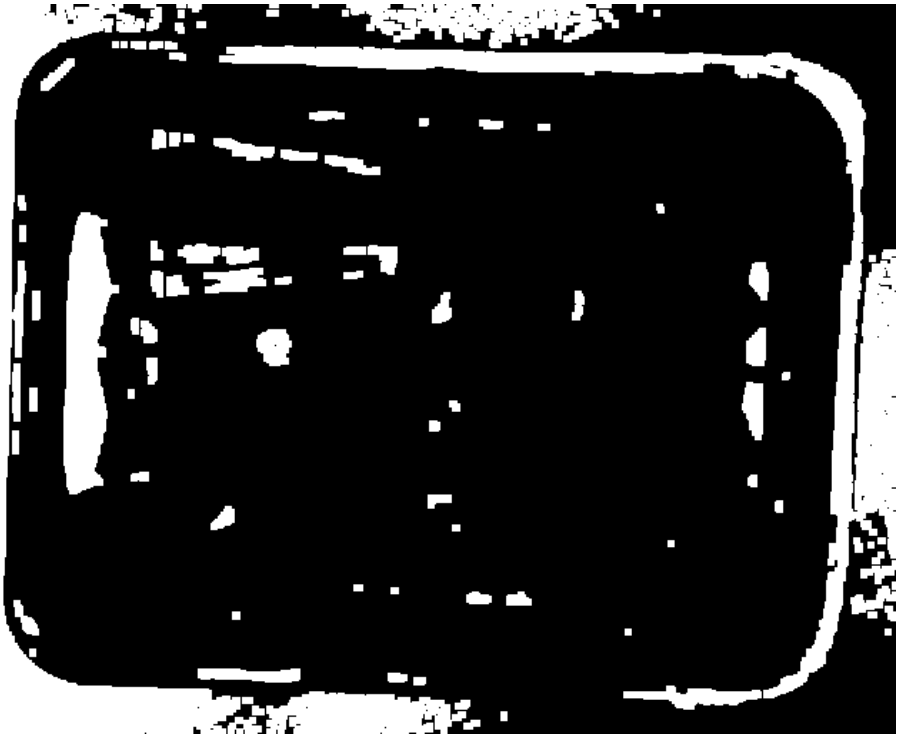

Figure 2: Threshold image of the background after morphological opening

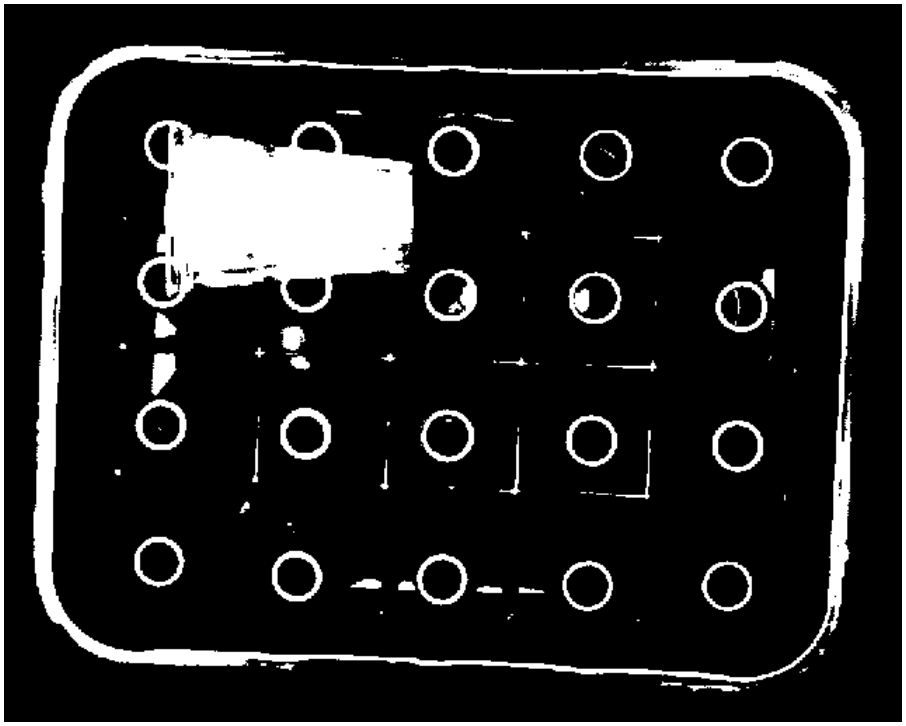

Figure 3: Threshold image of the bottle reflections

Label connected components in the difference image. Use the areas of the connected components to determine which components can be classified as clutter. Remove the resulting image pixels from the difference image. If you perform a morphological opening operation on clutter image before the difference operation, it helps to differentiate bottles from clutter in some cases. For component

removal you might find Steve Eddins' blog entry useful: Using ismember with the output of regionprops. http://blogs.mathworks.com/steve/2009/02/27/using-ismember-with-the-output-of-regionprops/

After clutter removal, see image 5, there still are noisy and non-circular areas in the image. Use the size of the connected components to discriminate noisy areas from the bottle candidates. The result is several non-filled candidates for bottle reflections. Fill the holes in the candidate image. Matlab command imfill can be used for filling holes.

Round bottle objects can be determined by measuring the eccentricity of the connected components in the candidate image. If you perform a morphological opening operation on the image before measuring the eccentricity, it helps to make the bottles to deviate less from being circular in some cases.

Draw green circles over correctly inserted bottles and orange circles over bottles inserted upside-down. Some examples of correctly classified bottles in a bottle crate can be seen in Figures 7–10.

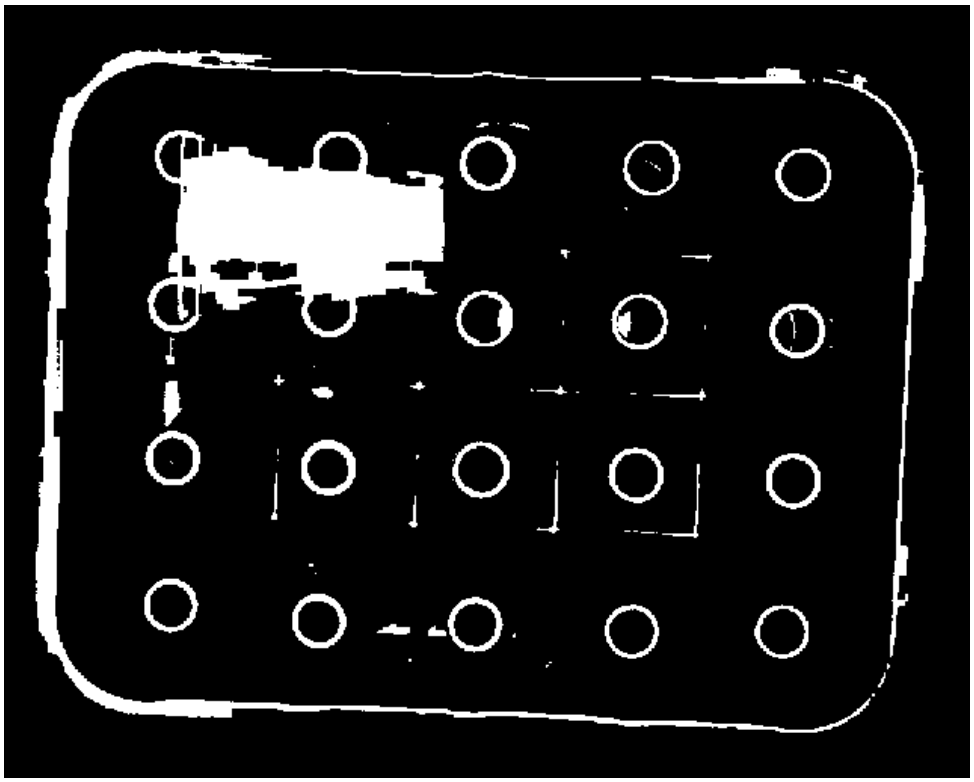

Figure 4: The difference between images 3 and 2

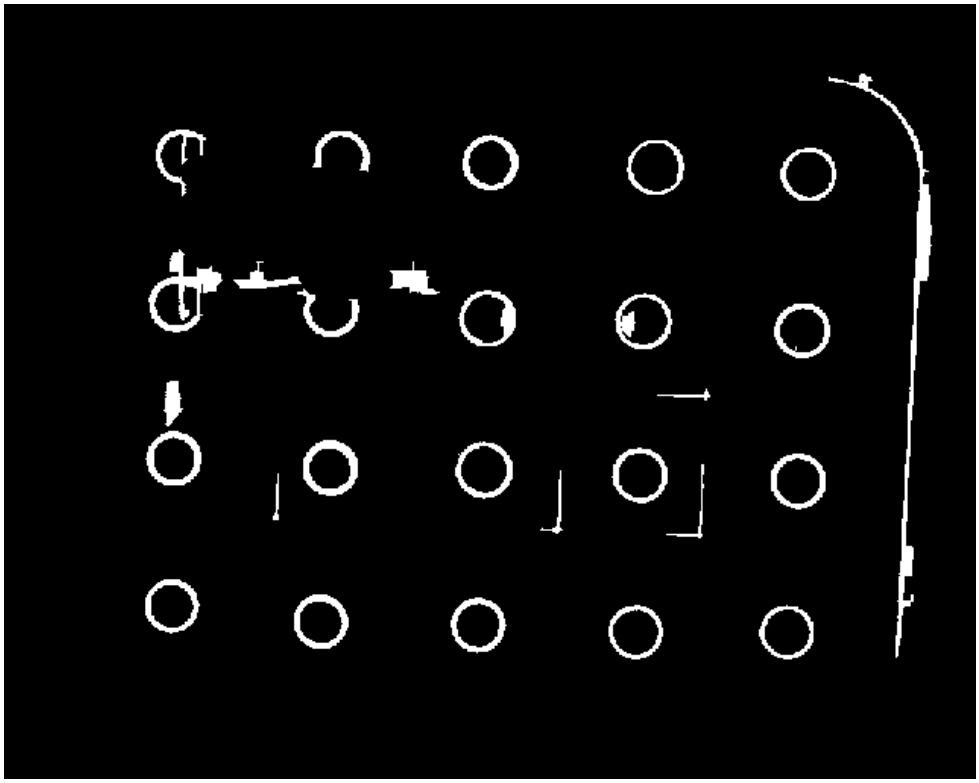

Figure 5: After clutter removal

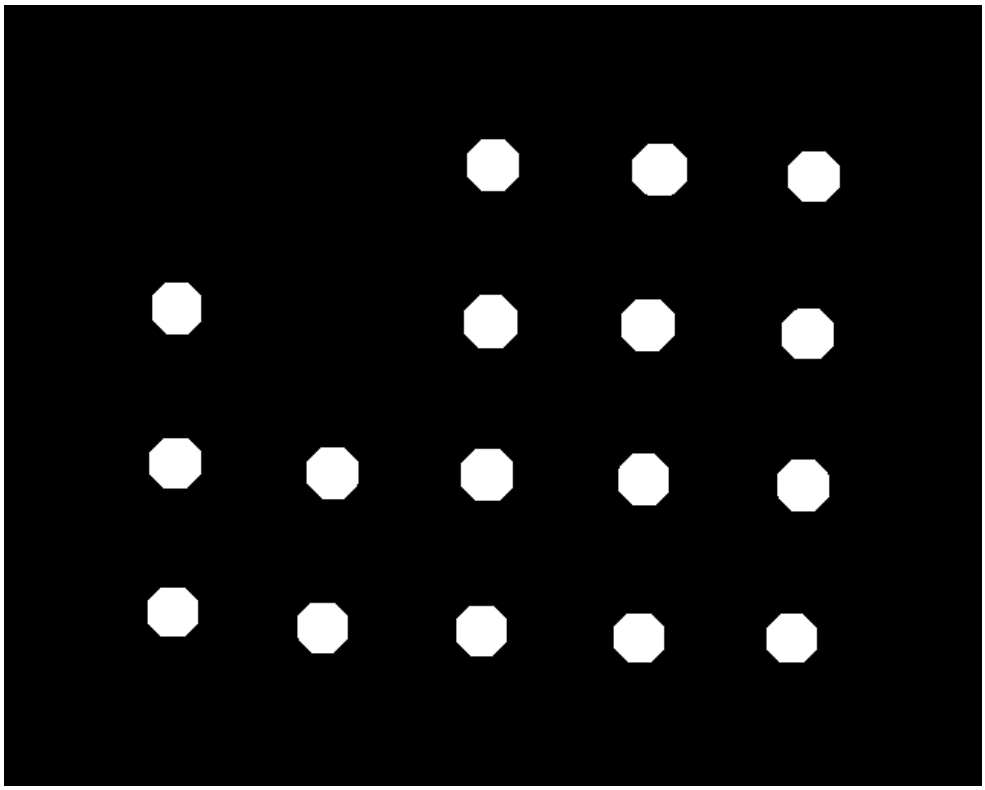

Figure 6: Noisy regions and non-circle area have been ignored; the remaining components have been filled

2.3 Example Code

To get started, take a look at the included example code for Matlab. The code assumes that the images are either in the current directory or in the Matlab path. You can add the directory containing test images using path command, e.g., path(path,'c:\work\kon\bottles').

The code loads and displays each test image one at a time. The code also draws a green circle with a constant 20 pixel radius on the location (100,100) on the original images. In the example code, ZhenhaiWang's code for drawing circles is used.

http://www.mathworks.com/matlabcentral/fileexchange/2876-draw-a-circle

The next image will be processed after a user presses a key.

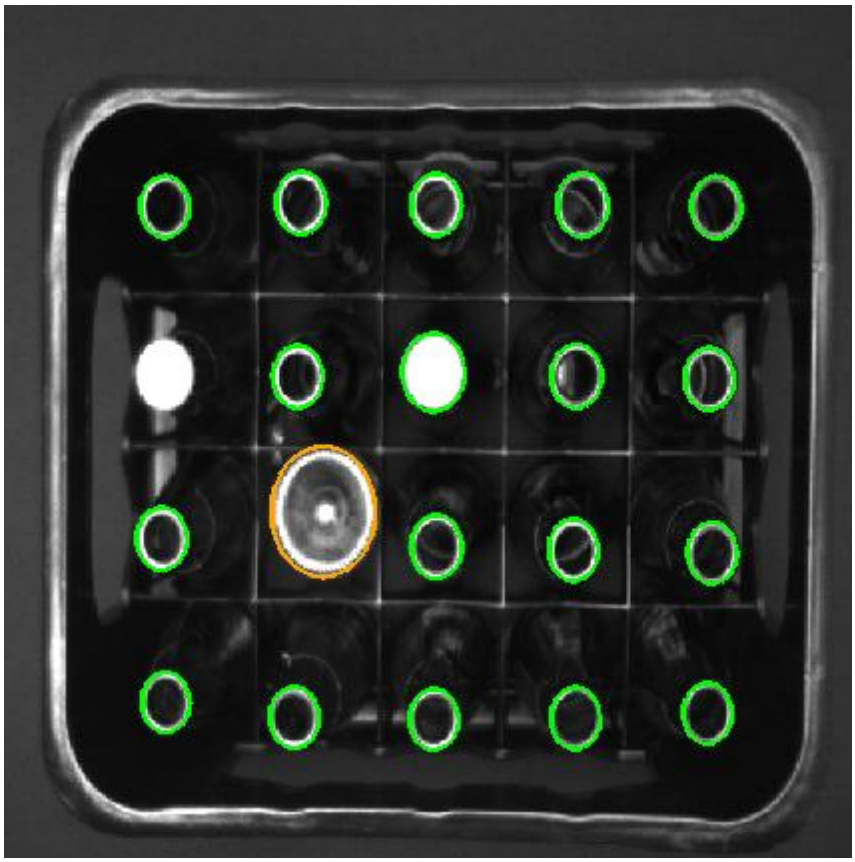

Figure 7: An example of correct classification

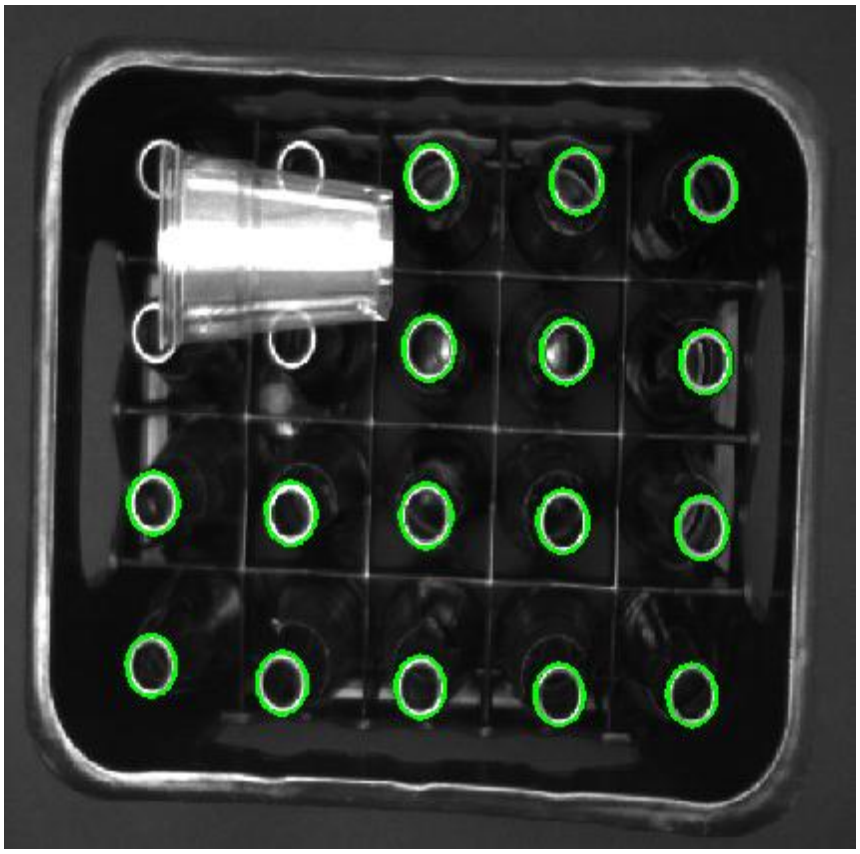

Figure 8: An example of correct classification

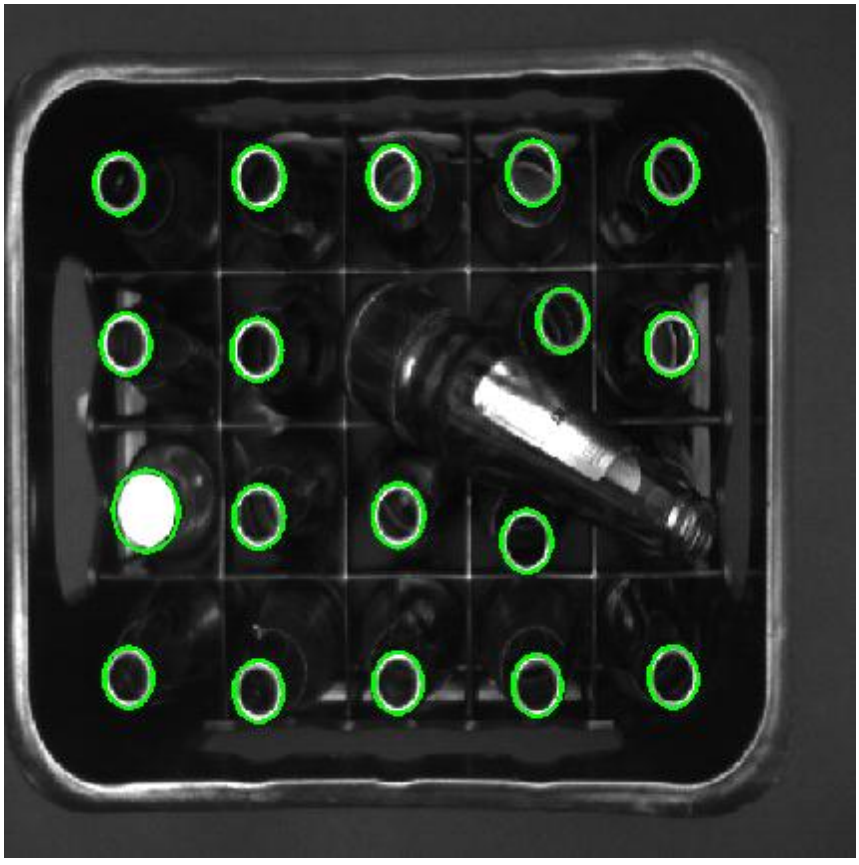

Figure 9: An example of correct classification

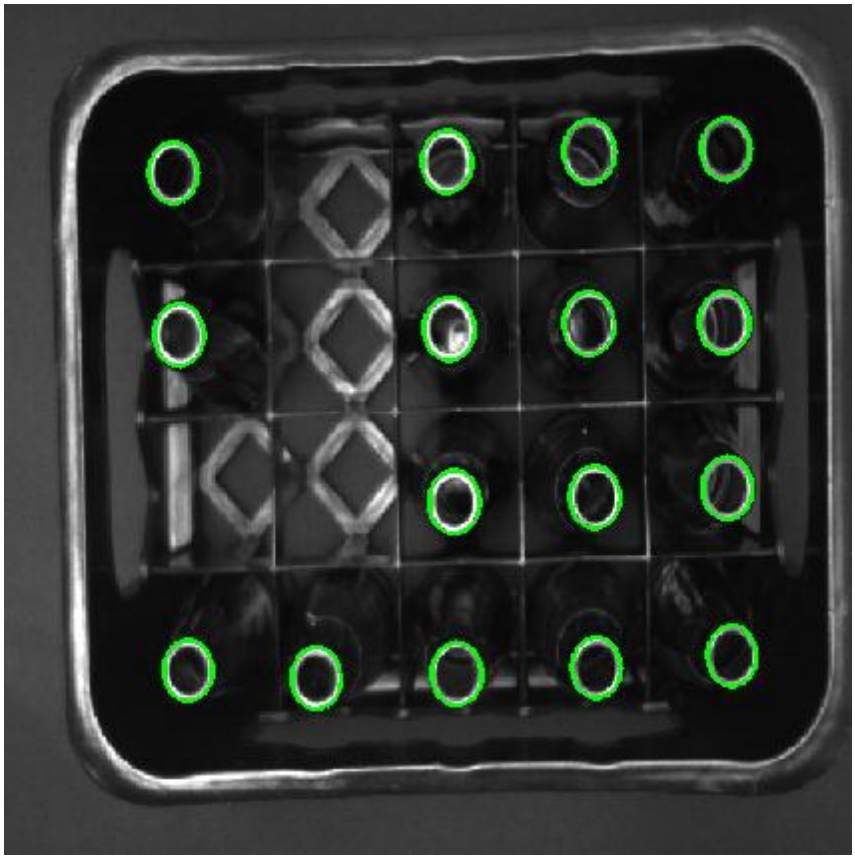

Figure 10: An example of correct classification