CAPS INSPECTION

In the following projects, the students will practice the image inspection of plastic and aluminum caps.
Each of the projects includes “good pieces” and “defective pieces” along with the description of the defect the students are required to detect.
The image file name format is `x_nn.bmp` where `x=g` means the cap is good and `x=d` means the cap is defective; `nn` is the numeric identifier of the cap.

The students are required to follow the hints to create an inspection recipe that segregates the defectives samples away from the conforming samples.

The projects are proposed by SACMI IMOLA (www.sacmi.it).
Reference for additional information about the projects: Donato Laico (Donato.Laico@sacmi.it)

Project 1 – Plastic cap liner inspection

1 Introduction

Students should develop a software program to locate the defects in the liner of a plastic cap.
The cap is composed of two parts: the white plastic shell (1) and the silver cardboard liner (2) (see Figure 1).
The image to be processed is similar to that shown in Figure 2.

Figure 1 – The shell is 1, the liner is 2.

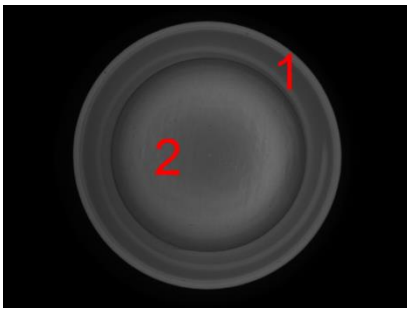

Figure 2 – The image to process: the shell is 1, the liner is 2.

2 First task: cap segmentation and defect detection

Students should:

- Outline the cap by generating a circle that fits the cap mouth (see Figure 3).
  HINT: Circle Hough transform can be used to find the mouth circle.

- Search for the defects in each cap. These are the minimum requirements for each image to be recorded:

- the position of the center of the cap;
- the diameter of the cap mouth;
- the answer to the questions “Is the liner missing?” and “Is the liner incomplete?”;

- Optional requirement: in case of “incomplete liner” the program should outline the straight edge of the incomplete liner (see Figure 4).
  HINT: the cap shell with no liner has a different average lightness than the liner. The incomplete liner can be detected inspecting the magnitude of the gradient.

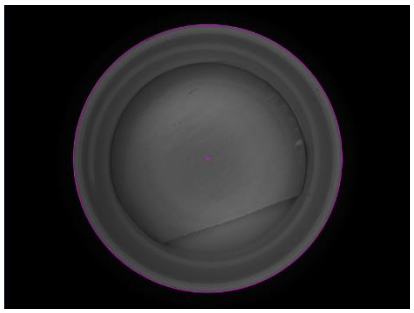

Figure 3 – In magenta the circle fitting the cap mouth.

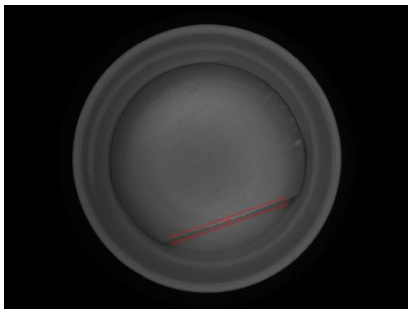

Figure 4 – In red the outline of the "incomplete liner" defect.

Images of good cap: `g_01.bmp`, `g_02.bmp`, `g_03.bmp`, `g_04.bmp`, `g_05.bmp`, `g_06.bmp`.
Images of defective cap due to incomplete liner: `d_17.bmp`, `d_18.bmp`, `d_19.bmp`, `d_20.bmp`.
Image of defective cap due to missing liner: `d_31.bmp`.

3 Second task: liner segmentation

Students should:

Outline the liner by generating a circle that fits the liner border (see Figure 5).
For each image the program should record the position of the center of the liner and the diameter of the liner.
HINT: Circle Hough transform can be used to find the border of the liner.

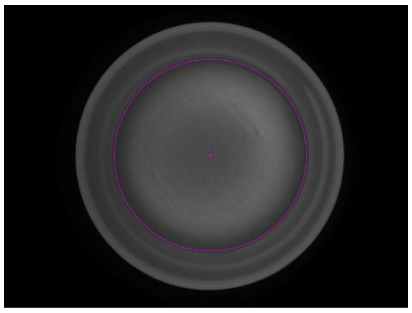

Figure 5 – In magenta the circle fitting the border of the liner.

Project 2 – Cavity number preprocessing

1 Introduction

Students should develop a software program to preprocess an image and get it ready to perform the OCR of the cavity number of a plastic cap.
The cap has an external tab (1) at a fixed position in relation to the cavity number (2). Find in Figure 6 a picture of the external side of the cap and in Figure 7 the image to be preprocessed.

Figure 6 – The tab is 1.

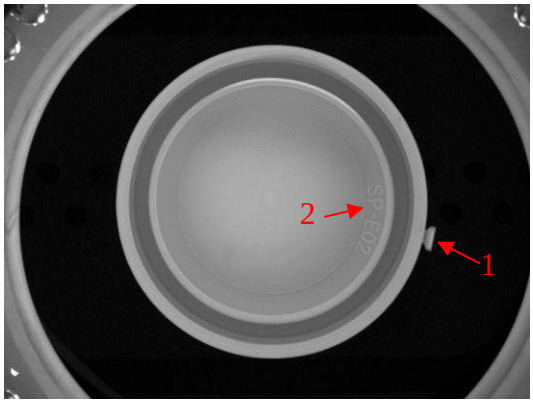

Figure 7 – The image to preprocess: the tab is 1, the cavity number is 2.

2 First task: generate a crop of the cavity number.

Students should:

- Outline the cap by generating a circle that fits the cap mouth, see Figure 8.
  HINT: Circle Hough transform can be used to find the mouth circle.

- Generate a crop containing the cavity number.
  The crop should contain the cavity number and it should appear upright as in Figure 9.
  HINT: Find the annular region (radius > cap radius) which contains the tab; get a binary image where the tab is a white connected component. The centroid of the connected component and the center of the cap mouth are the end-points of a line segment; this segment and a vertical line gives an angle; use this angle to rotate the image in order to put the tab at the top of the image; crop the image.

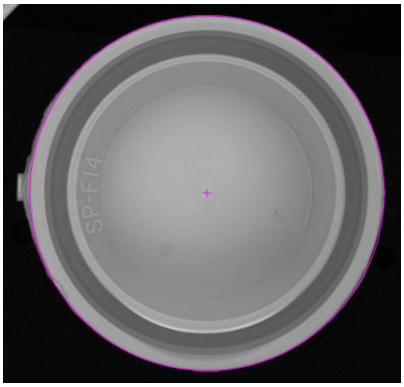

Figure 8 – In magenta the circle fitting the cap mouth.

Figure 9 – The crop contains the cavity number.

3 Second task: generate a rectified crop of the cavity number

Students should:

Generate a rectified crop containing the cavity number (see Figure 10).

HINT: Apply a polar transform.

Figure 10 – The crop contains the rectified cavity number.

Project 3 – Off–center decoration

1 Introduction

Students should develop a software program to compute the off–center of a decoration in an aluminum cap, see Figure 11.

In Figure 12 an example of CVS image to be processed: the color of the cap is red and the color of the decoration is grey. The off–center is defined as the distance between the center of the decoration and the center of the cap.

Figure 11 – The aluminum cap for spirits.

Figure 12 – The image to process.

2 Task: compute the off–center distance.

Students should:

- Outline the cap and the decoration by generating a circle that fits to the cap and a circle that fits the decoration, see the blue and the green circles in Figure 13.
  HINT: The image of the cap can be segmented in three parts using the different colors: the decoration is grey, the cap is dark red and the border of the cap is bright red.
  Then use the Circle Hough transform to fit the decoration (grey pixels) and the cap (bright red pixels).

- Compute the distance between the center of the cap and the center of the decoration.

Figure 13 – The blue circle is the cap and the green cap is the decoration.