CVIP Project Work

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Background

I decided to develop *Visual Inspection of Motorcycle Connecting Rods* project.

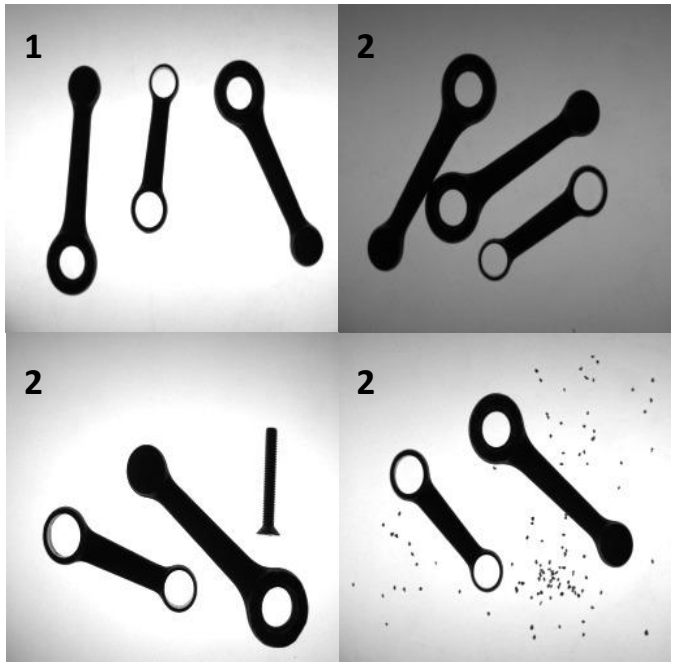
The assignment is:
Given a series of different images containing two different types of connecting rods, for each connecting rod appearing in the image, the vision system should provide the following information:

- Type of rod (A or B).
- Position and orientation (modulo).
- Length (L), Width (W), Width at the barycenter (WB).
- For each hole, position of the centre and diameter size.

Background

First Task:

- Images contain only connecting rods
- Connecting rods have been carefully placed within the inspection area
- Images have been taken by the backlighting technique

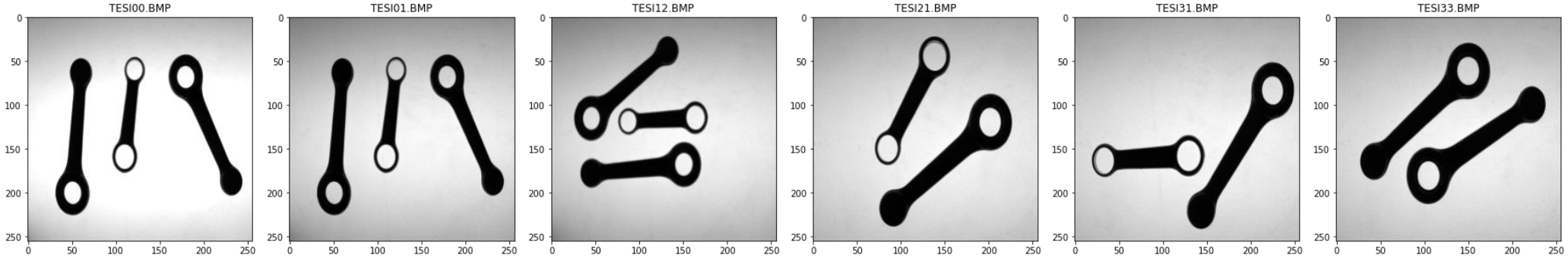


Second Task:

- Images may contain other objects
- Rods can have contact points but do not overlap one to another
- The inspection area may be dirty due to the presence of scattered iron powder

First Task: Image Segmentation (1)

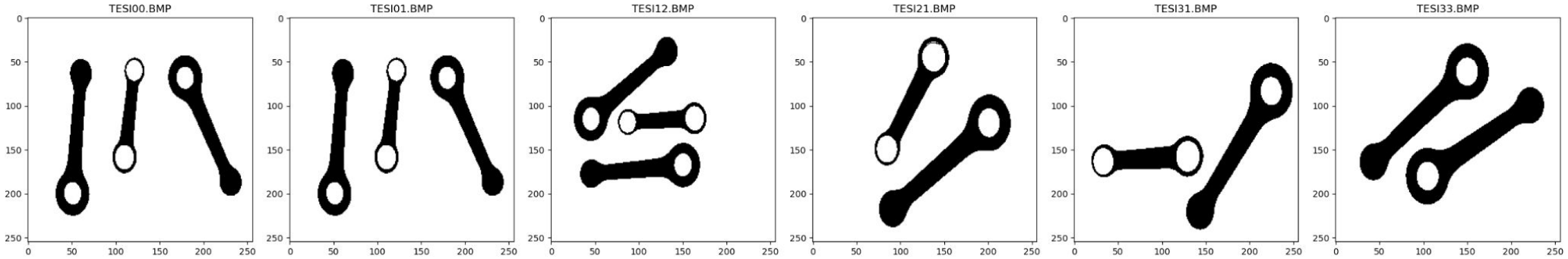
The segmentation is done to distinguish the information part related to the rods even though the images were taken with the backlight technique and the rods are easily distinguishable from the background.



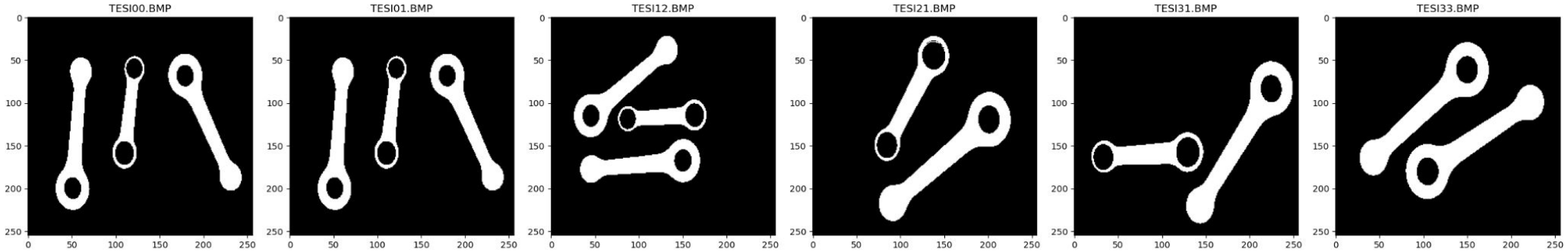
Considering the various segmentation techniques that can be performed, I decided to use the Otsu algorithm. I used this algorithm because it automatically determines the threshold value.

First Task: Image Segmentation (2)

Otzu is advantageous because it allows a different threshold for each image and adapts the threshold more easily to variations in illumination.

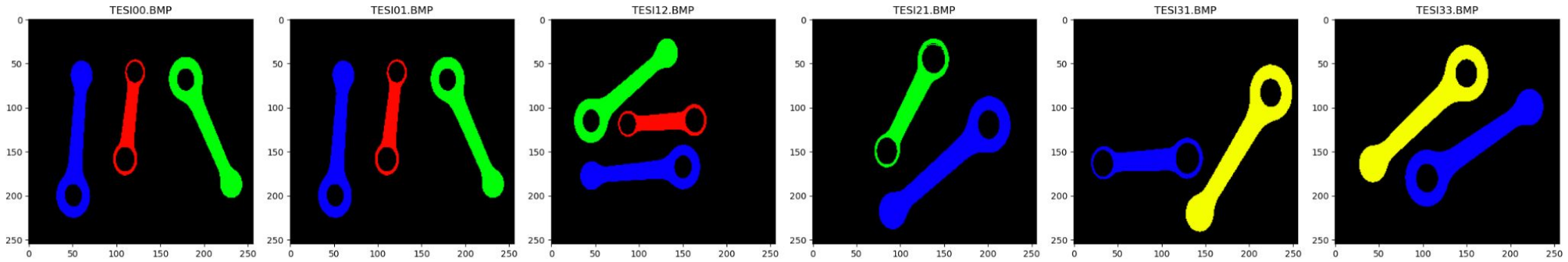


Then I inverted black and white in order to let the function *findContours()* find the proper contours:



First Task: Extraction and Classification of rods

In order to complete the extraction of the objects and isolate the connecting rods I used the *connectedComponentsWithStats()* function with *connectivity* equal to 4.



Connecting rods are classified according to the number of holes they have and I decided to use the *findContours()* function.

First Task: Position and Orientation

In order to calculate the position of the connecting rods, I need to find the barycentre of each connecting rod.

I used the Principal Component Analysis algorithm to find the orientation of the connecting rod.

First Task: Length and Width

To find the information of length and width I used the minAreaRect() function available in the OpenCV library.

This function takes the foreground points as input and finds the enclosing rectangle of minimum size. I found the length and the width of the connecting rod by taking the length and the width of the enclosing rectangle drawn around the connecting rod.

First Task: Width at the barycentre

In order to find the width at the barycentre of each connecting rod, I used information already calculated in the previous points.

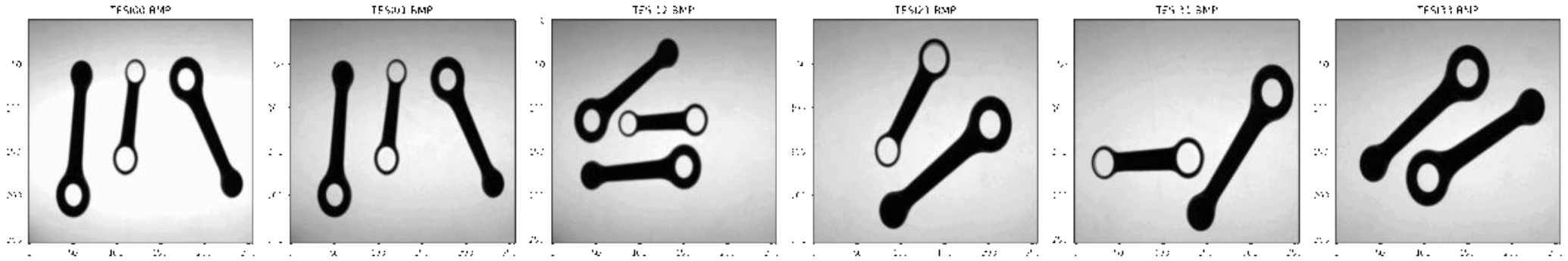
Having the position of the barycentre and the angle of the major axis I find two points by finding the intersection of the line passing through the barycentre, perpendicular to the major axis of the connecting rod, and the points of the connecting rod contour.

Then the width at the barycentre is equal to the distance between these two points.

First Task: Center and diameter size for each hole

Once the contours have been extracted, in particular the ones of the holes, since the holes have a circular shape, the center of each hole correspond to the barycenter of its contour.

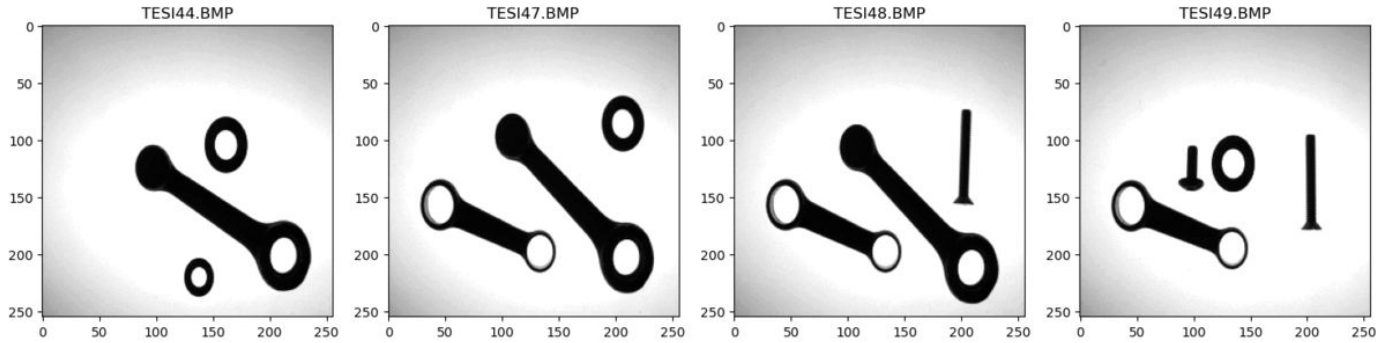
To find the diameter I calculated the distance between a random contour point and the centre of the hole.



Second Task: Screws and washers

Within the first variant, the system should be able to take into account some other components, called distractors, that should be ignored along the analysis.

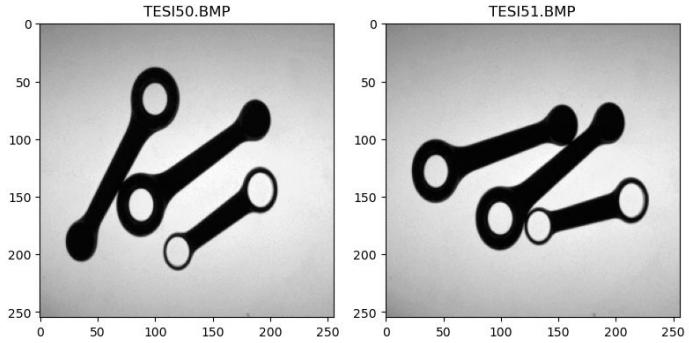
So I filtered elements by area because road have a bigger area and by circularity in order to exclude those round shapes



Second Task: Joined connective rods

Within the second variant, the system should be able to take into account some touching rods.

An endeavour with morphological operators was attempted (in particular with erosion), with several structuring elements. Nevertheless, the erosion degraded too much the head of the rods, making a failing analysis.

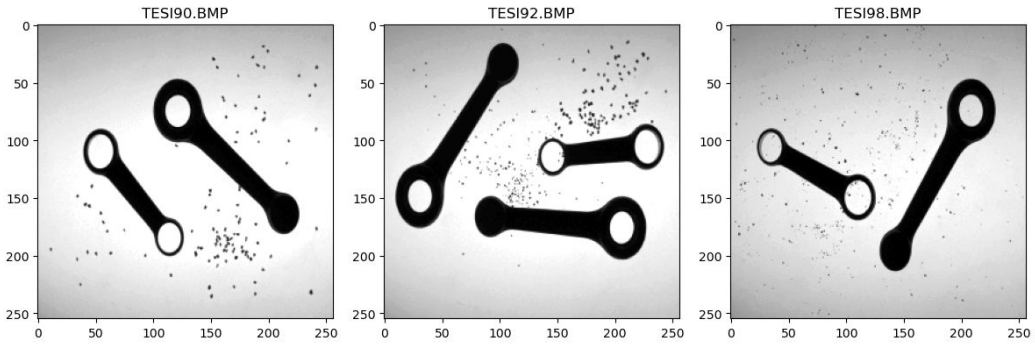


Second Task: Iron powder

To remove the iron dust present in some of the images in the dataset, I decided to use the median filter.

I have chosen the median filter because it is very advantageous in eliminating impulse noise.

The median filter was applied by a cascade method because some noise components were not easily removed.



Thanks for the attention!