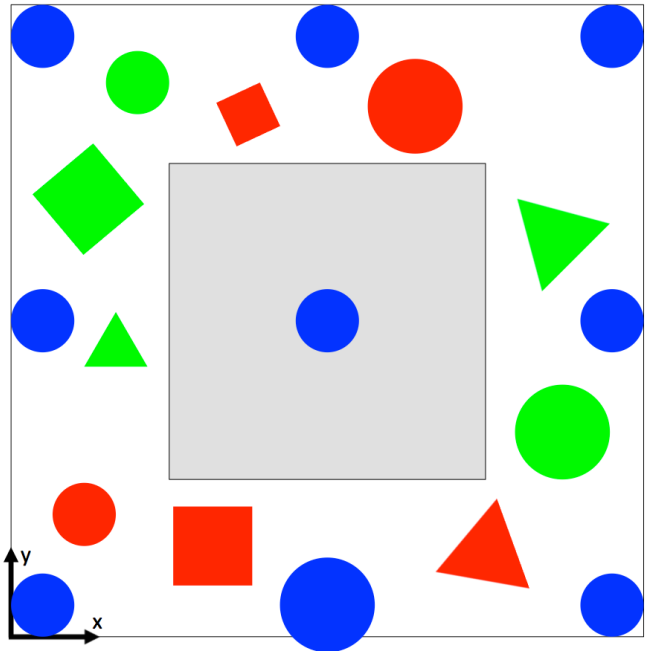
# Vision Prac Exam (For a team of THREE)

This exam consists of 2 parts. You will have to solve both parts to get all 20 possible marks.

## Part 1




### Setup

A work sheet (see example above) will be secured to your bench top at the beginning of the Prac Exam session. The shapes other than the grey square and the calibration marks will be in the set [small, large], [red, green], [triangle, circle, square].

1. The blue circles are calibration markers. There are nine in a grid with a spacing to the centres of the markers of 180mm. Note that one blue circle is bigger than the others.
2. Each shape will appear at least once in each of red and green.
3. Each shape will appear at least once in each size (small and large).
4. Each size+shape will appear at least once. That is, there will be at least one small triangle, one large triangle etc.
5. The shape and size are independent of colour. That is, all large triangles are the same size, all small circles are the same size, etc.
6. There will not be more than one object of a particular size+shape+colour.

At the start of your test you will be provided with a test sheet on which is printed three-coloured shapes that you will need to identify on the exam work sheet, for example:

An example test sheet

**The three shapes on the test sheet will be printed to the same scale as the work sheet.** You will have a total of 3 minutes to take the photos you need for the remaining steps (a photo of the test sheet and of the exam work sheet).

**Tasks for a team of three**

As a team of three team members, you must develop a program that will perform the following steps:

1. Automatically identify the three coloured shapes (shape, colour and size) of the test sheet you are given. Display the corresponding shape, colour and size information.

   (4 marks)

2. Segment the blue calibration marks on the work sheet. Display a binary image corresponding to the blue object pixels with overlaid bounding box and centroid on each of the 9 calibration marks. The program will then pause.

   (2 marks)

3. Segment the other shapes on the work sheet. Display a binary image corresponding to all of the other shapes in the scene. Mark the centroids of all these shapes. Display a bounding box on all of the triangles and a different coloured bounding box on all of the green shapes. The program will then pause.

   (3 marks)

4. Determine (on the work sheet) the shapes that are described in the test sheet provided. Display a single binary image corresponding to those 3 shapes with overlaid bounding box and centroid on each of the shapes.

   (5 marks)

5. Compute the homography and then use it to compute the workspace coordinates of the three shapes given earlier. Display the shape, colour and size of the shape along with its calculated coordinates in units of mm. The program will then pause.

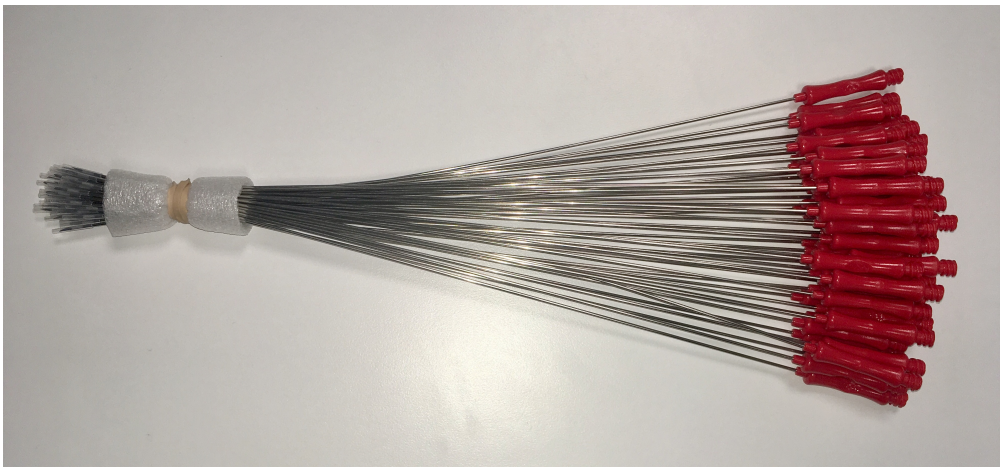
   (3 marks)

where you are awarded 0.5 mark each for estimated position within 20mm of true value
0.5 mark each for estimated position within 10mm of true value

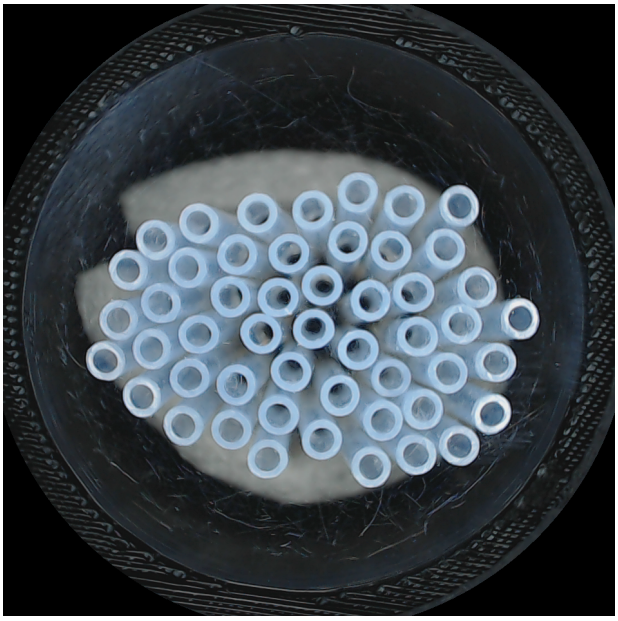
The final result for each team will be the best result out of the two runs.

# Part 2 – Real World Computer Vision

Consider the following scenario: You are a robotics and computer vision engineer and are asked to solve the following problem for a client. The client produces medical devices for minimally invasive surgery, such as the needles pictured below. For safety reasons the tips of the needles will always be covered by protective plastic caps.



You and your colleagues have developed a robot that automatically packages these needles into bundles (see picture). This is the last processing step before the needles are shipped to the customers. As part of the final quality assurance, you have to develop a computer vision system that counts how many needles were packaged into a bundle. So far, you have developed a prototype device into which a bundle of needles can be placed tip-first. A camera then takes a picture of the needle tips to produce images similar to the one shown below.




Now a software solution that automatically analyses these images and counts the needles in the bundle has to be developed.

You will be given a practice image to work with during the pracs. For the exam, you will be given a very similar image, with the exact same histogram as the practice image.

Apply what you learned about computer vision to solve the following tasks:

**Tasks**

1. Display a binary image where only the ring-shaped tips of the protective caps are visible. The program will then pause. (1 mark)
2. Segment the needle caps. Display the segment centroids in the binary image used above. The program will then pause. (1 mark)
3. Automatically determine and report the number of needles in the bundle. (1 mark)

**Hints**

- The toolbox function 'iblobs' is useful. Pay special attention to the 'class' option of that function. What does this option influence?
- It can be hard to reliably separate the segments of two needle caps if they are touching each other. Apply your problem solving skills and think about a solution.

**END OF PAPER**