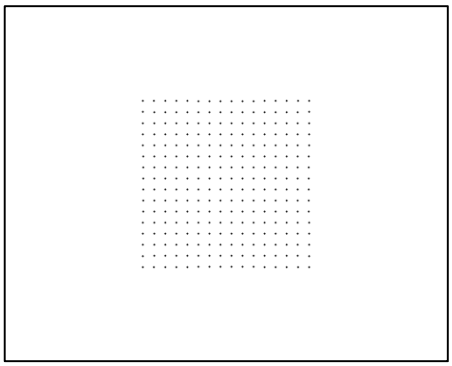
CASE STUDY 1
INTRODUCTION TO MetroVisonLAB TOOLBOX. CALIBRATION ALGORITHMS, CALBRATION CASES AND GAUGE OBJECTS

Objectives:

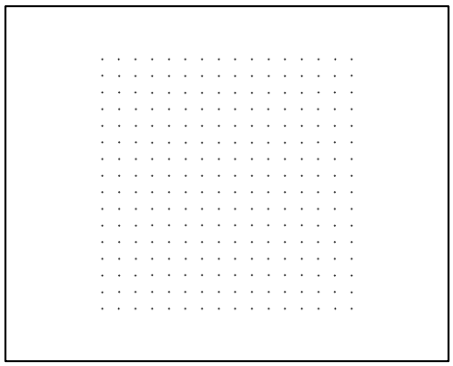
- **Become familiar with the simulation software Metrovisionlab.**
- **Consolidate the knowledge on camera calibration and the different methods of calibration acquired during the theoretical classes.**
- **Reinforce the ability to analyze measuremet problems based on machine vision. Analysis of calibration gauge objects.**

The questions must be answered jointly by all the students who form the group. When all the sections have been answered, the proposed answers must be verified with the help of Metrovisionlab. In each one of the sections it is necessary to explain in detail which has been the procedure followed with Metrovisionlab to verify if the answer were correct.

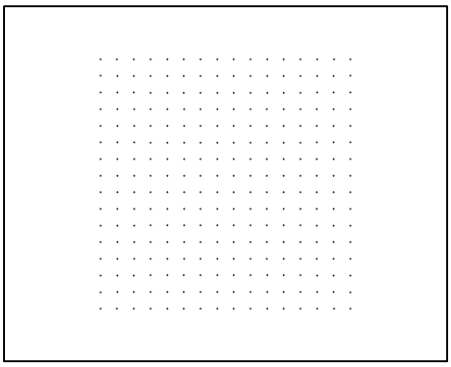
1.- Associate each image with the suitable camera and calibration gauge parameters.



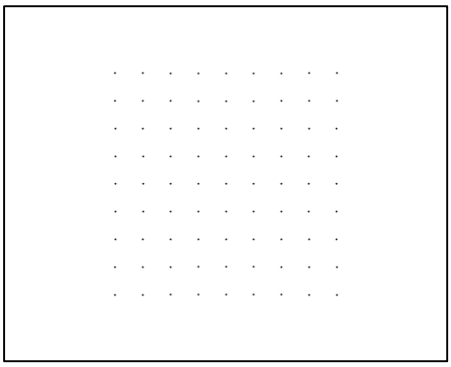
(a)



(b)



(c)



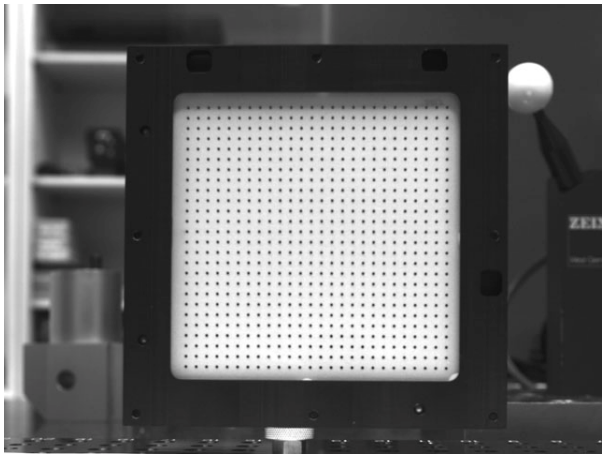
(d)

(i) focal length 30 mm, distance between points 10 mm and Tz = 1200 mm.
(ii) focal length 10 mm, distance between points 20 mm and Tz = 1200 mm.
(iii) focal length 50 mm, distance between points 10 mm and Tz = 1200 mm.
(iv) focal length 15 mm, distance between points 20 mm and Tz = 1200 mm.

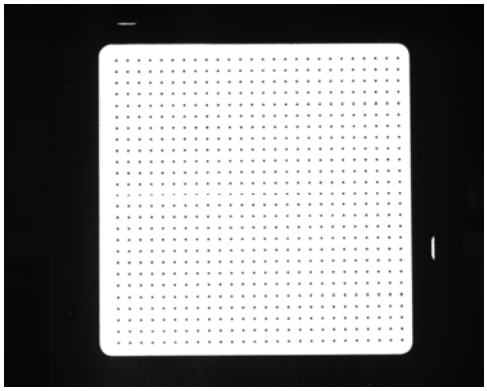
2.- When performing a Tsai calibration with the following image, the calibration parameters shown below were obtained. Are these calibration results correct, why?

f = 6.0951 (mm)
k1 = 0.01071
sx = 0.99986

3.- Is it possible to perform a Tsai non coplanar calibration with the gauge of the image? If possible, describe the procedure.



4.- When performing a Tsai calibration with the following image, the calibration results shown were obtained. Are these calibration results correct? What is the main cause for these results?



f = -0.00012917 (mm)
k1 = -0.29855
sx = 1

Tx = -129.9987 (mm)
Ty = -129.9966 (mm)
Tz = 0.33267 (mm)

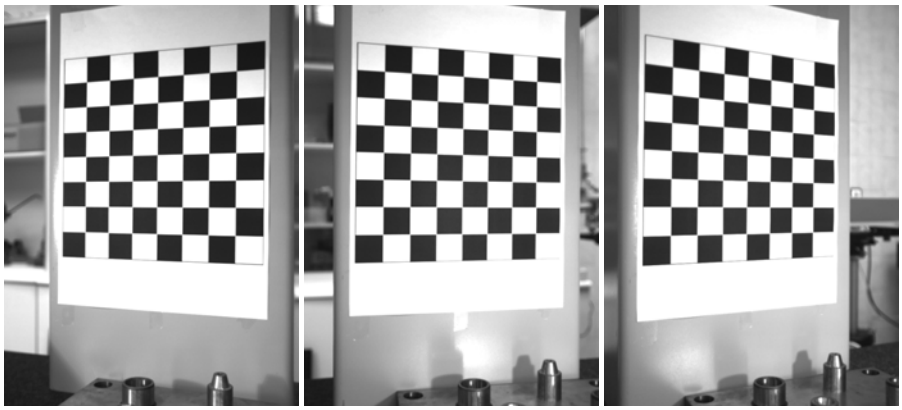
Rx = 0.24292º
Ry = 0.39709º
Rz = 0.00025528º

NCE = 27.9993

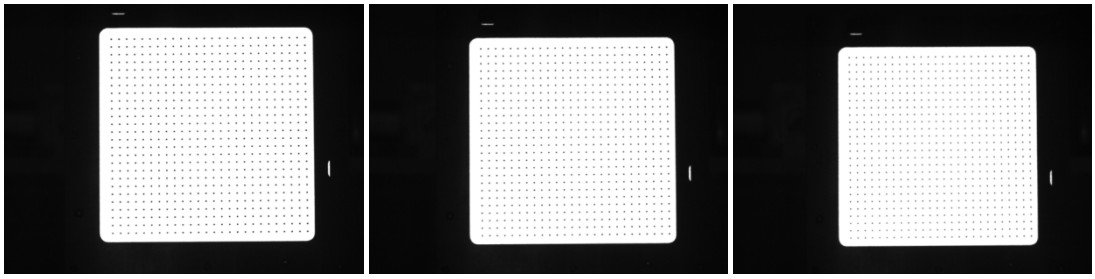
5.- To perform a calibration using the method of Zhang, Which of the two procedures is most appropriate, why?

(i) Set the camera position and move the gauge.
(ii) Set the gauge and move the camera.

6.- Given the following images taken by the same camera and knowing that the exact position of the gauge cannot be known: Indicate what calibration methods would be suitable to calibrate the camera and which are not. Think why it is or is not appropriate each calibration method.



7.- Given the following images taken by the same camera and knowing that the exact position of the gauge cannot be known: Indicate what calibration methods would be suitable to calibrate the camera and which are not. Think why it is or is not appropriate each calibration method.



8.- In the case of Tsai's coplanar calibration, and knowing that, in the extraction of points of the calibration image, an average error of 0.2 pixels is committed, how does the distance between the gauge and the camera affects to the reconstruction error of the coordinates (X, Y, Z)?

9.- If you know that the optical center of a camera has an offset error calibration, which calibration method is more appropriate to calibrate the camera? How does it affect the offset error to the calibration parameters in Tsai and Faugeras calibration models?

10.- Indicate which of these two calibration results is not acceptable and why.

f = 15.0027 (mm) k1 = -0.00064301	f = 14.9273 (mm) k1 = -0.0006547
Tx = -139.9701 (mm) Ty = -139.9855 (mm) Tz = 718.9368 (mm) Rx = -4.9755º Ry = -0.093738º Rz = 0.0015494º	Tx = -139.9988 (mm) Ty = -140.0064 (mm) Tz = 736.5096 (mm) Rx = -5.0247º Ry = 0.021846º Rz = 0.00033501º
NCE = 2.052	NCE = 0.78961