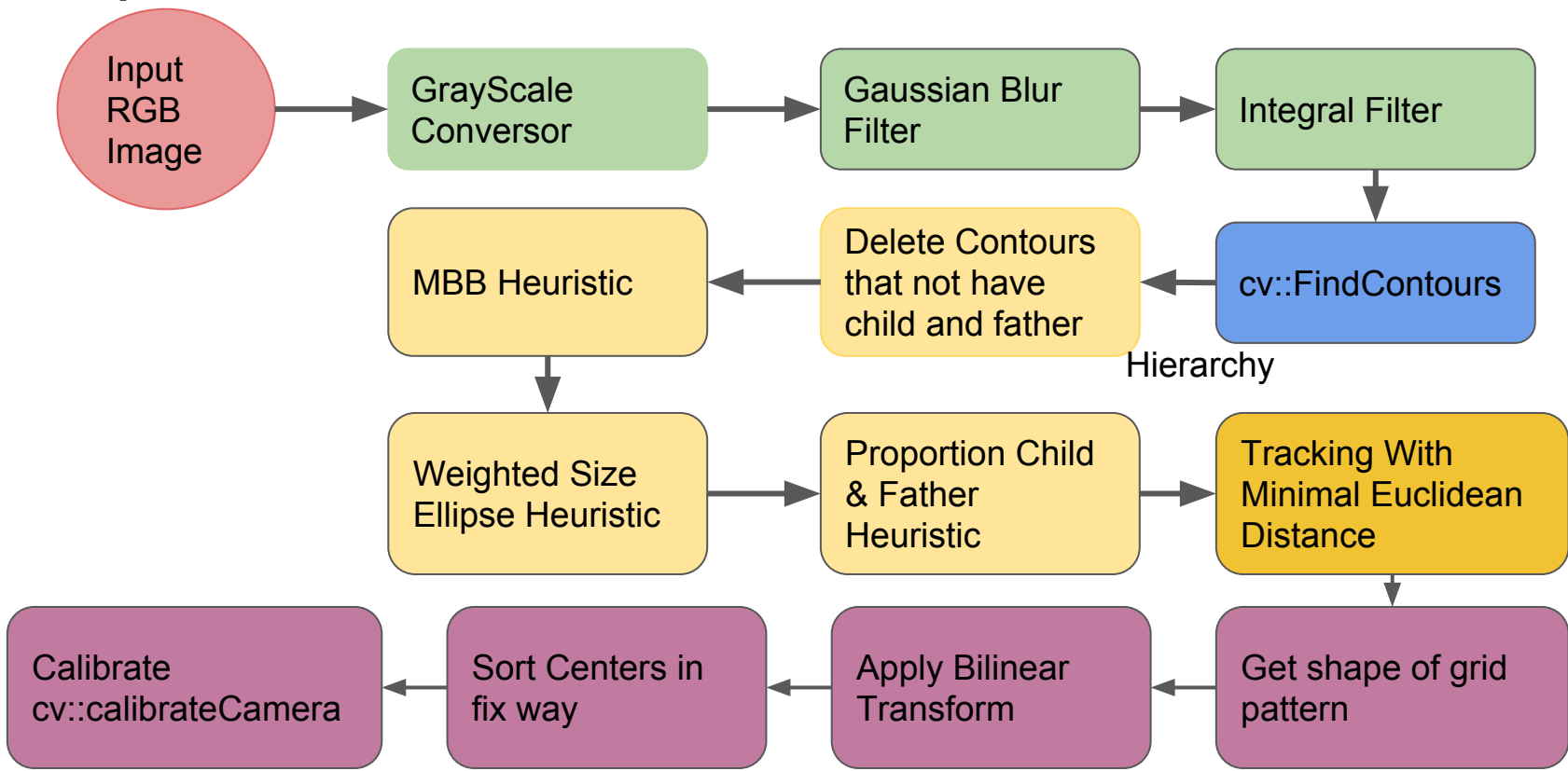


Camera Calibration with Concentric Rings Pattern Using OpenCV

Erick Tornero, Walter Zuniga

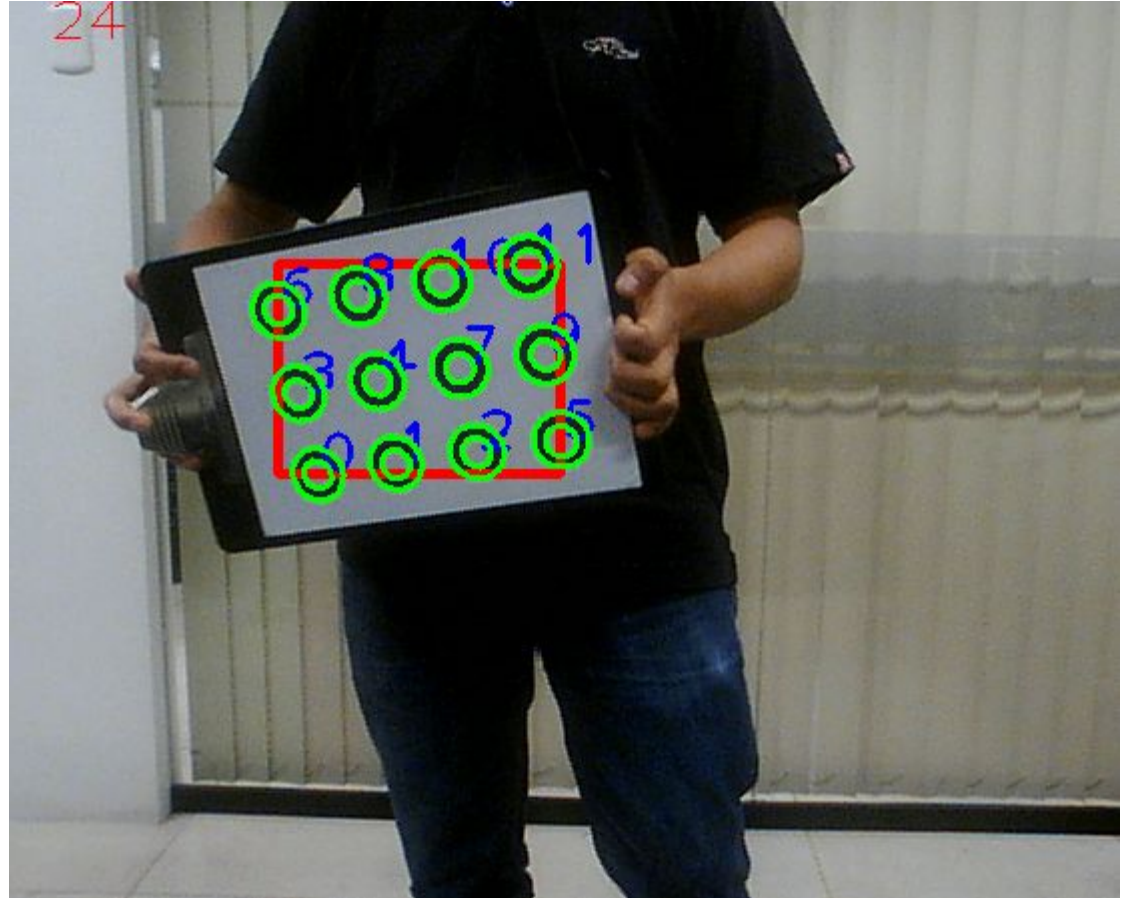
Pipeline



Last Work

Centers was obtained
and tracking was working
well.

But sort the centers was
missing.

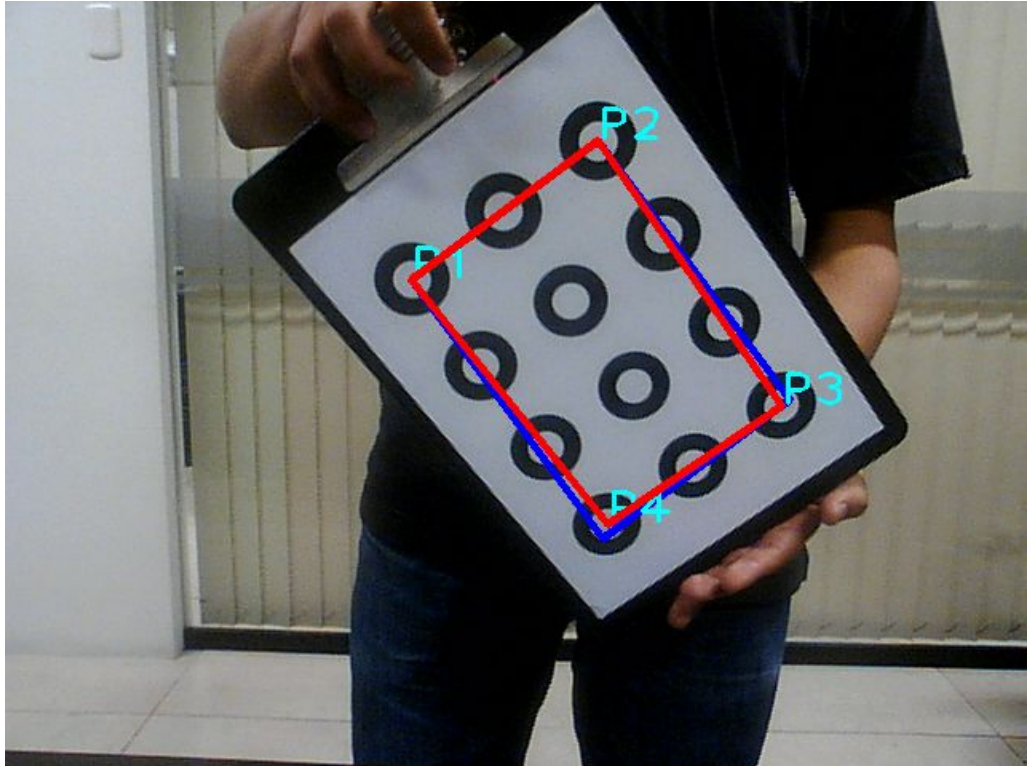


Get Shape of Grid Pattern

Compute `cv::minAreaRect` by Least Square and epsilon determine at least two apposite vertices.

Blue Rectangle: `minAreaRect`

Red shape: shape of centers

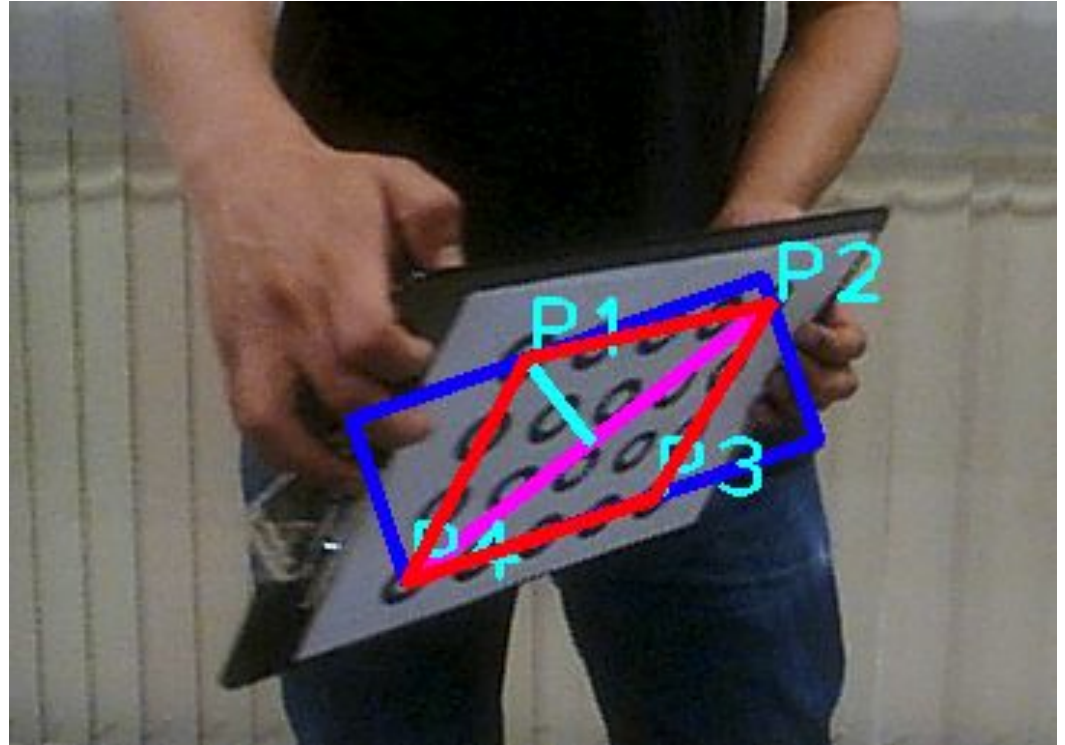


Get Shape of Grid Pattern

There are cases where is not possible to get all corners. Apply Least Square in that cases can generate errors.

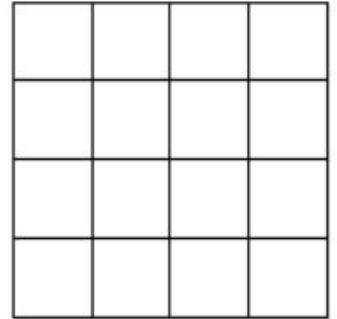
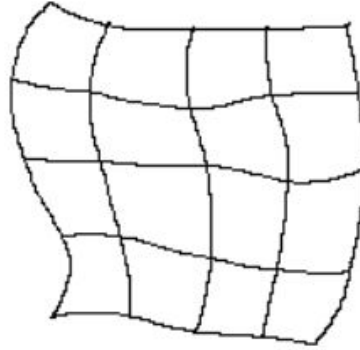
With the opposite diagonal. Get that points that are far away from that rect (Pink line).

P1 (Cian Rect is one point far away from the rect pink)



Bilinear Transform

Idea, from an
quadrilateral transform
to a rectangle well
defined



Sort in a Fix Way

Since in the transformed space each center have an specific position (there may be an minimal error). Sorting in this space is trivial



Calibrate Camera

Get Certain number of frames to calibrate, usually between 10 and 75.

Use `calibrateCamera` from OpenCV. This will retrieve the matrix of calibration and the distortion Coefficients

The screenshot displays a camera calibration software interface with the following components:

- Frame:** A video feed showing a person holding a calibration board with a grid of points. A red '40' is visible in the top left corner.
- Fronto - Parall:** A video feed showing the same scene from a different perspective, likely for stereo calibration.
- Gaussian:** A grayscale image showing the calibration board with a grid of points.
- Integer:** A binary (black and white) image showing the calibration board with a grid of points.
- Calibration:** A section with input fields and buttons:
 - Grid:** w = 5, h = 4
 - Fr. To Calib.:** 30
 - Space Grid:** 44.000
 - Calibrate:** A button with a '100%' status indicator.
- Play:** A section with a 'Start!' button and a 'Grid' field with w = 5, h = 4.
- Log:** A text area showing the following text:

```
Successfully!  
RMS = 0.579392  
Fx = 699.231  
Fy = 691.498  
Cx = 310.204  
Cy = 297.784
```
- Accuracy (%):** 76,687119
- Execution Time per Frame (ms):** 2,441718

Results for Camera 1:

Resolution: (640x480)

Camera 1	Concentric Rings	ChessBoard	Asymmetric circles
RMS	0.608033	0.440583	0.562
Fx	704.066	612.111	714.987
Fy	695.628	609.819	714.98
Cx	304.701	346.530	359.777
Cy	299.865	256.937	250.6776

Fronto paralelo - Cámara 1

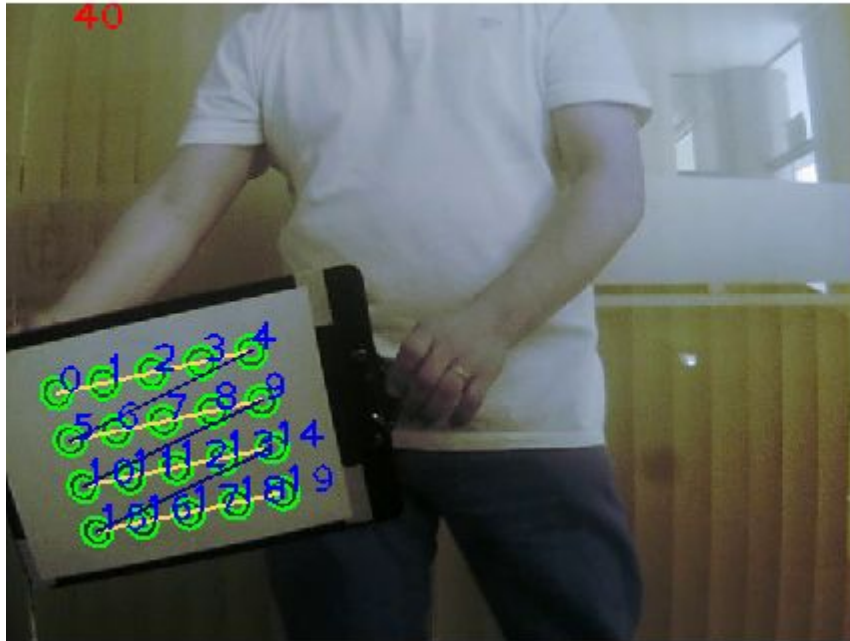
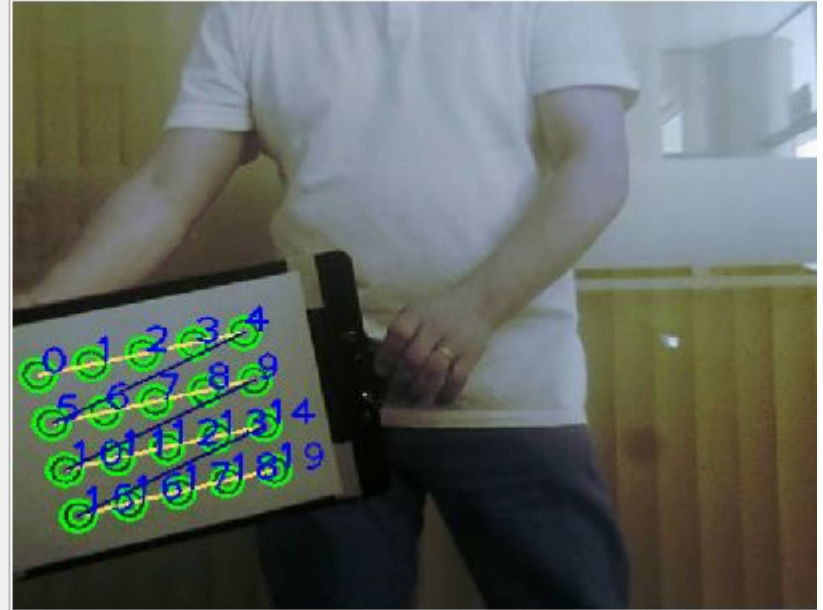


Imagen Real



Fronto-Paralelo

Results for Camera 2:

Resolution: (640x360)

Camera 2	Concentric Rings	ChessBoard	Asymmetric circles
RMS	0.54349	0.318246	0.297
Fx	493.711	480.274	496.339
Fy	496.559	478.263	496.33
Cx	332.322	331.361	330.504
Cy	189.267	162.747	176.938

Fronto paralelo - Cámara 1

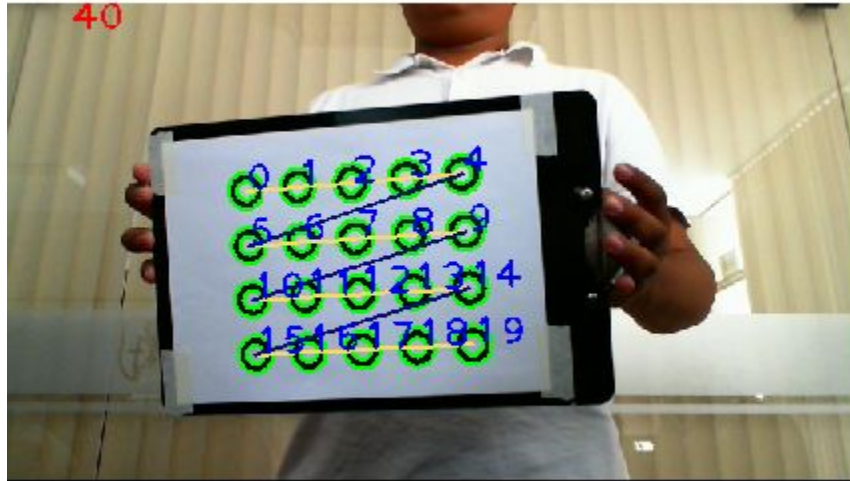
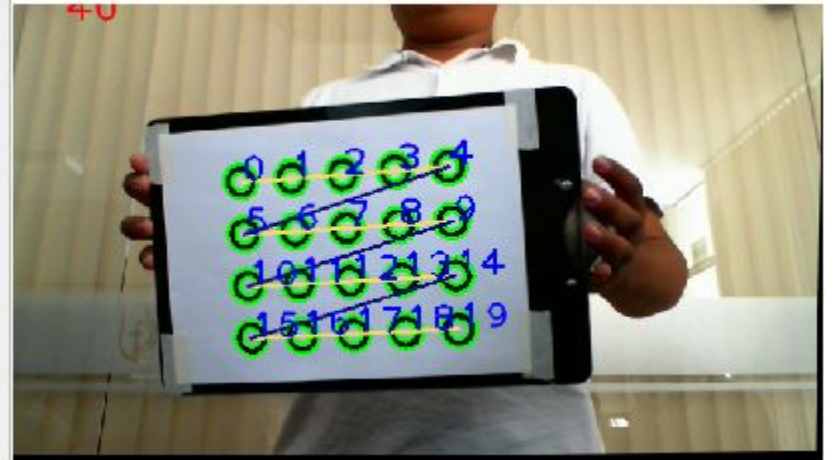


Imagen Real



Fronto - paralelo