Accurate Ellipses Detection based on Co-clustering Algorithm

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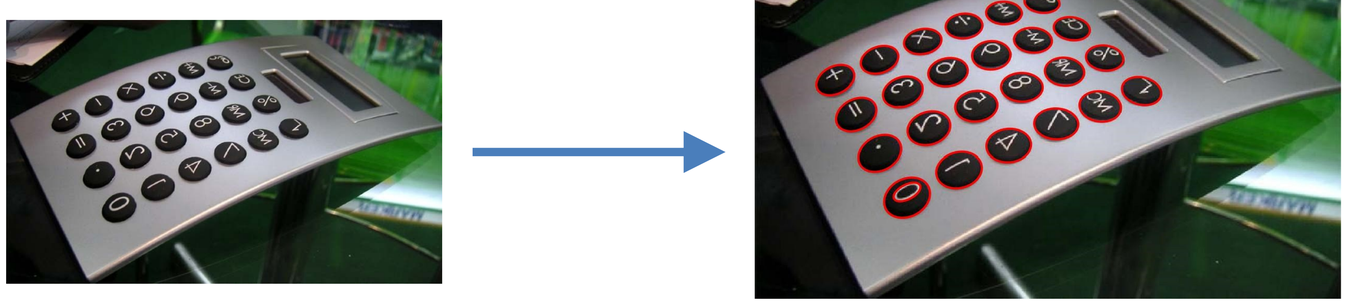
Abstract

Circles are important structures in computer vision since they play as a common feature for especially human-made objects, and they expose more information than points or lines of an object. Here we propose a method to detect the perspective projection of human-made perfect circles, which are accurate ellipses, based on the co-clustering algorithm. To speed up and drop redundant information, we first extract arc segments from source images with an efficient and accurate arc-support line segment detection method. After some connecting are done among the little arcs we gain from last steps, we define a 5D metric space that can express the ellipse-relationship among those arcs and conduct co-clustering algorithm to determine the number of ellipses in the source image and specify which arcs are from the same ellipse. Afterwards, we have a validation procedure to ensure what we detect is an accurate ellipse and visualize the result.

Project Aims



To detect ellipses from images

Ellipse

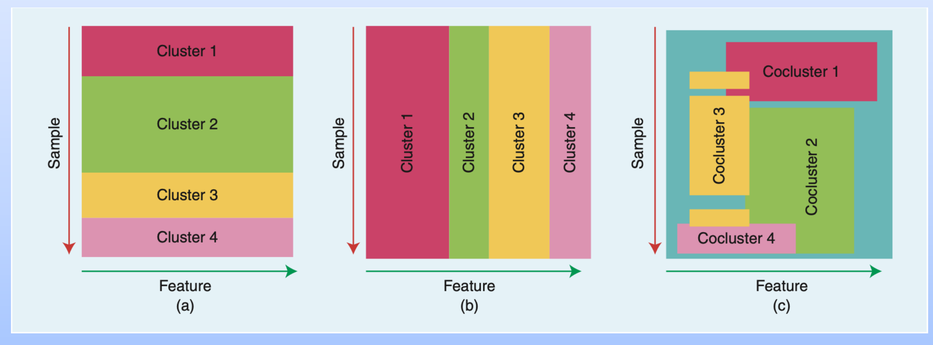
To describe an ellipse we need 5 parameters:

$$Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$$
$$B^2 - 4AC < 0$$

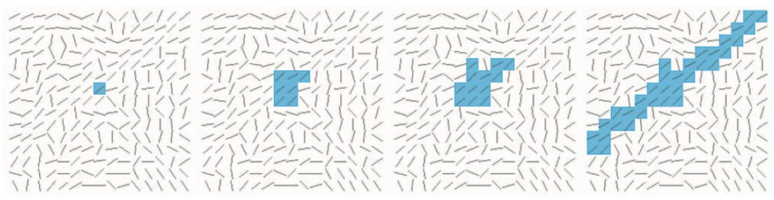
Procedures

- To detect the arc segments;
- To predict the 5 parameters for ellipses;
- Co-clustering;
- Validation.

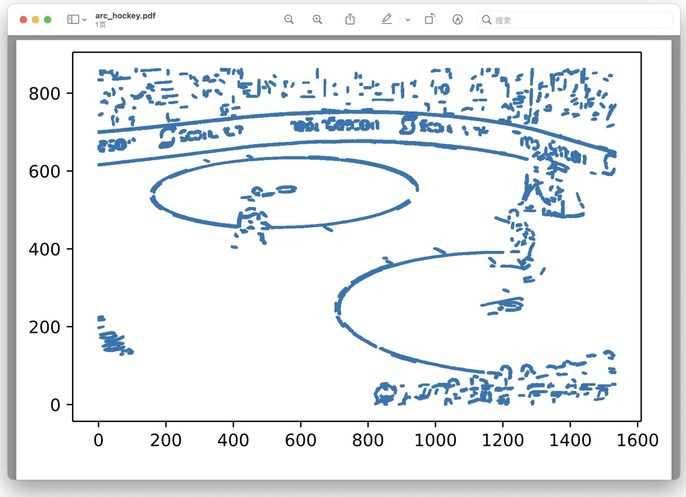
Coclustering



Arc segments Detection



Finding sharpest -> Growing -> Validating

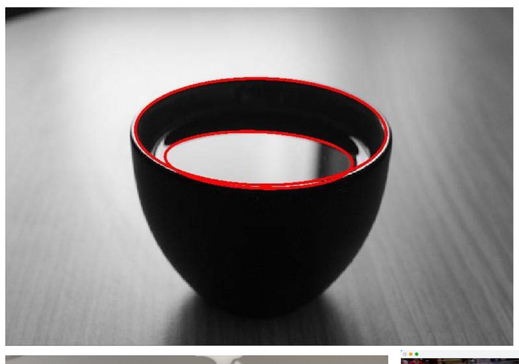


Parameters Prediction & Validation

$$\mathbf{D} = \begin{bmatrix} x_1^2 & x_1y_1 & y_1^2 & x_1 & y_1 & 1 \\ x_2^2 & x_2y_2 & y_2^2 & x_2 & y_2 & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_n^2 & x_ny_n & {y_n}^2 & x_n & y_n & 1 \end{bmatrix}_{n\times 6}$$

$$\mathbf{C} = \begin{bmatrix} 0 & 0 & -1 & \cdots & 0 \\ 0 & 2 & 0 & & \\ -1 & 0 & 0 & & \vdots \\ \vdots & & & \ddots & \\ 0 & & \cdots & & 0 \end{bmatrix}_{6\times 6}$$

Pilot Result



To minimize $\left|\left|Da\right|\right|^2$ → $2D^TDa - 2\lambda Ca = 0, a^TCa = 1$

About me

WU, Zihan

Second Year PhD Student supervised by Prof. YAN Hong.

Graduated from University of Science and Technology of China (USTC), now in Electrical Engineering of CityU.