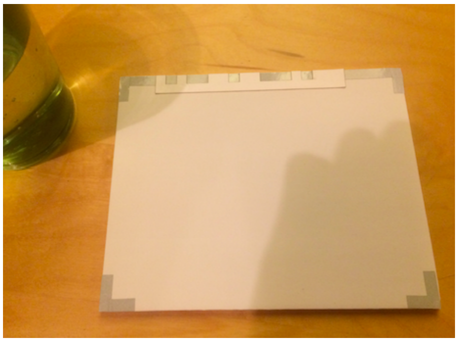
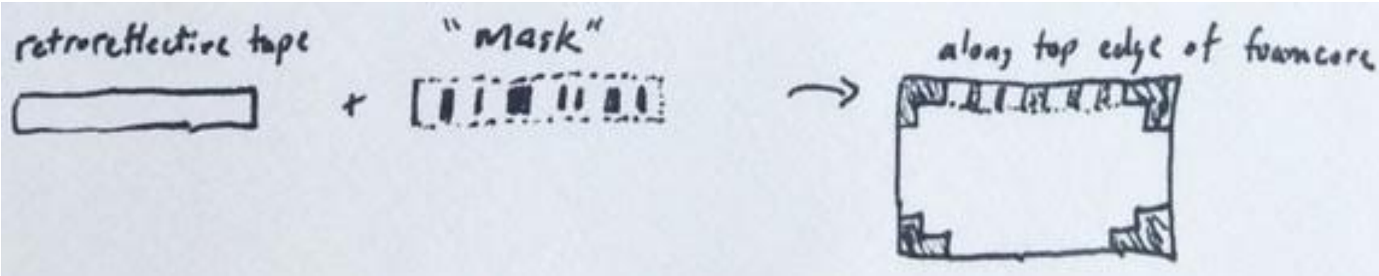
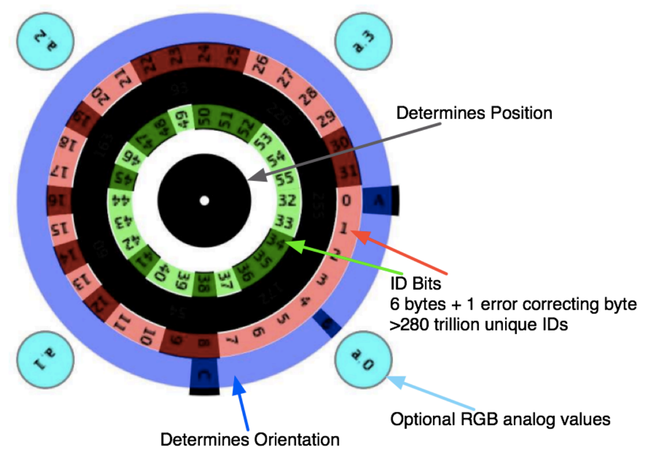
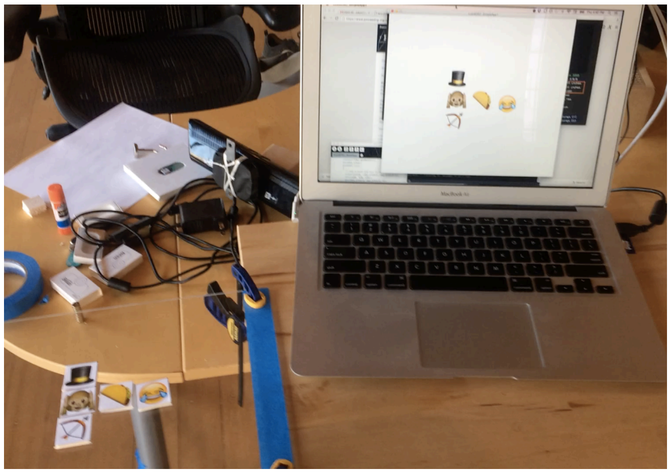
Retroreflective Bar Codes
Bret, Toby





Trackmate (Under the table tracking)
Adam Kumpf





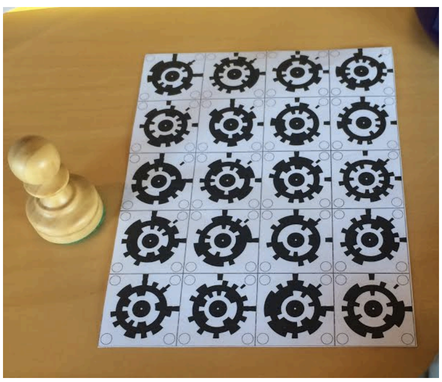
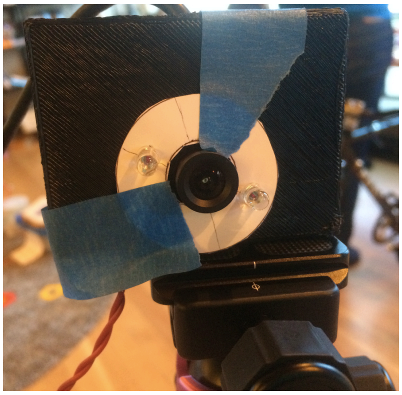
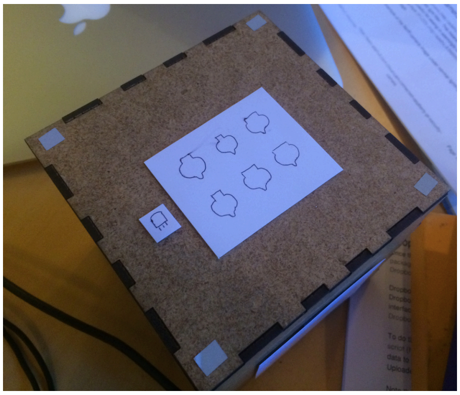


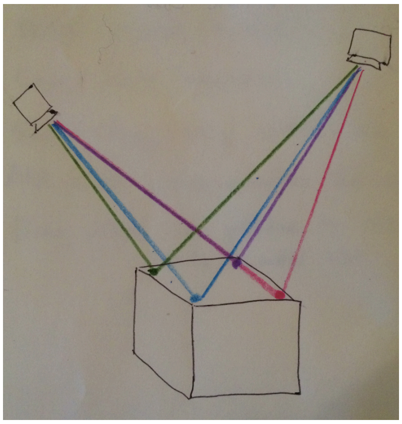
Figure 4-10: Five ways to build Trackmate. From left to right: Portable Plexi Cliffhanger, Classy Hardwood Curio, Overhead LCD Overture, Simple Floating Shelf, and the Basic Basswood Boxcar.

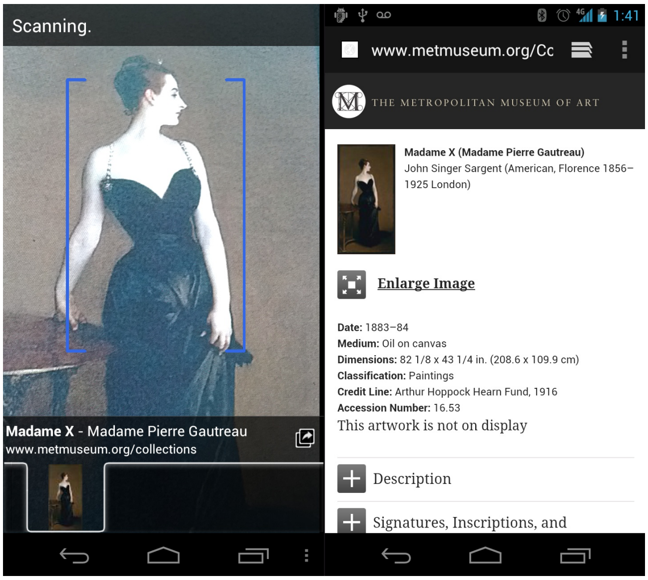
Retroreflective Markers

Toby

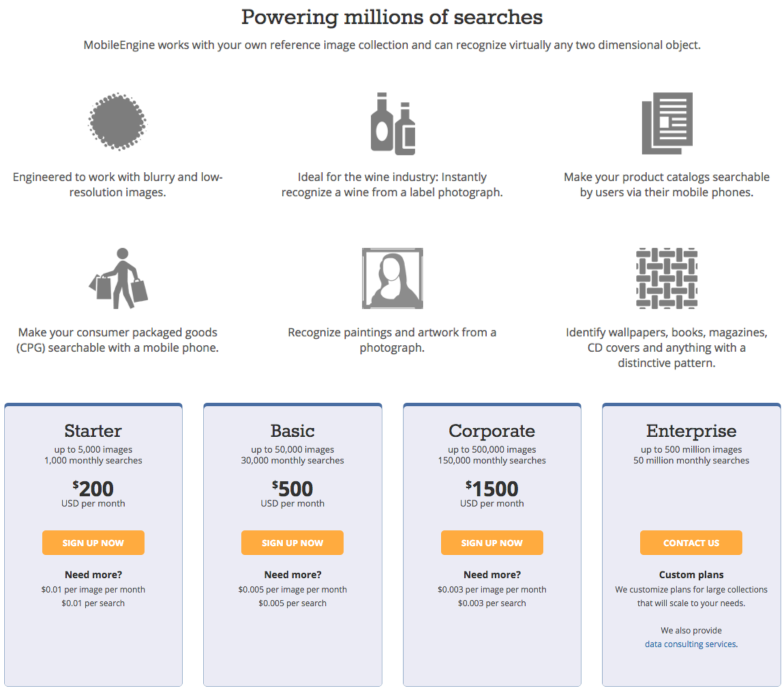








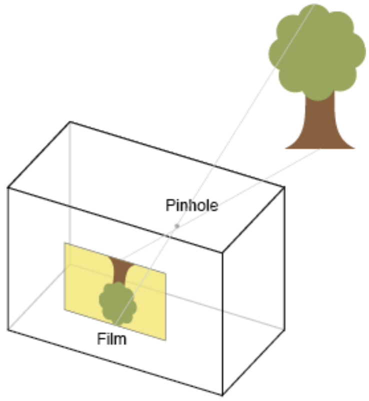
Google Goggles indexes the Metropolitan Museum of Art's collection. Search by taking a photo on your phone.

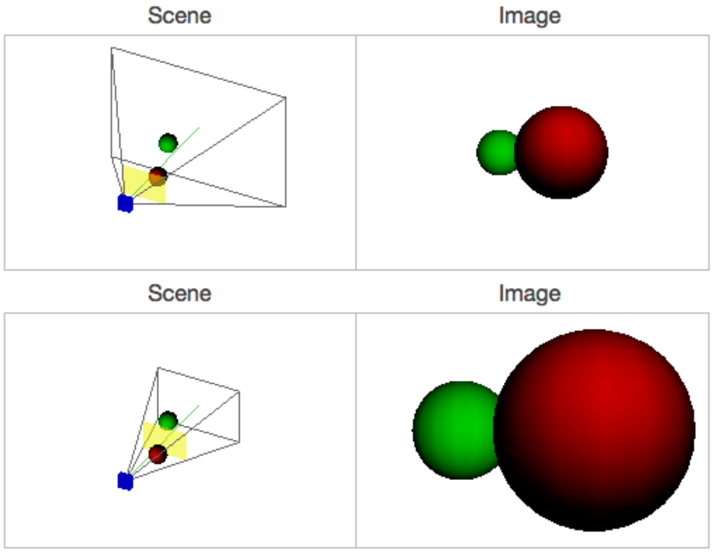


TinEye MobileEngine
Query by image as a service.

The *Intrinsic* Camera Matrix

Properties internal to the camera, doesn't change if you move the camera.





$$K = \begin{pmatrix} f_x & s & x_0 \\ 0 & f_y & y_0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$= \underbrace{\begin{pmatrix} 1 & 0 & x_0 \\ 0 & 1 & y_0 \\ 0 & 0 & 1 \end{pmatrix}}_{\text{2D Translation}} \times \underbrace{\begin{pmatrix} f_x & 0 & 0 \\ 0 & f_y & 0 \\ 0 & 0 & 1 \end{pmatrix}}_{\text{2D Scaling}} \times \underbrace{\begin{pmatrix} 1 & s/f_x & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}}_{\text{2D Shear}}$$

The *focal length* is equivalent to the size of the camera *viewing frustum*.

The *Extrinsic* Camera Matrix

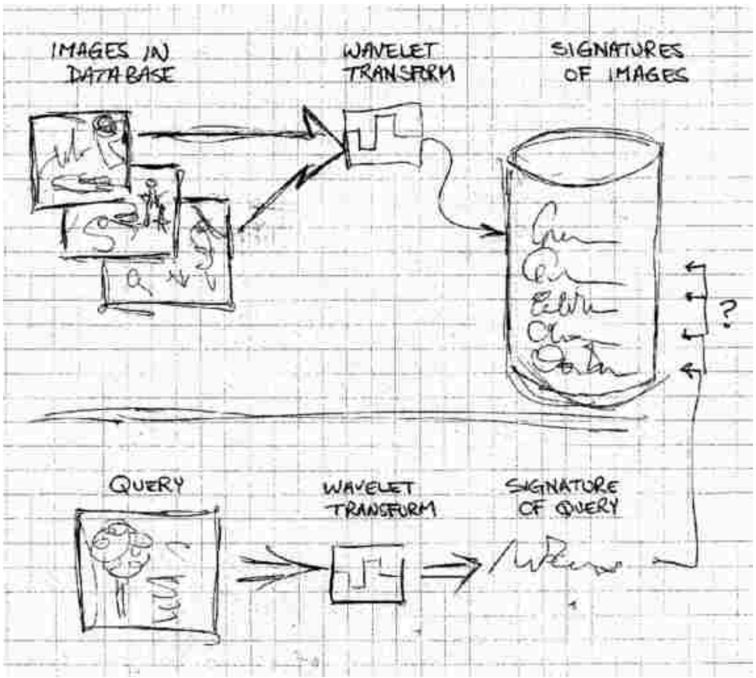
Where the camera is in space and the direction it's pointing, relative to some absolute coordinate system.

$$\left[\begin{array}{c|c} R & \boldsymbol{t} \\ \hline \boldsymbol{0} & 1 \end{array}\right] = \left[\begin{array}{c|c} I & \boldsymbol{t} \\ \hline \boldsymbol{0} & 1 \end{array}\right] \times \left[\begin{array}{c|c} R & \boldsymbol{0} \\ \hline \boldsymbol{0} & 1 \end{array}\right]$$

$$= \left[\begin{array}{ccc|c} 1 & 0 & 0 & t_1 \\ 0 & 1 & 0 & t_2 \\ 0 & 0 & 1 & t_3 \\ \hline 0 & 0 & 0 & 1 \end{array}\right] \times \left[\begin{array}{ccc|c} r_{1,1} & r_{1,2} & r_{1,3} & 0 \\ r_{2,1} & r_{2,2} & r_{2,3} & 0 \\ r_{3,1} & r_{3,2} & r_{3,3} & 0 \\ \hline 0 & 0 & 0 & 1 \end{array}\right]$$

Fast Multiresolution Image Querying

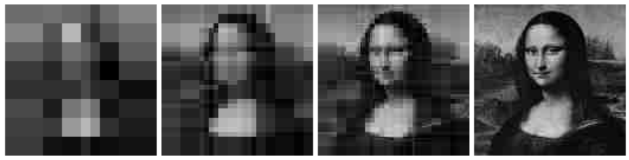
Charles E. Jacobs, Adam Finkelstein, David H. Salesin



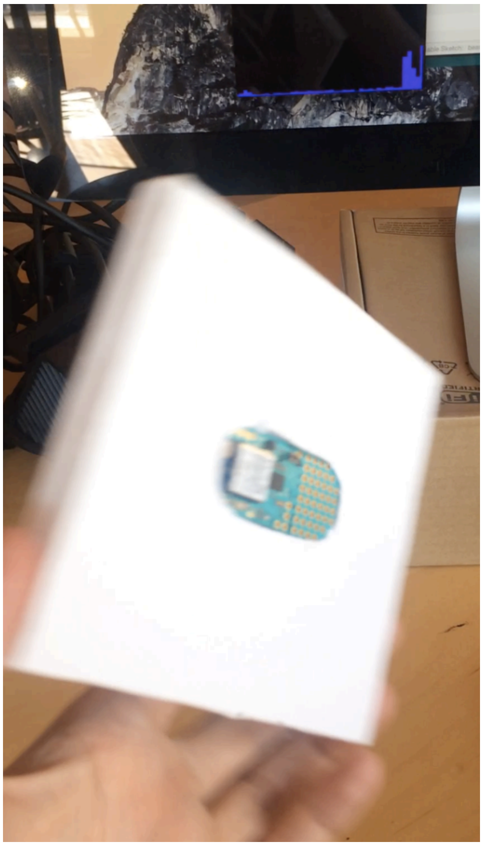
Query by Content

Painted | Scanned | Target

The Wavelet Transform



20 coeffs | 100 coeffs | 400 coeffs | Original (16,000 coeffs)



LightBlue Bean for object movement detection
Toby

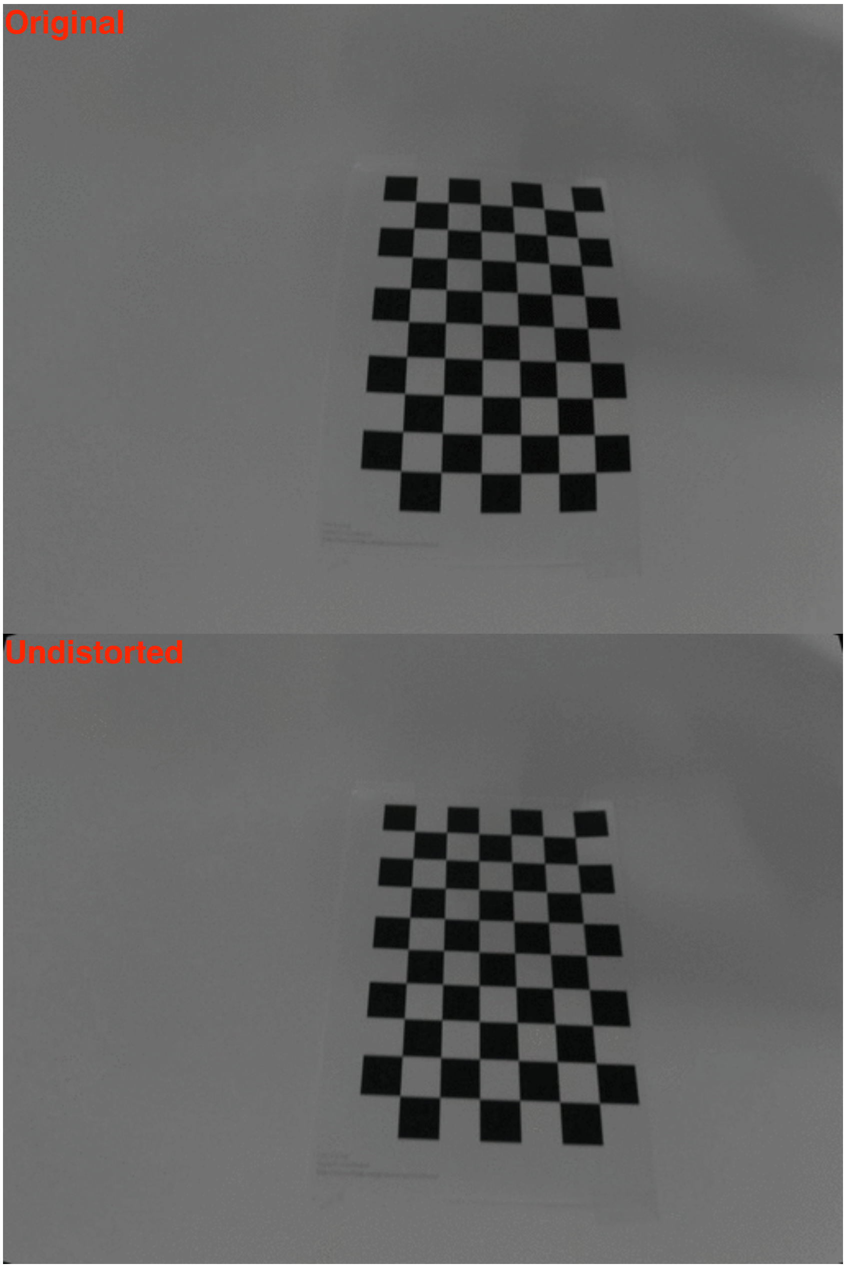


Illustration of Camera Undistortion

Shape Matching and Object Recognition Using Shape Contexts
Serge Belongie, Jan Puzicha

Shapes (e.g. handwritten letters) are resampled as points along their outline. These points are placed on a log-polar "grid" (c) and a histogram is taken. This histogram is used to match against reference shapes. (Note: the shape is moved around on the grid to find the best alignment. Each point in the shape is tried out as a center point.) Once an alignment is found, a correspondence between points can be found (g). This correspondence is assigned a "distance" based on how much it needs to distort the shape.

Fig. 1. Examples of two handwritten digits. In terms of pixel-to-pixel comparisons, these two images are quite different, but to the human observer, the shapes appear to be similar.

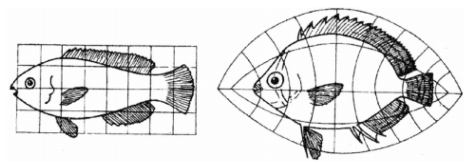


Fig. 2. Example of coordinate transformations relating two fish, from D'Arcy Thompson's *On Growth and Form* [55]. Thompson observed that similar biological forms could be related by means of simple mathematical transformations between *homologous* (i.e., corresponding) features. Examples of homologous features include center of eye, tip of dorsal fin, etc.

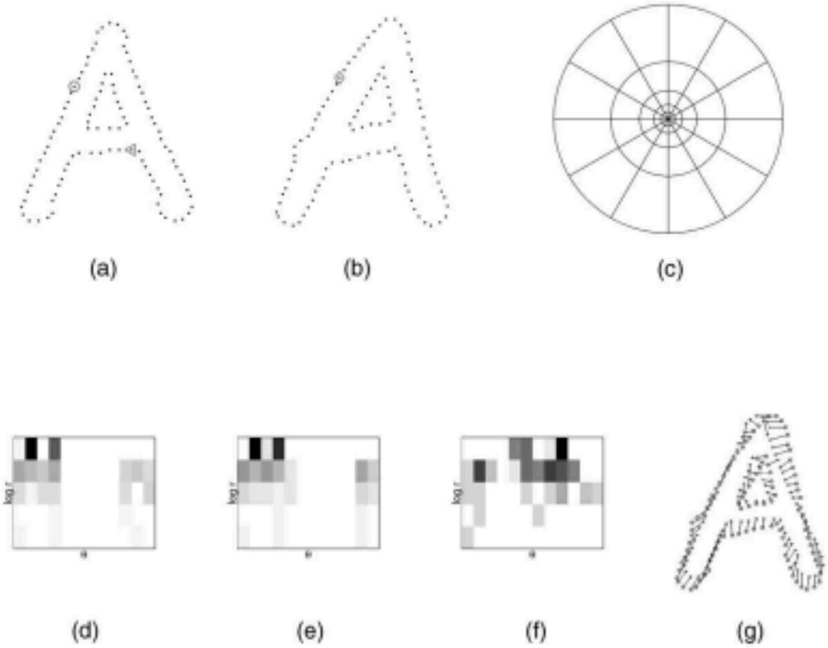


Fig. 3. Shape context computation and matching. (a) and (b) Sampled edge points of two shapes. (c) Diagram of log-polar histogram bins used in computing the shape contexts. We use five bins for $\log r$ and 12 bins for θ. (d), (e), and (f) Example shape contexts for reference samples marked by ○, ◇, ◁ in (a) and (b). Each shape context is a log-polar histogram of the coordinates of the rest of the point set measured using the reference point as the origin. (Dark=large value.) Note the visual similarity of the shape contexts for ○ and ◇, which were computed for relatively similar points on the two shapes. By contrast, the shape context for ◁ is quite different. (g) Correspondences found using bipartite matching, with costs defined by the χ^2 distance between histograms.