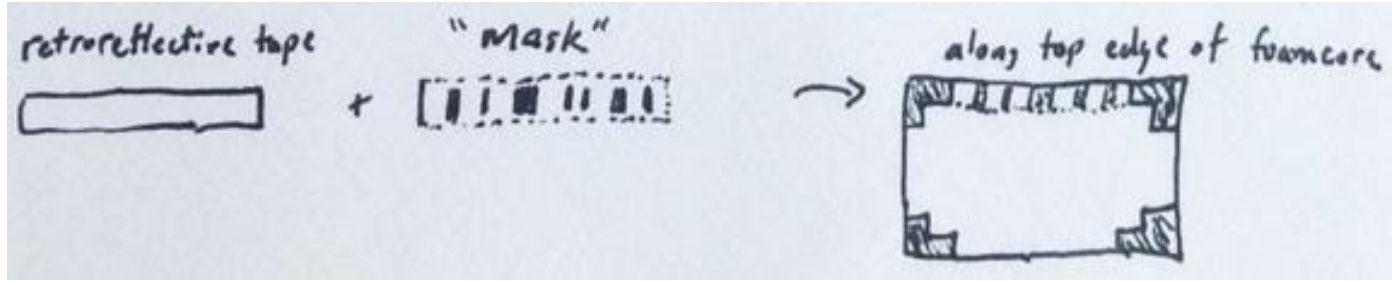
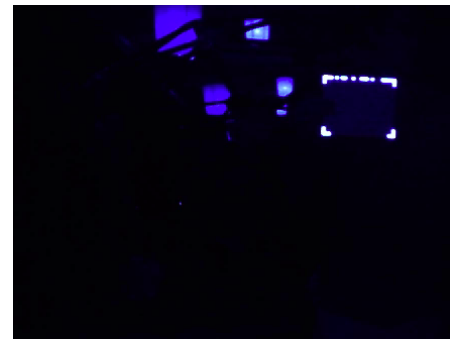
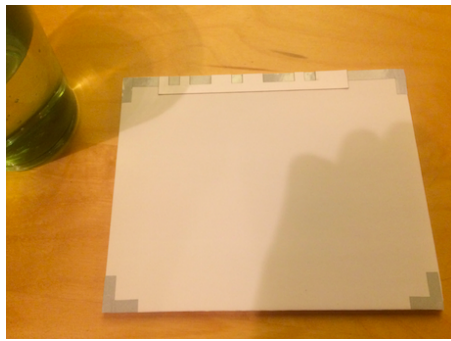


Retroreflective Bar Codes

Bret, Toby



Trackmate (Under the table tracking)

Adam Kumpf

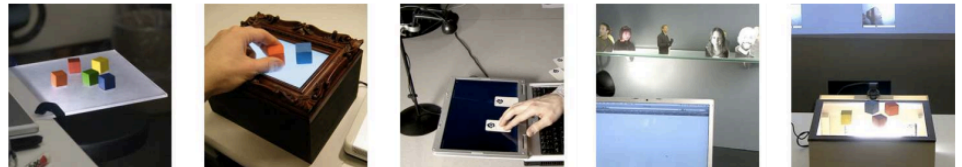
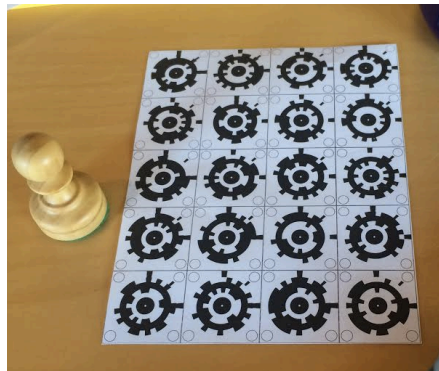
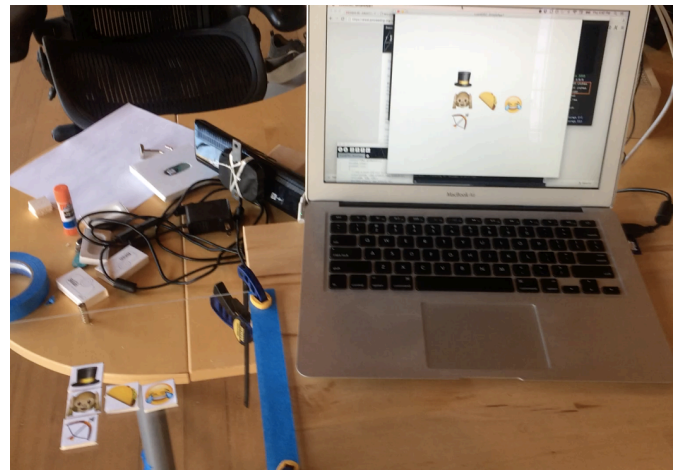
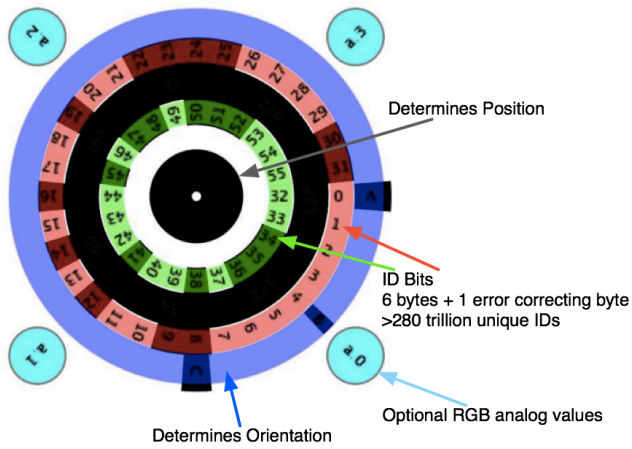
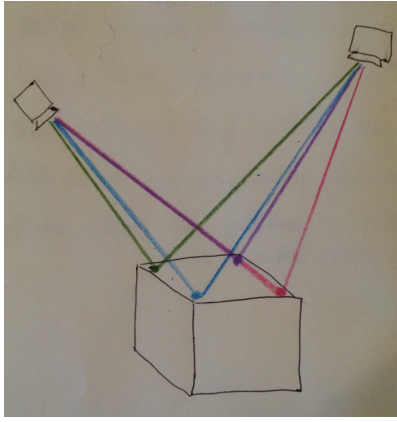
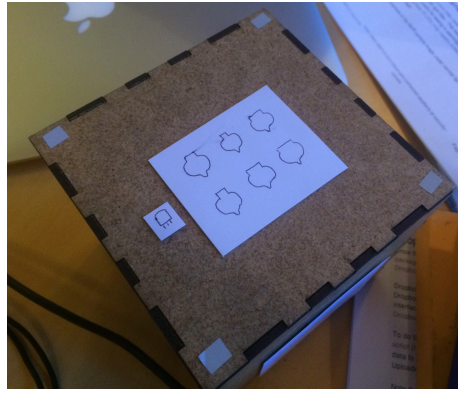
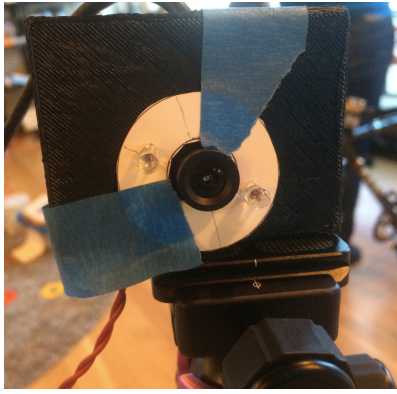
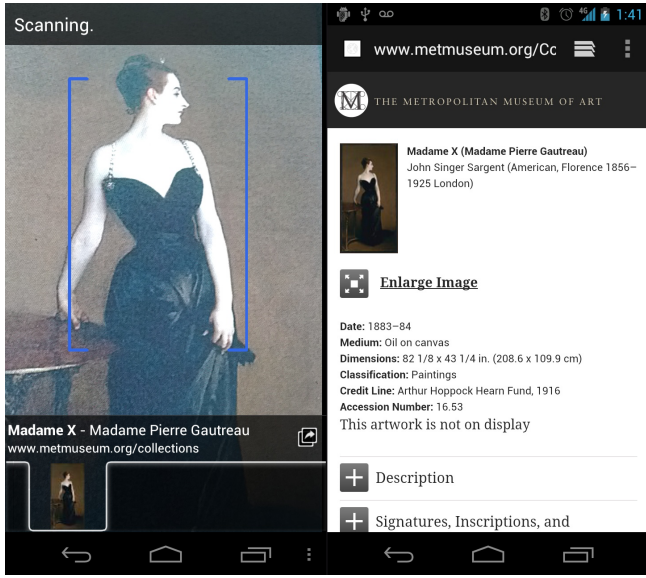


Figure 4-10: Five ways to build Trackmate. From left to right: Portable Plexi Cliffhanger, Classy Hardwood Curio, Overhead LCD Overture, Simple Floating Shelf, and the Basic Basswood Boxcar.

Retroreflective Markers

Toby





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

Powering millions of searches

MobileEngine works with your own reference image collection and can recognize virtually any two dimensional object.

Engineered to work with blurry and low-resolution images.

Ideal for the wine industry: Instantly recognize a wine from a label photograph.

Make your product catalogs searchable by users via their mobile phones.

Make your consumer packaged goods (CPG) searchable with a mobile phone.

Recognize paintings and artwork from a photograph.

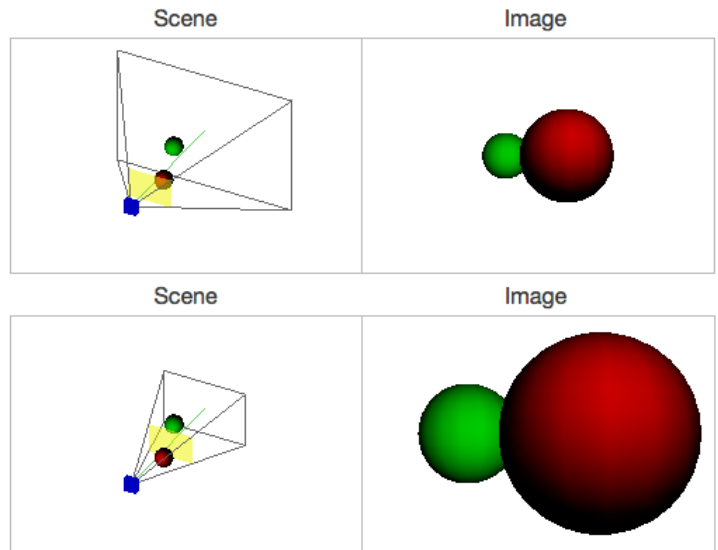
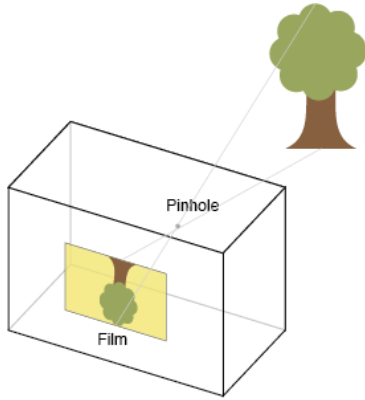
Identify wallpapers, books, magazines, CD covers and anything with a distinctive pattern.

Starter	Basic	Corporate	Enterprise
up to 5,000 images 1,000 monthly searches	up to 50,000 images 30,000 monthly searches	up to 500,000 images 150,000 monthly searches	up to 500 million images 50 million monthly searches
\$200 USD per month	\$500 USD per month	\$1500 USD per month	
SIGN UP NOW	SIGN UP NOW	SIGN UP NOW	CONTACT US
Need more? \$0.01 per image per month \$0.01 per search	Need more? \$0.005 per image per month \$0.005 per search	Need more? \$0.003 per image per month \$0.003 per search	Custom plans We customize plans for large collections that will scale to your needs. We also provide data consulting services.

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

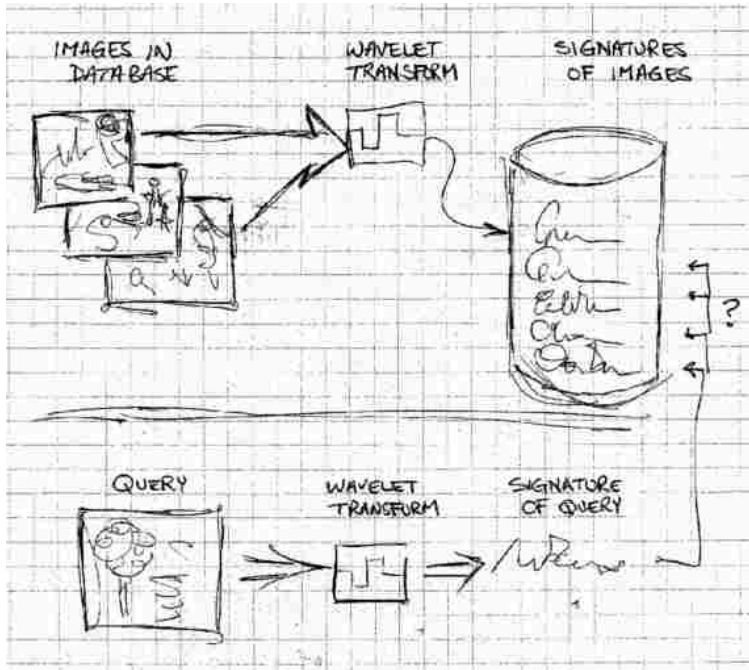
Where the camera is in space and the direction it's pointing, relative to some absolute coordinate system.

$$\begin{bmatrix} R & | & t \\ \hline \mathbf{0} & | & 1 \end{bmatrix} = \begin{bmatrix} I & | & t \\ \hline \mathbf{0} & | & 1 \end{bmatrix} \times \begin{bmatrix} R & | & \mathbf{0} \\ \hline \mathbf{0} & | & 1 \end{bmatrix}$$

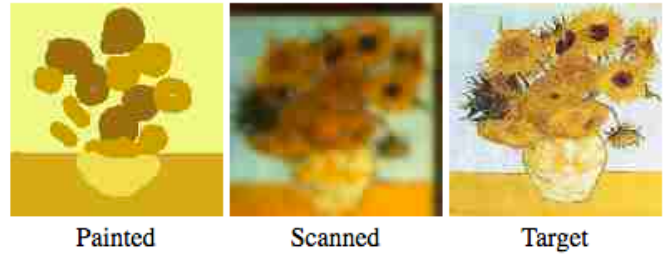
$$= \begin{bmatrix} 1 & 0 & 0 & | & t_1 \\ 0 & 1 & 0 & | & t_2 \\ 0 & 0 & 1 & | & t_3 \\ \hline 0 & 0 & 0 & | & 1 \end{bmatrix} \times \begin{bmatrix} r_{1,1} & r_{1,2} & r_{1,3} & | & 0 \\ r_{2,1} & r_{2,2} & r_{2,3} & | & 0 \\ r_{3,1} & r_{3,2} & r_{3,3} & | & 0 \\ \hline 0 & 0 & 0 & | & 1 \end{bmatrix}$$

Fast Multiresolution Image Querying

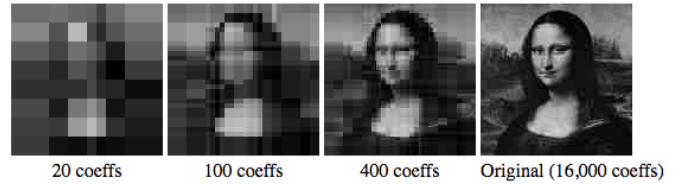
Charles E. Jacobs, Adam Finkelstein, David H. Salesin



Query by Content



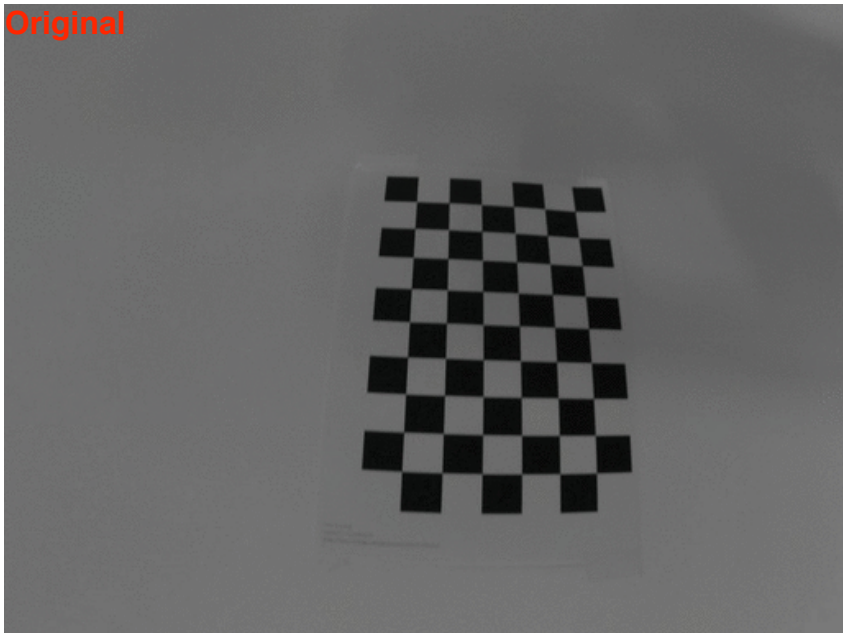
The Wavelet Transform





**LightBlue Bean for object
movement detection**
Toby

Original



Undistorted

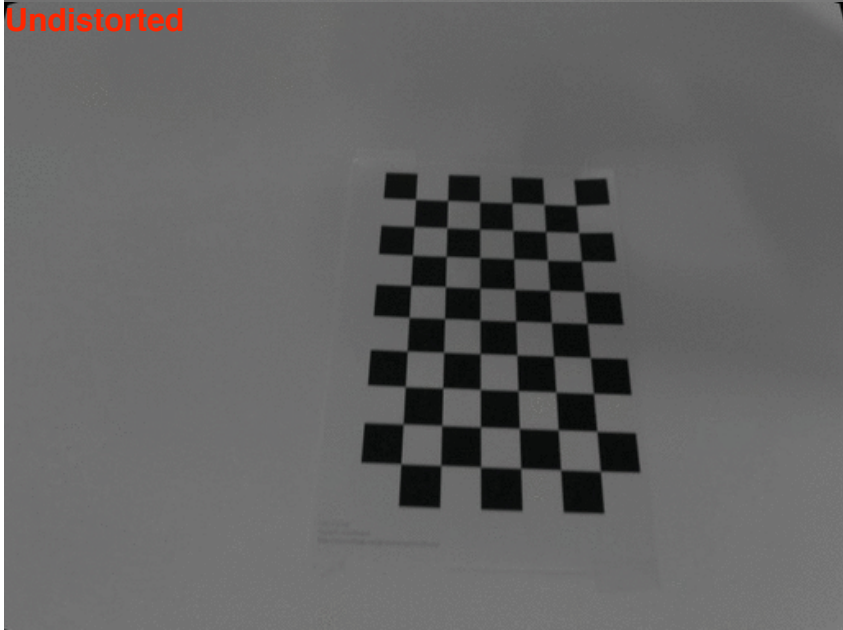


Illustration of Camera Undistortion

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.

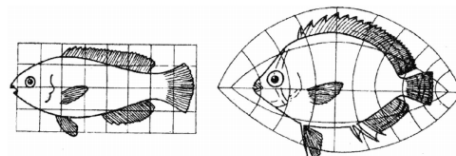


Fig. 2. Example of coordinate transformations relating two fish, from D'Arcy Thompson's *On Growth and Form* [55]. Thompson observed that similar biological forms could be related by means of simple mathematical transformations between homologous (i.e., corresponding) features. Examples of homologous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

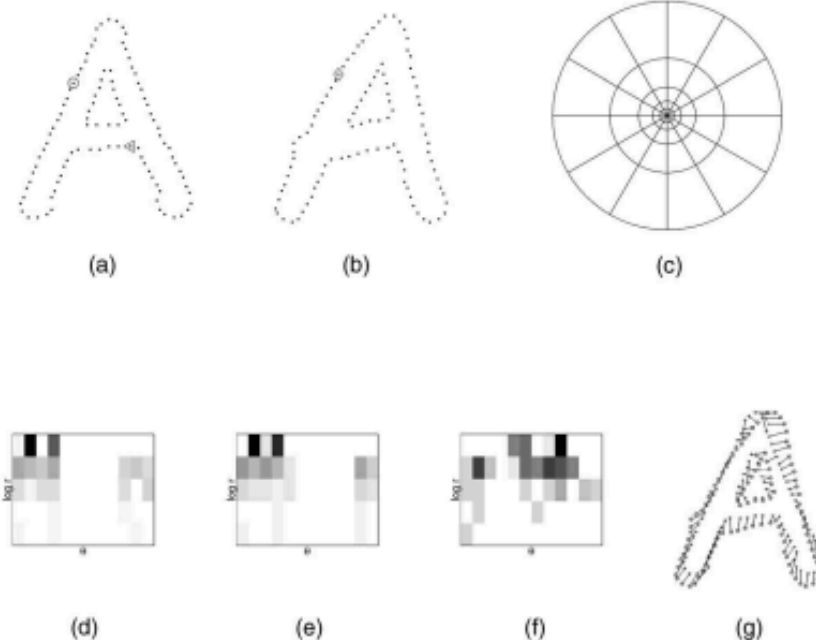


Fig. 3. Shape context computation and matching. (a) and (b) Sampled edge points of two shapes. (c) Diagram of log-polar histogram bins used in computing the shape contexts. We use five bins for $\log r$ and 12 bins for θ . (d), (e), and (f) Example shape contexts for reference samples marked as \circ , \diamond , \triangle 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 \circ and \diamond , which were computed for relatively similar points on the two shapes. By contrast, the shape context for \triangle is quite different. (g) Correspondences found using bipartite matching, with costs defined by the χ^2 distance between histograms.