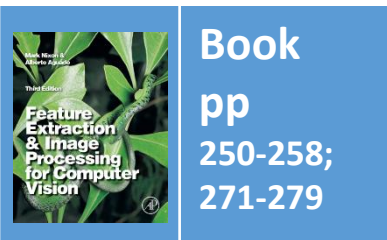


Lecture 9 Finding More Shapes

COMP3204 & COMP6223 Computer Vision

How can we go from conic sections to general shapes?



Book
pp
250-258;
271-279

**Department of
Electronics and
Computer Science**

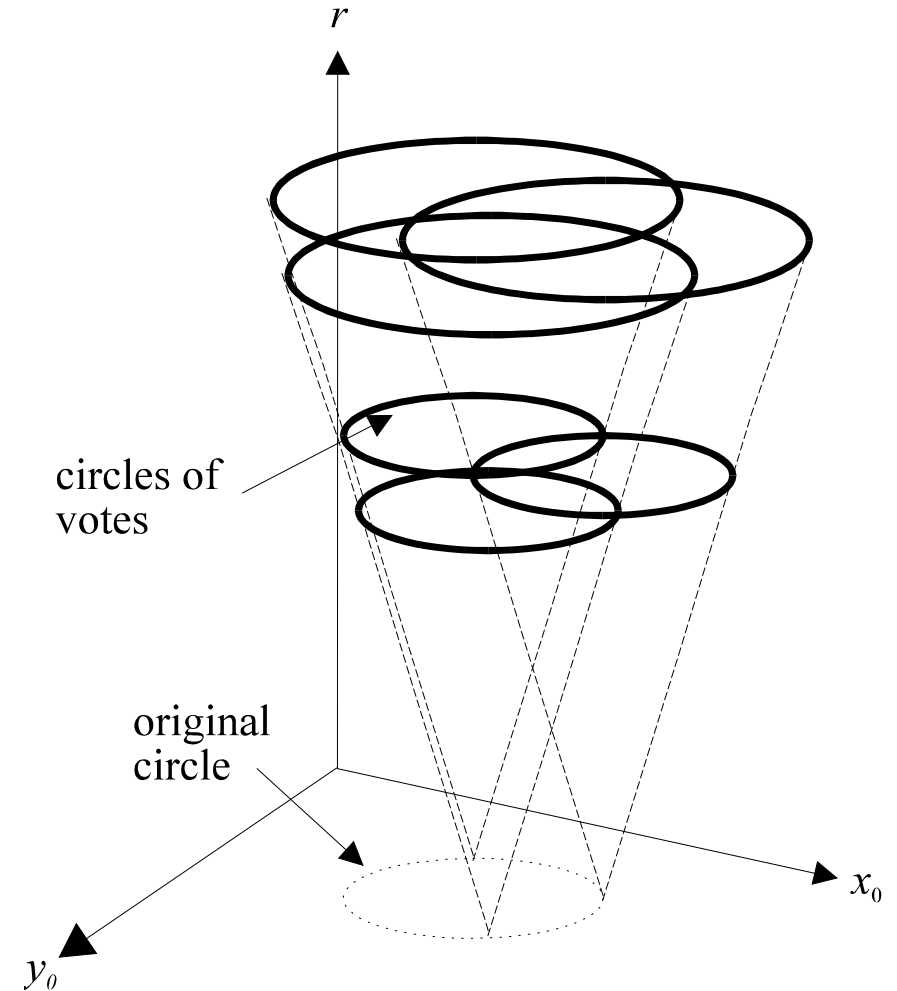
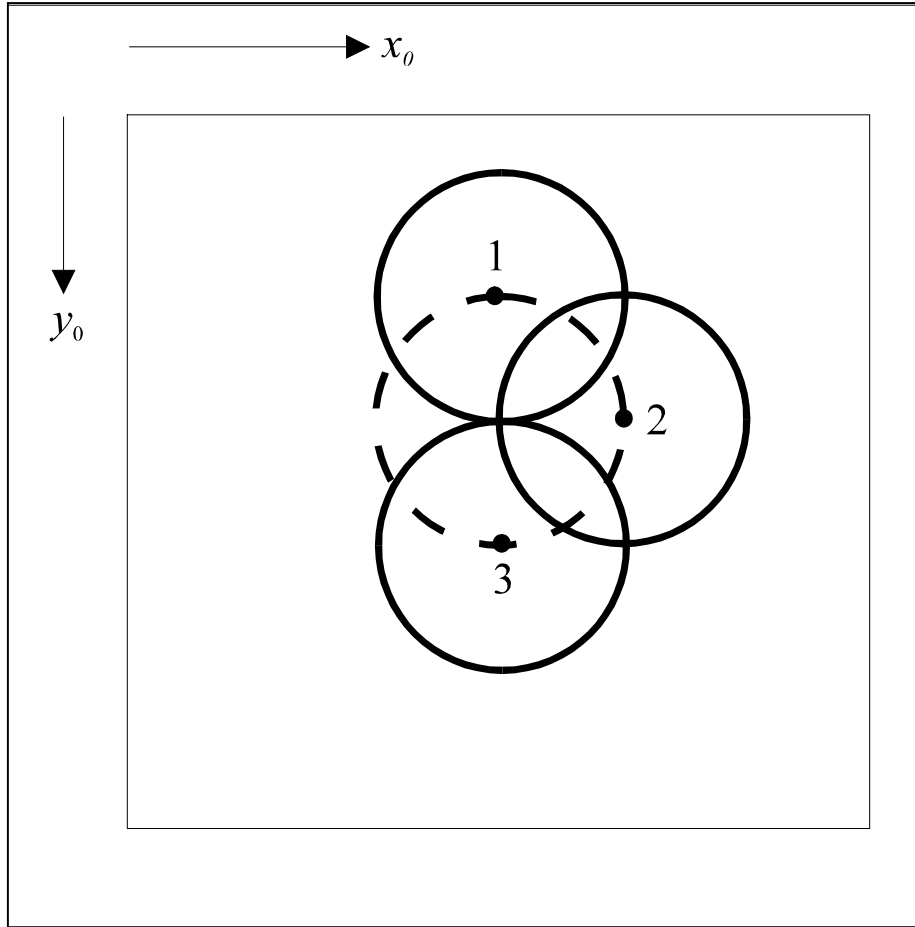
**UNIVERSITY OF
Southampton**
School of Electronics
and Computer Science

Hough Transform for Circles

- Again, it's **duality**: $(x - x_0)^2 + (y - y_0)^2 = r^2$
- Points: x, y parameters x_0, y_0 radius r
- Points: x_0, y_0 parameters x, y radius r



Circle Voting and Accumulator Space



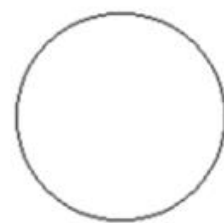
Speeding it up.....

- Now it's a **3D** accumulator, fast algorithms are available
- E.g. by **differentiation** $\frac{dy}{dx} = -\frac{(x - x_0)}{(y - y_0)}$
- So **edge gradient direction** can be used, e.g. 2D accumulator by

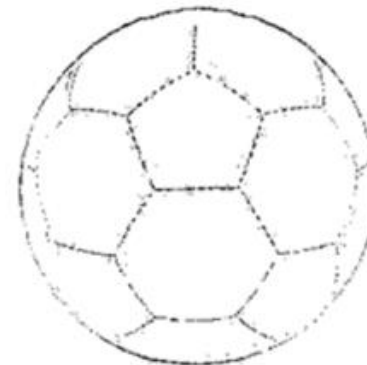
$$\left(\frac{dy}{dx}\right)^2 (y - y_0)^2 + (y - y_0)^2 = r^2$$



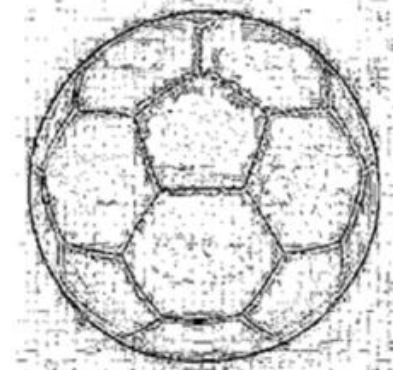
Applying the HT for circles



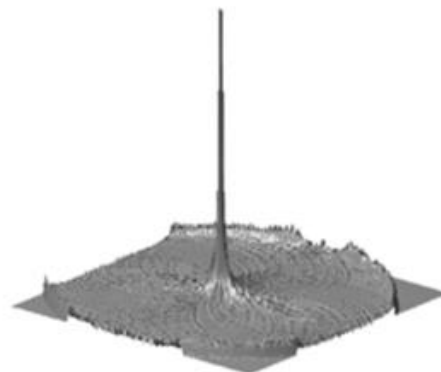
(a) circle



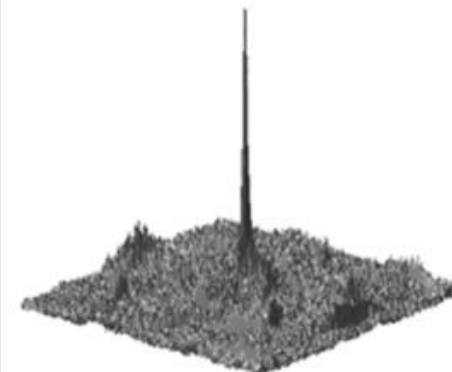
(b) soccer ball edges



(c) noisy soccer ball edges



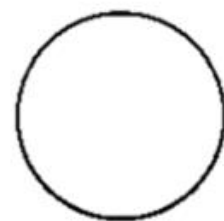
(d) accumulator for (a)



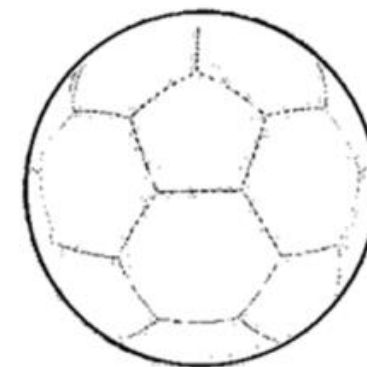
(e) accumulator for (b)



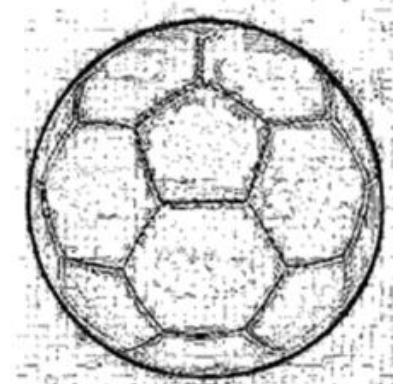
(f) accumulator for (c)



(g) circle from (d)



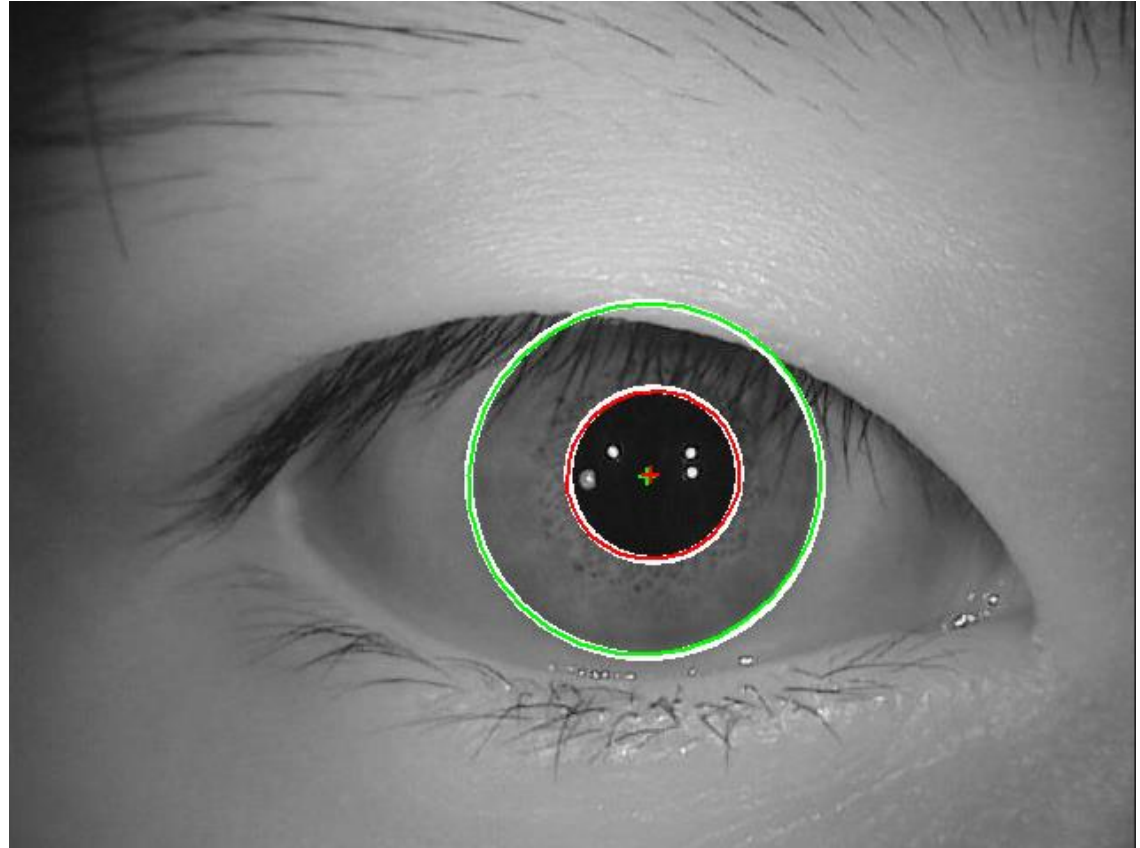
(h) circle from (e)



(i) circle from (f)



Integrodifferential operator?



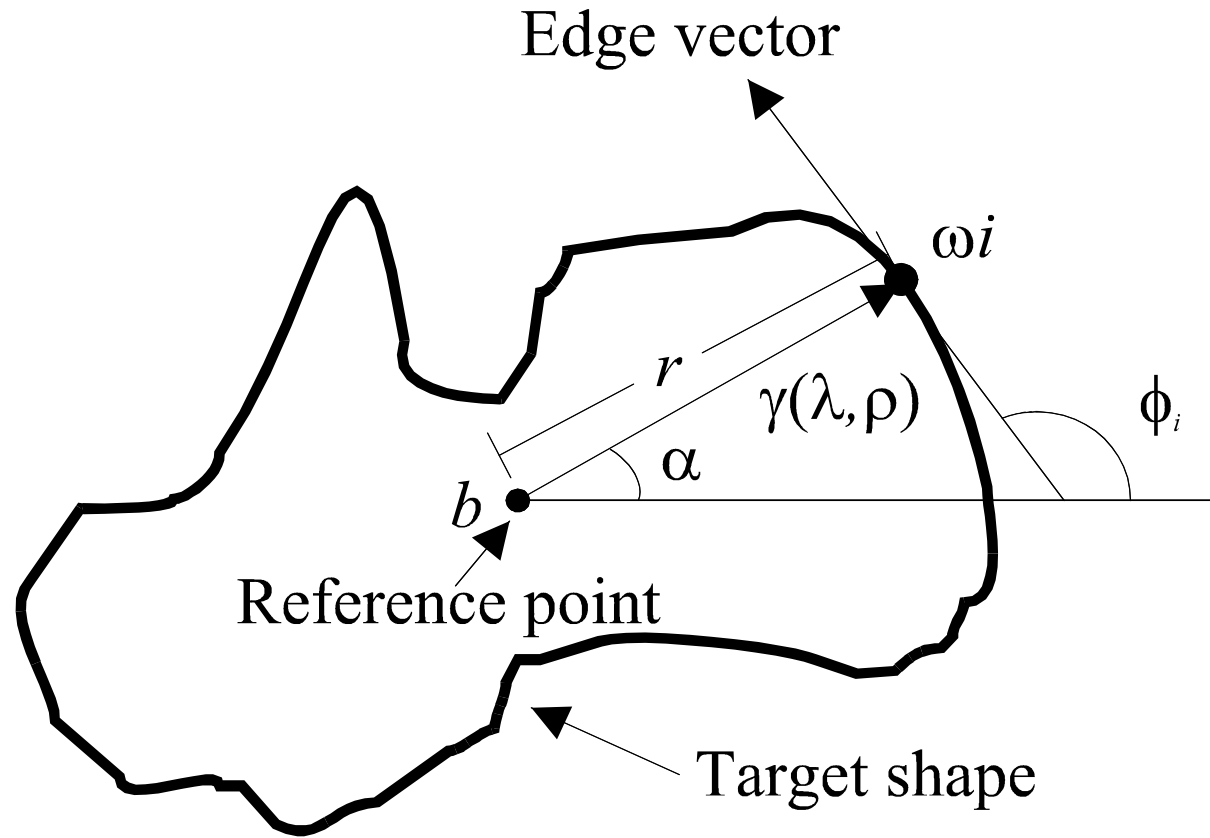
<https://stackoverflow.com/questions/27058057/comparing-irises-images-with-opencv>

Arbitrary Shapes

- Use Generalised HT
- Form (discrete) look-up-table (R-table)
- Vote via look-up-table
- Orientation? Rotate R-table voting
- Scale? scale R-table voting
- Inherent problems with discretisation



R-table Construction



$\hat{\phi}_i'$	$\gamma = (r, \alpha)$
0	$(r_0, \alpha_0), (r_1, \alpha_1), (r_2, \alpha_2)$
$\Delta\phi$	\vdots
$2\Delta\phi$	\vdots
...	...

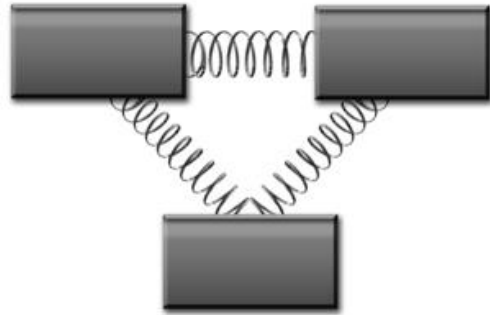


Active Contours

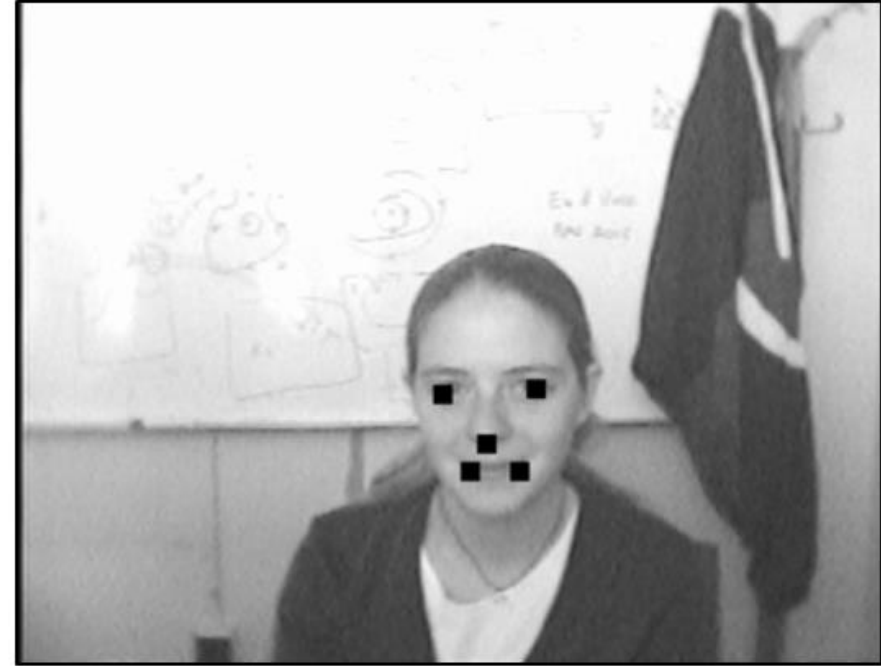
- For **unknown** arbitrary shapes: extract by **evolution**
- **Elastic band** analogy
- **Balloon** analogy
- Discrete vs. continuous
- **Volcanoes?**



Parts



(a) mechanical equivalent



(b) finding face features

Parts-based Shape Model

Symmetry



(a) walking subject's silhouette



(b) symmetry plot

Applying the Symmetry Operator for Recognition by Gait