Generalized Hough Transform

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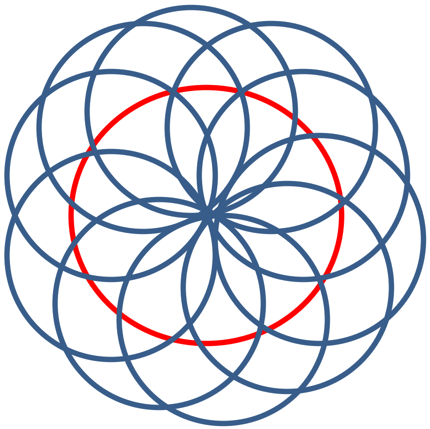
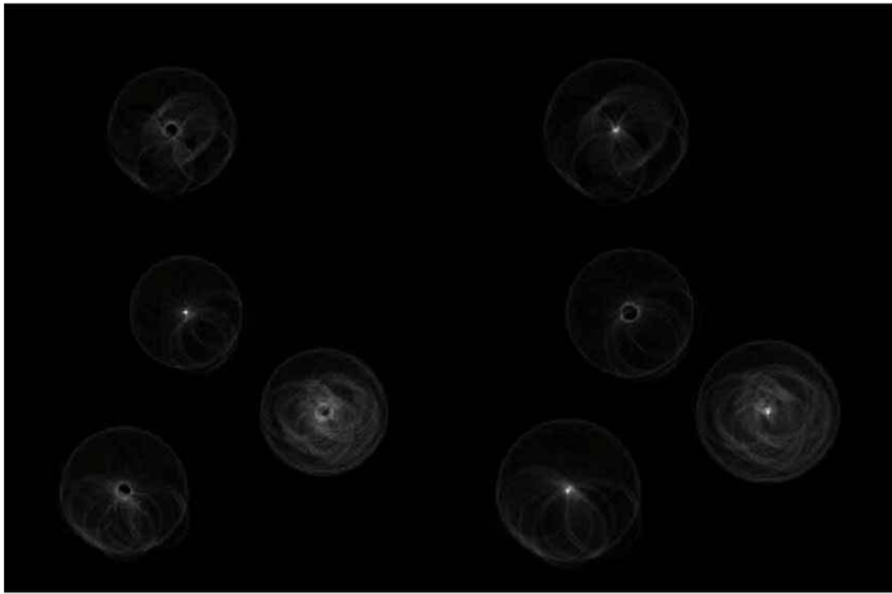
Original Hough Transform

- $(x-x_0)^2+(y-y_0)^2=r^2$
- Each point is evidence for a circle.
- Given (x,y,r) increment bins in all satisfying (x_0,y_0)
- Find local maxima in accumulator

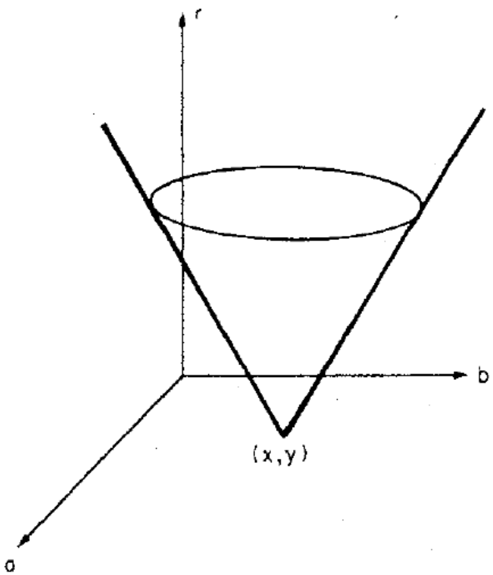


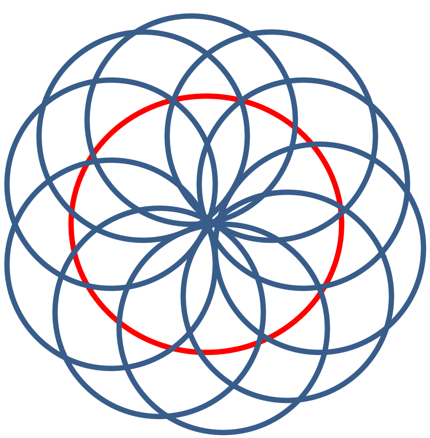


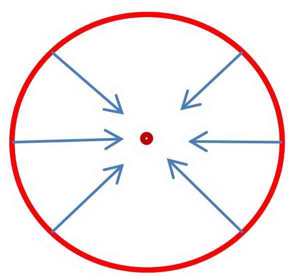
Gradient Information $\phi(x)$

$$\frac{df}{dx}(x,a)=0$$

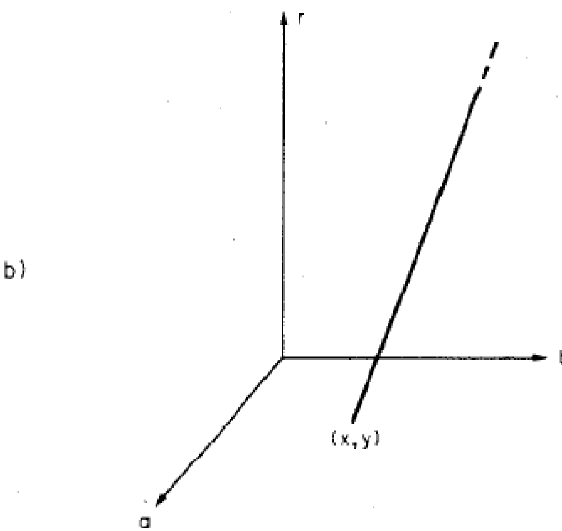
$$\frac{dy}{dx}=\tan[\phi(x)-\frac{\pi}{2}]$$





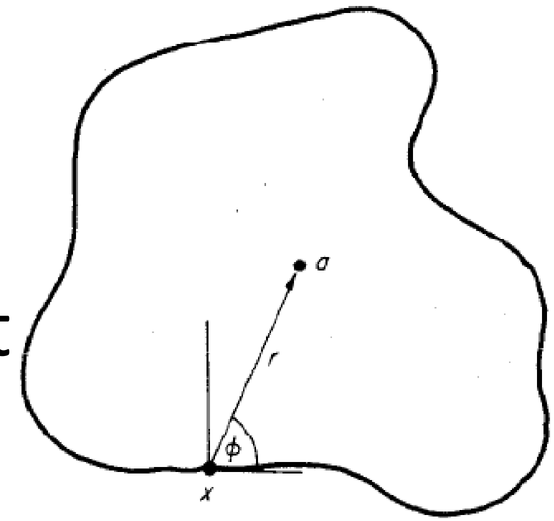


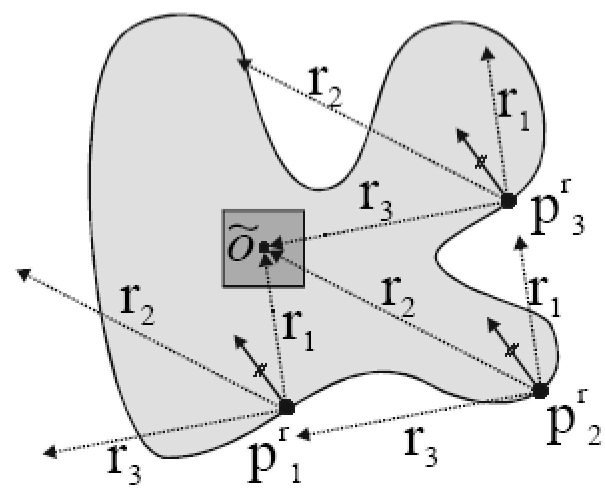
(b)



Arbitrary Shape

- Reconstruction of the reference origin by adding all displacement vectors to all boundary points
- R(ϕ(**x**)) table holds all reference points that a certain gradient is evidence of.





Scale(s) / Rotation(θ)

$$T_s[R(\Phi)] = sR(\Phi)$$

- Vote in all bins ranging over scale

$$T_\theta[R(\Phi)] = Rot\{R[(\Phi - \theta) mod 2\pi], \theta\}$$

- Vote in all bins ranging over rotation

- Accumulator space is now 4D
  - A((x,y),θ,s)

Composite Images

- Sub-shapes(S_k) of shape(S) can be found by taking voting on the union of R-tables of sub-shapes.

$$R_s(\phi) = T_s\left\{T_\theta\left[\bigcup_{k=1}^{N} R_{S_k}(\phi)\right]\right\}.$$

Strength in numbers

- Dynamic Programming
- Connected Components
- Weight Functions

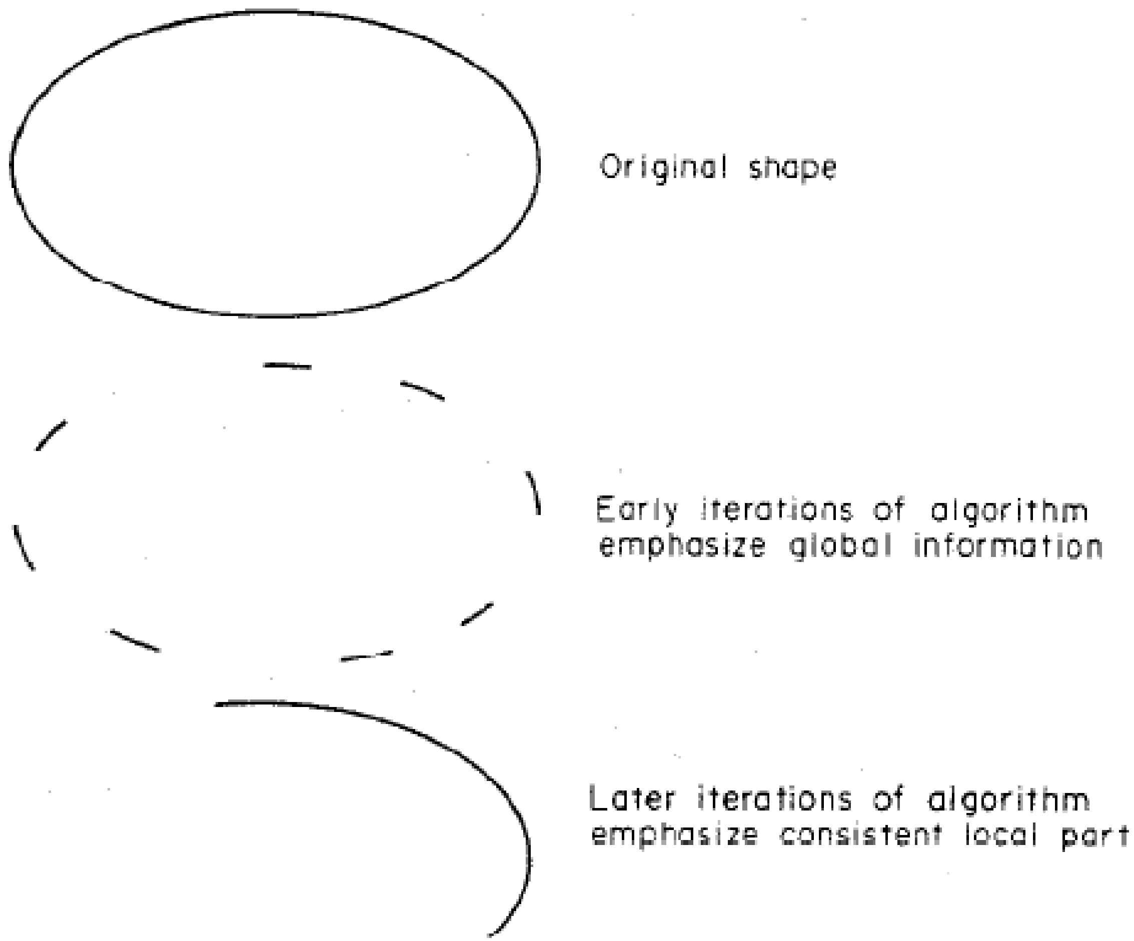


Fig. 12. Dynamic Hough transform.