FEEL & FIND
Shape Matching Game

Shape Matching

Boguslaw Obara

Shape Matching - Bibliography

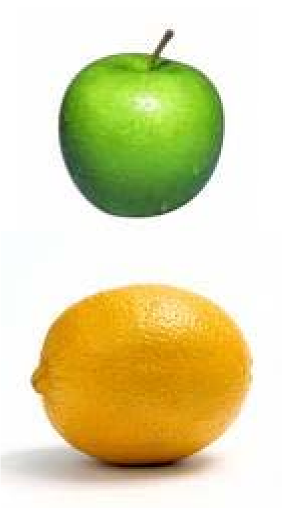
Shape Matching

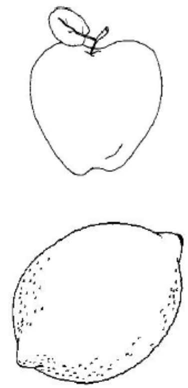
- S. Belongie, J. Malik and J. Puzicha, *Shape Matching and Object Recognition using Shape Context*, *IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 24, No. 24, pp.* 509-522, 2002.
- A. Diplaros, T. Gevers, I. Patras, *Color-Shape Context for Object Recognition*, IEEE Workshop on Color and Photometric. Methods in Computer Vision, Nice, France, 2003

Cost Function

- R. Jonker and A. Volgenant: *A Shortest Augmenting Path Algorithm for Dense and Sparse Linear Assignment Problems*, Computing 38, 325- 340,1987
- Cpapadimitriou and K. Steiglitz, *Combinatorial Optimization: Algorithms and Complexity,* Prentice hall, 1982

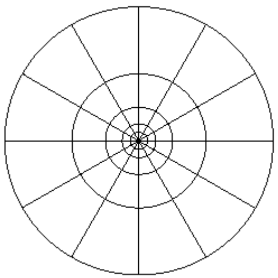
Shape Matching Algorithm

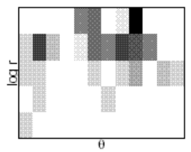


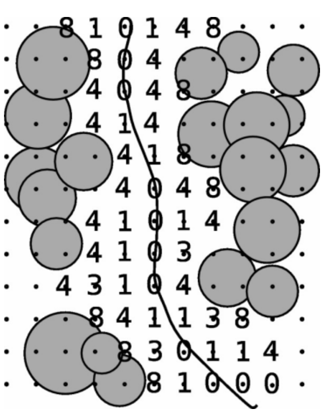


<u>Edge detector</u>
Roberts Cross, Prewitt, Sobel, Canny
???

<u>Sampling method</u>
Jitendra ???





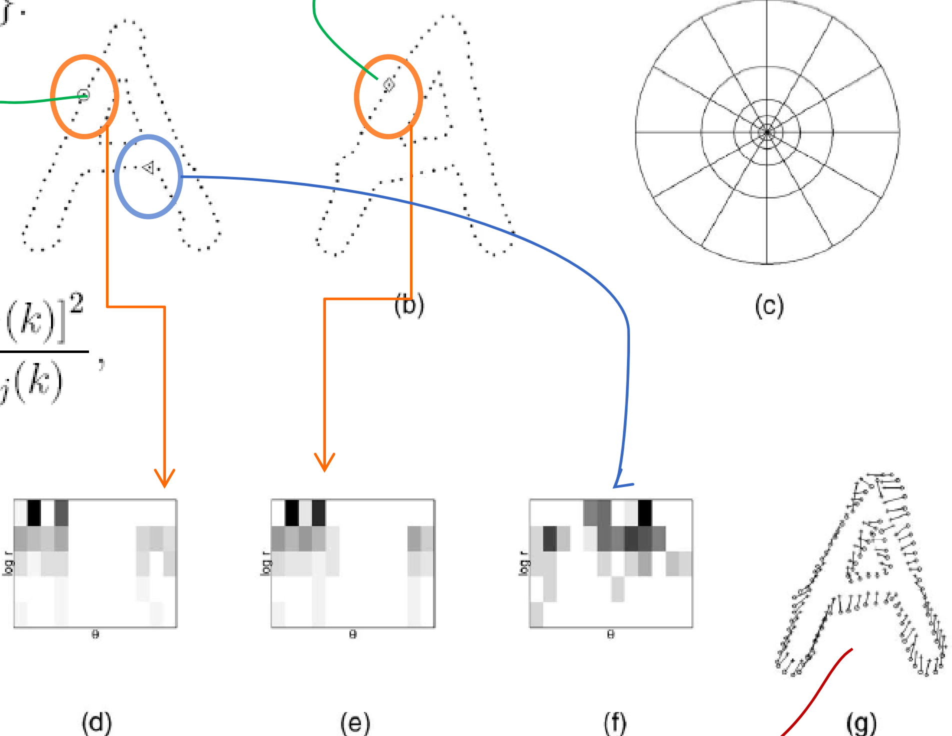


Shape Matching Algorithm

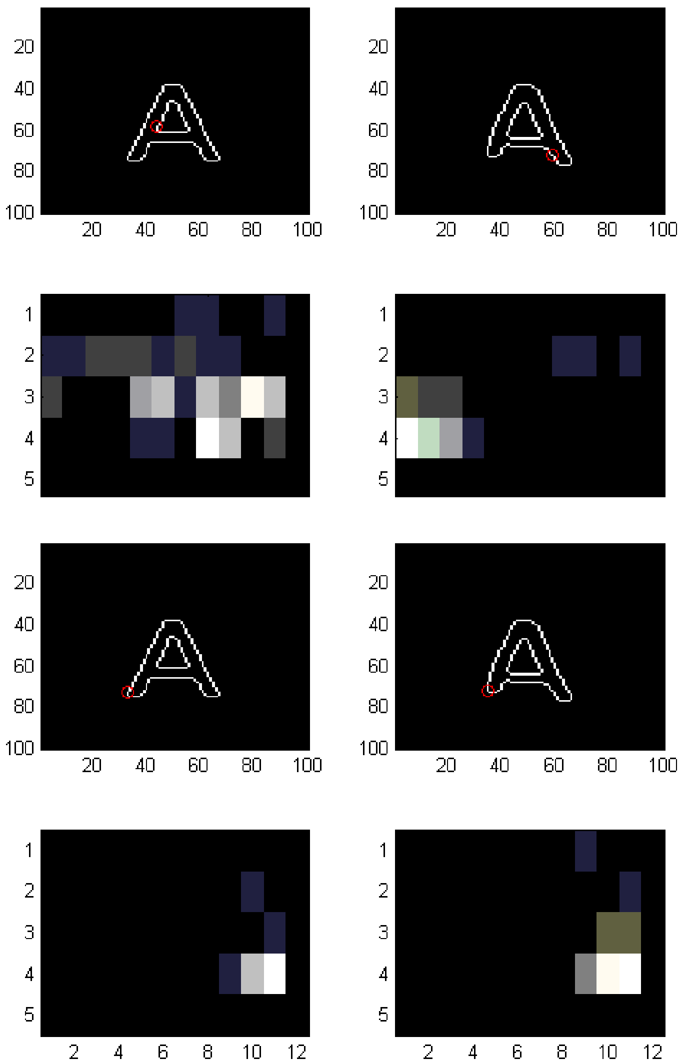
$$h_i(k) = \#\{q \neq p_i \ : \ (q - p_i) \in \text{bin}(k)\}.$$

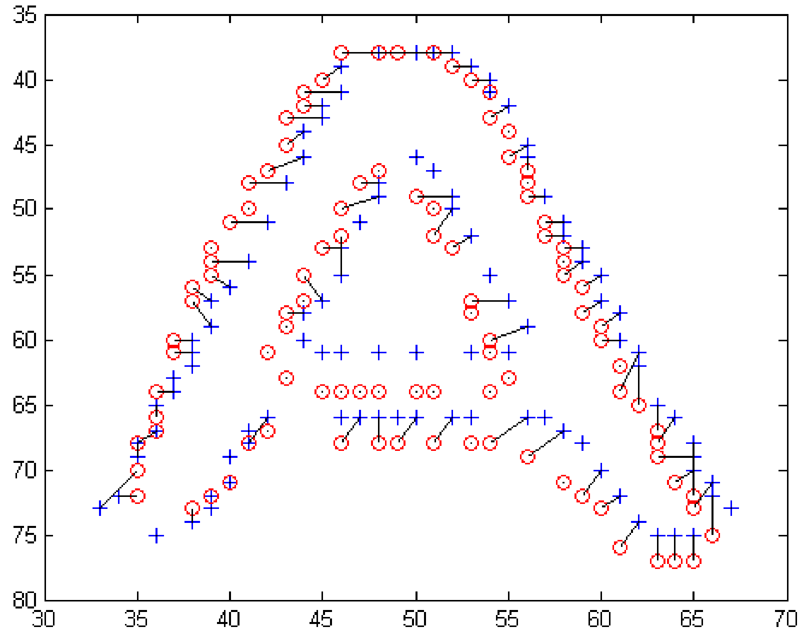
$$C_{ij} \equiv C(p_i, q_j) = \frac{1}{2}\sum_{k=1}^{K} \frac{[h_i(k) - h_j(k)]^2}{h_i(k) + h_j(k)},$$

$$H(\pi) = \sum_i C(p_i, q_{\pi(i)})$$



Shape Matching – Preliminary Results





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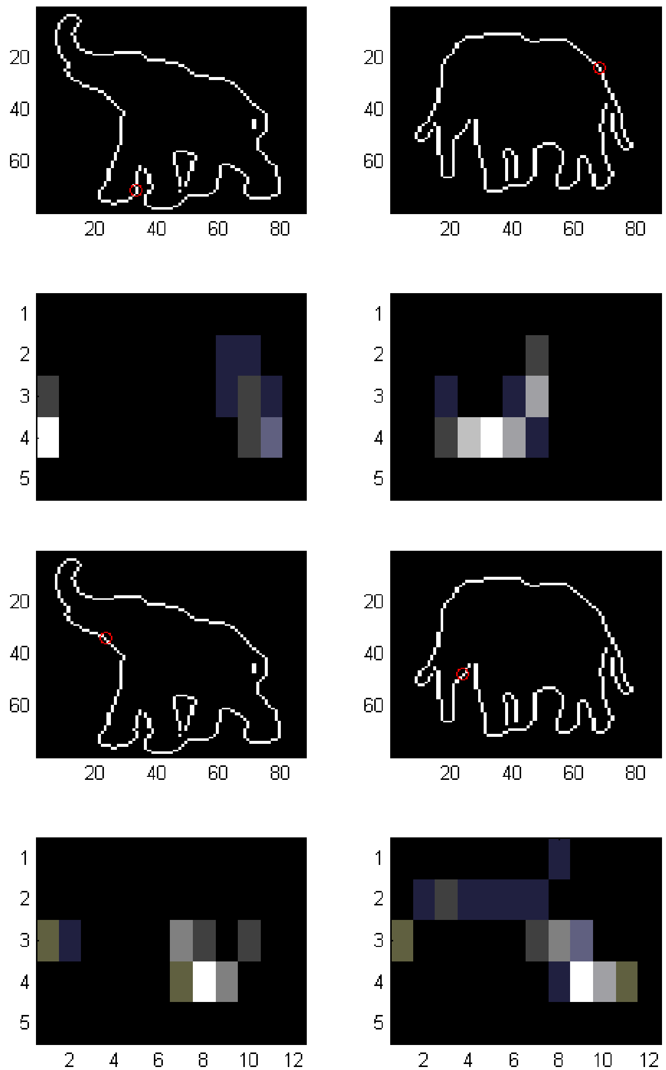

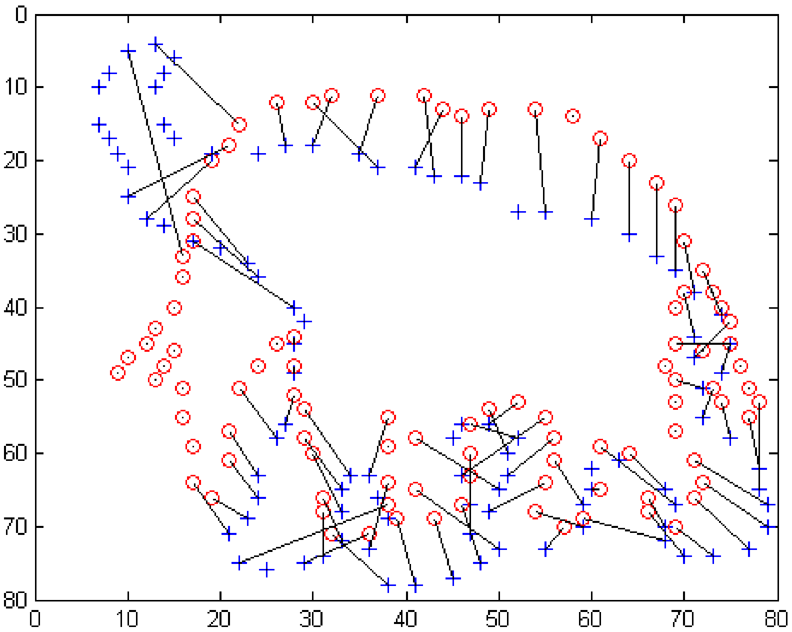

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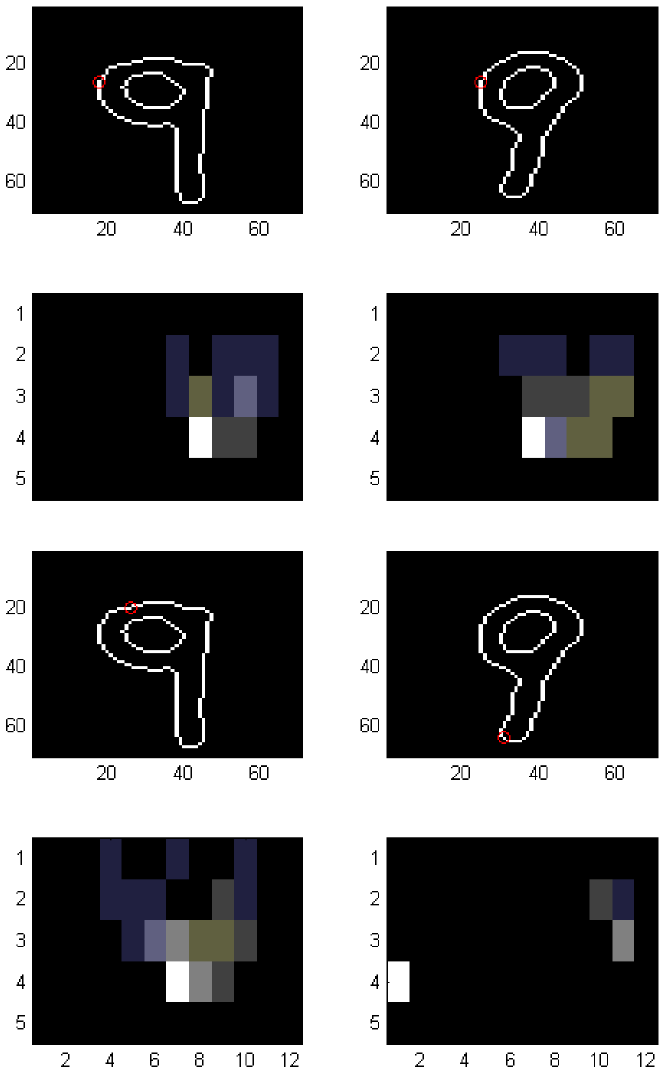
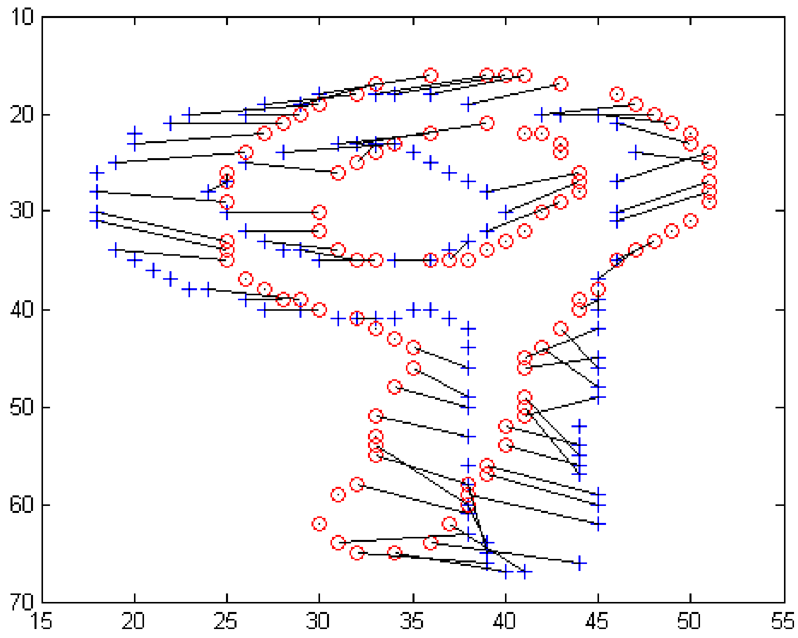
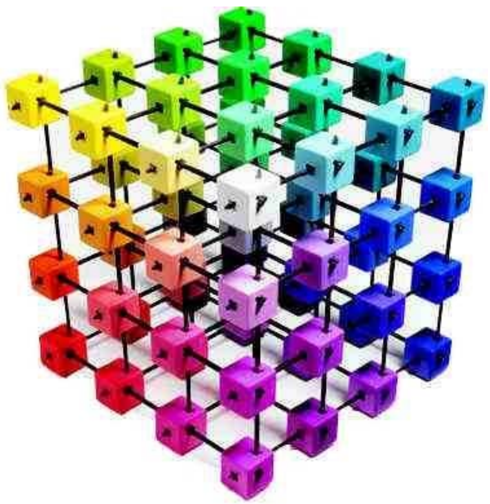




Shape Matching - Updates



4.1 Color-Shape Representation Scheme

The color-shape framework is as follows. For a color image $\mathcal{I} : \mathbb{R}^2 \rightarrow \mathbb{R}^3$, illumination invariant edges are computed to obtain a binary image $\mathcal{E} : \mathbb{R}^2 \rightarrow \{0, 1\}$. Then at the edge points we define:

$$\vec{p}_n = (x, y, m_1, m_2, m_3)| \;\; \mathcal{E}(x, y) = 1 \qquad (19)$$

where x, y are pixel coordinates in image $\mathcal{E}$ and m_1, m_2, m_3 are the color invariant ratios calculated in image $\mathcal{I}$. Further, $\vec{p_n} \in \mathbb{R}^5$.

We can decompose each of these $\vec{p}_n$ vectors as follows:

$$\vec{p}_n = \vec{p}_{S_n} + \vec{p}_{C_n} \qquad (20)$$

where:

$$\vec{p}_{S_n} = (x, y, 0, 0, 0)$$
$$\vec{p}_{C_n} = (0, 0, m_1, m_2, m_3)$$

4.3 Matching in complex scenes

More specifically, the occlusion field of spatial cell k is defined as:

$$O_k = \begin{cases} 1 & : \quad d_k/q_k > T \\ 0 & : \quad d_k/q_k \leq T \end{cases}$$

where d_k denotes the accumulated cost of matching in the spatial cell k and is defined as :

$$d_k = \frac{1}{2} \sum_{\{n \mid f(n)=k\}} \frac{(h_a(n) - h_b(n))^2}{(h_a(n) + h_b(n))}$$

where f(n) denotes a mapping from the index of the color-shape context to the appropriate spatial cell index k. q_k denotes the percentage of points of the two images in the spatial cell k and is defined as:

$$q_k = \sum_{\{n \mid f(n)=k\}} (h_a(n) + h_b(n))$$

The cost function is now as follows:

$$C'_{ab} = C_{ab} - \sum_k O_k \frac{1}{|N_k|} \sum_{l \in N_k} (d_k - T q_k O_l) \qquad (23)$$

where N_k is the 4-neighborhood of spatial cell k. The way

COMPLEX SCENE
ACRYLIC ON CANVAS 2004

Shape Matching

Figure 5. *2 objects under varying illumination intensity generating each 4 images with SNR* $\in \{24, 12, 6, 3\}$.

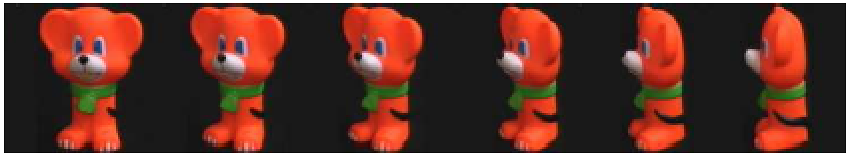


Figure 2. *Different images recorded from the same object under varying viewpoint. The COIL-100 database consisting of 7200 images of 100 different objects with 72 different views each.*

Figure 7. *Left: Image containing cluttering and occlusion. Right: The objects that were retrieved from a dataset of 100 objects.*

Shape Matching – What's next?

That's a good question!

- Cortina?
- image segmentation?

Thank You