PERCEPTUALLY MOTIVATED SHAPE CONTEXT WHICH USES SHAPE INTERIORS

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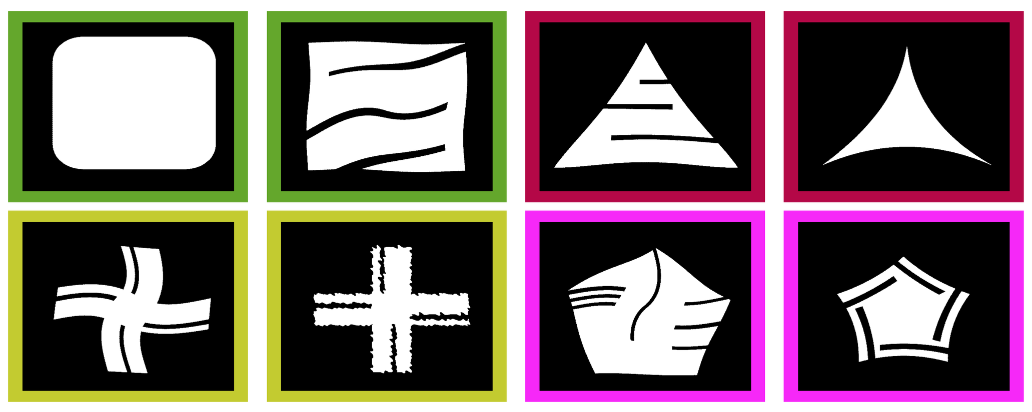
Abstract

We propose a novel technique to capture the interior shape properties of an object. A given shape is approximated into a set of densely sampled interior points. We also sample a set of sparse points that lie on the contour of an object, and describe the shape, at each of these sparse points, using the Solid Shape Context(SSC). Matching shapes is formulated as an order-preserving assignment problem. SSC captures the overall shape structure in a better way than the contour-based shape descriptors.

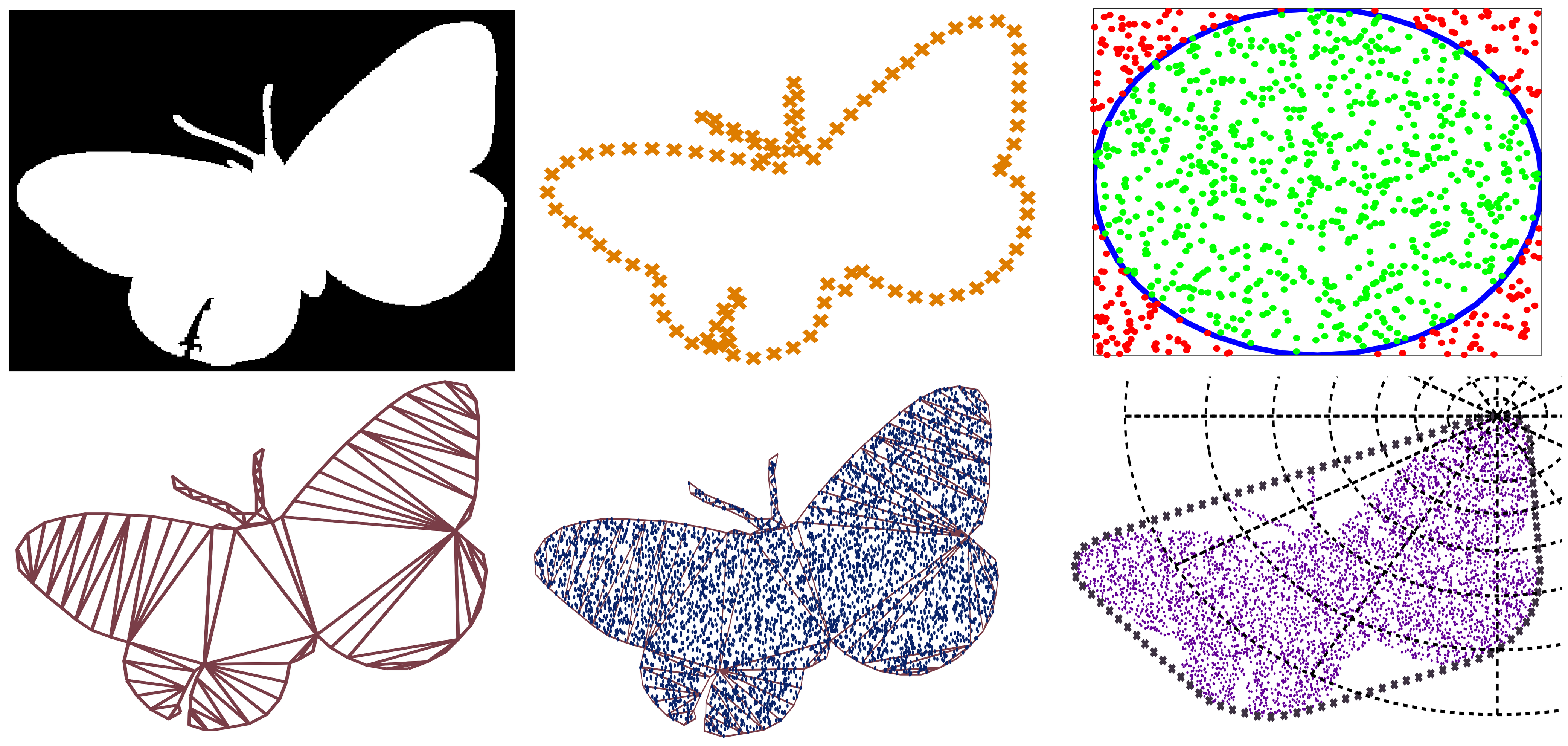
Visually Similar Shapes



Steps to Generate Solid Shape Context

1. Sample N_{DP}, uniformly distributed, dense points from within the shape: We triangulate the shape using constrained Delaunay Triangulation, and sample from the triangles using Equation 1.

$$P = (1-\sqrt{r_1})A + \sqrt{r_1}(1-r_2)B + \sqrt{r_1}r_2 C \quad (1)$$



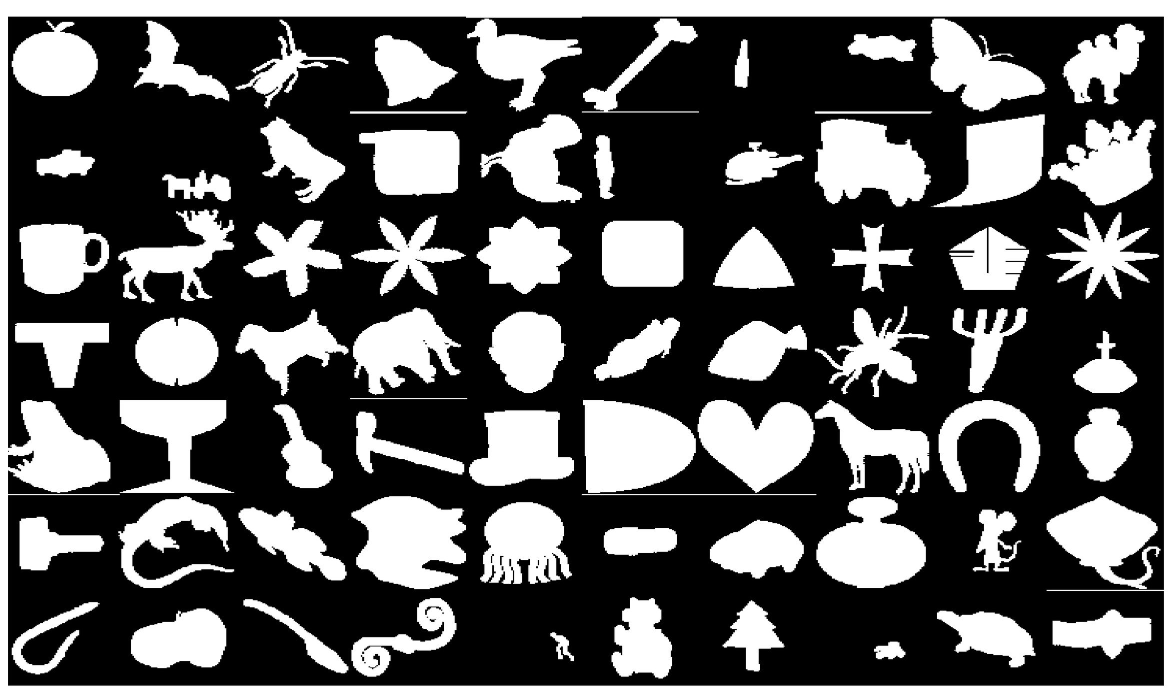
2. Sample N_{SP} ($<< N_{DP}$) Sparse Points.
3. Histogram : $\mathcal{H}_i^S(k) = \#\{\mathcal{DP}_j^S : \mathcal{DP}_j^S \in bin(k)\}$
4. SSC can be made invariant to rotations [1].

$$|\mathcal{P}^{Tri_i^S}| = \frac{A_{Tri_i^S}}{\sum_{j=1}^{N_{\mathcal{B}}-2} A_{Tri_j^S}} N_{DP}$$

$$d(S_1, S_2) = \min(d_1(S_1,S_2), \alpha d_2(S_1,S_2)); d_1 = IDSC, d_2 = SSC \quad (2)$$

Retrieval Results

We tested our algorithm on the well-known MPEG7 shape database, which consists of a total of 1400 images, divided equally among 70 classes. The database consists of silhouettes of both rigid and articulating objects. The objects have varied levels of translation, rotation, scale, articulations, deformations and occlusions.



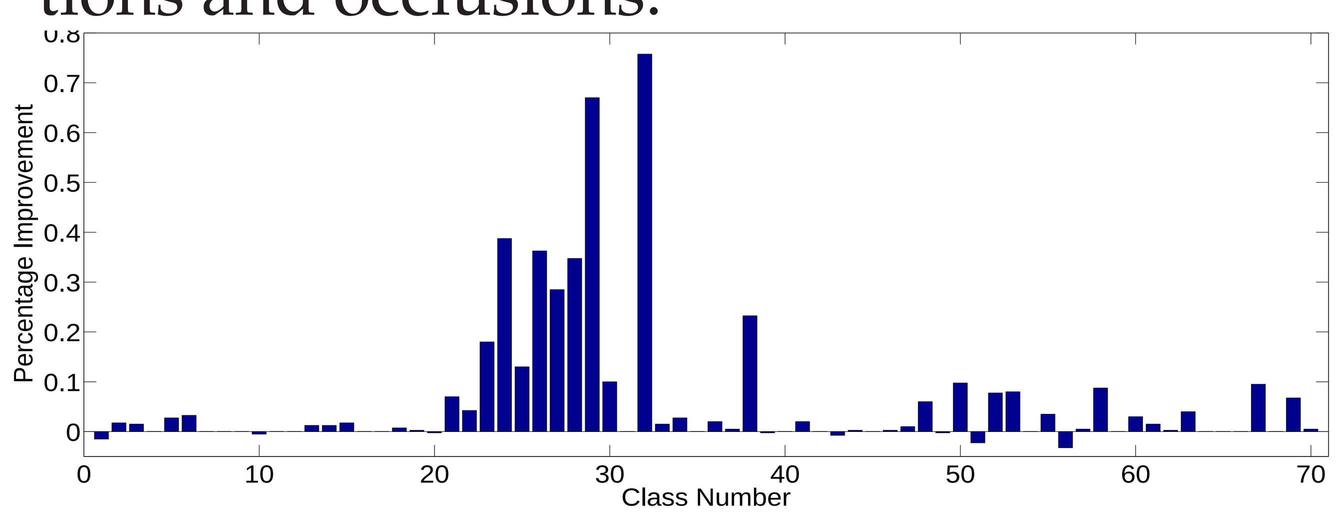


Figure : The percentage gain in Bullseye score for each class.

Algorithm	Bullseye Score
IDSC[2]	85.40%
IDSC+SSC	**91.83%**
IDSC+LCDP[3]	92.36%
IDSC+SSC+LCDP	**98.48%**

Table 1: Use of SSC improves Bullseye Score.

IDSC

SSC

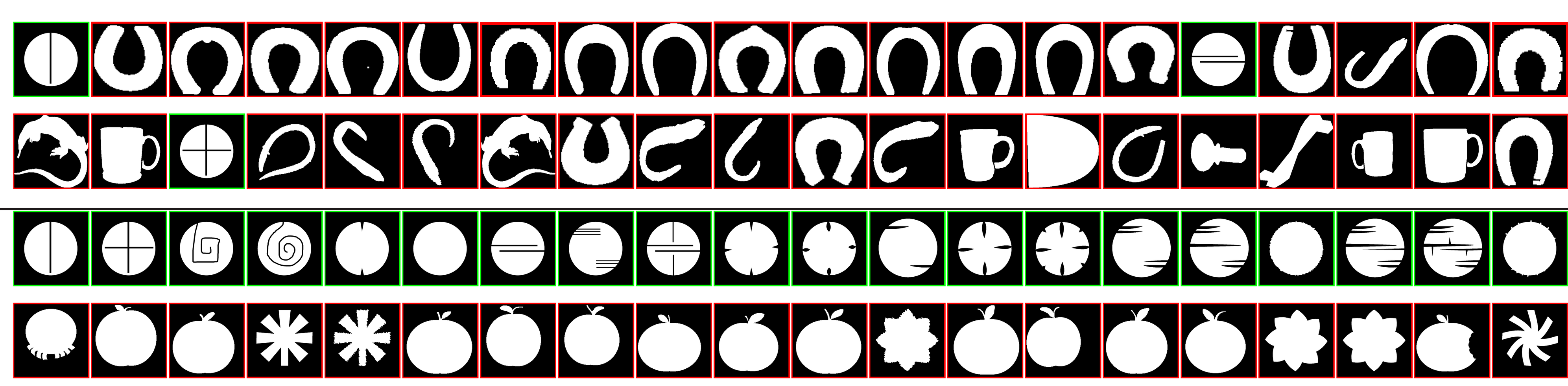


Figure: Top-40 retrieval results for a query object. The green boxes indicate correct retrievals while the red boxes indicate incorrect retrievals.

Future Work

As a part of the future work, we would like to look at how to perform dense and sparse sampling on objects that have multiple, non-connected, parts/lobes. Matching such shapes would require a much more complex registration step as there would be no order-preserving constraints.

References

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[2] H., Ling, D., Jacobs. Shape Classification Using the Inner-Distance, in *PAMI*, 2007

[3] X., Yang, S., Tezel, L., Latecki. Locally Constrained Diffusion Process on Locally Densified Distance Spaces with Applications to Shape Retrieval, in *CVPR*, 2009