Shape matching using CPS and Splines

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Introduction

The human vision collects important information of the surrounding environment. Although the human vision is a sense very well developed for its function, computer vision still needs a lot of improvement. This article proposes a variant of the shape descriptor CPS - Contour-Point Signature - that involves the usage of cubic Splines to smooth the edges of the original image. This strategy allows to eliminate high frequencies in the contour. Once the shape descriptor is built, an image dissimilarity measure is established, which can be used in shape recognition algorithms. The method is then tested against a shape database, ~~and its results are compared to other existing methods to~~ obtain a comparative performance of the proposed algorithm.

CPS - Contour Point Signature

The Contour-Point Signature (CPS) uses a subset of points sampled from the image's contour to define a shape descriptor. It captures the lengths of the strings that go from one reference point to all the others, discarding the strings' orientation. This is a local descriptor for the given point.

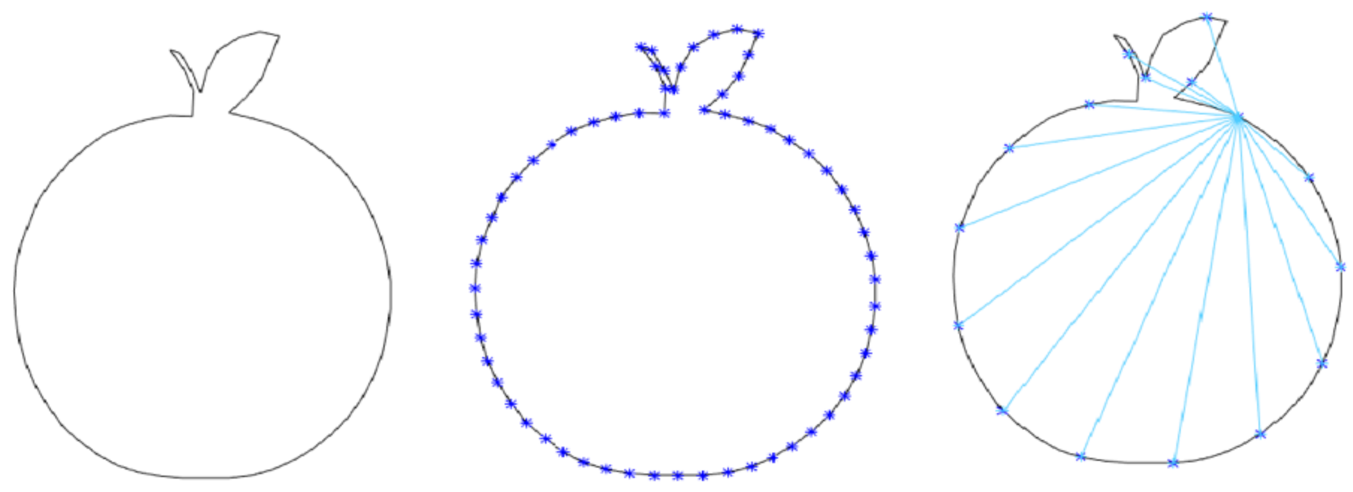


Image 1: *Local shape descriptor definition*

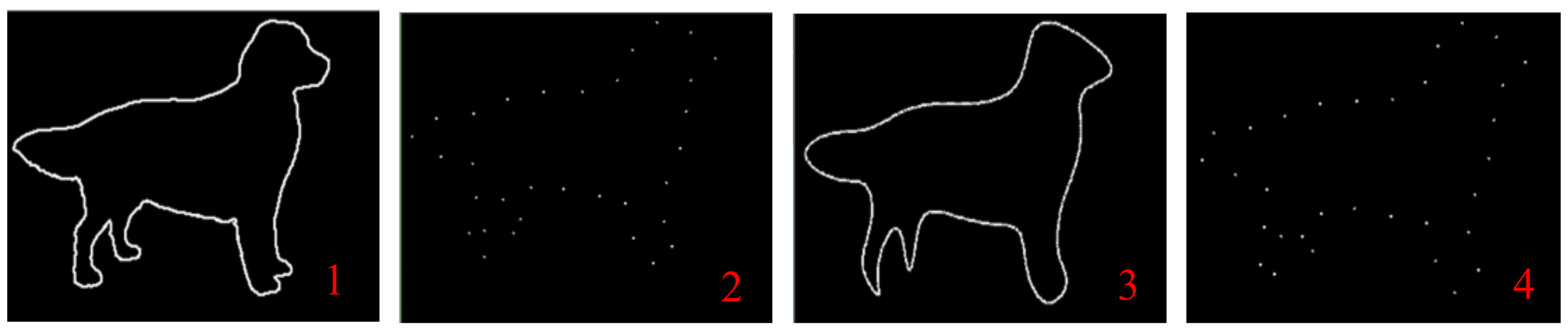
By taking all the local signatures $P = \{p_i\}$ together as rows of a single characterization matrix, we get our global descriptor.

Image 2: *CPS Matrix*

Spline Refinement

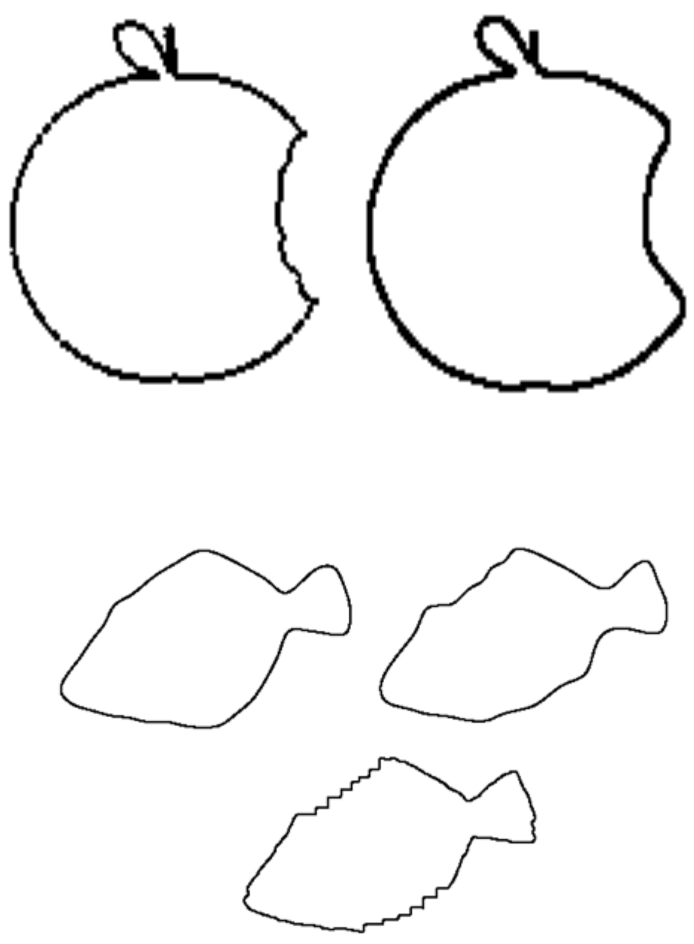
A limitation of the CPS consists in the necessity to refine the number of sampling points in the outer contour if the image has high variation in its contour, and more specifically at edge corners. In an effort to solve these problems, cubic splines were introduced to the signature computation process. We now:

1) Take the original image and find its contour.
2) Sample N points from the contour using a desired criterion
3) Build a cubic spline ~~that crosses~~ over each of the points in our sample. This smooths out the contour.
4) Take a new sample of N' points (N and N' can be different)
5) Compute the local signature for each of the new points in the sample, and build the CPS Matrix.



Experiments and Results

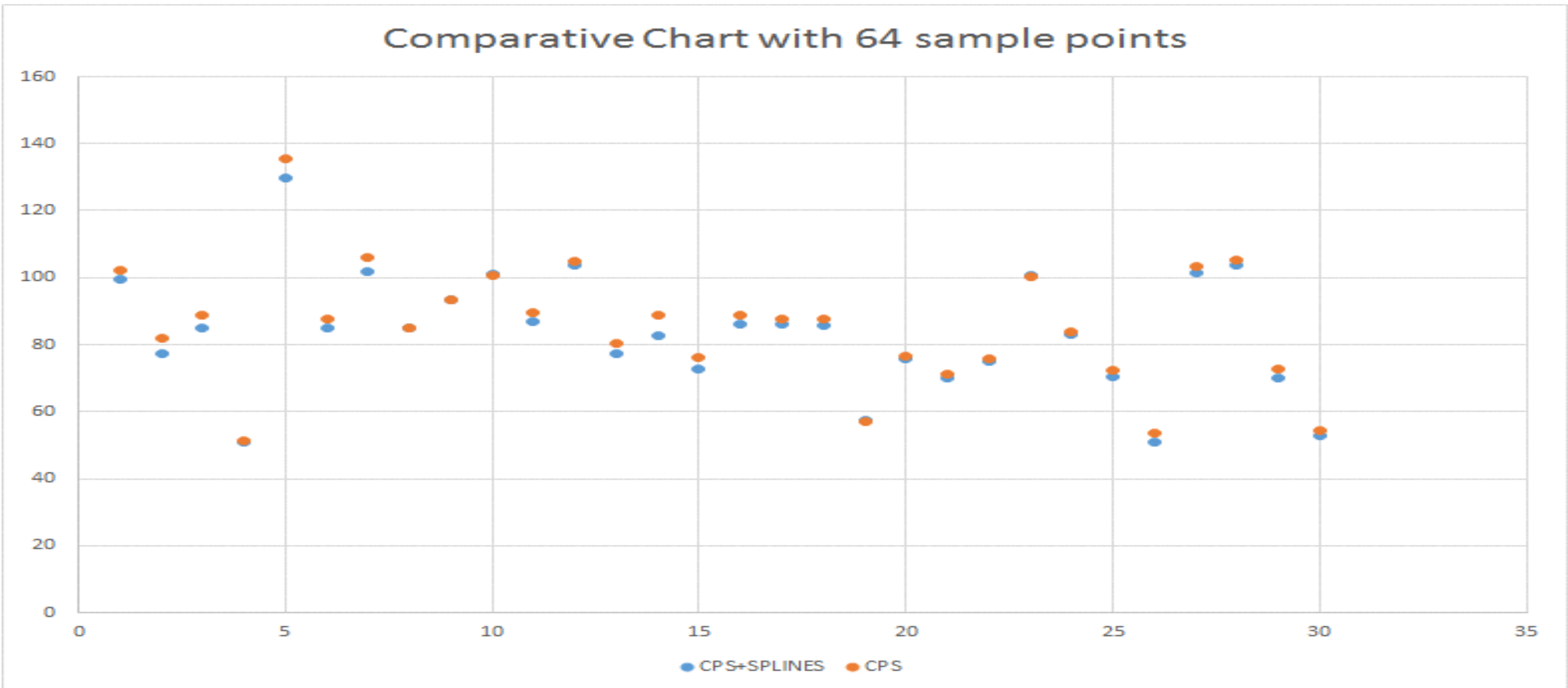
Experiment #1: Deformed figures



For this experiment, we generated 30 images groups. Each group containing a picture A and several variants of the same image. These variations were introduced in a way they change the original aspect of the image borders.

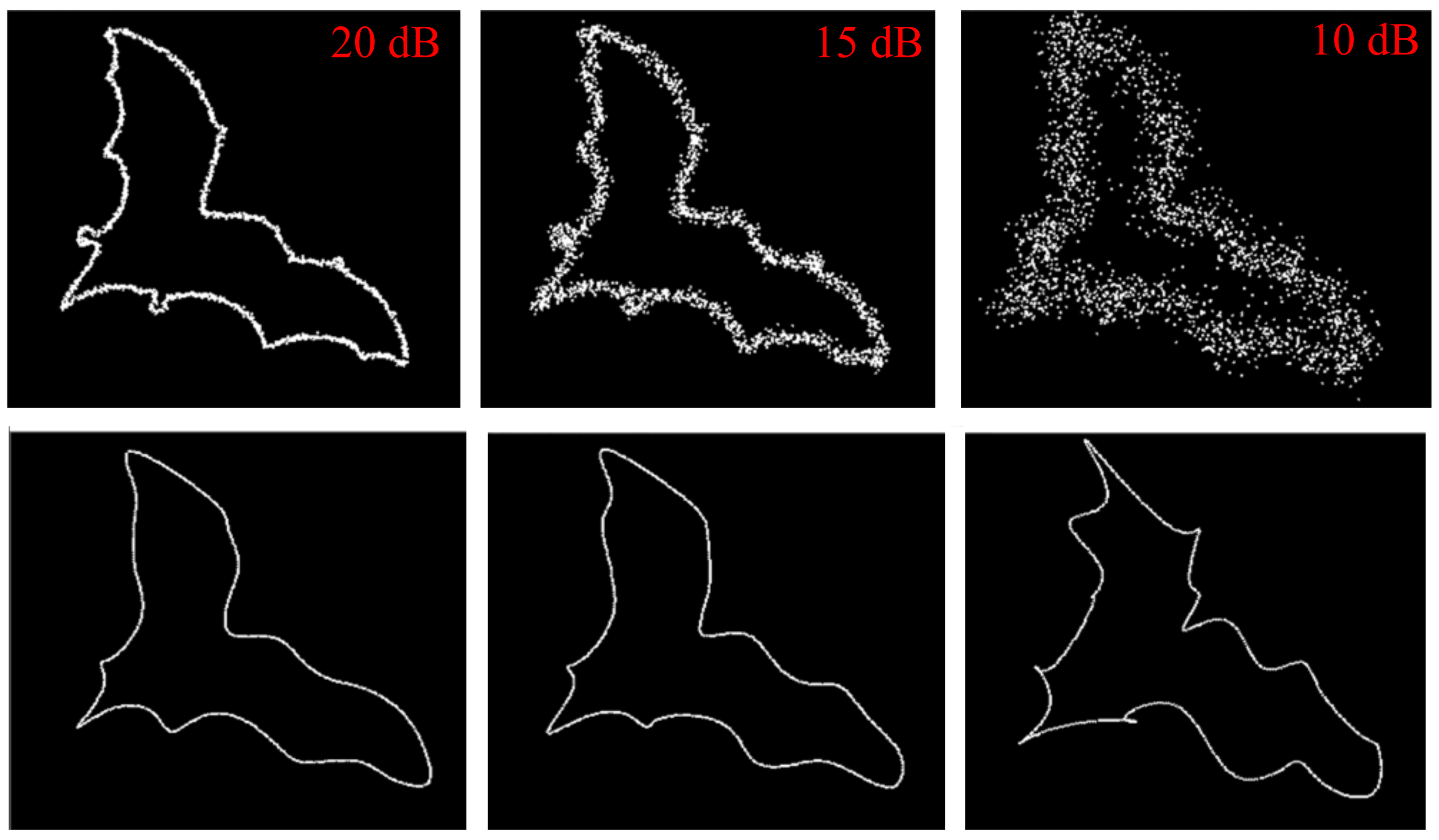
We proceeded to determine the "distance" between the original image and those on the set, using both the regular CPS and the CPS with Spline Refinement.

Conclusion: Analyzing each group we got the result we can see in the chart. In 25 of the 30 groups, the algorithm using the spline refinement was better than the regular version of it (this is, a smaller distance was obtained between group members).



Experiment #2: Introducing Noise

Noise was added to the image's contour in order to see how this impacts the results of image comparisons using both regular CPS and CPS with the spline refinement.



Conclusion: The introduction of the splines in the process allows for the capture of shape information even under the presence of noise. The curve generated by the cubic spline resembles the original shape, and therefore the distances obtained by the CPS with Spline Refinement are better than the regular version of the algorithm

References

[1] Villamayor-Venialbo W., Legal-Ayala H. and Christian E. Schaerer.
Contour-point signature: A new descriptor for matching rigid shapes with a single closed contour.
[2] Alejandro Giangreco.
Image Processing: Similarity between contours.
[3] Larry L. Schumaker. Spline Functions Computational Methods(2015)
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