DISSIMILARUTY VALUE BETWEEN 2D SHAPES

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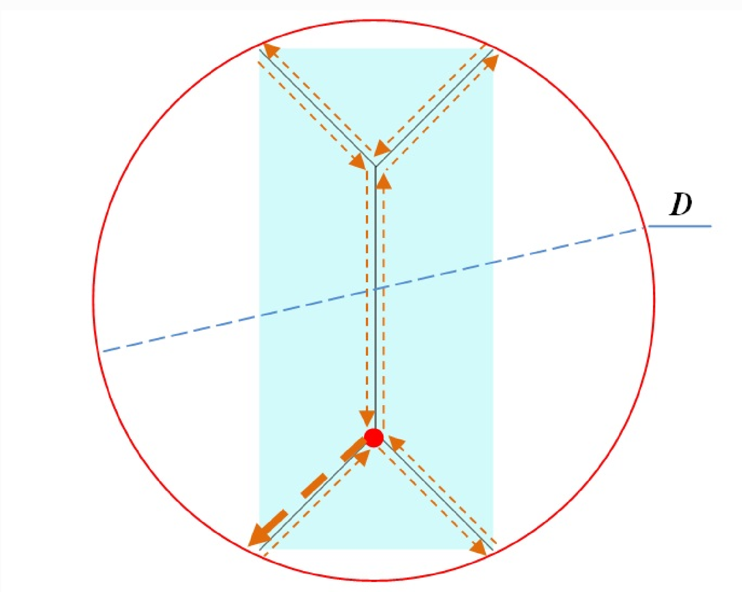
Abstract

I propose a new approach of binary images comparison. First, the skeleton of a binary image is encoded as a chain of primitives. A primitive is a pair of numbers, the first one is the length of the some edge and the second one is the angle between this and the neighbour edges. The width of shape is described by Legendre polynomial coefficients. They are incorporated as the third vector component into the primitive. Then the pair-wise comparison function based on alignment of chains is built.

Skeleton Topology

Traversing skeleton [1] from an initial node we write down the length of the current edge and the angle between the current and the next edges and obtain the sequence (chain) of primitives. A primitive $\omega = \{l, \alpha\}$, l–the scaled length of the edge (scaling unit is the diameter of minimal circumcircle), α–normalized (to 2π) angle [2]:

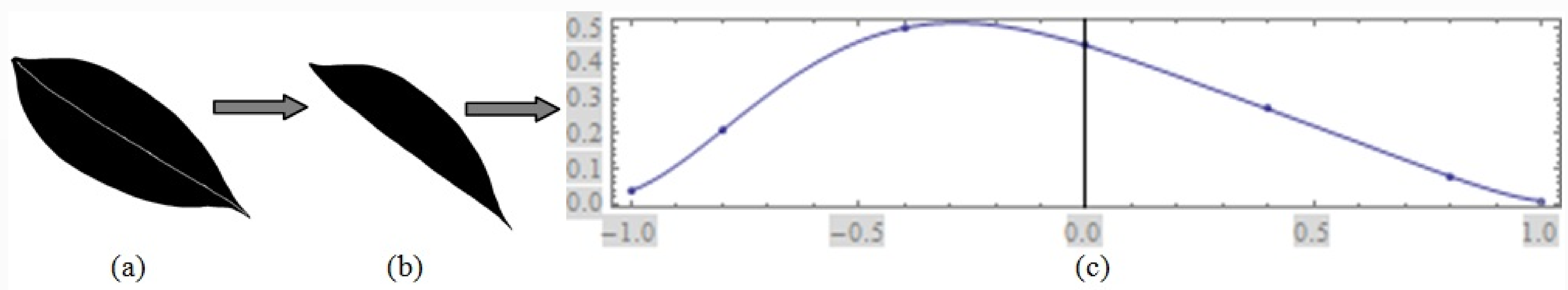


{0.29; 1}{0.29; 0.25}{0.29; 1}{0.29; 0.38}{0.48; 0.38}{0.29; 1}
{0.29; 0.25}{0.29; 1}{0.29; 0.38}{0.48; 0.38}

Width of the Shape

Using just the topology of skeleton in shape description isn't enough in some cases. It is valuable to take into account the radial function (width) of the skeleton:

The width function is interpolated by Legendre polynomials. The vector of Legendre coefficients is referred to as the shape descriptor:



$\mathbf{r} = \{r_0, \ldots\} = \{0.298; 0.113; -0.309; 0.135; 0.011; -0.037; 0.024\}$
(d)

Dissimilarity Value

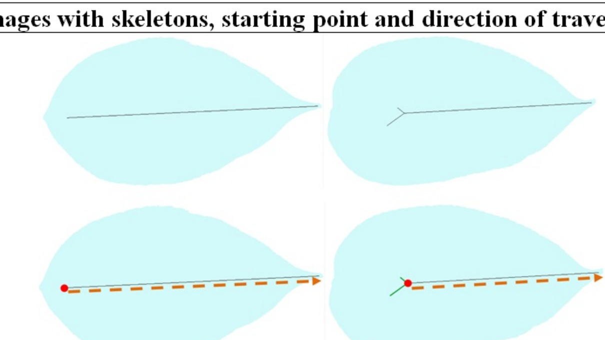
The main concept of skeleton comparison is an alignment of two primitive chains. To compare chains of different length we should extend the set of primitives by special element $g ='' -''$. The optimal alignment determined by reference vector $\hat{\mathbf{z}}$. This vector shows references of elements (primitives) of the first chain to the elements of the second one and can be found by means of dynamic programming. Based on the achieved alignment we calculate the measure of dissimilarity between the two skeletons defined by two primitive chains ω' and ω'' [3]:

$$D(\hat{\mathbf{z}}) = \sum_{t=1}^{N} \rho(\omega'_t, \omega''_{z_t}),$$

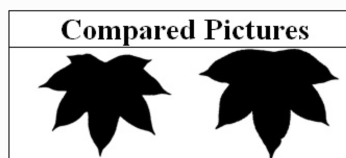
where $\rho(\omega', \omega'') = \begin{cases} c, & \omega' = g \ \vee \ \omega'' = g, \\ (l' - l'')^2 + (\alpha' - \alpha'')^2 + \sum\limits_{i=0}^{n} (r'_i - r''_i)^2, & otherwise \end{cases}$

Simple Examples

Images with skeletons, starting point and direction of traversing



The first primitive chain	The second primitive chain
{ 1.0 1.0 (0.370 -0.190 -0.280 0.120) }	{ 0.912 1.0 (0.480 -0.390 -0.120 0.050) }
{ 1.0 1.0 (0.370 0.190 -0.280 -0.120) }	{ 0.912 0.380 (0.480 0.390 -0.120 0.050) }
-	{ 0.041 1.0 (0.670 -0.030 0 0) }
-	{ 0.041 0.210 (0.670 0.030 0 0) }
-	{ 0.102 1.0 (0.630 -0.070 0 0) }
-	{ 0.102 0.410 (0.630 0.070 0 0) }
Dissimilarity measure based on above alignment $D(\hat{\mathbf{z}}) = 1.365$ ($c = 0.2$)	

Compared Pictures	Dissimilarity Value
	0.988
	0.475
	3.797

References

[1] H., Blum, A transformation for extracting new descriptors of shape, in *Models for the perception of speech and visual form 19(5), 362–380*, 1967

[2] M., Bystrov, Structural approach application for recognition of binary image skeleton, in *Proceedings of Petrozavodsk State University, 2(115), 76–80 (in Russian)*, 2011

[3] O., Kushnir, O., Seredin, Parametric Description of Skeleton Radial Function by Legendre Polynomials for Binary Images Comparison, in *A. Elmoataz et al. (Eds.): ICISP 2014, LNCS 8509, 520–530. Springer International Publishing Switzerland*, 2014