Towards a New Format for Image Coding

Afifa Dahmane and Slimane Larabi
USTHB University,
Computer Science Department,
BP 32 EL ALIA, Algiers, Algeria

***Abstract*—AAOur aim is the coding of image with XML text, the decoding of such descriptors and the reconstruction of the corresponding shapes. The image is assumed segmented into regions and each one is considered as shape. We present firstly a review of the textual format (LWDOS: Language for Writing Descriptors of Outline Shapes) proposed in the literature to write the geometrical description of parts and separating lines obtained by shape decomposition. In this paper we propose an XML format for writing these descriptors. and an algorithm for shape reconstruction from its descriptor. We show also how to use this result for image reconstruction. Our approach has been implemented and the obtained results encourage us to improve them in order to succeed to an XML format for image coding.**

I. Introduction

In order to homogeneous all databases of image descriptions and to offer accessibility to all users, the more suitable format is XML. Coding images with XML format allows the easiness in image indexing, easiness in their comparison and storage.

From the methods proposed in the literature for shape description, few descriptors have been written with XML format. The most known of these methods are:

- Region-based method and contour-based method integrated in the MPEG-7 standard[17]
- The SVG format that describes regular shapes (boxes, circles, etc) with XML format for graphical images [9]

The XML shape descriptors used in MPEG7 does not appertains to the class of information preserving due to the used methods for shape description. Indeed, it can not possible to reconstruct with accuracy shapes from these descriptors. However, the SVG format is appropriate only for regular shape whose outline is composed by lines, circle,..., contours. Irregular shapes can not be represented by this format.

A new shape descriptor has been proposed in [14] where shape is firstly is decomposed into parts and separating lines. In the next, outline parts and separating lines are described geometrically. The tree structure corresponding to the shape is translated into textual description.

The first purpose of this work is to propose an XML syntax for this textual description. The second one is to propose a method for shape reconstruction from the XML descriptor (decoding and visualizing).

In this paper, we will start by presenting some related works in section 2. We will describes in section 3 a review of the shape description proposed in [14] and the proposed syntax for its description with XML format. In section 4, we propose a method for its decoding for visualization. In section 5 we present and discuss obtained results about shape reconstruction and image reconstruction.

II. Related Works

Various methods have been developed for shape representation. The most interesting methods may be classified as follow:

- Part-based methods where shape is decomposed into parts [12],[19], [24], [25], [30], [32]
- Aspect-graph methods that are viewer-centered representations of a three-dimensional object [8], [13]
- Methods that use the medial axis of shapes [10], [26], [33]
- Methods based on the shock graph [27], [31]
- Methods using graph for shape representation [2], [16]
- Methods that approximate the outline shape by 2D features [7], [11], [21], [23]
- Methods based on the reference points of outline shape [5], [19], [18], [29]
- Methods based on the attributes of outline shape [1], [4], [22], [28]
- Methods based on the shape context [3]
- Appearance-based methods [20]

The region-based descriptor (Angular radial transform), specifies regions within image with brief and a scalable representation of a box or polygon, approximates the size, orientation and geometry of objects as closely as desired. It takes into account all pixels describing the shape of an object in an image, making it robust to noise. Whereas, the Contour shape describes the closed contour of 2D-object in the Curvature Scale-Space. However, even the desriptor of shape is written with XML format, this not allow to reconstruct them because used methods in MPEG are'nt from the class of information preserving.

The second format that codes shapes with XML is the SVG language. It describes two-dimensional graphics and graphical applications in XML. SVG language uses standard shapes predefined for common graphical operations, specifically: rectangle, circle, ellipse, line, polylines, polygon canvas [9]. The inconvenient of this format that is not suitable to code shapes with irregular outline.

Our approach contributes to shape coding and decoding, with these specificities:

- Any shape is coded with XML format and reconstructed. The quality of the reconstruction depends on the quality of image segmentation into regions.

978-1-4244-8610-6/10/$26.00 ©2010 IEEE

- The proposed coding concerns firstly binary shape. We explain how it is possible the description of any image segmented into regions and how we code the color of regions.
- The visualization of complex shapes from their XML descriptors is interesting for network applications. The few space memory required and the time necessary for the visualization is interesting for transmitting of images.
- The availability in the XML format proposed of semantic information that may be extracted directly from the shape descriptor. It concerns the number of parts, separating lines and their organization. This information contributes also to the indexing of image

III. XML DESCRIPTION OF SHAPES

A. *Review of part-based shape description method [14]*

The sweeping of outline of any shape allows to locate a set of concave points for which the direction change from top-bottom-top or bottom-top-bottom [14]. Shape is partitioned into parts by means of these points (see figure 1). The row associated to each one of these points defines a separating line (junction or disjunction line). The proposed up-bottom shape parsing creates thus a set of parts and separating lines. The parsing process is also applied to parts and separating lines. Each one of parts is parsed into two boundaries (left and right) which are segmented into elementary contours. In the same way, separating lines are segmented into segments(see figure 2).

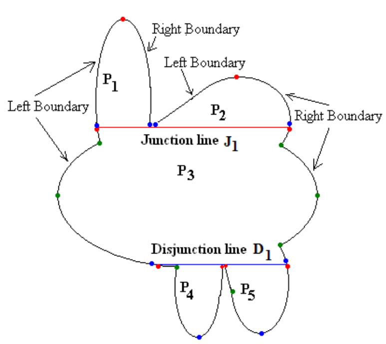

Fig. 1. Shape decomposition into parts

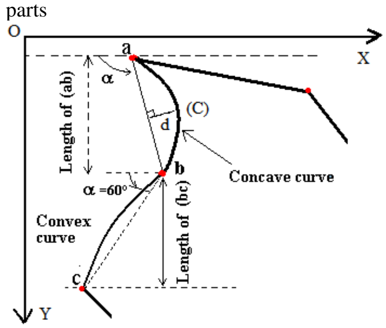

Fig. 2. Decomposition of parts into elementary contours

Any elementary contour is described by its:

- Type that may be: line, convex curve or concave curve
- Degree of concavity or convexity of the curve. The degree of a curve (C) is computed as the ratio of d and the distance of the correspondent chord of (C), where d is the maximum of distances from points on the curve to associated chord
- Angle of inclination of the line or the curve. This angle is defined by the line joining the two extremities of elementary contour and the row axis
- Length of the line or the curve computed as the distance between its two extremities

Each one of separating line segments is described by:

- Type that may be: Shared (links two parts), Free-low(neighboring to the low part), Free-high (neighboring to the high part),
- Parts numbers that links
- Length

The notion of composed part is proposed to write the grouping of parts linked by a separating line. A Composed part is either:

- the grouping of the parts P_1 P_2 .... P_n, Junction line J and a part P_{n+1} written as: P_1 P_2 .... P_n J P_{n+1}
- the grouping of a part P_1, disjunction line D and the parts P_2 P_3 .... P_n written as:P_1 D P_2 P_3 .... P_n

The composed part may be also the grouping of parts and composed parts. This allows the writing of all components of the shape.

B. *Translating the textual descriptor into XML descriptor*

In this work we propose the XML syntax for writing the LWDOS descriptors.

The XML description of part is written as follows:
< P num='x'>
< L > Description of left boundary < /L >
< R > Description of right boundary < /R >
< /P >
where descriptions of the two boundaries (left and right) are the grouping of descriptions of their elementary contours. To do this, we write for:
- XML line description: < LN inclin='xx' length='yy'/ >
- XML convex and concave curve description:
< CV inclin='xx' length='yy' degree='zz'/ >
and < CC inclin='xx' length='yy' degree='zz'/ >
The XML description of segments of junction line and disjunction line are:
< S numpart1='x' numpart2='y' length='z' / >
or < W numpart='x' length='z' / >,
or < H numpart='x' length='z' / > The XML format of composed part is then written as follow:
< CP > $P_1 P_2 \ldots P_n J_k P_{n+1}$ < /CP >
or < CP > $P_1 D_l P_{i1} P_{i2} \ldots P_{in}$ < /CP >
where < CP > and < /CP > are the marks indicating the beginning and the end of the composed part, P_i refers to the description of the part number i, J_k and D_l refer to the description of junction and disjunction lines. The entire

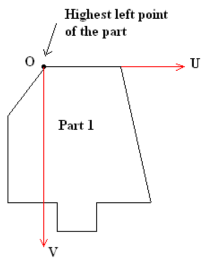

Fig. 3. The drawing referential in case of one part

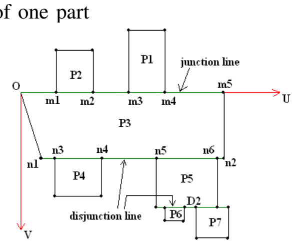

Fig. 4. The drawing referential in case of many parts

descriptor is delimited between ¡XLWDOS¿ and ¡/XLWDOS¿. For example, the global descriptor of the shape illustrated by figure 1 is: $< XLWDOS > < CP > < CP > P_1$ P_2 J_1 $P_3 < /CP > D_1$ P_4 $P_5 < /CP > < /XLWDOS >$ In the detailed descriptor, each one of parts and separating lines are the grouping of the description of their elements.

IV. Shape and image reconstruction

A. Basic Principle of the Method

Our aim is to draw the shape starting from its XML descriptor. To do this we distinguish two cases:
- The shape descriptor contains only one part. The highest left point of this part is considered in this case the starting point in the drawing process. The coordinates of extremities of all elementary contours relatively to the starting point are extracted from the descriptor and therefore all elementary contours are drawn (see figure 3).

- In case where shape is described by a set of parts, the starting point is chosen as the left point of the first separating line encountered in the XML descriptor (see figure 4). The positioning of the first pixel of a separating line and the use of associated XML description permits to deduce the positions of extremities of all other segments of this line.

As each one of these segments is linked to one or two parts, extremities of their boundaries should be easily deduced. This permits to compute the positions of all extremities of the elementary contours of each linked part.

Recursively, if any drawn part is linked to a separating line, the position of extremities of this line will be computed, and so on.

Figure 4 illustrates this process where the first step is the positioning of the points m_1, m_2,m_3,m_4 and m_5. The second step is the positioning of extremities of elementary contours of parts P_1, P_2 and P_3. The outline of these parts are then drawn. As the part P_3 is linked to disjunction line and the positions of the points n_1 and n_2 are known, the next step is the use of XML description of this line for the computation of the position of n_3, n_4,n_5 and n_6. This information permits to draw the parts P_4 and P_5, and so on.

B. Quality Assessment of the Drawn Shape

The quality of the drawn shape depends on the outline shape decomposition into elementary contours and on their description. For outline shape decomposition into elementary contours we applied the algorithm of Chetverikov [6].

In this algorithm, author defines a corner in a simple and intuitively appealing way, as a location where a triangle of specified size and opening angle can be inscribed in the curve. A curve is represented by a sequence of points p_i in the plane. The ordered points are densely sampled along the curve. In the first pass, the algorithm scans the sequence and selects candidate corner points. In each curve point p the angle $\alpha = \widehat{p^- p p^+}$ is computed where p^- and p^+ are at d pixels from the point p. If the angle $\alpha < \alpha_{max}$ the point p is selected. The second pass is a post-processing step to remove superfluous candidates. In case where consecutive candidates p are located, the p having the minimum angle α is selected. Applying this algorithm with different values of the d and α_{max}. The number of curvature points increase when d and α_{max} increase. In the reconstruction process of shape from its XML description, more there are elementary contours, more is the quality of drawn shape. Indeed, the description of curved outline is more precise if it is well segmented in elementary contours. If an elementary contour is well described without segmenting it once again, its reconstruction will be without loss of information.

C. Colored shape and Image reconstruction

The color information may be added in the descriptor as three values between two tags $< C >$ and $< /C >$. The reconstruction of colored shape is then identical to the reconstruction of binary shape. The color is added in the drawing process. Any image is considered as a set of regions. The knowing of the position of reference contour point (the most high left) of each one of outline shapes relatively to the image referential permits the reconstruction of all shapes.

V. Experimental results

To asses the quality of reconstructed shapes, we used real images of complex shape. Figure 5 illustrates two shapes of the database of Leibe and Shiele [15].

For each one of these shapes, figures 6 and 7 illustrate the result of their decomposition into parts, junction and disjunction lines and into elementary contours with different values of α_{max} and d of Chetverikov's algorithm [6].

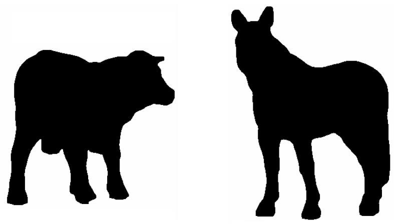

Fig. 5. Initial shapes

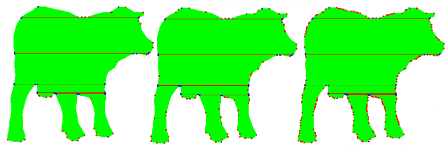

Fig. 6. Cow decomposition with $(\alpha_{max}, d) = (150\,°, 5), (160\,°, 5), (170\,°, 5)$

Applying the decoding process over the XML descriptor of each one of shapes decomposed and described with a specific values of (α_{max}, d), the drawn shapes are illustrated respectively by figures 8 and 9.

The visual quality of reconstructed shape approximates the initial shape when the outline is well decomposed and well described. To quantify this quality, we will use the fact that the separating lines of the two shapes (initial and reconstructed) are identical. The superposition of these shapes through one of the separating lines involves the superposition of all lines. The defects of shape reconstruction concerns the outline shape. We calculate therefore the of loss of pixels RL as the sum of rate of additional pixels the rate of missing pixels. For example the drawn shape "cow" RL decreases from 5.3% to 0.7% when the angle α increases from $150\,°$ to $170\,°$. This is the case of the drawn shape "horse" for which the RL decreases from 6.8% to 0.9% when the angle α increases from $150\,°$ to $170\,°$.

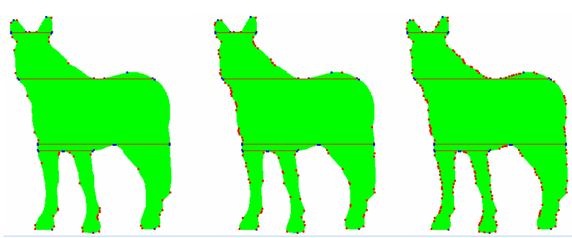

Fig. 7. Horse decomposition with $(\alpha_{max}, d) = (150\,°, 5), (160\,°, 5), (170\,°, 5)$

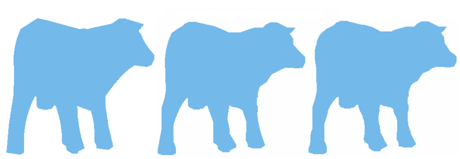

Fig. 8. Reconstructed shape with $(\alpha_{max}, d) = (150\,°, 5), (160\,°, 5), (170\,°, 5)$

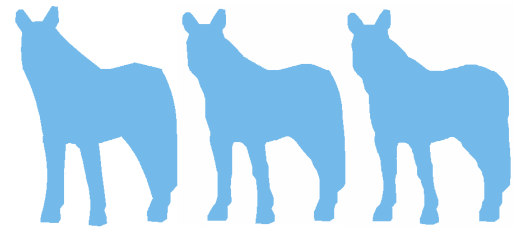

Fig. 9. Reconstructed shape corresponding to $(\alpha_{max}, d) = (150\,°, 5), (160\,°, 5), (170\,°, 5)$

Fig. 10. The initial image

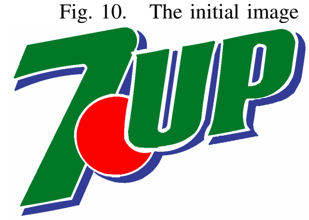

Fig. 11. The reconstructed image

In addition to image quality, there are other important aspects which are the time needed to decode an image and the size of the image descriptor. With PC Pentium IV $2.66GHz$, the execution time depends on the used parameters α, d in shape coding. More α is greater, more is the execution time. This time varies from 110 to 188 milliseconds for the reconstructed shape "cow" and from 125 to 172 milliseconds for the reconstructed shape "horse".

The same algorithm is applied to all shapes of any image. For example for images of industrial logos for which the segmentation gives better results, the reconstruction depends only on the quality of the decomposition of outlines of parts into elementary contours. Figures 10 and 11 illustrate the initial image (logo) and the reconstructed images starting from the descriptors of all shapes. The good reconstruction is due to the values of the parameters d and the angle α equal respectively to $5pixels$ and $150\,°$. The same results are obtained for another logo illustrated by figures 12 and 13.

VI. Conclusion

In this paper, we proposed firstly an XML syntax for writing shape descriptor which is obtained after its decomposition into parts and separating lines and their description. The second contribution is the decoding and drawing of shape starting from its XML descriptor.
The proposed method is implemented. The quality of the drawn shapes depends on the quality of their description. The reconstruction of regular images (as industrial logos) is

Fig. 12. The initial image

Fig. 13. The reconstructed image

done with high quality. The next step of this work is the reconstruction of real images starting from their segmentation into regions and the coding of texture and degraded color of regions.

REFERENCES

[1] N. Arica, F. T. Y. Vural. BAS a perceptual shape descriptor based on the beam angle statistics. *Pattern Recognition Letters, vol. 24, issues 9-10, pp. 1627-1639, (2003)*

[2] O. E. Badawy, M. Kamel. Shape representation using concavity graphs. *Proceeding of the 16th International Conference on Pattern Recognition (2002)*

[3] S. Belongie, J. Malik, PJ. uzicha. Shape Matching and Object Recognition Using Shape Contexts. *IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24 (2002)*

[4] T. Bernier, J. A. Landry. A new method for representing and matching shapes of natural objects. *Pattern Recognition, Vol. 36 (2003), 1711-1723*

[5] S. Berretti, A. Bimbo. Retrieval by shape similarity with perceptual distance and effective indexing. *Transactions on Multimedia, vol. 2, N4, December (2000)*

[6] D. Chetverikov. A Simple and Efficient Algorithm for Detection of High Curvature Points in Planar Curves. *10th International Conference, CAIP 2003, Groningen, The Netherlands, August 25-27, (2003)*

[7] T. M. Cronin. Visualizing concave and convex partitioning of 2D contours. *Pattern Recognition Letters, 24 (2003), pp 429-443*

[8] C. M. Cyr, B. B.Kimia A similarity-based aspect-graph approach to 3D object recognition. *International Journal of Computer Vision, 57 (1), 5-22, (2004)*

[9] J. Frost, S. Goessner, M. Hirtzler. Learn SVG: The Web Graphics Standard. *http://www.learnsvg.com/*

[10] D. Geiger, T. Liu, R. V. Kohn. Representation and Self-Similarity of shapes. *IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.25, N1, January (2003)*

[11] W. I. Grosky, R. Mehrota. Index-based recognition in pictorial data management. *Computer Vision Graphics and Image Processing, vol 52, pp 416-436, (1990)*

[12] D. H. Kim, I. D. Yun, S. U. Lee. A new shape decomposition scheme for graph-based representation. *Pattern Recognition, 38(2005), pp 673-689*

[13] J.J. Koenderink, V. Doorn. the internal representation of solid shape with respect to vision. *Biol. Cyber., Vol. 32, (1976)*

[14] S.Larabi, S. Bouagar, F.M. Trespaderne, E.F. Lopez. Language for Writing Descriptors of Outline Shapes. In *the LNCS proceeding of Scandinavian Conference on Image Analysis, June 29 - July 02, Gotborg, Sweden, 2003*

[15] B. Leibe, B. Schiele. Analyzing appearance and contour based methods for object categorization. In *the Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2003*

[16] T. Lourens, R. P. Wurtz. Object recognition by matching symbolic edge graphs. *Proceeding of ACCV'98, (1998), pp. 193-200*

[17] B. S. Manjunath, P. Salembier, T. Sikora. Larger ImageIntroduction to MPEG-7: Multimedia Content Description Interface. *John Wiley and Sons, 2002*

[18] F. Mokhtarian. Silhouette-Based isolated object recognition through curvature scale space. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 17(5) 539-544, (1995)*

[19] F. Mokhtarian, A. K. Mackworth. A Theory of Multiscale, Curvature-Based Shape Representation for Planar curves. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 14(8), pp 789-805, (1992)*

[20] H. Murase, S. K. Nayer. Visual learning and recognition of 3-D objects from appearance. *International Journal of Computer Vision, vol. 14(1), (1995)*

[21] R. C. Nelson, A. Selinger. Large-scale tests of a keyed, appearance-based. 3-D object recognition system. *Vision Research, Vol. 38, N 15-16, (1998)*

[22] C. Orrite, J. E. Herreo. Shape matching of partially occluded curves invariant under projective transformation. *Computer Vision and Image Understanding, vol. 93(1), (2004)*

[23] E. G. M. Petrakis, A. Diplaros, E. Milios. Matching and Retrieval of Distorted and Occluded Shapes Using Dynamic Programming. *IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24, N 11, (2002)*

[24] I. Pitas, A. N. Venetsanopoulos. Morphological shape decomposition. *IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 12(1) pp38-45, (1990)*

[25] P. L. Rosin. Shape partitioning by convexity. *British Machine Vision Conference, 1999*

[26] C. Ruberto. Recognition of shapes by attributed skeletal graphs. *Pattern Recognition, 37(2004), pp 21-31*

[27] T. B. Sebastian, P. N. Klein , B. B. Kimia. Recognition of Shapes by Editing Their Shock Graphs. *IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.26, N5, (2004)*

[28] A. Sethi, D. Renaudie, D. Kriegman D., Ponce J. Curve and surface duals and the recognition of curved 3D objects from their silhouette. *International Journal of Computer Vision, 58(1), pp 73-86, (2004)*

[29] Z. Shao, J. Kittler. Shape representation and recognition based on invariant unary and binary relations. *Image and Vision Computing, 17 (1999), pp 429-444*

[30] K. Siddiqi, B. B. Kimia. Parts of visual form computational aspects. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 17(3), pp 239-251, (1995)*

[31] K. Siddiqi, B. B. Kimia. A shock grammar for recognition. *Conference of Computer Vision and Pattern Recognition, 1996*

[32] L. Yu, R. Wang. Shape representation based on mathematical morphology. *Pattern Recognition Letters, (2004)*

[33] S.C. Zhu, A. L. Yuille, FORMS: A flexible object recognition and modeling system. *Fifth International Conference on Computer Vision, June 20-23, M.I.T. Cambridge, 1995*