ROBUST SHAPE RECOGNITION USING CONTOUR ANALYSIS

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Abstract: *In this paper we introduce an approach for shape recognition on the basis of contour analysis for traffic signs. Our project describes the theoretical bases of contour analysis and aspects of its practical application for shape recognition. In our project we introduce an approach for shape matching that uses contour segment matching for shape similarity computation. Each contour segment is represented by rotation and scale invariant feature vector. The similarity of two shapes is determined by matching their contour segments using CA(contour analysis) complex-valued coding. The most significant feature of our project is (i) introduction of new features extraction technique for contour segment. (ii) the impressive robustness of method. A local contour based feature extraction method is designed for 2D shapes using ICF(inter-correlation function) and ACF(auto-correlation function). ICF is a measure of similarity of two contours and it is invariant to transposition, scaling, rotation and starting point shift. The advantage of our proposed algorithm is invariant to rotation, transposition and scaling. It can be use in various applications like CBIR, OCR.*

Keyword*– Shape Recognition, Contour Analysis, ICF, ACF, Complex valued coding, C#.net, Traffic signs .*

I. INTRODUCTION

Now-a-days in Image Processing, Contour analysis is the hot area. There are various robust methods for shape recognition. In this paper we are focusing on Shape recognition using contour analysis for traffic sign detection.

Contour: The contour is a boundary of shape, a population of points(pixels), separating shape from background.

Properties of contour:

1. The sum of an elementary vector of a closed contour is equal to zero. It is trivial - as the EV's result in starting point, their sum is equal to a zero-vector.
2. The CV does not depend on parallel transposition of the source image. The mode of coding is invariant to starting point as the contour is encoded, relative to starting point. [1]
3. Image turn on certain angle is equivalent to turn of each elementary vector of a contour on the same angle.
4. The starting point modification results in cycle shift. As elementary vectors are encoded concerning the previous point, it is clear that at a modification of starting point, the sequence of an EV will be the same, but the first elementary vector will be what begins in the starting point.
5. The source image rescaling can be considered as multiplication of each elementary vector of a contour to scale factor.

Our project also includes library for operation with the contour analysis, and a demo-example. The contour analysis allows to elaborate, store, compare and find the objects presented in the form of the exterior outlines - contours. It is supposed that the contour contains the necessary information of the shape. Interior points of the shape are not accepted to attention. Contour analysis allows to effectively solve the main problems of a pattern recognition that is transposition, rotation and a rescaling of the image. CA methods are invariant to these transformations.

II. LITERATURE REVIEW

Author in the paper demonstrated various strategies that can be employed to improve performance of shape algorithm. The disadvantage is skeleton matching is low sensitive to limb growth and articulation.[1]

The Author demonstrated that combine property of skeleton and boundary is used to implement general decomposition approach but the drawback of this, method is rotation variant and highly sensitive to shape deformation.[2]

The Author describes that curve matching is very efficiently working for images who doesn't involve rearrangement. Skeleton matching is very complex but better than curve matching in case of articulation or rearrangements of parts.[3]

The Author demonstrated object recognition on the basis of texture analysis.GLCM and Haar wavelet transform are the most primitive methods for texture analysis.[4]

The Author introduce an approach that uses contour segment matching for shape similarity computation. The Hungarian algorithm is used for matching their contour segments.[5]

III. PROPOSED SYSTEM

Proposed system will be based on contour analysis. For shape recognition, image will be transformed to gray-scale then it is binarized by Adaptive Threshold and contours are extracted. Contours are filtered on linear parameter like length, square, etc. Finally contours are equalized on the basis of calculation of ACF, ACF descriptors and ICF. This algorithm is invariant to transposition, rotational and scaling. We proposed an algorithm which will be beneficial in shape recognition in the various applications like Augmented Reality, Autonomous Vehicle, CBIR(Content Based Image Recognition), Traffic sign detection.

PROCESS:

- Camera Interfacing: Image is captured by using the capture class then it is updated on GUI(graphical user interface), Image Preprocessing(image enhancement) .
- Color filter application: Convert the image to gray-scale level.
- Noise Removal: There are two operations i.e. Erode and Dialate.
  - The erode technique is used to remove the noise, each pixel of the boundary line will get shrink.
  - Dialate is used to expand the boundary line of the shrink shape but in this process boundary is get corrupt.
- Smoothing: By using "Smoothing Guassian Function" the corrupted boundary is get corrected i.e. the boundary is get blurred.
- Thresholding: It is used to get a smooth curve .
- Contour Detection: To detect the contours use findContour() which is present in OpenCv.
- Contour Feature Extraction/ Template Generation : The feature of contours are extracted by the calculation of ACF and ICF.
- Shape Matching:On the basis of the analysis the generated template is used for shape matching.

IV. COMPONENT

Our system comprises of following steps to acquire result:

1) Normalized Scalar Product(NSP)
2) Intercorrelation function (ICF)
3) Autocorrelation function(ACF)

4.1 Normalized Scalar Product

As scalar product of contours, Γ and N are called complex numbers.

$$\eta = (\Gamma, \mathrm{N}) = \sum_{n=0}^{k-1} (\gamma_n, \nu_n) \quad (1)$$

$$(a + ib, c + id) = (a+ib)(c-id) = ac+bd+i(bc-ad) \quad (2)$$

The number of elementary vectors in contours should coincide. There is difference between scalar product of usual vectors and scalar product of complex numbers. By multiplying an elementary vector as a simple vector the scalar product will be,

$$\big((a,b),(c,d)\big) = ac + bd \quad (3)$$

Comparing (2) and (3) we get,

- Result of scalar product of vectors is real number and result of product of complex number is complex number.
- Complex product includes vectorial scalar product.
- If two vectors are perpendicular to each other then scalar product is zero and if they are opposite to each other then scalar product value is maximum.

The normalized scalar product:

$$\eta = \frac{(\Gamma, \mathrm{N})}{|\Gamma||\mathrm{N}|} \qquad (4)$$

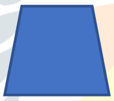
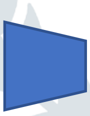
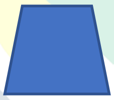
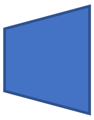
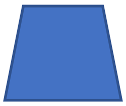
Where |Γ| and |N| of contours calculated as:

$$|\Gamma| = \left(\sum_{n=0}^{k-1} |\gamma_n|^2\right)^{\frac{1}{2}} \qquad (5)$$

The lengths are multiplied and angles are added at the time of multiplication of contours. If Γ and N are same then the value of NSP is maximum i.e. unity.

To count normalized scalar product of vector on itself take NSP = 1, to turn contour on 90 degrees take NSP = 0+i, to turn on 180 degrees take NSP = -1. Real part of NSP will give cosine angle between contours and norm of NSP that is always equals to 1.

Table no.1: properties of the normalized scalar product of contours.

	NSP	|NSP|
 X 	1	1
 X 	i	1
 X 	-1	1
 X 	-i	1

Similarly, if we increase a VC by some real coefficient (scale) we also receive NSP=1 (it simply to see from the formula (4)).

When starting point of two contours coincide at that time norm of their NSP will always equals to unity.

4.2 Inter Correlation Function

$$\tau(m) = \left(\Gamma, \mathrm{N}^{(m)}\right), \qquad \mathrm{m} = 0, \ldots, \mathrm{k} - 1 \qquad (6)$$

Where $N^{(m)}$ - a contour received from N by cycle shift by its EV on m of elements.

ICF is defined on all set of integral numbers. ICF is periodic, as cycle shift on k leads us to an initial contour with phase k of limit 0 to k-1.

$$\tau_{max} = max\left(\frac{\tau(m)}{|\Gamma||N|}\right), \qquad m = 0, \ldots, k-1 \tag{7}$$

From determinations of Normalized Scalar Product and Inter Correlation Function, it shows that τ_{max} is a measure of similarity of two contours, invariant to transposition, scaling, rotation and starting point shift. The norm $|\tau_{max}|$ shows similarity of contours and $arg(\tau_{max})$ gives an angle of rotation of one contour, concerning another.

4.3 Auto Correlation Function

ACF is an ICF for which N=Γ. It is scalar product of contour on itself with respect to various shift of starting point.

$$\upsilon(m) = \left(\Gamma, \Gamma^{(m)}\right), \qquad m = 0, \ldots, k-1 \tag{8}$$

Properties:

- The Auto Correlation Function does not depend on a choice of starting point of a contour.
- If ACF is the total of pairwise products of an EV of a contour then each pair meets two times on an interval from 0 to k. Let, for example, N = (n1, n2, n3, n4), we write values an ACF for different m:
  ACF(0)=(n1,n1)+(n2,n2)+(n3,n3)+(n4,n4)
  ACF(1)=(n1,n2)+(n2,n3)+(n3,n4)+(n4,n1)
  ACF(2)=(n1,n3)+(n2,n4)+(n3,n1)+(n4,n2)
  ACF(3)=(n1,n4)+(n2,n1)+(n3,n2)+(n4,n3)
  ACF(4)=(n1,n1)+(n2,n2)+(n3,n3)+(n4,n4)
  Let's note that items in an ACF(1) same, as in an ACF(3), to within permutation of factors. And recalling that for complex numbers (a, b) = (b, a)*, we receive that an ACF(1) = ACF(3)*, where * - a conjugate complex number sign. And as |a*| = |a| turns out that norms of ACF(1) and an ACF(3) - coincide. Similarly, norms an ACF(0) and an ACF(4) coincide.
- If the contour has any symmetry then Auto Correlation Function has similar symmetry.

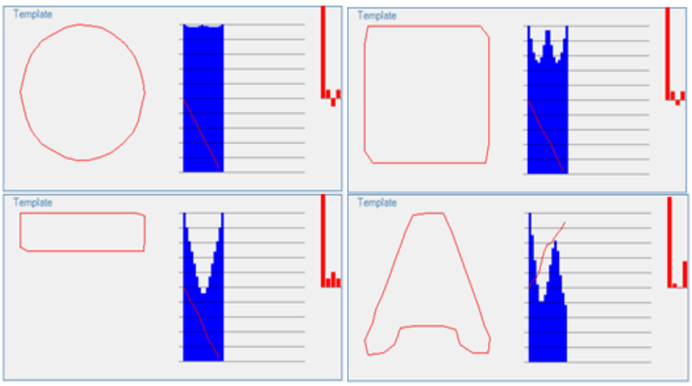


Fig no. 1:Template

As shown in Fig no. 1, dark blue color represents the norm of the ACF and the last template leads to ACF symmetry.

- Normed the Auto Correlation Function does not depend on a scale, position, rotation and a choice of starting point of a contour. It follows from point of 1st and from properties a NSP. Instead of two contours, ACF is a function of one contours as an ICF. ACF is a shape descriptor of contours.

4.3.1 Equalization Of Contour

In the real image contours have arbitrary length. In process of equalization, for searching and comparing contours all of them should be led to uniform length.

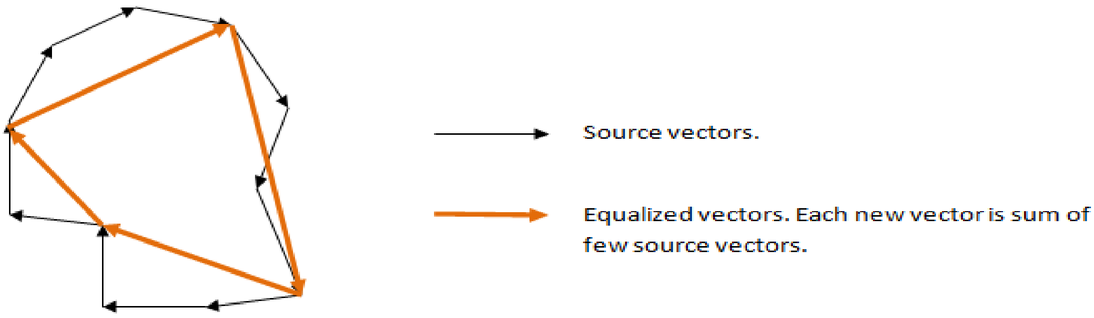
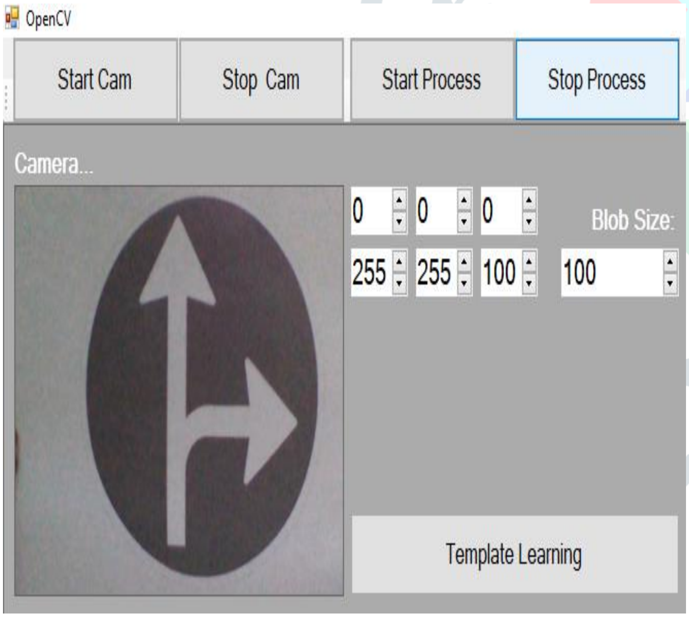


Fig no. 2: Equalization of contours

V. OUTCOMES OF TESTING METHOD

- In spite of limitation, contour analysis methods are attractive for the simplicity and high-speed performance. In the presence of accurately expressed object on a contrasting background and lack of parasites of a contour analysis well copes with a recognition.
- The contour analysis treated 249 images of a various size (from 400x400 to 1280x960) for 30 seconds.
- Besides recognition of freeze frame images, high-speed performance of a contour analysis allows to process video in a real-time mode. The video showing a possibility of a contour analysis.

VI. RESULT:



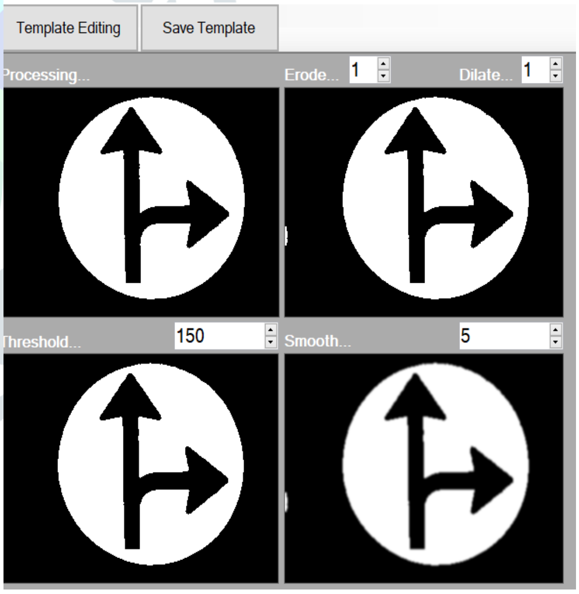


Fig no.3:Captured Image

Fig no. 4:Processing

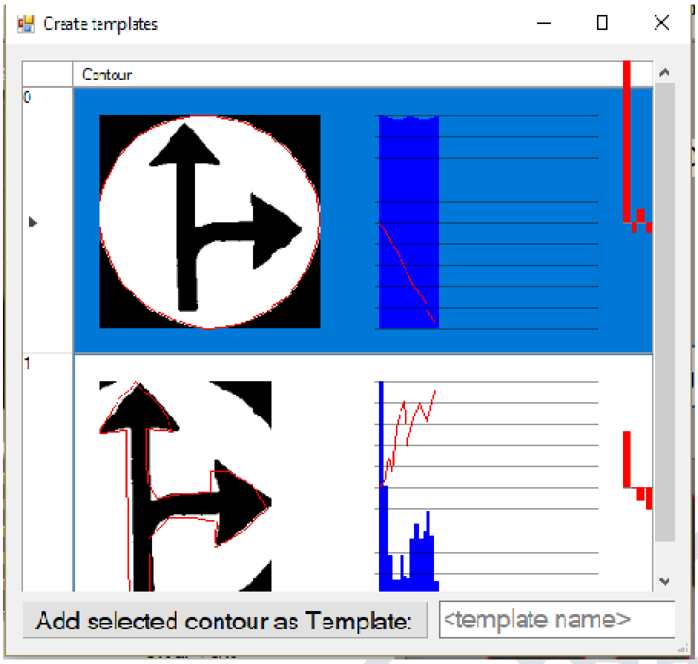


Fig no. 5:Create Template

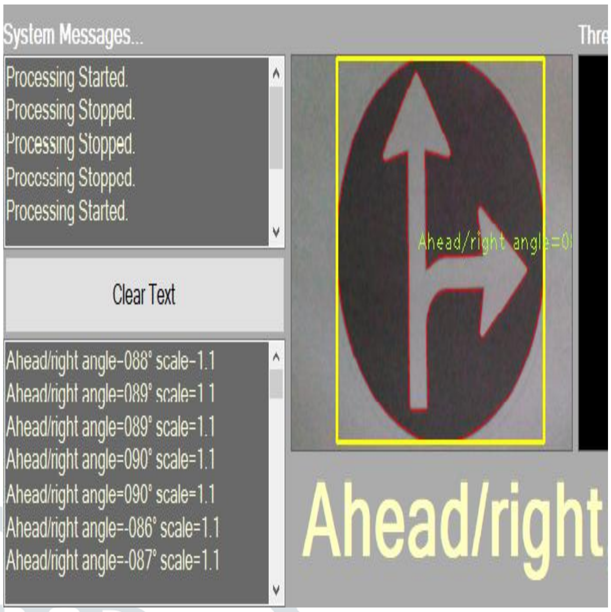


Fig no.6:Detection of Shape

VII. CONCLUSION:

In this paper we conducted a study of the Robust Shape Recognition using Contour Analysis. The study also focus on shape recognition is invariant to transposition, scaling and rotation. From results, we have used this system for Traffic Sign Detection.

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