2-D Object Recognition Approach using Wavelet Transform

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Abstract—Humans have supernatural ability to observe, analyze, and tell about the layout of the 3D world with the help of their natural visual system. But contrary to machine vision system, it remains a most difficult task to recognize various objects from images being captured by cameras. This paper presents 2-D image object recognition approach using Daubechies (Db10) wavelet transform. Firstly, an edge detection is carried out to delineate objects from the images. Secondly, shape moments have been used for object recognition. For testing purpose, different geometrical shapes such as rectangle, circle, triangle and pattern have been selected for image analysis. Simulation has been performed using MATLAB, and obtained results showed that it accurately identifies the objects. The research goal was to test 2-D images for object recognition.

Keywords—Wavelet transforms; db10; edge detection; object recognition; shape moments

I. INTRODUCTION

Since last few years, object recognition has remained one of the challenging tasks in different applications of domain, namely, computer vision, pattern recognition, data mining, object tracking and remote sensing. It can be defined as a process for highlighting, identifying, and extracting the targeted objects from the image and video based repositories. Object recognition is being extensively used in various applications for different purposes, such as in medical technology, researchers are interested in finding the specific regions that can assist doctors to recognize abnormalities in human body, in surveillance and monitoring systems, inspection is necessary security measure to point out a particular person for fraudulent activities. Similarly, in bio related trait systems, individual object verification is required for authentication [1]-[4]. Object recognition is core area of pattern recognition, which uses supervised as well as unsupervised machine learning techniques for mining hidden structures in the data. However, building an efficient object recognition system heavily relies over proper image segmentation method. In this paper, research has been solely carried out for 2-D images for the shape recognition. There are various techniques that have been used for shape representation; however, they are roughly categorized into contour and region methods. First one retrieve the shape from the boundary and second one extracts the shape from the whole region. The comprehensive study on shape features have been given in [5]. The contents of this paper are arranged in the following order. Section one describes the literature review, which is related to 2-D objects for shape recognition and retrieval. Section 2 explains wavelets transform and its methodology for edge detection and object recognition. Section 3 describes the experimental calculation and simulation results for object retrieval and finally Section 4 provides the conclusion.

II. LITERATURE REVIEW

Over the past, various approaches have been put forwarded by authors for 2-D images for shape recognition. In [6] Jiann-Der Lee and Jau-Yien Lee suggested a recognition technique for partial 2-D perspective shapes. This method was able to recognize the unknown shape from arbitrary perspective. However, efficiency of the system was limited for those objects missing only 20% of data. Similarly, K.C. Wong and Y.Cheng presented a recognition method for polyhedral objects with the aid of triangular pair feature. The rate of identification for objects was relatively high but their method does not considered spatial and temporal information [7]. In other paper [8], P.K Sinha and F-Y Chen, implemented wavelet transform for the 2-D images for shape recognition. There are various techniques that have been used for shape representation; however, they are roughly categorized into contour and region methods. First one retrieve the shape from the boundary and second one extracts the shape from the whole region. The comprehensive study on shape features have been given in [5]. The contents of this paper are arranged in the following order. Section one describes the literature review, which is related to 2-D objects for shape recognition and retrieval. Section 2 explains wavelets transform and its methodology for edge detection and object recognition. Section 3 describes the experimental calculation and simulation results for object retrieval and finally Section 4 provides the conclusion.
demonstrate the effectiveness of the proposed method to efficient content analysis.

III. WAVELET TRANSFORM

Wavelet is a type of frequency transform technique which is being used for signal analysis. Also, it has been an important tool for researchers for image analysis since more than a decade. Wavelet transform is characterized by its orthogonal function, which can be used on limited group of data. It provides multi scale signal analysis using low pass and high pass filter. In this paper, wavelet has been implemented on 2-D images for edge detection and object retrieval. This technique is efficient in the sense that discrete image is decomposed through these filters and change in grey level intensity can easily be detected for object recognition. There are number of wavelets families which are known by their particular name. However, each of them is characterized by its basic scaling function and wavelet shape function; these values are used for particular signal analysis.

A. Proposed Methodology

Our proposed methodology is based on our previous research work which was carried out for 2-D edge detection [15]. In this paper, it has been extended for 2-D object recognition.

Initially, an original image in Fig. 1 is given as an input to db10 wavelet transform for edge detection [16]. After that it decomposes image up to three levels for separation of approximation and details co-efficient. The details contain higher frequencies which correspond to the actual edges, so we have suppressed the approximation effect.

4. Save them in an array.
5. Combine them to get approximations and details.
6. Save them into workspace.
7. Now, this is first level reconstruction.
8. Do it again from step 2 through 6 by taking first level reconstructed approximations and details.
9. This process is carried out until we get original image.
10. The edges of original image will be retrieved at CA3=0
11. Meanwhile, Use thresholding to nullify ghost edges.
12. Finally, an original image will be displayed with edges.

B. Object Recognition

Once the edges are found, the next step is to recognize objects. For this purpose, database has been created as shown in Fig. 3, which consists of different object patterns, such as rectangle, triangle, circle and pattern. Later, these objects have been taken as query image for object recognition.

Fig. 1. Original image.

Secondly, an original image has been reconstructed for the detection of image edges as shown in Fig. 2. For this purpose, an algorithm is devised below:

Algorithm for Reconstruction of Image

1. Take approximations as well as detailed coefficients for three level decomposition.
2. Perform up sampling.
3. Use low and high pass filter (Reconstructed filter).

Fig. 2. Edges of the image.

Fig. 3. Database for object recognition.
The algorithm for object recognition has been described as below.

Algorithm for Object Recognition

1. Find first pixel
2. Store its location in arrays individually containing rows and columns
3. Zero the pixel from an input image
4. Check its 8 neighborhood connectivity
5. Save its neighborhood pixel locations in the same array containing first pixel location
6. Simultaneously, zeroing those pixels from input image
7. Taking pixels immediately next to the first pixel from arrays containing locations of detected pixels
8. Check its 8 neighborhood connectivity
9. Store the location of the detected pixel in the same array declared previously
10. This process is repeated until the time 8 neighborhood connectivity pixels of preceding pixels exit
11. Declare it the first object
12. Again first pixel is detected
13. Repeat steps from 2 to 11
14. Declare it the second object

C. Shape Moments

Shape moments are good at exploiting global features of an image which is useful for object recognition. These moments are defined over Cartesian moments that contain basic set function \{xp, yq\}. However, \((p + q)\) th 2-D geometric moments for an image \(I(x, y)\) are denoted by a matrix \(mpq\) and can be narrated as:

\[
m_{pq} = \int_{\infty}^{\infty} \int_{\infty}^{\infty} x^p y^q I(x, y) dx dy
\]  

(1)

In (1) \((x, y)\) depicts the continuous image function, which is stored as two-dimensional array \((i, j)\) in the computer memory. The \(i = 0,1,...,Nx - 1\) and \(j = 0,1,...,Ny - 1\) represents an array \(Nx \times Ny\). However, moments are calculated by omitting integrals with summation as shown in (2).

\[
m_{pq} = \sum_{i} \sum_{j} I(i, j) \cdot i^p j^q
\]  

(2)

And, also normalized moments for x-y axis can be approximated by:

\[
m_{pq} = \sum_{i} I(x_i, y_i) \cdot x_i^p y_i^q
\]  

(3)

Similarly, in (3) summation is performed for all image pixels where \(x_i, y_i\) are central coordinates of ith pixel. Shape moments are efficient in finding intensity distribution of an image. These are invariant to translation, rotation and scale. Therefore, central moments, normalized moments and invariant moments have been calculated for each object and then stored in an array. Later, individual query object is recognized through comparing its actual moments in the database.

D. Mathematical Calculation

In this section, central moments, normalized moments and invariant moments of Rectangle, Triangle, Pattern and Circle have been calculated for shape recognition, respectively as shown below in Table I.

In addition to aforementioned tabular calculation, central, normalized and invariant moments have been computed using following formulæ:

1) Central moments

\[
r-bar = \text{mean}(r);
\]

\[
c-bar = \text{mean}(c);
\]

Momlist \((i) = (r(i) - r-bar) \cdot p \cdot (c(i) - c-bar) \cdot q;\)

Central moments (CM) = sum (Momlist);

Where, \(p\) and \(q\) are showing the order of CM, are saved in an array.

2) Normalized moments

\[
\text{NCM}=\text{CMpq}/(CM00)^J
\]

Whereas \(J = (p+q)/2+1;\)

Normalized moments are saved in an array.

3) Invariant moments

\[
\text{Inva_moment1} = h20^2 + h02^2;
\]

\[
\text{Inva_moment2} = (h20-h02)^2 + 4*h11^2;
\]

\[
\text{Inva_moment3} = (h30-3*h12)^2 + (h03-3*h21)^2;
\]

\[
\text{Inva_moment4} = (h30+h12)^2 + (h03+h21)^2;
\]

\[
\text{Inva_moment5} = (h30*h12)*(h30+h12)*((h30+h12)^2 - (h03+h21)^2);
\]

\[
\text{Inva_moment6} = ((h03+h21)^2 - (h03+h21)^2) + 4*h11*(h30+h12)*(h03+h21);
\]

\[
\text{Inva_moment7} = (3*h21-h03)*(h30+h21)^2 - (h03+h21)^2;
\]

Invariant moments are saved.

<table>
<thead>
<tr>
<th>TABLE I. SHAPE MOMENTS CALCULATION</th>
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<tbody>
<tr>
<td><strong>Moment</strong></td>
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<tr>
<td>-----------</td>
</tr>
<tr>
<td>Moment</td>
</tr>
<tr>
<td>Triangle</td>
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<td>Moment</td>
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<td>Circle</td>
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<td>Moment</td>
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<tr>
<td>Rectangle</td>
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<td>Moment</td>
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<td>Pattern</td>
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IV. RESULTS AND DISCUSSIONS

In this section, we have shown results which are being generated using MATLAB programming. For this purpose, discussion has been made for object detection. In order to detect object, an input query image is feed to a system, after that it computes its features using shape moments. Then matching of features is achieved from the database. And finally system recognizes shape of an object. It can be observed from Fig. 4 to 7 that detected object are rectangle, triangle, pattern, and circle respectively. From these results, it can be concluded that wavelet transform for edge detection and shape moments for object recognition performed well over grey level intensity images.

Fig. 4. Rectangle object detection.

Fig. 5. Triangle object detection.

Fig. 6. Pattern object detection.

Fig. 7. Circle object detection.

V. CONCLUSIONS

In this paper, 2-D image edge detection and object recognition approach was achieved using Db10 wavelet transform and with shape moments. Simulation results showed that wavelet transforms for edge detection and shape moments for object recognition generate efficient results for 2-D type images. And it is suitable for grey scale images for object recognition. However, proposed system has some limitation, as it does not work well with colour images. Therefore, in future one can improve these algorithms for the sake of high level pattern recognition.

REFERENCES


