Birds Classification Based on Gray-level Co-occurrence Matrix (GLCM)

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Abstract: This paper describes a new approach for the classification of birds types. It is based on the fact that a tested image is composed of different texture regions that can be classified depending on features of Gray-level Co-occurrence Matrices (GLCM). This approach consists of two stages, the first stage is built a data base of features for a large number of variety images using texture features, and the second step is decomposed the tested image into patterns and extracting the texture features by using the gray-level Co-occurrence matrix (GLCM) in different four directions. The obtained results for unknown bird which features calculated for it compared with patterns data base demonstrate that the existing paper in a good results for certain features using different directions.

Keyword: Birds Classification, Gray-Level Co-occurrence Matrix (GLCM), Texture features.

الخلاصة: هذا البحث يصف طريقة جديدة لتصنيف كائنات الطيور.ويعتمد على حقيقة أن اختبار الصورة يتكون من مناطق نسيج مختلفة يمكن تصنيفها بالاعتماد على صفات مصفوفة حدوث المستويات الرمادية (GLCM). الطريقة تتكون من مرحلتين، المرحلة الأولى تتضمن بناء قاعدة بيانات الصفات لعدد كبير من الصور المتنوعة باستخدام صفات النسيج، والخطوة الثانية تم بتحليل الصورة المراد اختبارها إلى نماذج واستخرجنا صفات النسيج لها باستخدام مصفوفة حدوث المستويات الرمادية (GLCM) في أربعة اتجاهات مختلفة. النتائج النهائية لصورة طير غير معروف وتم حساب الصفات له والتي قورنت مع نماذج قواعد البيانات كانت جيدة في صفات معينة باستخدام اتجاهات مختلفة.

1. Introduction

This paper introduces a new approach of bird's classification which is a part of image processing using Gray level co-occurrence matrix (GLCM). The simplest away practice in this paper is a classification of bird's images into patterns with the use of their textures features in different direction of GLCM matrix to match the experimental results with a feature of data base. The patterns have high variability of reflection texture charactertics. Therefore using texture features analysis methods of image is a good way to obtain accurate results [1].

Another direction in this paper is using a feature of data base for a large number of variety images. Patterns features of data base may be applied for realizing a wide pattern in different texture without imposing any restriction on their distribution [2]. Based on a topicality of the given approaches this paper present the texture segmentation for a new approach by using Gray level Co-occurrence Matrix (GLCM) [3].

Machine classification vision based on gray level co-occurrence matrix of birds classification is necessary and important method. As it lead to obtain a good results for classification in certain features characteristics. There are different approaches in computer vision, Commander K.Velu [4] used an Intelligent Segmentation of Industrial Component Images. Virendra Pathak and Onkar Dikshit [5] used Segment based classification of Indian urban environment. P. Tymkow, A. Borkowski [6] introduced land cover classification using airborne laser scanning data and photographs.

When we propose a bird classification based on Gray level co-occurrence matrix (GLCM) in this paper, it is necessary to allocate following points.

a. Choice the patterns of textures attribute for a large numbers of variety Images and saving it in a data base.
b. adaptive Image segmentation for the input image.
c. Texture Features extraction using GLCM Matrix in different Direction.
d. Test unknown image by calculate the texture features which compared with data base.

2. Gray Level Co-occurrence Matrix (GLCM)

The GLCM has been a technique used in textures analysis, the GLCM generated provides information of the relationship between grey-scaled pixels values of the image, therefore many textures features could be extracted from the GLCM. [7].

To generate a GLCM, by using image matrix G x G, there are four directions that could be focused on during the generation of the matrix, which are 0 degrees (or horizontal) direction, 45 degrees direction, 90 degrees (or vertical) direction, and 135 degrees direction as shown in Figure (1) [8]. The direction and spatial distance from the reference pixel x will be defined, such as 1 space for horizontal direction is to check the value of the adjacent pixel next to the reference pixels.

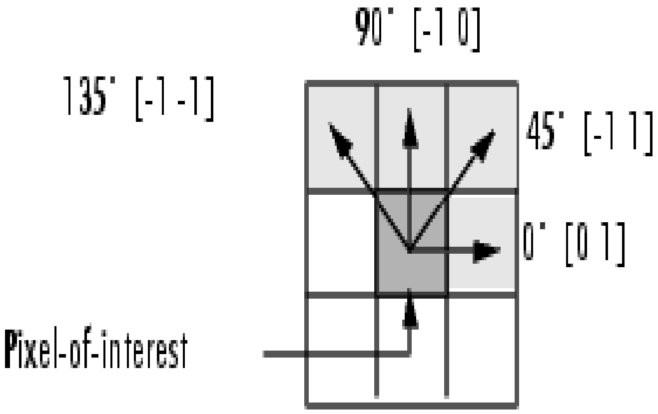

Fig.(1): Direction for generation of GLCM

As shown in Figure (2) as an example, GLCM calculates the value of glcm(1,1). This element contains the value 1 because there is only one instance in the image where two, horizontally adjacent pixels have the values 1 and 1. As the figure shows, glcm(1,2) contains the value 2 because there are two instances where two, horizontally adjacent pixels have the values 1 and 2.

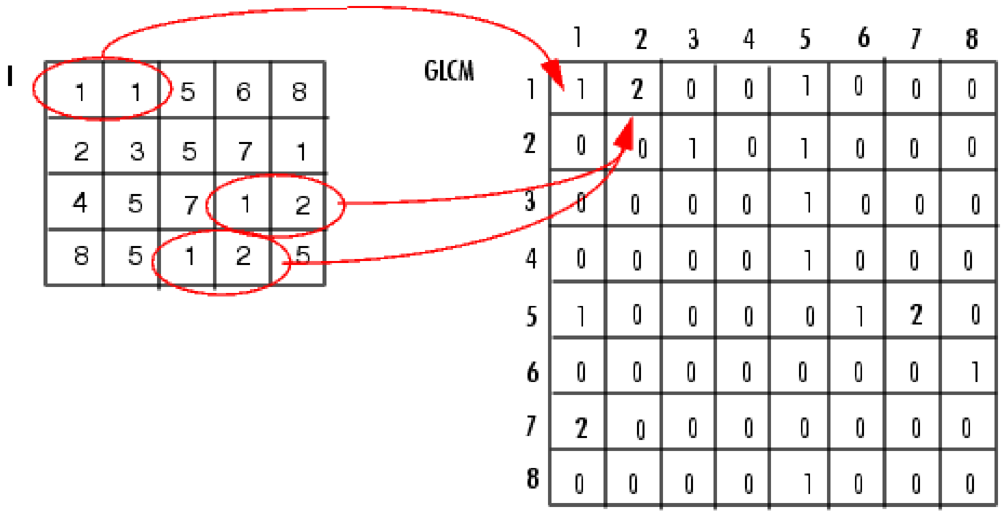

Fig.(2): generating of GLCM based on 0^0 degree Direction

The GLCMs are represented by Cd(m,n) where d is the spatial distance between two pixels where the first pixel is having the grey-scaled value of m, and the second pixel is having the grey-scaled value of n. The joint probability density function normalizes the GLCM by dividing all its elements by the total number of pairs of pixels used for calculation, which can calculated as shown below [9].

$$p(m,n) = \frac{1}{All\_Pairs\_of\_Pixel\_Used} C_d(m,n)$$

3. Texture features

Most of the GLCM texture calculations used in remote sensing were systematized in a series of papers by Robert Haralick in the 1970's.[10], When the GLCM is generated, there are a total of 14 textures features that could be computed from the GLCM, such as contrast, variance, sum average, and etc. The five common textures features discussed here are contrast, correlation, energy, homogeneity, and entropy. Contrast is used to measure the local variations, correlation is used to measure probability of occurrence for a pair of specific pixels, energy is also known as uniformity of ASM (angular second moment) which is the sum of squared elements from the GLCM, homogeneity is to measure the distribution of elements in the GLCM with respect to the diagonal, and entropy measures the statistical randomness. The five common textures features are shown in figure (3). Hence, 20 features or more will be extracted using GLCM methods, i.e. four directions for every feature functions of contrast, correlation, energy, entropy, and homogeneity with different spatial distance (d) for every feature.

Energy	$\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} P(m,n)^2$
Entropy	$\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} p(m,n)\log p(m,n)$
Contrast	$\frac{1}{(G-1)^2}\sum_{m=0}^{G-1}\sum_{n=0}^{G-1}(m-n)^2 p(m,n)$
Correlation	$\frac{\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} mnp(m,n) - \mu_x\mu_y}{\sigma x \sigma y}$ *where* $\mu_x = \sum_{m=0}^{G-1} m \sum_{n=0}^{G-1} p(m,n)$ $\mu_y = \sum_{n=0}^{G-1} n \sum_{m=0}^{G-1} p(m,n)$ $\sigma_x = \sum_{m=0}^{G-1}(m-\mu_x)^2 \sum_{n=0}^{G-1} p(m,n)$ $\sigma_y = \sum_{n=0}^{G-1}(n-\mu_x)^2 \sum_{m=0}^{G-1} p(m,n)$
Homogeneity	$\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} \frac{p(m,n)}{(1+\lvert m-n\rvert}$

Fig. (3): Textures Features to be calculated

4. **The Proposed System**

The proposed system consists of two stages as below:-

First Stage : Building a data base of features as illustrated in figure (4)

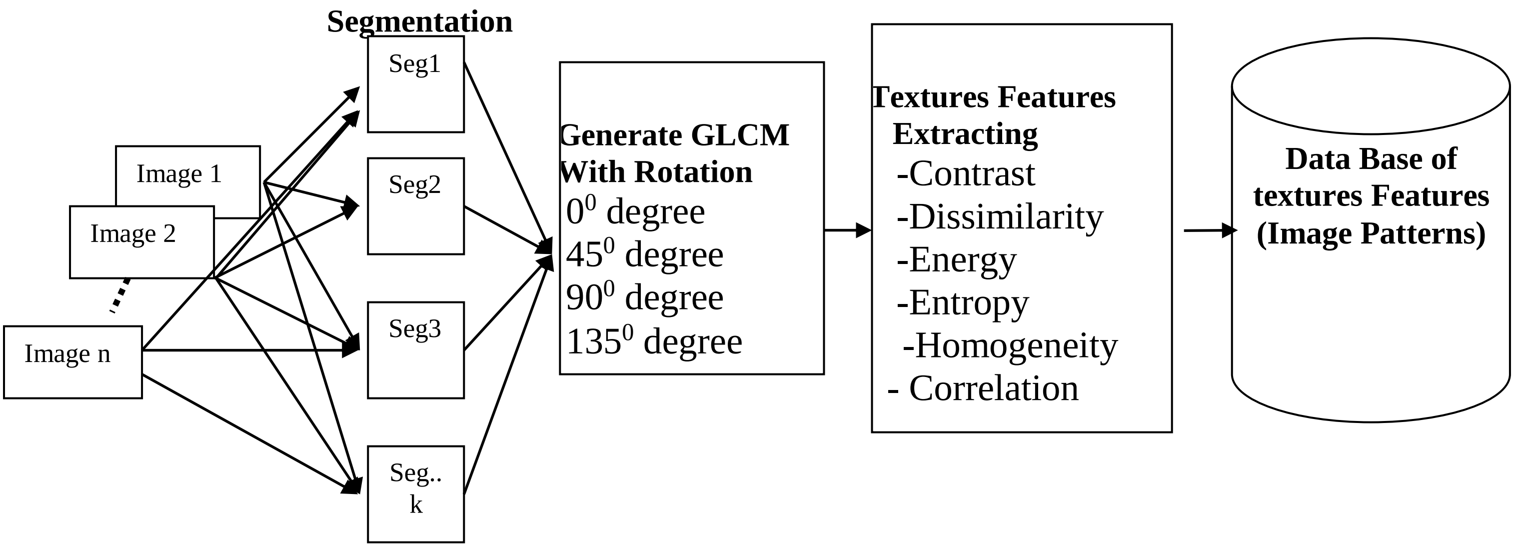

Fig. (4): Block Diagram of Constructing Data Base

The constructing of data base is depending on different image patterns, for each image, we perform the following:-

a. Segment (adaptive segmentations) each image to different segments (patterns).

b. For each segment, we calculate the GLCM method and then use it to extract textures features using the equations in Fig (3).

c. Save the obtained results in table records of data base, figure (5) illustrated the structure of data base table

Pattern Name	Energy	Entropy	Contrast	Correlation	Homogeneity
Pattern(1)					
Pattern(2)					
Pattern(3)					
Pattern(4)					
Pattern(k)					

Fig. (5): Structure of a data base file of textures features

The image which used in constructing data base in this work is shown in Fig.(6).

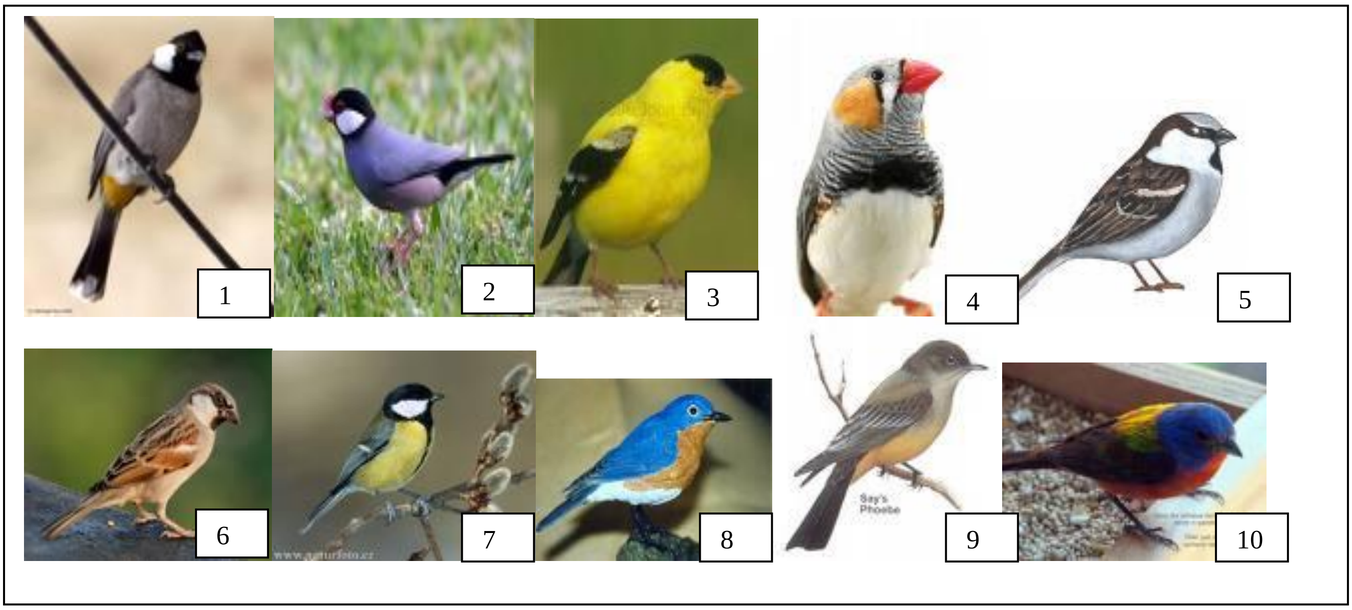

Fig. (6): images used to construct data base feature

<u>Second stage:</u> Testing and classification

To test unknown image and classify, two steps are used, the first one is segmented the image into patterns and calculate the GLCM for each pattern. The obtained GLCM is used to extract features depending on equations which shown in figure (3).

The second step is comparison the above features with the feature values of data base to determine the pattern belong to which pattern of bird's type. The taken decision is made according to results.

Therefore, we run the experiment in all four directions with spatial distance from 1 to 20. All of these analysis and experiments are run on patterns which are not further enhanced, such as histogram equalization.

The results shows that the value differs in all spatial distances for energy, therefore the pattern of change for energy may be useful as a feature to be extracted. For the other four features, they are having closer values when the spatial distance is small, so in such case, smaller spatial distance are more suitable to be used for extraction of the features such as correlation equation.

5. <u>Experiments and Results</u>

Our experiment results is determining by taken image of unknown bird and segment it to different patterns, each pattern is passing to GLCM for extracting features. The results is checking with the features of a data base shows that the patterns belongs to bird image (1) in figure (5) and the table (1) shows features value that used for comparison (as an example) in data base.

Pattern Name	Contrast	Dissimilarity	Homogeneity	Energy	Entropy	Correlation
Pattern(1)	40.1880	0.49610	0.000356	0.00027	0.2855	0.8964
Pattern(2)	21.3672	0.28970	0.000983	0.00023	0.4121	0.9832
Pattern(3)	34.3210	0.39953	0.000309	0.00047	0.2666	0.9473
Pattern(4)	23.3556	0.33840	0.000172	0.00045	0.3132	0.9653
Pattern(k)	44.9892	0.47170	0.000872	0.00084	0.2615	0.8321

Table (1): a feature values of data base

6. Conclusion

Regardless of segment type method that used in this paper, the experimental results show that the GLCM and a data base of features method is proved to be useful for classify the textures images such as Birds Classification. The data being analyzed on the images shows that the orientation in small distance values in different viewing direction such as 0^0, 45^0, 90^0 and 180^0 shows a good feature extracted from the images for the closer patterns in textures. When the spatial distance increases, the differences in values for different patterns (segmentation) of a same species will be more obvious. As an example the results for the entropy during greater spatial distances are not useful. Also obtained results show that the gray level co-occurrence matrix (GLCM) is useful for extracting features from the images where the normalization factor is easy to check with a feature of data base which yields to a good comparison. The only majority is that the results closer when the pattern textures features are similarity. For the future a birds classification based on gray level co-occurrence patterns is planned to be tested on different algorithms to search for a better algorithm for solving such that similarity.

References

1. Tuceryan M., Jain A.K., 1998. 'Texture Analysis. The handbook of Pattern Recognition and Computer Vision (2nd Edition)' / C.H. Chen, L.F. Pau, P.S.P. Wang (eds), World Scientific Publishing Co.. – PP. 207–248.
2. Rauf S. , Marina Luk., 2008. 'Texture segmentation of satellite images By neural networks approach', The Belarusian State University of Informatics and Radioelectronics, p. 1.
3. Materka A., StrzeleckiM., 1998. 'Texture Analysis Methods – A Review', Technical University of Lodz, Institute of Electronics, COST B11 report, Brussels.
4. Commander K.Velu and V.Selladurai, July 2007. 'Intelligent Segmentation of Industrial Component Images' , IJISE,GA,USA,ISSN:1934- 9955 ,VOL.1,NO.3, p.1.
5. Virendra Pathak and Onkar Dikshit, 2004. ' Segment based classification of Indian urban environment' , Department of Civil Engineering IIT-Kanpur, Kanpur-208016 (UP), India.
6. P. tymkow, a. borkowski, 2008. ' land cover classification using airborne laser scanning data and photographs', Department of Geodesy and Photogrammetry Wroclaw University of Environmental and Life Sciences Wroclaw, C.K. Norwida 25/27, Poland, p.1 .
7. Shapiro L.G. and Stockman G.C., 2001. 'Computer Vision', Prentice Hall, Upper Saddle River, N.J., p. 752.
8. Haralick R.M., Shanmugam K., Dinstein I., Nov 1973. 'Textural Features for Image Classification', IEEE Transactions on Systems, Man and Cybernetics.No 6. - PP. 610–621.
9. Jing Yi Tou, Phooi Yee Lau, Yong Haur Tay, ' Computer Vision-based Wood Recognition System' , Faculty of Information and Communication technology Universiti Tunku Abdul Rahman (UTAR), Malaysia
10. Haralick, R.M., 1979. 'Statistical and Structural Approaches to Texture', Proceedings of the IEEE, 67:786-804