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Recognition and Classification of Object Images Using Features Extraction

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ABSTRACT: This paper presents a recognition and classification of different types of object images based on texture features analysis. We have considered nine different types of object images namely, Ewer, Lamp, Watch, Stapler, Bike, Camera, Scissor, Cup and Headphone. GLCM and wavelet transform methods are used to extract the texture features. For recognition and classification of objects images, a back propagation neural network (BPNN) is used. Experimental result shows that GLCM gives efficient result than wavelet transform method.

KEYWORDS: Features Extraction, Artificial Neural Network.

I. INTRODUCTION

A artificial vision system is extensively used in various application such as biometric systems, face recognition system, identify and categories abnormalities in medical images, recognition and classification of fruits, pests, objects, vehicle parking system and many more machine vision system. Humans are able to tell object identity and category with the simple glance, based on its appearance, on opposite to it machines cannot identify objects because of the variations in the appearance of objects like shape, size, colours, etc. Many repetitive task can be automated if highly standard artificial vision system is created. Therefore, it is natural to study the mechanisms used of biological vision system for recognition and classification of an objects and to examine the applicability of similar processes on artificial computer vision system [1, 2].

II. PROPOSED METHODOLOGY

The present work refers to recognition and classification of objects using texture features extraction. Features are extracted using Gray level co-occurrence matrix (GLCM) and wavelet transform methods. A Back Propagation Neural Network (BPNN) is used as a classifier.

A. *Gray Level Co-occurrence Matrix (GLCM)*

GLCM contains the second order statistical information of pixels of an image [3]. Many useful textural properties can be calculated from GLCM matrix to expose details about the image. Haralick *et al.* first introduced the use of GLCM for extracting various texture features. Computing the GLCM matrix and calculating texture features based on GLCM, these two steps are proposed by Haralick [4]. Let *I* be a given grey scale image. Let *N* be the total number of grey levels in the image. The Grey Level Co-occurrence Matrix defined by Haralick is a square matrix *P* of order *N*, where the $(i, j)^{th}$ entry of *P* represents the number of occasions a pixel with intensity *i* is adjacent to a pixel with intensity *j*. The normalized co-occurrence matrix is obtained by dividing each element of *P* by the total number of co-occurrence pairs in *P*. We have considered seven texture features which are extracted from calculated GLCM, they are contrast, correlation, homogeneity, energy, standard deviation, dissimilarity and entropy.

B. *Wavelet Transform*

A wavelet transforms is very simple concept. Multiscale analysis is provided by wavelet transform. This means that a sequence or function can be broken down and analysed in greater detail. The general concept of the wavelet transform is to analysing a signal as a superposition of wavelets across multiple scales. The discrete wavelet transform (DWT) uses filter banks to perform the wavelet analysis and image divides into various frequency bands. The wavelet transform technique decomposes the image into four sub bands, at each level, named as LL, HL, LH and

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HH. The LL band gives the approximate image and can be decomposed further. The other three bands are the detail bands and contain information about the directions [5, 6].

C. Features Extraction

We have extracted seven texture features which are as follows: contrast, correlation, homogeneity, energy, standard deviation, dissimilarity, entropy [7].

- Contrast= $\sum_{n=0}^{N_g-1} n^2 \{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j)\}$
- Homogeneity= $\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} \frac{1}{1+(i-j)^2} p(i,j)$
- Energy= $\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} \{p(i,j)\}^2$
- Dissimilarity= $\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} |i-j| p(i,j)$
- Entropy= $-\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j)\log\big(p(i,j)\big)$
- Correlation= $\frac{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i,j)p(i,j)-\mu_x \mu_y}{\sigma_x \sigma_y}$

Where μ_x, μ_y, σ_x and σ_y are the means and standard deviations of p_x and p_y.

$$\mu_x = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} i p(i,j)$$

$$\mu_y = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} j p(i,j)$$

$$\sigma_x = \sqrt{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i-\mu^2) p(i,j)}$$

$$\sigma_y = \sqrt{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (j-\mu^2) p(i,j)}$$

D. Artificial Neural Network

Neurons are the simple processing elements of Artificial Neural Networks (ANN). Motivation behind the design of ANNs was a human brain. Artificial neural network with feed-forward topology is called Feed-Forward artificial neural network. BPNN is also a feed-forward neural network and best suited for classification of different objects. Three layers are present in BPNN which are input layer, hidden layer and output layer [8].

E. Algorithm 1: Texture Features Extraction using GLCM

In training phase, BPNN is trained using features which are extracted from calculated GLCM. In testing phase, to test unknown image and classify, first GLCM of unknown image is calculated and texture features are extracted which are listed above. The second step is to train the neural network using extracted features with the desired values and test it to determine the object class of a given unknown image. Figure 1 shows flow diagram of GLCM method.

Algorithm

Step 1: Read the input color image and resize it.
Step 2: Image preprocessing is applied.
Step 3: Calculate GLCM of a given input image.
Step 4: Extract texture features from calculated GLCM.
Step 5: For classification, train the BPNN using extracted features.
Step 6: Test the given image.
Stop.

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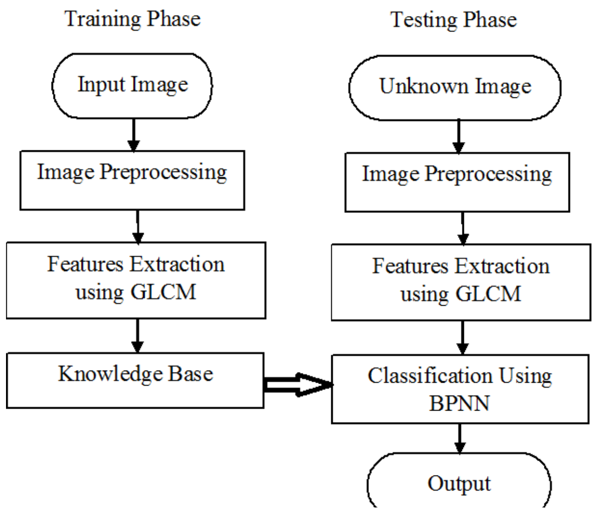

Figure 1. Flow Diagram of GLCM Method.

F. Algorithm 2: Texture Features Extraction using Wavelet Transform

In training phase, neural network is trained using features which are extracted from calculated wavelet transform. Wavelet transform technique is used to calculate wavelet decomposition. In testing phase, to test unknown image and classify, first wavelet transform of an unknown image is calculated and texture features are extracted which are listed above. The second step is to train the neural network using extracted features with the desired values and test it to determine the object class of a given unknown image. Figure 2 shows flow diagram of wavelet transform method.

Algorithm

Step 1: Read the input color image and resize it.
Step 2: Image preprocessing is applied.
Step 3: Calculate Wavelet Transform of a given input image.
Step 4: Extract Texture features from calculated Wavelet Transform.
Step 5: For classification, train the BPNN using above extracted features.
Step 6: Test the given image.
Stop.

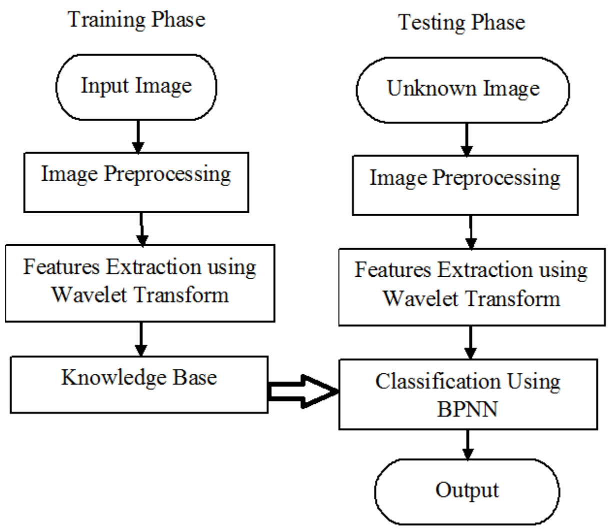

Figure 2. Flow Diagram of Wavelet Transform Method.

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III. RESULTS AND DISCUSSION

In this section, experimental results of developed methodology is given. A comparative study of two methods used in this work is presented. Table 1 shows summarized results of GLCM and wavelet transform technique.

Table1. Summarized Results of GLCM and Wavelet Transform Technique.

Object Class	Train Images	Test Images	Total	Accuracy in %	
				GLCM	Wavelet
Ewer	9	17	26	100	82
Lamp	9	17	26	94	88
Watch	9	17	26	100	82
Stapler	9	17	26	94	88
Bike	9	17	26	94	88
Camera	9	17	26	94	82
Scissor	9	17	26	100	88
Cup	9	17	26	100	88
Headphone	9	17	26	100	82

GLCM and wavelet transform techniques are applied on nine object classes which are as follows: Ewer, Lamp, Stapler, Bike, Camera, Scissor, Cup and Headphone. The summarized results of GLCM based recognition and classification is 97%. Figure 3 represents the graph of GLCM technique. It represents that the percentage recognition of Lamp, Stapler, Bike and Camera is 94%. The classification rate of Ewer, Watch, Scissor, Cup and Headphone is 100%.

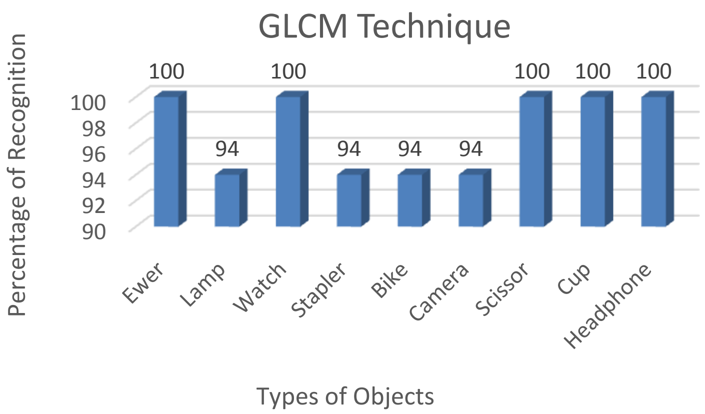

Figure 3. Summarized Result of GLCM Technique.

Figure 4 shows the summarized results of wavelet transform based recognition and classification and its accuracy is 85%. The graph represents the classification of Ewer, watch, Camera, Headphone is 82%. The classification rate of Lamp, Stapler, Bike, Scissor, and Cup is 88%.

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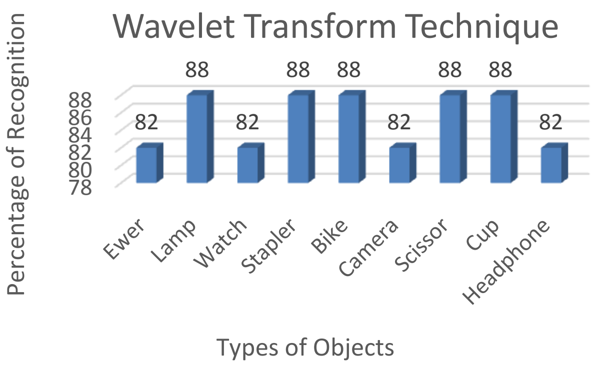

Figure 4. Summarized Results of Wavelet Transform Technique.

The summarized results of both GLCM and wavelet transform based recognition and classification is shown in figure 5. Accuracy of GLCM is 97% and wavelet transform's accuracy is 85%.

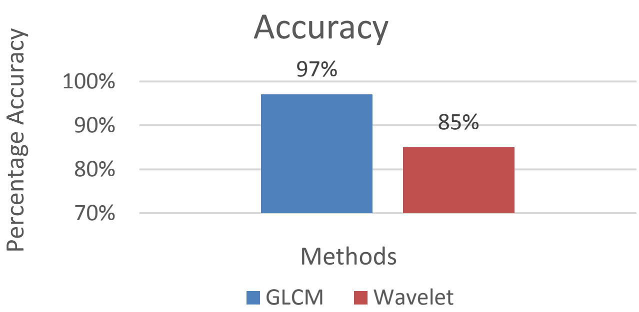

Figure 5. Accuracy of GLCM and Wavelet Transform.

IV. CONCLUSIONS

We proposed a novel system of texture features extraction using GLCM and wavelet transform technique and BPNN used as a classifier. The proposed system was tested using a various objects datasets. We also conducted comparison experiments with GLCM and wavelet transform techniques. We compared the performance of both the GLCM and wavelet transform in the object verification task. The performance of GLCM based features extraction and classification method in terms of detection accuracy is more efficient as compared to wavelet transform technique as GLCM is best suited for texture features extraction.More powerful visual feature detectors can be used to improve the accuracy of detection.

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