Object Recognition from an Image through Features Extracted from Segmented Image

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Abstract— Object recognition is a technological discipline that deals with the process of understanding, design, development and construction of techniques to recognize the objects in the image. The objective of an object recognition system is to make the computer to recognize objects without the assistance of the human. The major problem in designing object recognition is automatic identification of the object with respect to its size, location, orientation and in different illumination conditions. When designing an object recognition system, the following are the two problems to be addressed, the first one is choosing the correct set of features to represent the image and the second one is selecting best classifier for recognition. To solve the first problem, it is important to extract features that should be invariant to the object's transformation like scale, translation and rotation. For the second problem, the classifier should recognize the object with less computation time and should provide high performance. This paper discusses the method of slicing the image into several segments and extracting the features.

Keywords— Object Recognition, Feature Extraction, locating object, Classifiers

I. INTRODUCTION

Object Recognition is a method to identify the objects in the given image. It plays a vital role in the challenging fields like surveillance systems, fault diagnosis systems, leaf species detection, etc., [10]. In general the object recognition systems were consisting of following phases

    i)   Image acquisition – acquire the image and convert into digital form for further processing.
    ii)   Pre-processing – the digital image is processed in such way to remove the noise, colour conversion, background subtraction, edge detection etc.,
    iii)   Feature extraction – extracting the salient features of the image.
    iv)   Recognition – steps involved in classifying the image or to recognize the object in the image.

Feature extraction is considered as a process of finding important features or information from the image for classification or recognition. The important objective of the feature extraction is to extract the relevant and optimum characteristic features for the recognition process, since the classification accuracy is based on the amount of features extracted from the image. Global features are the features computed from the entire image. Moment Invariants are the features extracted from the image and it had attracted many researchers to use it in their applications. Since the moment invariant is invariant with respect to change in size, translation, and rotation. The moment invariant has been classified into several categories like Cartesian geometrical moments, geometrical moments, rotational moments, orthogonal moments, and complex moments.

Pattern recognition or object recognition is considered as an important task in machine learning. Machine learning is treated as a process of providing intelligence to machine to act like humans. Machine learning can be done either as supervised or unsupervised. In supervised learning, a label is associated with each training pattern. In unsupervised learning, no labels are associated with the training pattern. In unsupervised learning, through the inductive inference, the classifier identifies the class of the pattern. Some of the classification techniques are k-Nearest Neighbor (k-NN) classification, Neural Networks, and Support Vector Machines (SVM). In the earlier work, compared the performance of Back Propagation Network is compared with k-Nearest Neighbour, but in this Radial Basis Function network is compared with k-Nearest Neighbour [11].

II. LITERATURE SURVEY

Mamta Juneja and Parvinder Singh Sandhu (2009) in their paper, showed the Canny Edge detection operator provided better result when compared to the Sobel, Prewitt, Robert and Laplace of Gaussian. In their paper, they proved Canny's edge detection algorithm performed better than all other operators under almost all circumstances.

Imola Fodor (2002) conducted a survey of dimension reduction techniques for the problem of dimensional reduction of high dimensional data into low dimensional data. He considered both the linear and non-linear dimension reduction techniques. He outlined the functionalities of each and every dimension reduction techniques.

Danny Roobaert and Marc Van Hulle (1999), in their work demonstrated the performance of Support vector machine in pattern recognition tasks and 3D object recognition. For the experiment, COIL-100 was used as dataset, which consists of 100 objects each has 72 views, from which 36 views were chosen for training and testing.

III. PROPOSED SYSTEM

Object recognition system designed using k-Nearest Neighbor using the proposed feature extraction method is implemented using MATLAB. Object recognition is treated as a holistic approach. It consists of Image Acquisition, Pre-Processing, Feature Extraction and Recognition. Feature extraction and recognition are important phases in the object recognition system. For feature extraction, the proposed method is used. The k-Nearest Neighbor is used as a classifier with Euclidean distance metric. The k-Nearest Neighbor is simplest and learning free classifier for classification and recognition of objects.

Feature extraction is a very important task in pattern recognition, since it converts the image into set of quantifiable properties called features. There are several ways to represent the image. More basic and simple way to represent the digital image is array of pixel values and it is called as feature vector. If the image size is large, the feature obtained is high-dimensional. Also it is not necessary to keep the entire image intensity for the processing and it will increase the cost of recognition. When the input data to an algorithm is too large to be processed and it is identified as redundant then the input data will be transformed into a reduced representation set of features. The feature extracted should uniquely represent the object, without leaving important information about the object in the image. Feature extraction is considered as process of reducing the amount of information required to describe a large set of data accurately. Based on the literature review conducted for feature extraction, it is observed that the Global feature provides more details and prominent one for object recognition.

The proposed object recognition model for the recognition of 2D objects is given in the Fig. 3.1. It consists of 5 stages. They are

1. Pre-Processing

It is the first stage in object recognition, here the given colour image is converted into greyscale image and the image is resized into the standard resolution 128 x 128. From the greyscale image, the noise reduction technique is applied to remove the noise in the image. From the resultant image, the edge detection method is applied to detect the edges. For edge detection Canny's edge detection method is used.

2. Feature Extraction

The second stage of the system is feature extraction, the proposed feature extraction method extracts the feature and constructs the feature vector for the given image. In general, Hu's moment invariant are computed for the entire image, if the resolution of the image is too high the computation process takes more time. In the proposed method, the Hu's moment invariant is computed from the local parts of the image. Initially the edge detected image is segmented into sixteen parts, each of size 32 x 32. For all the sixteen parts, Hu's moment invariant is computed and arranged into a matrix consists of 16 x 7, totally 112 features are extracted for the given image.
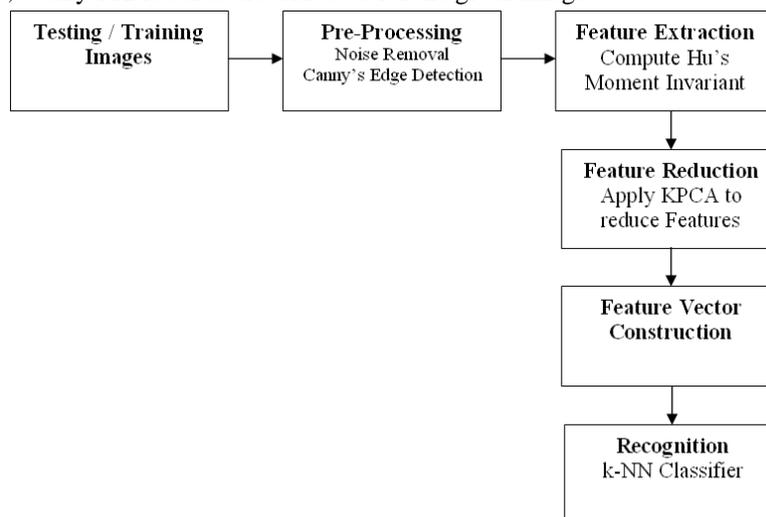

Fig. 3.1 Proposed 2D object recognition model using k-NN classifier

3. Feature Reduction

Feature reduction is the third stage of the object recognition system considered, it is also called as dimensionality reduction. The performance of the k-nearest neighbor classifier degrades when the numbers of features are more. In order to reduce the feature, dimensionality reduction technique is applied. In the proposed work, KPCA method(Kernel Principal Component Analysis) is applied to reduce the number of features. The constructed 16 x 7 (112) features is given as input to the KPCA, it produces the Eigen component, the first 15 Eigen component is selected as feature for recognition.

4. Feature Vector Construction

The generated Eigen component for the given image is arranged as row in the feature vector, and the same process is repeated for all the training images. Each training image Eigen component is considered as row of the feature vector. Once all the training images are processed, the feature vector is constructed and the label of the training image is obtained and formed as part of the feature vector.

5. Recognition

For recognition, the learning free classifier, k-Nearest Neighbor is used. To recognize the object in the test image, the Eigen component is obtained from the test image using the stages 1 to 3. Using the k-Nearest Neighbor, the object in the test image is recognized.

Feature extraction is the salient and more important part in the object recognition system. The objective of the proposed feature extraction method is to extract the features that are sufficient to identify the object and to locate the object in the image. The proposed method adopts the process of calculating the Hu's seven moment invariant from the local parts of the image. The given colour image is converted into greyscale image and the image is resized into 128 x 128 resolution and edge detected. The image is segmented into 16 equal parts, each local part of size 32 x 32. The above said process is shown in Fig. 3.2 to 3.5.

Fig. 3.2 Colour image from COIL 100 dataset

Fig. 3.3 Greyscale image of the original image

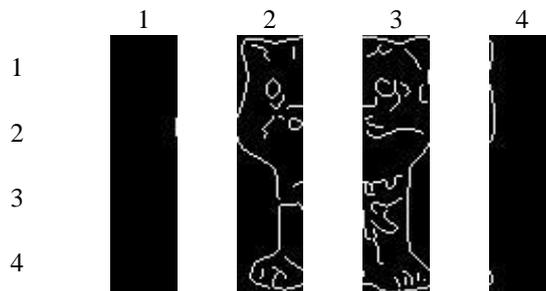Fig. 3.4 Edge detected image using Canny's edge detection operator

Fig. 3.5 Edge detected image segmented into 16 segments

IV. EXPERIMENTATION AND RESULTS

The proposed object recognition system is implemented using MATLAB 7.5 and tested with benchmark dataset like COIL 100. The experiment is performed to show the efficiency and accuracy of the proposed object recognition method. The result of the proposed object recognition method is compared with the Radial Basis Function network [1]. To prove the effectiveness of the proposed feature extraction method, the geometrical moment computed for the entire image, Zernike moment and the Legendre moment are used as feature extraction method. The experimentation is conducted to highlight the importance of the proposed feature extraction method and its efficiency while compared to other feature extraction methods.

Once the training feature vector and the test feature vector and training image labels are ready, the k-Nearest Neighbor classification is done. The Euclidean distance metric is used for finding the distance between the training image and test image feature vectors. Once the distance between the first test image feature values and the training feature vector is computed, the distance is sorted and first '6' values are selected and the respective label is obtained. The majority among the first '6' labels is assigned as label for the test image. The process is repeated for the rest of the test images. There is no specific rule for selecting k in k-Nearest Neighbor classification. In this work, the value for k is selected as '6' by conducting several experiments with different k values.

Table 4.1 Performance of the object recognition for the COIL 100 dataset

Classifier employed	Number of Training Images	% of Recognition for the feature extraction Method			
		Proposed	Geometric	Zernike	Legendre
k-NN	30	93	81	83	83

	60	94	86	87	89
	100	97	87	86	85
	30	85	83	82	83
RBF	60	88	85	84	84
	100	88	86	85	84

From the Fig. 4.1, and Fig. 4.2, it is shown the proposed feature extraction method outperforms the other traditional method and the k-Nearest Neighbor classifier performs well in classifying the object compared to the Radial Basis Function network. From the experimentation results, it is observed that the performance increases when the number of training images increases, as shown in Table 4.1.
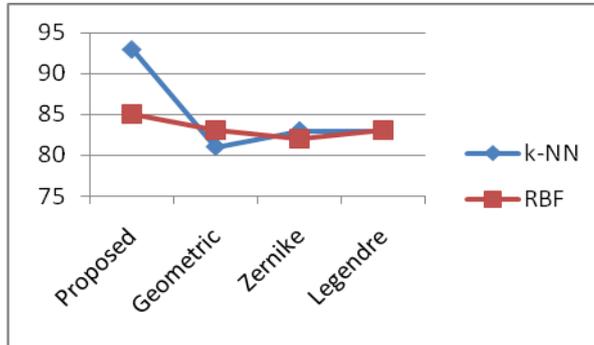

Fig. 4.1 Performance of the classifiers with 30 training images for COIL 100 dataset
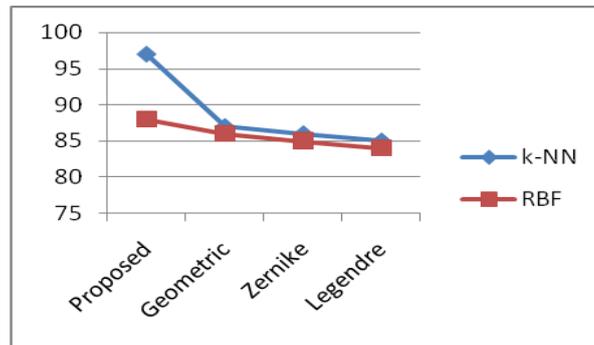

Fig. 4.2 Performance of the classifiers with 100 training images for COIL 100 dataset

The efficiency and the performance of the proposed feature extraction is tested by conducting different set of experiments using different number of training images. From the results obtained during experimentation it is observed that the proposed feature extraction performs well in recognition. Also the number of images used for training is of maximum 100 only, so the performance of the k-Nearest Neighbor is efficient. Once the object in the image is identified, the location of the object is calculated by making simple computation over the local parts of the image. The change in intensity in all the local parts is obtained and the location of the object is calculated and stored as location matrix. Once the location matrix is formed, the bounding box is drawn over the test image to indicate the object.

V.   CONCLUSION

Object recognition system is designed using k-Nearest Neighbor classifier. The classifier was supported by the features generated by the novel feature extraction method. The features are the first 15 Eigen components as an outcome of dimensionality reduction technique over the 112 moment invariant values extracted from the local parts of the image. The efficiency of the proposed feature extraction method is proved by comparing with the traditional feature extraction methods like Geometric moment invariant, Zernike Moment Invariant, and Legendre Moment Invariant. Also to prove the performance of the classifier k-Nearest Neighbour, it is compared with Radial Basis Function neural network. The proposed object recognition system is evaluated with benchmark dataset COIL 100. From the experimentation, it is observed that the proposed object recognition system performs well in recognizing the objects and identifying the location effectively.

REFERENCES

[1]   Asha Gowda Karegowda, Asfiya Nasiha, Jayaram, M.A. and Manjunath, A.S. "Exudates Detection in Retinal Images using Radial Basis Function Neural Network", International Journal of Computer Applications, Vol. 25. No.3, pp. 25-31, 2011.

[2]   Danny Roobaert and Marc Van Hulle, M. "View-Based 3D Object Recognition with Support Vector Machines", In Proc.IEEE International workshop on Neural Networks for Signal Processing (NNSP99), Madison, USA, 1999.

[3]   Hu, M.K. "Visual problem recognition by moment invariant", IRE Transaction on Information Theory, IT-8, pp.179-187, 1962.

[4]   Imola Fodor, K. "A survey of dimension reduction techniques", LLNL technical report, June 2002, UCRL-ID-148494, Vol. 18, No. 1, pp. 1-18, 2002.

[5]   Mamta Juneja, Parvinder Singh Sandhu "Performance Evaluation of Edge Detection Techniques for Images in Spatial Domain", International Journal of Computer Theory and Engineering, Vol. 1, No. 5, pp. 614-621, 2009.

[6]   Mukundan, R. "Some Computational Aspects of Discrete Orthogonal Moments", IEEE Transactions on Image Processing, Vol. 13, No. 8,   pp. 1055-1059, 2004

[7]   Muralidharan, R. and Chandrasekar, C. "Object Recognition using SVM-KNN based on Geometric Moment Invariant", International Journal of Computer Trends and Technology, Vol.1. No.3 pp.215-220. 2011. ISSN: 2231-2803.

[8]   Muralidharan, R. and Chandrasekar, C. "Object Recognition using Support Vector Machine augmented by RST Invariants", IJCSI International Journal of Computer Science Issues, Vol. 8, No.3, pp. 280-286, 2011. ISSN: 1694-0814. (Impact factor : 0.248)

[9]   Muralidharan, R. and Chandrasekar, C. "3D Object Recognition using Multiclass Support Vector Machine – K-Nearest Neighbor supported by local and global feature", Journal of Computer Science,   Vol. 8, No. 8, pp. 1380-1388, 2012. (SNIP : 0.020 & SJP : 0.071)

[10]   Muralidharan, R. "Three dimensional object recognition supported by local and global features" (Doctoral Thesis). Anna University. Retrieved from http://shodhganga.inflibnet.ac.in/handle/10603/26894, 2013.

[11]   Muralidharan R, "Object Recognition Using K-Nearest Neighbor Supported By Eigen Value Generated From the Features of an Image", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 2, Issue 8, pp. 5521 – 5528, 2014. ISSN : 2320-9798.

[12]   Nene, S.A., Nayar, S.K., and Murase, H. "Columbia object image library (COIL-100)", Technical report, Columbia University, 1996.

[13]   Te-Hsiu Sun, Chi-Shuan Liu and Fang-Chih Tien "Invariant 2D object recognition using eigenvalues of covariance matrices, re-sampling and autocorrelation", Expert Systems with Applications, Vol.35, pp.1966-1977, 2008.

[14]   Thawar Arif, Zyad Shaaban, Lala Krekor and Sami Baba "Object Classification Via Geometrical, Zernike and Legendre Moments", Journal of Theoretical and Applied Information Technology, Vol. 7, No. 1, pp. 31-37, 2009.