

Face Recognition Using Textural Feature And KNN

Komal¹, Bindia Handa², Dr. Isha Malhotra³

^{1,2,3}*Dept. Of electronics and communication*

^{1,2,3}*Dronacharya College of Engineering Khentawas, Gurugram, INDIA*

Abstract—Texture features are the very important parameter in the field of image classification and identification. Texture feature-based descriptor are very efficient in face detection and recognition, expression recognition, and in recognizing different component of the face. In this work, face recognition using textural features and k-nearest neighbor has been proposed. In this research, recognition process involves two phases. In first phase some pre-existing techniques are used to detect the face and then gray level co-occurrence matrix (GLCM) is considered from the detected face image after that some statistical texture structures are obtained. In the second segment, these textural features are classified using k-NN classifier. And accuracy of the proposed technique is calculated.

Index Terms—*texture features; classifier; texture classification; feature extraction; k-nearest neighbour.*

I. INTRODUCTION

Texture is the spatial property of image that defines the pixel arrangements on the external surface. It is the complex pattern made up of pixels. Image texture shows different type of properties such as shape, color, brightness, size, etc. For image understanding it is necessary to understand the properties and characteristics of image i.e., how it looks and what are the special features of the image. For human's face image texture analysis, appearance matters a lot. Face appearance varies different times. Such as a single subject can have different face appearance with change in emotions e.g., Happiness, sadness, surprise etc. These differences can be grouped into two parts: difference in size or shape and difference in texture (pixels arrangement). Texture of an image appears as features that can be fixed, progressively variable, and it can be considered as similarity grouping of the image [1]. Spatial variation of image pattern has been recognized using texture analysis. For this purpose, various mathematical operations were performed.

These mathematical models obtained the information from the face image. There is various type of procedures available for labelling the image texture [2]. These techniques can be classified as: statistical, geometrical, model-based techniques, and single processing techniques. The most generally used technique is statistical approach established on second order GLCM. Gray level co-occurrence matrix (GLCM) is a statistical model to obtain the texture features and find out the spatial relation between the pixels of image [3]. GLCM determines the texture by computing the relation between two pixels with fixed values within a fixed spatial arrangement in the image.

Computer recognize the face as a robust object just like as fingerprint recognition. Face recognition is an important parameter in security applications. The excitement to use texture features for face recognition is that these features provide further features of image to utilize in pattern recognition systems. Just like other biometrics approaches facial recognition approach is used for extracting and matching unique features of individuals. So that identification and recognition tasks can be performed with accuracy [4].

In recent years face detection and recognition receives a great interesting from researchers in biometric issues, computer vision and pattern recognition fields. Michael A. Wirth [5] in his research defines the textures so well and mention its technical uses and different applications in the field of image processing and recognition. Akshay et al. [6] projected a method for face recognition using texture features extracted from haarlet pyramid. In this work author decompose the face image on different levels and extract the image features using haarlet pyramid. Level-3 and level-4 of their haarlet experiment outperformed the preexisting techniques. The author worked on coarse texture features and fine textures features. Abdullah et al. [7] in their work they used RGB transformation of

HSI color modal to obtain the layer saturation. Features of the image was extracted using PCA algorithm. They apply these features to the Elman neural network for recognition and their results shows 94% accuracy. Alazawi et al. [8] extracted shape features of image by utilizing moment's value from central moments in gray image. For this they extract essential features of image such as nose, eyes etc. further face was recognized by comparing these feature values with face features present in the database. Dixit et al. [9] worked on face retrieval system. They have used GLCM metric for retrieval face documents. In their research they extract facial feature vector for retrieval of document then these feature documents are compared with face features documents which are already stored in systems database. For face retrieval they have used Mahalanobis distance measurement technique. Lu et al. [10] suggested a system for face retrieval. In this work the author retrieves the face using fused shape and texture features. Author utilize the SDM technique for texture feature extraction. These extracted features are used for recognition and for face retrieval they have used fused shape technique. Ahmed et al. [11] designed a recognition system for low resolution face images. In their work the author used local binary pattern histogram (LBPH) technique to extract the facial topographies. This system based on face angles for identifying the individual by face tracking. The author has used LR500 dataset for training and recognizing. Reddy et al. [12] suggested a method for face recognition. In this work the author utilizes LBP to obtained eight texture features of face image. LBP-Low, LPB-High and their various combination was used to drive these features values. This method provided good recognition results in ideal conditions but insufficient to handle light variation problems. Sundos Abdulameer Alazawi et al. [13] proposed a face recognition and retrieval system in which author have used GLCM feature taking out technique for recognition and for face retrieval, minimum distance between these texture features was calculated, and this calculation was further used for matching and recognition.

For face detection and recognition, researchers hardly depend on skin completion and mathematical computations. But when face image is captured during different time or age interval, skin texture may have scars or some other skin variation. In such a situation,

we consider texture features. Form this viewpoint, texture features for face detection and recognition are used in this research. In this proposed research, we have used edge detection techniques. This technique detects the pixel values at the edge of the image to acquire the large region (whole face). After this some preprocessing operations are applied on the image and then texture features are obtained using GLCM method. These features were stored in feature database. This was the first phase of our work and the result of this phase was applied to the k-nearest neighbor algorithm in order to verifying and recognizing the face images.

II. PRE-PROCESSING OPERATIONS

Beforehand texture feature withdrawal, some pre-processing techniques needs to be applied so that we can get desired results. This technique includes color conversion, edge detection, image enhancement etc. some traditional methods are required to smooth the pattern analysis of image for texture feature extraction [14]. If the face image is colored then firstly it is converted to the gray level image, then image enhancement is performed for noise removal. After this image is converted into binary image. Then in order to get a black and white edge object, we perform thinning operation on face image. Image is segmented into small sections, and the largest region among the segmented regions is the center of the face. And this central segmented image is used for image features matching and recognizing purpose.

A. Textural Feature Extraction using GLCM

Texture analysis is employed in a number of fields and applications. Such as biometric issues, remote sensing, pattern recognition etc. For image processing operations it is essential to mine the significant features. These features can be obtained by GLCM. This technique is widely used by researchers to extract the image features [15]. The GLCM algorithm is carried out for extracting second order matrix of image textures. It is the furthestmost classical second order statistical technique for texture analysis. Image texture of a particular image involves the spatial distribution of pixel intensity. Image texture can be perceived at different resolution levels. The information concerning the location of pixel at which similar gray values are contained within, is obtained

using GLCM algorithm. In this matrix, equal number of rows and columns are occurred together with the numeral of gray levels in an image.

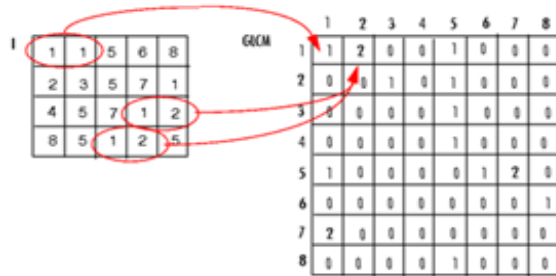


Fig. 1: Gray level co-occurrence matrix of face image.

Texture features computations use the contents of the GLCM to give a measure of the variations in concentration at the pixels of interest. As shown in figure a GLCM matrix is always a square matrix, same no of rows and columns and it is identical to the quantization level of the image. The face image matrix is sampled into 4-bit image after segmentation in order to make the calculation easy and to enhance the performance of system. GLCM textures can be calculated in any angle or direction.as given below:

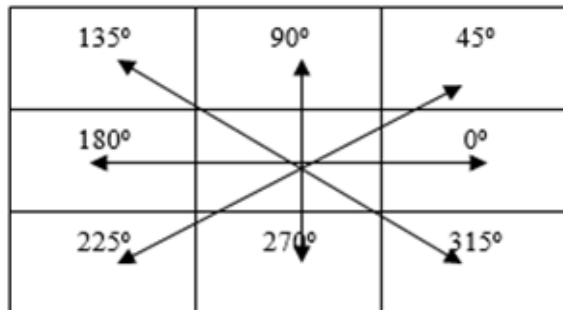


Fig.2: Angle Related to Pixels and its Neighbors for GLCM Calculation.

There are various texture attributes which can be extracted from the Gray-Level Co-Occurrence Matrix. To attain this, some representations are executed: G represents the numeral of gray levels used.

μ is the mean value of P

$\mu_x, \mu_y, \sigma_x, \sigma_y$ denote the means and standard deviations of P_x , and P_y . $P_x(i)$ is used to represent the i th entry in the marginal-probability matrix attained with the sum the rows of $P(i, j)$.

1. Contrast: It is a degree of the local distinctions which is available in an image.

$$CONTRAST = \sum_{n=0}^{G-1} n^2 \left\{ \sum_{i=1}^G \sum_{j=1}^G P(i, j) \right\}, \quad |i - j| = n$$

The contributions from $P(i, j)$ will be favored by this measure of contrast or local intensity variation away from the diagonal, i.e., $i \neq j$

2. Homogeneity: It is a measure of the nearness of the distribution of elements in the Gray-Level Co-Occurrence Matrix to the diagonal of GLCM.

$$\sum_i \sum_j \frac{P_d[i, j]}{1 + |i - j|}$$

3. Local Homogeneity, Inverse Difference Moment (IDM):

$$IDM = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{1}{1 + (i - j)^2} P(i, j)$$

The homogeneity of the image effect the Inverse Difference Moment as the small contributions is obtained to the weighting factor $(1 + (i - j)^2)^{-1}$ IDM from inhomogeneous areas ($i \neq j$). Consequently, the low IDM value is obtained for inhomogeneous images and a comparatively upper value is obtained for the homogeneous images.

4. Entropy: It is a degree for the information content. The unpredictability of intensity dissemination is evaluated by the Entropy. Low first order entropy is contained in the Inhomogeneous scenes, whereas high entropy is included in a homogeneous scene.

$$- \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} P(i, j) \times \log(P(i, j))$$

5. Correlation: It is a feature of gray level linear dependency among the pixels at the definite points in relation to each other.

$$\sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{\{i \times j\} \times P(i, j) - \{\mu_x \times \mu_y\}}{\sigma_x \times \sigma_y}$$

6. Sum of Squares, Variance:

$$VARIANCE = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} (i - \mu)^2 P(i, j)$$

The comparatively high weights are inserted on the features using variance which is different from the average value of $P(i, j)$.

III. PROPOSED SYSTEM

This work introduces a new technique to recognize the human face using GLCM and k-nn algorithm. We use the system outline given in figure below. The preprocessing module includes the noise removal (if any). And calculation of pixel intensity and other features, such as contrast, homogeneity, and entropy, etc. using GLCM matrix and registration steps. After extracting these features KNN classifier is employed for classification purpose.

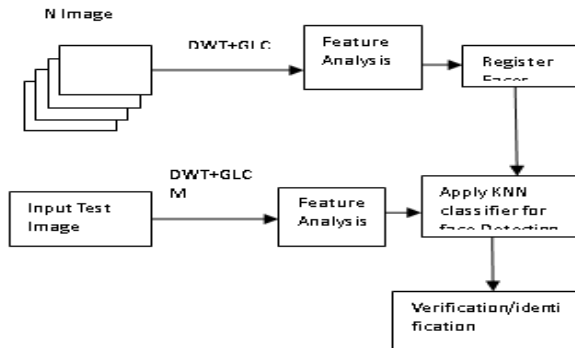


Fig. 3: Proposed System Flowchart.

In KNN classifier preparation samples are described using different n dimensional numeric attributes. A small point is denoted by sample in the n-dimensional space. After which, the part larger in size is stored in an n-dimensional pattern space among the training samples. In case, there is an unidentified sample then the k-nearest neighbor classifier identifies whether this sample is close training samples or not and also look for the pattern space. Euclidean distance technique is used to define whether the unknown sample is similar to training sample or not.

The technique of k-nearest neighbor will prepare the training set based on the features which are extracted. The features which are extracted are the eigen features and color features. The k nearest neighbors get calculated which will form the training set for the final prediction. In the test set, the eigen features of the image get calculated which will be matched with the test set to generate final results. The generated final result will be the predicted set of the test image. The GLCM algorithm is used to prepare training and test set which is described below:

1. The number of pixels present in the matrix is counted as it stores the data.

2. The calculated pixels are put in storage in the matrix P[I,j].

3. The similarity between pixels is checked in the matrix using histogram technique.

4. Calculate contrast factor from the matrix:

$$g = \exp\left[\frac{\text{mean}(I) - \text{minimum}(I)}{\text{maximum}(I) - \text{mean}(I)}\right]$$

5. The elements of g need to be normalized by dividing the pixels.

$$g = \begin{cases} 0.8 & \text{if } g < 0.8 \\ 1.2 & \text{if } g > 1.2 \\ \text{gotherwise} & \end{cases}$$

A. Proposed Algorithm

1. Input N Number of images for the training
2. Calculate GLCM matrix of each image in the dataset
3. Calculate DWT and GLCM features and store in database
4. Input test image for the detection
5. Calculate GLCM features of the test image
6. Define Centroid point on the features for the classification
7. Calculate Euclidian distance to each pixel
8. Show classified result

IV. EXPERIMENTAL RESULTS

We calculate GLCM values for each face image using GLCM algorithm. And classification of images was done using KNN classifier. For better understanding of proposed modal, here some different face images are shown which we have taken as input for recognition.

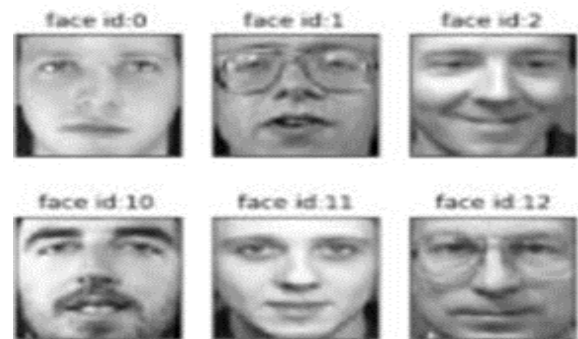


Fig.4: Input Images for Feature Extraction and Recognition.

Different textual features of these images are calculated for recognition, which are discussed above. Calculated values of these features are given below:

Table 1: Different Features Values of Face Images

Image Number	Contrast	Homogeneity	Correlation	Entropy
Image 1	0.92	0.891	1.2	2.56
Image 2	0.90	0.901	1.8	2.90
Image 3	0.89	0.905	1.6	2.78
Image 4	0.93	0.862	1.4	2.65
Image 5	0.92	0.910	1.3	2.12
Image 6	0.91	0.815	1.4	2.15

The presentation of the recommended model is tested in terms of precision, recall and accuracy. We find that proposed modal provides better accuracy. Accuracy, precision and recall rate of the model is given below:

Table 2: Performance Analysis values of Proposed Model.

Parameter	KNN Classifier	KNN+GLCM
Accuracy	84.56 percent	92.34 percent
Precision	83.45 percent	93.45 percent
Recall	81.90 percent	92.65 percent

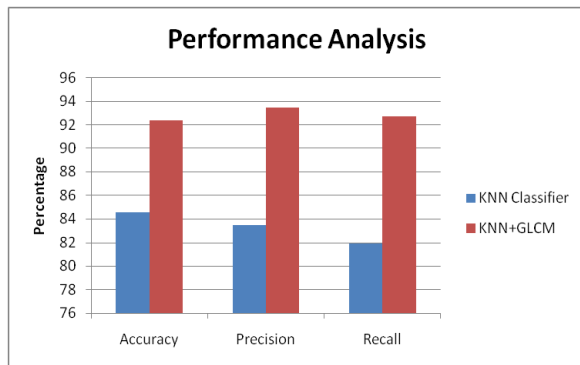


Fig.5: Performance Analysis of GLCM+KNN Face Recognition Model.

Performance analysis of the proposed model is presented in the form of graph (fig.5) to compare the preexisting techniques and our approach. And we find our method provides better results than preexisting techniques.

V. CONCLUSION

In this paper, texture features will be the identifier for face images. This method has been used for extracting features values using GLCM technique. In the occurrence that the input images are taken at different time, and due to this there may be some changes in skin texture, by keeping this in mind we consider textures features because it will help to overcome the above mention issue in the field of face recognition.

One of the most commonly used method for face recognition is to compare the input test face texture features with the image features stored in the database. By doing so we can find the minimum distance values of the image that the test image is related to in the database. This model can also be explored for colored images in order to color information fusion with texture features. And this work can be further explored for face image retrieval.

ACKNOWLEDGMENT

The authors are thankful to anonymous reviewers for their valuable suggestions to improve this research article in the interest of research in the field of face recognition.

REFERENCES

- [1] T. N. Pappas, D. L. Neuhoff, H. De Ridder, and J. Zujovic, "Image analysis: Focus on texture similarity," Proceedings of the IEEE, vol. 101, no. 9, pp. 2044-2057, 2013.
- [2] Tuceryan, M., Jain, A.K.: Texture Analysis. In: Chen, C.H., Pau, L.F., Wang, P.S.P.(eds.): Handbook of Pattern Recognition and Computer Vision, 2nd edn. World Scientific (1999) 207-248
- [3] X. Zhang, J. Cui, W. Wang, and C. Lin, "A study for texture feature extraction of high-resolution satellite images based on a direction measure and gray level co-occurrence matrix fusion algorithm," Sensors, vol. 17, no. 7, p. 1474, 2017.
- [4] R. Bhatia, "Biometrics and face recognition techniques," International Journal of Advanced Research in Computer Science and Software Engineering, vol. 3, no. 5, 2013.

- [5] Wirth, M. A. (2004). Colour Image Processing & Analysis.
- [6] Kekre, H. B., & Thepade, S. D. (2010). Face Recognition using Texture Features Extracted from Haarlet Pyramid. *International Journal of Computer Applications*, 975, 8887.
- [7] A. S. Abdullah, M. A. Abed, and I. Al Barazanchi, "Improving face recognition by elman neural network using curvelet transform and HSI color space," *Periodicals of Engineering and Natural Sciences*, vol. 7, no. 2, pp. 430-437, 2019.
- [8] S. A. H. Alazawi and J. H. Al-A'meri, "Face Feature Recognition System Considering Central Moments," *Int. J. Comput. Eng. Res*, vol. 3, no. 1, pp. 52-57, 2013.
- [9] U. D. Dixit and M. Shirdhonkar, "Face-based Document Image Retrieval System," *Procedia computer science*, vol. 132, pp. 659-668, 2018.
- [10] Z. Lu, J. Yang, and Q. Liu, "Face image retrieval based on shape and texture feature fusion," *Computational Visual Media*, vol. 3, no. 4, pp. 359-368, 2017.
- [11] A. Ahmed, J. Guo, F. Ali, F. Deeba, and A. Ahmed, "LBPH based improved face recognition at low resolution," in *2018 International Conference on Artificial Intelligence and Big Data (ICAIBD)*, 2018: IEEE, pp. 144-147.
- [12] K. S. Reddy, V. V. Kumar, and B. E. Reddy, "Face Recognition Based on Texture Features using Local Ternary Patterns," *International Journal of Image, Graphics & Signal Processing*, vol. 7, no. 10, 2015.
- [13] Alazawi, S. A., Shati, N. M., & Abbas, A. H. (2019). Texture features extraction based on GLCM for face retrieval system. *Periodicals of Engineering and Natural Sciences*, 7(3), 1459-1467.
- [14] P. Gumaste and V. Bairagi, "Feature Extraction of the Brain Tumours with the help of MRI, based on Symmetry and partitioning," *Periodicals of Engineering and Natural Sciences*, vol. 7, no. 3, pp. 1102-1113, 2019.
- [15] A. Humeau-Heurtier, "Texture feature extraction methods: A survey," *IEEE Access*, vol. 7, pp. 8975- 9000, 2019.