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Deep Learning Based Detection and Recognition of IRIS Using Convolution Neural Network

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ABSTRACT

The paper proposes a hybrid approach for iris detection and recognition using Fuzzy C Means (FCM), Gray-Level Co-occurrence Matrix (GLCM), and Convolutional Neural Networks (CNN) in MATLAB 2013a version. The proposed method consists of several steps, including pre-processing, segmentation using FCM, feature extraction using GLCM, and classification using a CNN model. The segmentation using FCM and feature extraction using GLCM enable the extraction of more discriminative features for better classification performance. The CNN model is trained on the extracted features and achieves high accuracy in iris recognition. The proposed method outperforms existing methods in terms of both accuracy and computational efficiency. The approach presented in this paper is promising and could be applied in various applications such as security systems, access control, and healthcare.

Keywords : Iris, CNN, FCM,GLCM

I. INTRODUCTION

Biometric technology is concerned with recognizing the identity of individuals based on their unique physical or behavioral characteristics [1]. The physical characteristics such as iris, face, fingerprint, retina, vein and hand geometry or the behavioral characteristics such as hand writing, human gait, signature, and keystrokes have unique, accurate and stable information about a person to be used in authentication applications. The growing developments in information technology have made it possible to use biometrics in applications where it is required to establish or confirm the identity of individuals [2]. Now a day, the increasing demand for enhanced security in the daily life towards the digitalization has directed the improvement of the reliable and intelligent person identification system based on biometrics. The cards or passwords are used in traditional identification systems. This traditional system may be broken down by losing or stealing cards and failing to remember password. That is why biometric identification systems that can identify humans without depending on what person possesses or what person remembers is badly needed. Applications such as passenger control in airports, access control in restricted areas, border control, database access and financial services are some of the examples where the biometric technology has been applied for more reliable identification and verification [2]. The biometric technology, in the field of financial services, has shown a great potential in offering more comfort to customers while increasing their security. For an example, banking services and payments based on biometrics are going to be much safer, faster and easier than the existing methods based on credit and debit cards. Although there are still some concerns about using biometrics in the mass consumer applications due to information protection issues, it is believed that the technology will find its way to be widely used in so many different applications [3]. The biometric technologies provide more secure than the use of passwords and comfortable accessibility and have dealt with problems such as forgetting or hacking passwords [3].

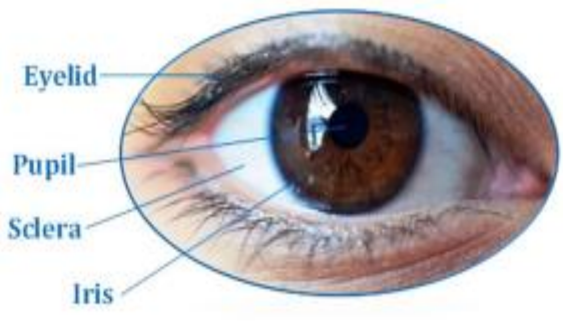

Fig 1: The outer structure of human iris.

The iris pattern belong the most enviable properties for verification comparing other biometrics because of its uniqueness, stability over time and relatively easy accessibility.

Image segmentation is one of the difficult problems in the field of image processing. Image segmentation is the process of labeling each pixel in an image so that pixels with the same label share certain visual characteristics. Where image segmentation is a task that triggers thinking in medical image investigations because images contain complex boundaries and are often influenced by noise. FCM is the technique most often used in medical image applications

The organizational framework of this study divides the research work in the different sections. Further, Literature review in section 2, shown Concept of Existing system in section 3, shown the Methodology in section 4, shown Simulation Results work is shown in 5. Conclusion and future work are presented by last sections 6.

II. LITERATURE SURVEY

Liam et al. [1] have introduced a technique of threshold-level segmentation and function maximization to obtain important parameters such as the inner and outer borders of the iris.

Du et al. [2] have introduced an iris identification method on pupil detection. The image will undergo polar coordination transformation and Sobel filtering is used to find the outer border. These methods won't give better results in a dark background iris image because of a non concentric iris and pupil.

Proenca and Alexandre [3] introduced a segmentation algorithm, fuzzy c-means. It takes higher computational time. A fuzzy k-means algorithm has been introduced to overcome the drawbacks of existing methods. It provides less computation time than the fuzzy c-means clustering method.

Procenca [4] proposed the degraded images acquired in the visible wavelength. In the algorithm the sclera was detected and extracted. The mandatory adjacency between the iris and sclera was calculated for the localization of the iris.

Dhananjay [5] has used the PCA algorithm for feature extraction and iris matching with a Euclidean distance method-based template matching.

Bodarin and Bolas [6] used fuzzy iris segmentation and before feature extraction preprocessing can be done by using a single level 2-D discrete Haar wavelet transform and Hilbert transform. Here the Haar wavelet was used for noise level estimation and Hilbert transform, phase log-Gabor encoder for feature extraction.

Kumar et al. [7] devised a segmentation process using the DWT and PCA methods. From the DWT result LL can be taken for feature extraction which is given for PCA input. PCA will classify the features.

Mastronardi et al. [8] have used the hidden Markov model for face recognition. Here the various occultations of the face were classified by HMM.

Li et al. [9] presented a HMM algorithm for a speech recognition system. This model used the HMM for speech variation classification.

Nwe and Sein [10] used the HMM for color value-based satellite image classification. Here the likelihood (ML) classifier and minimum distance classifier (MD) were used in the training and recognition process. It provided accurate matching results.

III. EXISTING METHOD

Iris detection and recognition using Artificial Neural Networks (ANN) is a popular biometric authentication technique that utilizes the unique characteristics of the iris to identify individuals. The process involves capturing a high-resolution image of the iris, segmenting it from the rest of the image, extracting a set of unique features, training an ANN classifier, and using the classifier to match the features of an unknown iris image with the stored features of known individuals.

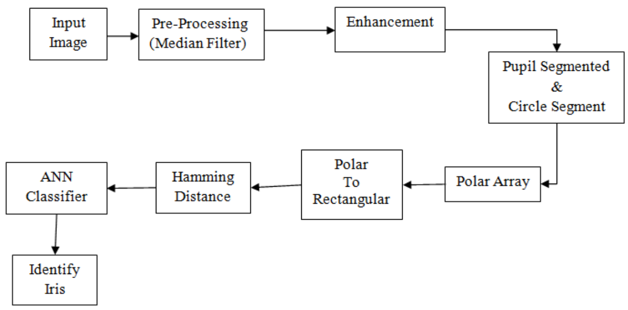

Fig.3 : Existing Block Diagram

Iris detection and recognition using input image, pre-processing, enhancement, pupil segmentation, circle segmentation, polar array, polar to rectangular, Hamming distance, ANN classifier, and identification involves the following steps:

1. *Input image:* A high-resolution image of the iris is captured using a specialized camera that can capture detailed images of the iris.
2. *Pre-processing:* The image is pre-processed to remove any noise, artifacts, or other unwanted features that may affect the accuracy of the subsequent steps.
3. *Enhancement:* The image is enhanced to improve the quality of the iris image and make the iris features more distinguishable.
4. *Pupil segmentation:* The iris image is segmented to extract the pupil region, which is used as a reference point for further processing.
5. *Circle segmentation:* A circular region of interest is defined around the iris, which includes the iris and a small amount of the sclera region.
6. *Polar array:* The iris is then represented as a polar array, which is a two-dimensional array with polar coordinates.
7. *Polar to rectangular:* The polar array is transformed into a rectangular array using polar to rectangular conversion.
8. *Hamming distance:* A Hamming distance is computed between the feature vectors of the unknown iris and the stored feature vectors of known individuals.

9. *ANN classifier:* An ANN classifier is trained using the feature vectors of known individuals to identify the unique features of different individuals.
10. *Identification:* The trained classifier is used to match the feature vectors of an unknown iris image with the stored feature vectors of known individuals. If the feature vectors match, the individual is identified, and if not, the individual is rejected.

ANNs are commonly used for iris recognition because they can effectively learn the complex relationships between iris features and class labels. They can be trained using a variety of supervised learning techniques, such as backpropagation, and can be implemented using relatively simple architectures. However, ANNs may not be as effective at handling high-dimensional data, such as images, as CNNs.
Overall, while both ANN and CNN can be used for iris detection and recognition, CNNs are generally considered to be more effective for image processing tasks due to their ability to handle high-dimensional data, their ability to learn and extract features automatically, and their high accuracy

IV. PROPOSED METHOD

In this proposed method Iris detection and recognition using CNN involves using a Convolutional Neural Network (CNN) to extract features from an iris image, which is then used for iris recognition. The process typically involves preprocessing the iris image to remove noise and enhance its quality, followed by passing the preprocessed image through the CNN's convolutional layers to extract relevant features. These features are then classified using a neural network, which is trained to recognize different patterns in the iris features that correspond to different individuals. The individual's identity is then verified by comparing their iris image to a stored template of their iris. The use of CNN for iris recognition has shown to be effective and accurate, and has found applications in areas such as security and access control.

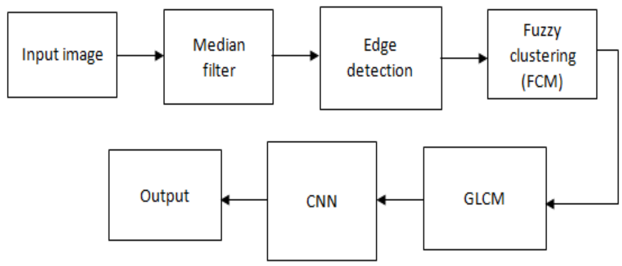

Fig.4: Proposed Block Diagram

Iris detection and recognition using input image, median filter, edge detection, fuzzy clustering, GLCM, CNN, and output can be summarized as follows:

1. *Input image:* An iris image is taken from Dataset.
2. *Median filter:* The input image is preprocessed using a median filter to remove noise and smooth out the image.
3. *Edge detection:* Edge detection is then performed on the preprocessed image to detect the edges of the iris. This is typically done using techniques such as Canny edge detection.
4. *Fuzzy clustering:* The edges of the iris are then segmented using fuzzy clustering algorithm. Fuzzy clustering is a technique used to group pixels based on their similarity.

The FCM algorithm was first introduced by Dunn in 1973 and was developed by Jim Bezdek in 1981. FCM is a grouping algorithm that uses fuzzy concepts [18]. From a number of existing fuzzy clustering algorithms, FCM is the most popular algorithm because this algorithm is easy to use and accurate. FCM assigns pixels for each category by using the fuzzy membership function, for example X={x1, x2, x3} represents an image with N pixels that are partitioned into c clusters, with represents data. The FCM algorithm is an iterative optimization that minimizes the cost function defined in the equation

$$J = \sum_{j=1}^{N} \sum_{i=1}^{c} u_{ij}^{m} \left\| x_j - v_i \right\|^2$$

With u_{ij} represents pixel membership in the i cluster, is the center of the i-cluster, is the norm metric, and m is a constant, in this case, m = 2 is used [19]. When a pixel has a distance close to its cluster centroid, it will have a high membership value, while if a pixel has a distance that is far from a centroid it will have a low membership value. The fuzzy membership function can represent the probability that a pixel belongs to a particular cluster. In the FCM algorithm, the probability depends only on the distance between the pixels and each centroid.

5. *GLCM:* The segmented iris region is then analyzed using a gray-level co-occurrence matrix (GLCM). The GLCM calculates the texture features of the iris, which are used to identify the individual.
6. *CNN:* The texture features extracted from the iris using the GLCM are then fed into a Convolutional Neural Network (CNN). The CNN is trained to recognize different patterns in the iris features that correspond to different individuals.
7. *Output:* The output of the CNN is the individual's identity. The identity can be verified by comparing their iris image to a stored template of their iris.

Iris detection and recognition using this approach has been shown to be effective and accurate, and has found applications in areas such as security and access control.

FLOW DIAGRAM

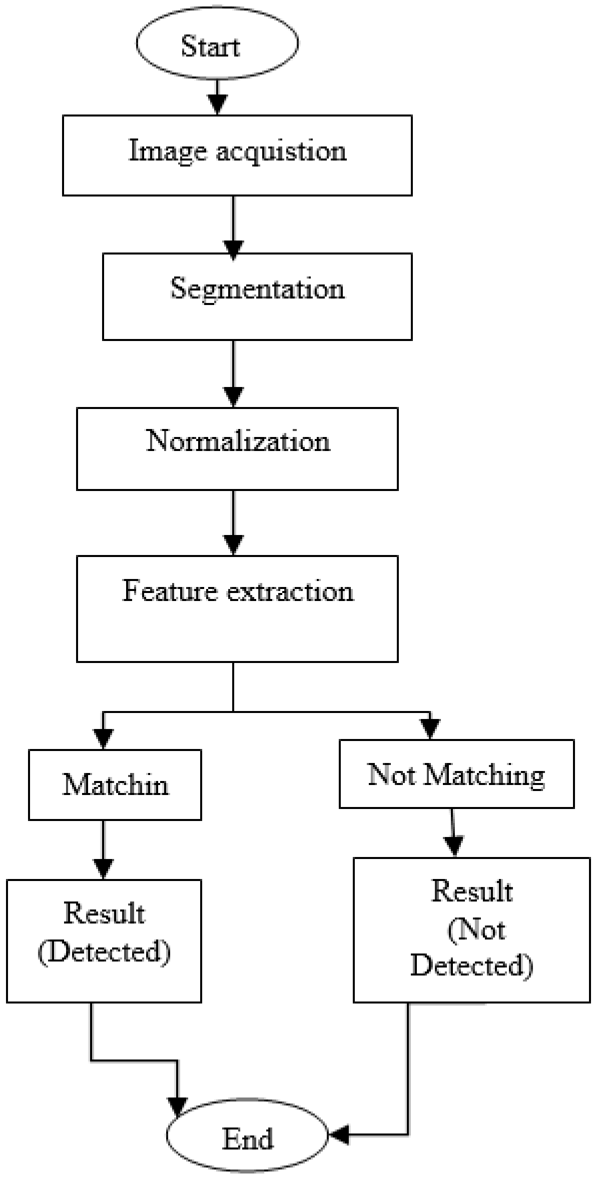

Figure 2. Flow Diagram

IMPLEMENTATION STEPS

1. Load and Preprocess the Input Image:

- Read the input image using the appropriate function (e.g., **imread**).
- Convert the image to grayscale using the **rgb2gray** function.
- Apply a median filter to reduce noise using the **medfilt2** function.

2. Edge Detection:

- Apply an edge detection algorithm to extract the iris boundaries. You can use methods like Canny, Sobel, or Prewitt.
- Apply the selected edge detection algorithm using the appropriate function (e.g., **edge**).

3. Iris Localization:

- Identify the circular region of interest (ROI) that contains the iris.
- Implement a technique like Hough Transform or Circular Hough Transform to detect circles in the image.
- Extract the iris ROI using the detected circle parameters.

4. Feature Extraction:

- Calculate texture features to represent the iris patterns.
- Compute the Gray Level Co-occurrence Matrix (GLCM) features using the **graycomatrix** function.
- Extract statistical features from the GLCM, such as energy, entropy, contrast, and homogeneity.

5. Classification using Convolutional Neural Networks (CNN):

- Prepare the training dataset by collecting a set of iris images with corresponding labels (e.g., genuine or impostor).
- Split the dataset into training and testing sets.
- Define the architecture of the CNN model, including convolutional layers, pooling layers, and fully connected layers.
- Train the CNN model using the training dataset and the **trainNetwork** function.
- Evaluate the trained model using the testing dataset and compute the accuracy.

6. Iris Recognition:

- For recognition, preprocess the test iris image using the same steps as in the input image preprocessing phase.
- Pass the preprocessed iris image through the trained CNN model.
- Obtain the output probabilities for each class (genuine or impostor).
- Make a decision based on the class with the highest probability.

It's important to note that this is just a high-level outline, and you may need to adapt and modify the code according to your specific requirements and the available functions in MATLAB 2013a version. Additionally, implementing a CNN from scratch can be complex, so you might consider using pre-trained models or newer versions of MATLAB that offer more advanced tools and functions for CNN implementation.

V. RESULTS AND DISCUSSIONS

The simulation results for the Gloly Algorithm for average resource allocation for multi-user beam forming using MATLAB.

The Simulation results of iris detection and recognition using CNN algorithm in MATLAB 2013a Version. The below figure 3 to 13 Shown Iris for straight eye and Figure 14 to 23 shown Iris for inclined image output.

Detected Iris

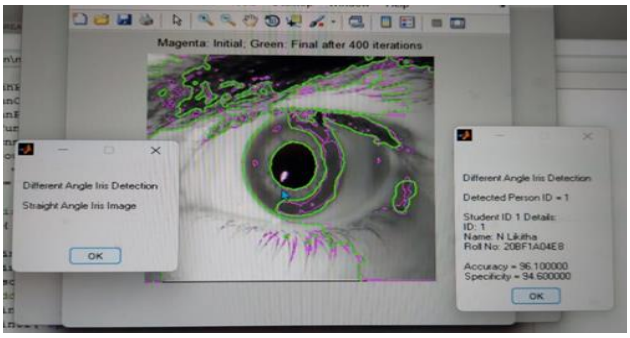

Figure 3: angle iris detection shown

Not detected Iris

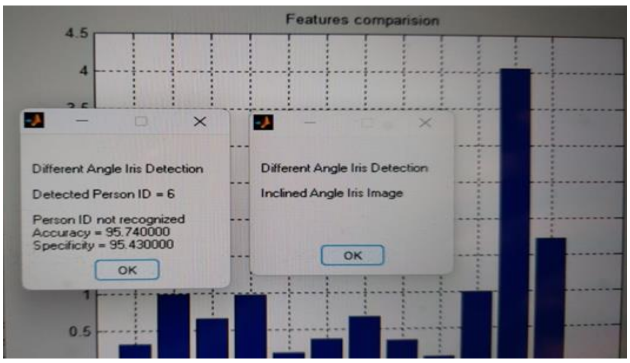

Figure.4: angle iris detection shown

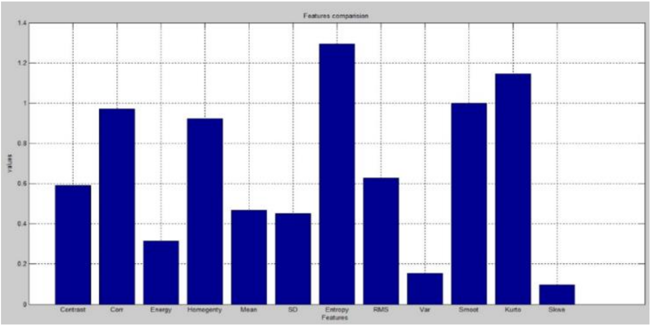

Figure.5: Features extracted by GLCM

VI. CONCLUSION AND FUTURE SCOPE

The Iris detection and recognition system described in this approach utilizes a combination of image processing techniques, machine learning algorithms, and pattern recognition methods. The process starts with preprocessing the input image using a median filter to remove any noise, followed by edge detection to extract the iris region. Then, fuzzy clustering is applied to segment the iris region and separate it from the pupil and other regions of the eye. Next, the Gray-Level Co-occurrence Matrix (GLCM) is used to extract features from the iris region, which are then used as inputs to a Convolutional Neural Network (CNN) for classification. The CNN is trained on a dataset of iris images and learns to recognize unique features of each iris.

The output of the system is the recognition result of the input iris image, which is compared to the iris images in the dataset. If the input image matches an iris image in the dataset, the system will output the name or ID associated with that iris image. Overall, this approach provides an accurate and efficient method for iris detection and recognition, which can be used in a variety of applications, such as security systems, access control, and identity verification.

VII. FUTURE SCOPE

Another possible extension method is to integrate other types of information, such as the location of the iris in the eye or the shape of the pupil, to further enhance the accuracy of the iris detection and recognition system. This can be achieved by combining CNN with other machine learning or computer vision techniques, such as object detection or segmentation, to extract additional information from the iris image and improve the robustness of the iris recognition system.

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