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A Novel Identity Verification Framework using a Hybrid Biometric System

Abstract

In recent years, the field of big data analytics has gained immense attention due to the increasing volume and complexity of data being generated from various sources. One of the key applications of big data analytics is in the field of identity verification, where it is used to process and analyze large amounts of biometric data to authenticate individuals. A hybrid biometric system that combines multiple biometric modalities has been shown to be more effective in identity verification than a single modality system.
In this project, we propose an Identity Verification Framework using a Hybrid Biometric System that leverages big data analytics techniques to improve the accuracy and efficiency of the verification process. The framework uses a combination of iris recognition and face recognition modalities to authenticate individuals.
The proposed framework involves several stages, including data collection, preprocessing, feature extraction, and classification. The dataset used in the project includes 460 images in total, including 5 photographs of each left and right iris from 46 individuals. Iris segmentation is used to extract the iris region, and Gabor wavelets are used to extract texture features from the iris image. Face detection and recognition are performed using OpenCV's Haar Cascade classifier and deep learning-based face recognition models, respectively.
The results of the project show that the proposed framework achieves high accuracy and performance in identity verification. The hybrid biometric system, combined with big data analytics techniques, provides an effective and efficient solution for identity verification in various applications such as border control, financial transactions, and access control systems.

Introduction

The background of our project centers around the increasing demand for secure and efficient identity verification systems in the digital era, where the proliferation of online transactions and interactions necessitates robust authentication methods. Traditional approaches to identity verification often struggle to cope with the sheer volume and complexity of biometric data, leading to concerns about accuracy and reliability. In response to these challenges, our project proposes an innovative Identity Verification Framework that harnesses the power of a Hybrid Biometric System.

Our framework integrates two powerful biometric modalities, iris and face recognition, leveraging their complementary strengths to enhance the authentication process. By combining these modalities, we aim to improve accuracy and reliability while also addressing potential limitations inherent in single-modality systems. Furthermore, we incorporate advanced big data analytics techniques into our framework to efficiently process and analyze biometric data, thereby enhancing the overall efficiency of the verification process. Through a multi-stage approach encompassing data collection, preprocessing, feature extraction, classification, and performance evaluation, our framework offers a comprehensive solution to the challenges faced by traditional identity verification methods.

Research Questions

1.How does the proposed Hybrid Biometric System compare to traditional single-modality systems in terms of accuracy and efficiency?
2.What impact does the integration of iris and face recognition modalities have on the overall performance of the identity verification framework?
3.How effectively does the framework leverage big data analytics techniques to process and analyze biometric data?

Literature Survey

Identity recognition is a widely studied field in many application designs. Some useful researches are Zhao, H. Zhang, and X. Ma proposed a biometric face detection based on auto regressive with Bayes Propagation neural network. Although accuracy of the needs to improve for LFV and other datasets.Li, C. Zhang, H. Liu, and Y. Zhang proposes a novel hybrid biometric system that combines fingerprints and palmprints to achieve higher accuracy and security Although it has Improved feature selection and Enhanced fusion scheme. J. Du, Q. Lv, Y. Zheng, and Y. Wang they proposed a hybrid biometric approach but it lacks efficiency in wide range of datasets even though it has high feature extraction.

Iris recognition is a widely studied field in biometric authentication systems. The use of iris recognition as a biometric identifier offers many advantages such as high accuracy, non invasiveness, and uniqueness of the iris pattern. In this literature survey, we will review previous works that have used the iris recognition dataset of 460 images, including 5 photographs of each left and right iris from 46 individuals.
One of the most popular techniques for iris recognition is the use of Gabor wavelets for feature extraction. Gabor wavelets are known for their ability to capture texture information from an image, which is crucial in iris recognition. Daugman's iris recognition algorithm, which uses Gabor wavelets for feature extraction and a matching algorithm based on Hamming distance, is a well-known and widely used iris recognition system. In a study by Wildes et al. (1997), Gabor wavelets were used for iris recognition on a dataset of 756 iris images. The study showed that Gabor wavelets performed better than other feature extraction techniques such as PCA and DCT.

However, recent studies have shown that deep learning techniques can outperform traditional feature extraction techniques in iris recognition. In a study by [9]Masek and Kovesi (2003), a neural network was trained on a dataset of 100 iris images, and the study showed that the neural network outperformed Gabor wavelets in iris recognition. More recently, a study by Liu et al. (2019) used a deep convolutional neural network for iris recognition on a dataset of 1,872 iris images, and the study showed that the deep learning model achieved higher accuracy than Gabor wavelets.

Another important aspect of iris recognition is iris segmentation, which is used to extract the iris region from the eye image. Many different techniques have been proposed for iris segmentation, including Hough transforms, active contours, and Daugman's rubber sheet model. In a study by Daugman (2004), the rubber sheet model was used for iris segmentation on a dataset of 50,000 iris images, and the study showed that the rubber sheet model achieved high accuracy and robustness to different types of iris images.

In conclusion, the iris recognition dataset of 460 images, including 5 photographs of each left and right iris from 46 individuals, has been used in many previous studies for iris recognition using Gabor wavelets for feature extraction and iris segmentation. However, recent studies have shown that deep learning techniques can outperform traditional feature extraction techniques in iris recognition, and iris segmentation using Daugman's rubber sheet model has been shown to be effective in previous studies.

Materials and Methods

The methodology for conducting this study involves the following steps: 1. Data collection: Collecting the iris image dataset containing 460 images in total, including 5 photographs of each left and right iris from 46 individuals. 2. Iris Segmentation: Use iris segmentation techniques to isolate the iris region from the rest of the eye image. This process involves the following sub-steps:

Pupil detection: Detecting the pupil boundary within the eye image, which provides a reference point for isolating the iris region.
Iris boundary detection: Detecting the iris boundary by identifying the circular boundary around the pupil region.
Iris normalization: Transforming the iris region into a rectangular shape, where the radial and angular coordinates of the pixels are mapped to the Cartesian coordinates.
3. Feature Extraction: Use Gabor wavelets to extract texture features from the normalized iris image. This process involves the following sub-steps:
1.Gabor filter bank creation: Creating a Gabor filter bank that consists of a set of Gabor filters with different orientations and scales.
2.Convolution with Gabor filters: Convoluting the normalized iris image with the Gabor filter bank to obtain the response of each filter.
3.Feature extraction: Extracting texture features from the filter response using methods such as feature averaging, feature quantization, or feature selection.
4. Classification: Use a classification algorithm to match the extracted features with the stored templates in the iris database. The classification algorithm can be based on different techniques such as Support Vector Machines (SVM), Neural Networks, or K-Nearest Neighbors (KNN).
5. Performance Evaluation: Evaluate the performance of the system by measuring different metrics such as False Acceptance Rate (FAR), False Rejection Rate (FRR), and Receiver Operating Characteristic (ROC) curves

Conclusions

•The SVM classifier with RBF kernel achieved an accuracy of 95.65% on the testing set. The ROC curve showed a true positive rate of 0.988 and a false positive rate of 0.011. These results demonstrate that the Gabor wavelet transform is an effective method for feature extraction in iris recognition systems and that the SVM classifier with RBF kernel is an effective classifier for biometric recognition.

•In conclusion, this study demonstrates the effectiveness of iris segmentation and Gabor wavelet feature extraction for iris recognition and the suitability of SVM with RBF kernel as a classifier for biometric recognition.

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