AID 324 Image Processing

Project Title:

Signature Biometric Identification

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Abstract

This project focuses on developing a signature biometric identification system using image processing techniques. The dataset consists of 30 handwritten signatures from 420 users, which were processed and analyzed to achieve high accuracy in identification. The key steps involved in the project include noise removal using median filtering, image enhancement through histogram equalization and contrast stretching, and edge detection using Laplacian and high-pass filters. Additionally, data augmentation techniques, such as reducing line thickness, adding random noise, and random stretching, were applied to the images. The preprocessed images were then resized to 224x224 pixels and normalized before being fed into a pre-trained MobileNetV2 model. The final model achieved a test accuracy of 98.33%, demonstrating the effectiveness of the proposed approach. Furthermore, the project incorporated an XOR algorithm for encryption and decryption of the signature images, enhancing the security and privacy aspects of the system.

Problem Definition:

The primary objective of this project is to develop a robust and efficient signature biometric identification system that can accurately recognize and authenticate individuals based on their handwritten signatures. Signature-based identification is a widely accepted and commonly used method for personal verification, as signatures are unique to each individual and can serve as a reliable biometric modality. However, the challenges associated with signature recognition, such as variations in signing styles, noise, and environmental factors, necessitate the development of advanced image processing and machine learning techniques to achieve high accuracy and reliability.

Objectives:

- Preprocessing the signature image dataset using various techniques, including median filtering, histogram equalization, contrast stretching, Laplacian filtering, and high-pass filtering, to enhance the image quality and remove noise.

- Applying data augmentation techniques, such as reducing line thickness, adding random noise, and random stretching, to increase the diversity and robustness of the training data.

- Developing a deep learning-based classification model using a pre-trained MobileNetV2 architecture, which is fine-tuned and optimized for the signature recognition task.

- Evaluating the performance of the developed model on the test dataset and achieving a high accuracy in signature identification.

- Implementing an XOR algorithm for the encryption and decryption of the signature images, ensuring the security and privacy of the biometric data.

Methodology:

The project was carried out in several stages:

Data collection and preprocessing:

The dataset of 30 handwritten signatures from 420 users was obtained, and various image processing techniques were applied to enhance the image quality and prepare the data for model training.

Data Preparation:

The images were resized to 224*224 pixels and normalized. The classes were named using numbers for model training.

Data augmentation:

To increase the diversity and robustness of the training data, data augmentation techniques, such as reducing line thickness, adding random noise, and random stretching, were employed.

Model Development:

A pre-trained MobileNetV2 model was used as the base architecture, and the final layer was modified to match the number of classes (users) in the dataset. The model was then fine-tuned and optimized for the signature recognition task.

Model evaluation:

The trained model was evaluated on the test dataset, and the overall accuracy was calculated to assess the performance of the signature biometric identification system.

Data Security:

The XOR algorithm was used to encrypt signature images, ensuring the security of the biometric data.

Results and Interpretation:

The median filtering effectively removed noise from the signature images, while histogram equalization and contrast stretching enhanced the image contrast and made the distinctive features more prominent. The Laplacian and high-pass filters helped in edge detection, further improving the ability of the model to capture the unique characteristics of each signature.

The data augmentation techniques, such as reducing line thickness, adding random noise, and random stretching, increased the diversity of the training data, making the model more robust and less susceptible to overfitting. This, in turn, contributed to the high accuracy achieved on the test dataset.

The signature biometric identification system developed in this project achieved a remarkable test accuracy of 98.33%, demonstrating its effectiveness in accurately recognizing and authenticating individuals based on their handwritten signatures. The combination of image preprocessing techniques, data augmentation, and the use of a pre-trained deep learning model (MobileNetV2) proved to be a successful approach in addressing the challenges associated with signature recognition.

The implementation of the XOR algorithm for encryption and decryption of the signature images adds an additional layer of security and privacy to the biometric identification system. This feature ensures the protection of the sensitive biometric data, addressing the growing concerns about the confidentiality and integrity of such information.