An effective model for the iris regional characteristics and classification using deep learning alex network

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Abstract

The research introduces an innovative model to enhance iris recognition systems, crucial for biometric security. Traditional iris recognition methods suffer from inaccuracies due to improper iris feature extraction when raw images are directly fed into deep learning models. Our proposed model significantly improves this process by incorporating a preprocessing stage that accurately delineates iris boundaries before they are inputted into an AlexNet deep learning network. This methodology achieves a remarkable accuracy of 99.1%, substantially increasing the reliability of iris-based identification systems.

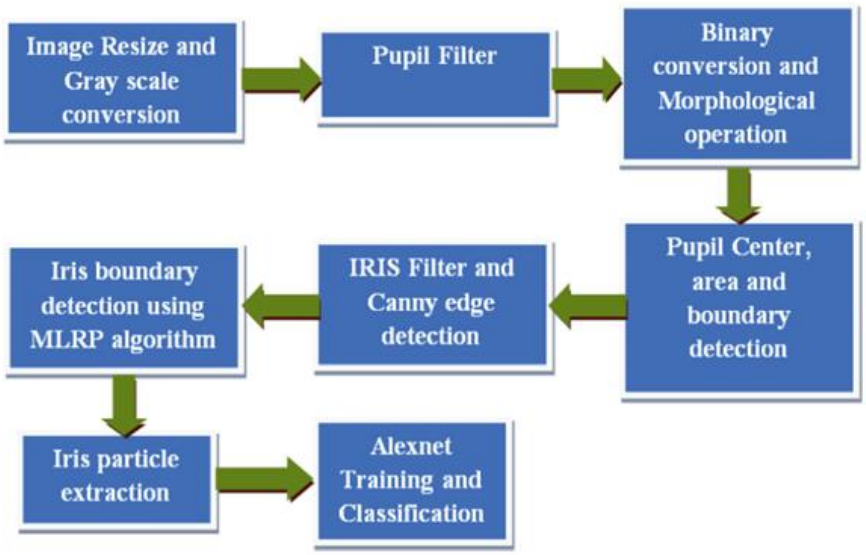
Introduction

Iris recognition technology is becoming a cornerstone of secure authentication and identification processes across various sectors due to its non-invasive nature and uniqueness for each individual. Despite its potential, current methodologies often face challenges due to the complex visual characteristics of the eye, where factors like eyelashes, eyelids, and reflection can obscure the iris features critical for accurate identification.

- Current Challenges: Existing systems often feed raw images into deep learning architectures like AlexNet without sufficient preprocessing. This results in the inclusion of irrelevant features such as eyelashes and eyelids, which compromise the integrity of iris feature extraction and subsequently reduce system accuracy.

- Proposed Solution: Our research proposes a model that preprocesses eye images to extract and refine iris boundaries accurately using a novel algorithm before they are fed into the deep learning model. This preprocessing includes the use of the Multiple Left-Right Point (MLRP) algorithm to detect precise iris boundaries, ensuring that only relevant features are considered during classification.

- Technological Advancements: The AlexNet architecture in the proposed model has been specifically modified by replacing its layers 23, 24, and 25 to tailor it for iris feature recognition. The adjustments made in other layers also support the customization, allowing the network to better handle the unique aspects of iris data.



Methodology

-Preprocessing: The initial step involves detecting and recording the pupil center and boundaries using advanced image processing techniques. This is followed by comparing these with a reference pupil center and boundaries, employing the MLRP algorithm for enhanced boundary detection.

- Deep Learning Model Enhancement: After preprocessing, the images undergo classification through a modified AlexNet model. The network has been fine-tuned to accommodate the specific characteristics of iris features, including adjusting several layers to optimize the training process based on the unique data structure of iris images.

- Validation and Testing: The processed and segmented iris features are then validated using a dataset that includes various challenging scenarios to ensure the robustness and reliability of the model under different environmental conditions.

Results and Discussion

- Model Performance: The model achieved a classification accuracy of 99.1%, demonstrating a substantial improvement over traditional methods which typically achieve between 95% to 98% accuracy.

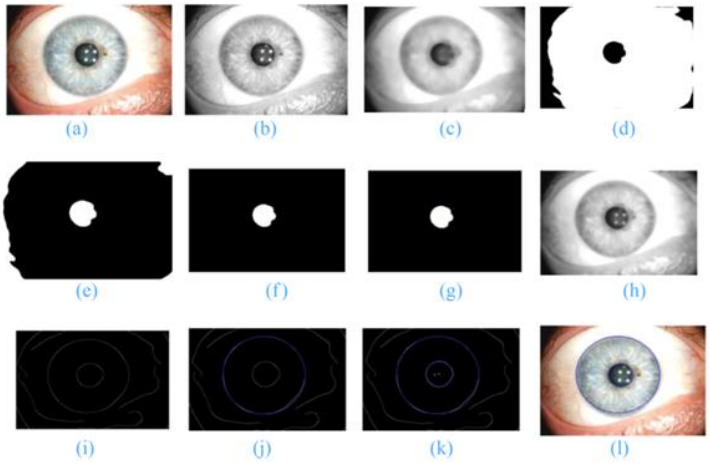
- Metric Improvements: Sensitivity and specificity metrics were exceptionally high at 99.68% and 98.36%, respectively, with an F1-score of 0.995, indicating very high precision and recall.

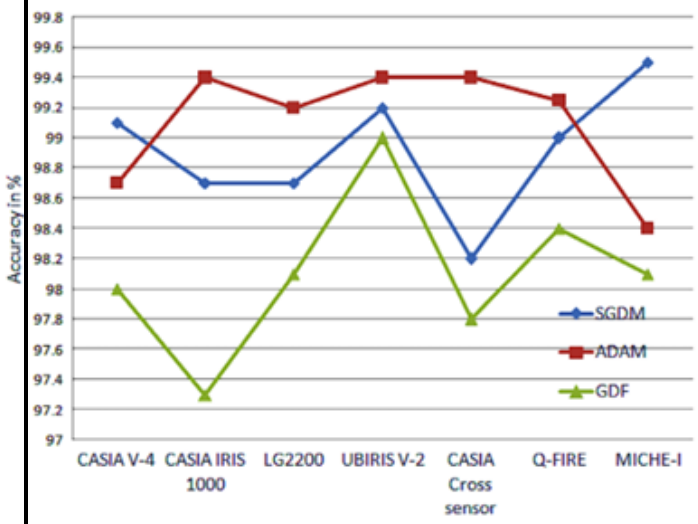
- Comparison with Existing Techniques: The study highlighted the superior performance of the proposed system against existing models. The introduction of a preprocessing step before the application of deep learning significantly enhances the extraction and classification of iris features, setting a new benchmark for the technology.

Conclusion and Future Work

This study successfully develops a high-performing iris recognition model that integrates advanced image preprocessing with deep learning techniques. The proposed method not only enhances the accuracy of iris recognition systems but also expands their applicability in real-world scenarios where environmental factors previously posed significant challenges.

Future research will focus on further refining the preprocessing algorithms to handle an even broader range of image quality and occlusion scenarios, potentially integrating real-time processing capabilities to extend the model's applicability in dynamic environments. Additionally, exploring the integration of this model into multi-modal biometric systems could provide a comprehensive framework for secure and reliable human identification technology.





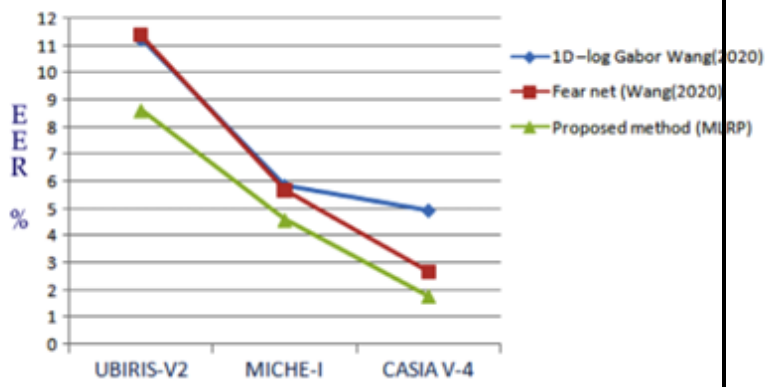


FIGURE 8 AlexNet solver analysis