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Finger Vein Detection using Deep Learning

Yashaswini Kini[1], Dr. Chitra K[2], Mrs. Harilakshmi V M[3]
Student MCA, IVth Semester[1]
Associate Professor, Department of MCA[2]
Assistant Professor, Department of MCA[2]
Dayananda Sagar Academy of Technology and Management, Udaypura, Bangalore, Karnataka, India
yashaswinikini0410@gmail.com

Abstract: *The deep learning is a part of machine learning that uses neural networks with many layers (deep architecture) to fit the intricate patterns. Deep learning has shown remarkable performance in image classification mainly due to its ability in learning and extracting features from the raw inputs. In this research study, some techniques of image preprocessing were described and utilized to machine learning algorithm for image classification. The purpose was to promote the specific preprocessing techniques on the impact, which are commonly used in classification model of images, relating to time and precision improvement. The techniques that are applied in this documentation include; image enhancement, binarization, transformation, edge detection and scaling. The present research study therefore comes handy in trying to establish the significance of enhancing statistic and the impact on the performance of the model. The following preprocessing methods have been used because the image datasets need preprocessing to be input for the machine learning models for better image classification*

Keywords: Image Processing, Binarization, Convolutional Neural Network, Image Segmentation, Feature Extraction

I. INTRODUCTION

Biometrics has become a common feature in people's daily life, ranging from doors and gates, attendance machines, border control, and customs among others, making biometrics a fundamental tool in the identification of individuals and security measures. Thus, finger vein recognition is characterized as unique and offers several advantages like distinguishing living bodies and immunity to copying, theft, and forgery. This has pulled into focus finger vein recognition as being a critical area of interest of biometrics[6].The step of image preprocessing is considered to be the key step when developing complex applications in the sphere of computer vision and machine learning. This process is comprehensive involving methods that aim at improving on the quality of images and hence their usability. The preprocessing indeed plays immense role for the success of machine learning models reducing the misclassification ratios. The purpose of this research paper is to come up with the right approach in which various preprocessing techniques will be incorporated in the enhancement of image classification. Through systematically applying these techniques the study aims at achieving the objectives of improving accuracy and reliability of model through preprocessing to emphasize on the critical place of preprocessing in the success of the fields of machine learning.

1.1 PROBLEM STATEMENT

Design a reliable bio metric finger vein recognition system that can effectively recognize people from the vein patterns extracted from the finger's infrared images. The system should involve pre-processing of images, followed by enhanced methods of computer vision, and end up with conclusions by efficient machine learning algorithms to ensure accuracy and reliability in the biometric identification process.

II. LITERATURE SURVEY

In the 2017 paper "Finger Vein Recognition", Dr. S. Brindha described a method of biometric authentication based on finger vein patterns. It has explained the process of near-infrared imaging to take unique vein patterns to enhance the system security and reliability[1]. The paper "Lightweight Multi-Scale Feature Bilinear Fusion Network for Finger

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Vein Recognition" Bin Ma, et al proposing the method by fusing the global and local features with bilinear pooling and mixed depth-wise separable convolution to decrease computation burden. Acquiring 99% recognition accuracy, It reduces the computational load by 25% and the average time per image to about 4 milliseconds, improving real-life finger vein recognition applications[2].

Nurhafizah Mahri, et al. in the year 2019 proposed a finger vein recognition algorithm by using Phase-Only Correlation instead of intensity data. This method improves the recognition accuracy and its stability to take necessary measures for the problems of mean variance, illumination, and image quality. On finger vein datasets, it presents high accuracy and enhances the biometric security systems[3].Zhi Liu and Shangling Song (2012) designed an embedded real-time fingerprint recognition system apply for protecting the security of user authentication for the mobile devices in IEEE Transmission on Consumer Electronics. Their approach uses fingerprint biometrics with low computing complexity guaranteeing high accuracy and real time results, which are useful in consumer electronics[4].

In their June 2021 paper "DGLFV: In "Deep Generalized Label Algorithm for Finger-Vein Recognition," Zhi Liu and Shangling Song enhance the finger vein recognition rate by developing a deep neural network. Theirs works on the aspects of the image segmentation and noise in the process of biometric identification helping to increase its efficiency. As experimental data indicates, it defines higher results compared with the existing standards [5].The paper of Lu Yang et al. presents Locality- Constrained Consistent Dictionary Learning (LCDL) to overcome the issues related to the partial sections of finger vein patterns with less number of imaging planes for small- area authentication. Directions for future work include growing the database of subjects and applying LCDL to other small-area vein recognition problems[6].

In the paper Finger Vein Recognition Based on Reflection Imaging, written in 2021by Zejun Zhang, et al., have introduced an improved method of finger vein recognition based on the reflection imaging. Algorithms tested offer a certain level of efficiency proving to excel the previous methodologies in several conditions, enhancing biometric security systems. [7].Zhongxia Zhang and Mingwen Wang also put forward the finger vein recognition method which does not involve image segmentation; thus, the method does not depend on qualities and noises of images. Based on their method, they achieved high accuracy on two finger vein databases and proposed method can be a potential technique of biometric recognition. In future work random data should be used as random as possible and larger databases should be collected in order to make fair comparisons[8].

III. METHODOLOGY

3.1. Existing Method

Previous work mainly analysed raw image data with minimal preprocessing and develops fuzzy machine learning models. This means that the machine learning algorithm is wired to provide noisy data, untrained features, and a lack of adequate training for its overall learning process.

3.2. Proposed Method

The following image preprocessing techniques are recommended to be adopted in order to prepare the image datasets to form a strong approach in the system as mentioned above. The pipeline includes the following steps: The steps that characterize the framework of the pipeline can be described as follows:

1. Image Sharpening: The increase of the image edges with the help of the associated convolution kernels.

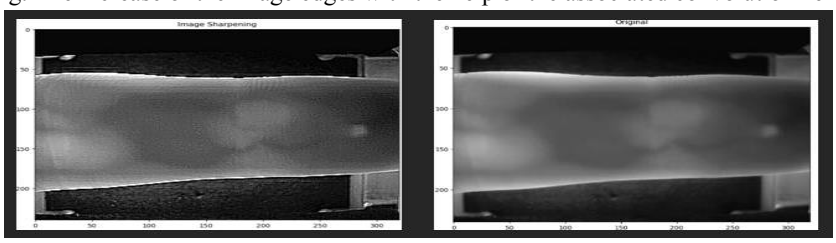

Figure 1. Original and Sharpened Image

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2. Thresholding: It is carried on the images by applying on the pictures to binary format using the Global Threshold and the Adaptive Threshold.

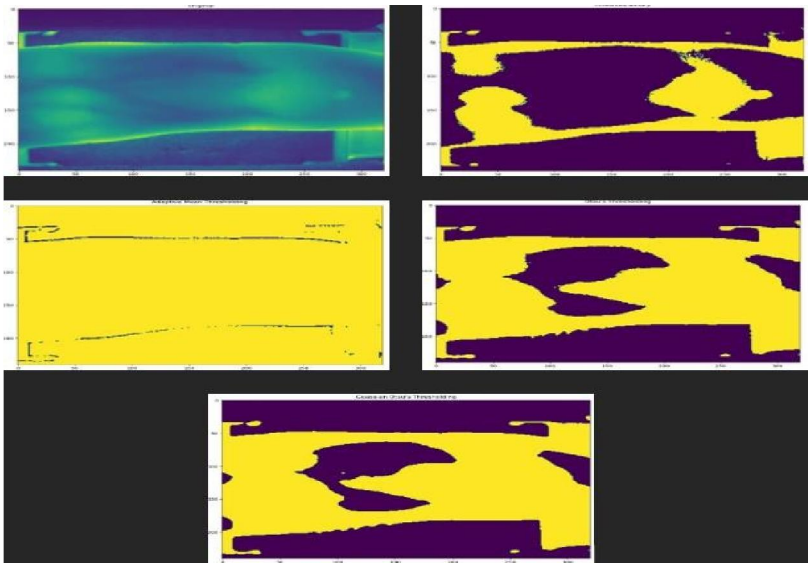

Figure 2. Original and Threshold Images

3. Morphological Operations: Considering bearings with regards to the techniques of erosion, dilation, opening and closing in the improvement of picture features.

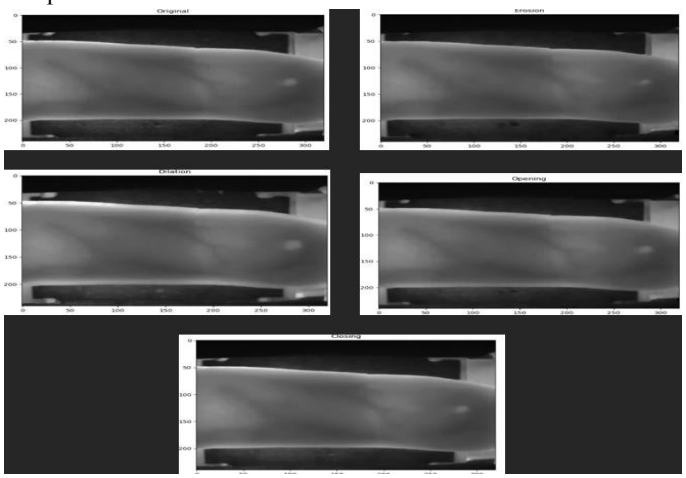

Figure 3. Original and Morphological Image

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4. Edge Detection: Sobel and Laplacian benchmarks as well as Canny were used in the next step to further detect more edges.

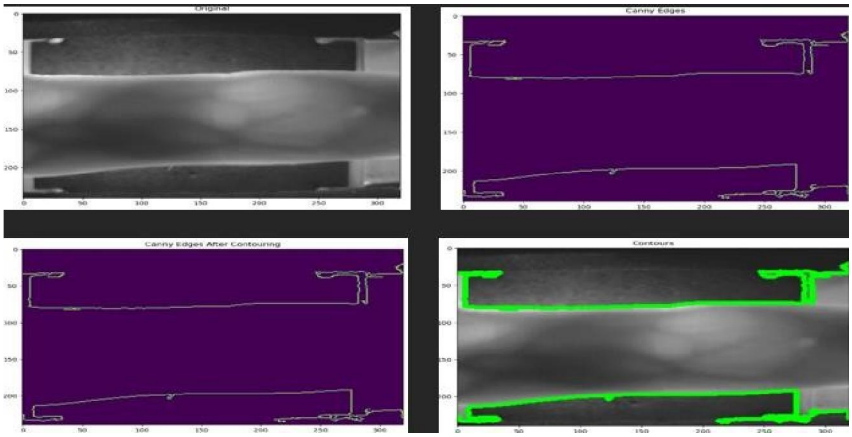

Figure 4. Original and Edge Detection Image

5. Image Scaling: Resizing images with the help of two techniques of interpolation.

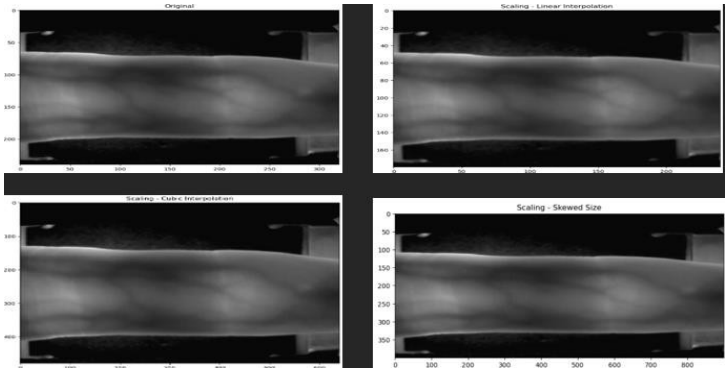

Figure 5. Original and Image Scaling

6. Data Augmentation: New image formation has more specific Basic Strategies to expand the dataset include using image variations by rotation, translation, scaling, and flipping to create new images.

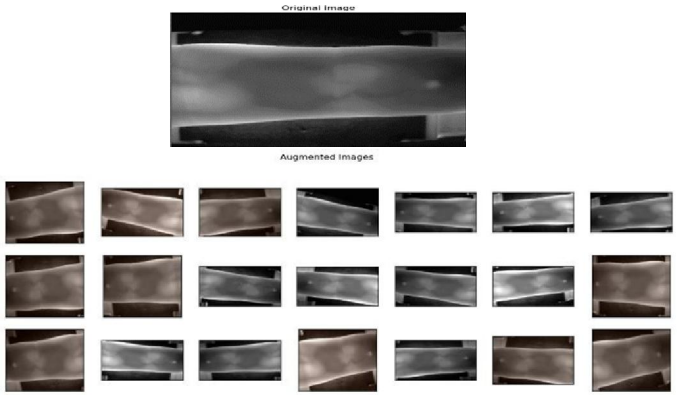

Figure 6. Original and Data Augmentation Image

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IV. RESULTS AND DISCUSSIONS

In this work, a consolidated list of image pre-processing and augmentation procedures that may help improve the results found in the application of deep learning models for image analysis was created. To enhance quality and variety of the images sharpening, threshold conversion and morphological transformations were carried out. It also simplifies the manner in which features of interest are identified and by removing irrelevant information the accuracy is also enhanced. To reduce overfitting and to improve the models robustness, the data was split into training, validation and test set and augmentation of the data was carried out on the three subsets.

V. CONCLUSION

In conclusion, this research aims at identifying several image processing and machine learning techniques in formulating the classification issue for the image databases. Alike, TensorFlow's Image Data Generator helped in applying data augmentation techniques which improved generality by generating many instances of the training data. Subsequently, several classifiers such as CNNs were trained and tested on the processed dataset of each class, with high accuracy. The study also notes that, incorporation of the new algorithms of image processing can go along way in improving diagnostic performance with the aid of machine learning.

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