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Performance of Hasty and Consistent Multi Spectral Iris Segmentation using Deep Learning

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ABSTRACT

The recognition system is composed of seven phases: acquisition, preprocessing, segmentation, normalization, feature extraction, feature selection, and classification. In the acquisition phase, iris images are captured, followed by preprocessing to enhance the quality of the images. The segmentation phase involves separating the iris region from the background, and the normalized iris region is shaped into a rectangle in the normalization phase. Iris segmentation is a critical step in iris recognition systems and has a direct impact on authentication and recognition results. However, standard segmentation techniques may not perform well in noisy iris databases captured under challenging conditions. Moreover, the lack of large iris databases hinders the performance improvement of convolution neural networks. The proposed method addresses these challenges by effectively handling irregular iris images captured under visible light. The iris region is processed and evaluated to generate a unique feature vector, which is then used for person identification. VGG16, a well-known deep learning model, is employed for image classification, and the feature vector is fed into VGG16 for classification purposes.

KEYWORDS: *Deep Learning, Multi Spectral Iris, neural networks, VGG16*

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INTRODUCTION

A biometric system is an automated system that recognizes individuals based on unique features or characteristics. Various biometric systems have been developed using different features such as fingerprints, facial features, voice, hand geometry, handwriting, the retina, and the focus of this thesis, the iris [1]. Biometric systems typically operate in two modes: an enrollment mode for adding templates to a database and an identification mode where a template is created for an individual and matched against the pre-enrolled templates in the database. . The iris comprises several layers, including the epithelium layer with densely pigmented cells and the stromal layer with blood vessels, pigment cells, and iris muscles [1]. The color of the iris is determined by the density of stromal pigmentation.

The epigenetic nature of iris patterns results in each eye of an individual having independent patterns, even in the case of identical twins. The iris is an externally visible and protected organ, maintaining its stable epigenetic pattern throughout adulthood. The visual system plays a crucial role in processing information within the human body [2]. An integral component of the visual system is the eye, which consists of three concentric layers. Biometric research and development require the analysis of human data. However, it is impractical to perform algorithm testing on real-time captured data due to various constraints [3]. Therefore, standardized biometric databases play a crucial role in the testing and evaluation of recognition methods.

Biometrics encompasses quantifiable data related to human characteristics and traits. It is used for identification and access control in computer science and surveillance applications. In the initial phase of biometric processing, various characteristics are captured. However, for automated capturing and comparison with stored data, the biometric characteristics should satisfy certain criteria.

Multimodal biometric systems utilize more than one physiological or behavioral characteristic for enrollment, verification, or identification. These systems are employed in applications such as border entry/exit, access control, civil identification, and network security to reduce false match and false non-match rates, provide alternative means of enrollment or identification, and counter fraudulent attempts [2]. The selection of a specific biometric for an application requires weighing these factors, as no single biometric can meet all requirements for every situation.

LITERATURE REVIEW

The concept of iris recognition was first proposed by Dr Frank Burch, an ophthalmologist, in 1936. In 1987, ophthalmologists Aran Safir and Leonard Flom patented the idea, and they enlisted John Daugman in 1989 to develop practical algorithms for iris recognition [12].

Cheng-Shun Hsiao, Chih-Peng Fan, and Yin-Tsung Hwang (2022) proposed an algorithm for locating the pupil center using an edge detection method. They recorded the grey level values on virtual concentric circles and constructed a zero-crossing representation based on a one-dimensional dyadic wavelet transform.

Viktor Varkarakis and Shabab Bazrafkan (2018) developed an effective deep learning method for iris biometric authentication. The proposed system utilizes semantic segmentation technology based on the UnEAT model to locate and extract the ROI (Region of Interest) of the iris in an eye image.

Mahmut Karakaya (2018) conducted a study on biometric authentication using an effective low-complexity YOLOv3 tiny-based deep learning inference network.

METHODOLOGY

The presence of noise regions in captured images increases the need for robust and adaptable segmentation techniques [11]. Various iris segmentation proposals have been described, including statistical approaches, alpha trimming operation, and checking the gray level transition.

Image segmentation refers to the division of an image into multiple components. It is a critical step in automated image processing systems as it forms the foundation for subsequent operations such as description or recognition [4].

VGG16 is a convolutional neural network (CNN) model proposed by K. Simonyan and A. Zisserman from the University of Oxford in their paper titled "Very Deep Convolution Networks for Large-Scale Image Recognition." This model gained popularity for its remarkable performance in the ImageNet dataset, achieving a top-5 test accuracy of 92.7%.

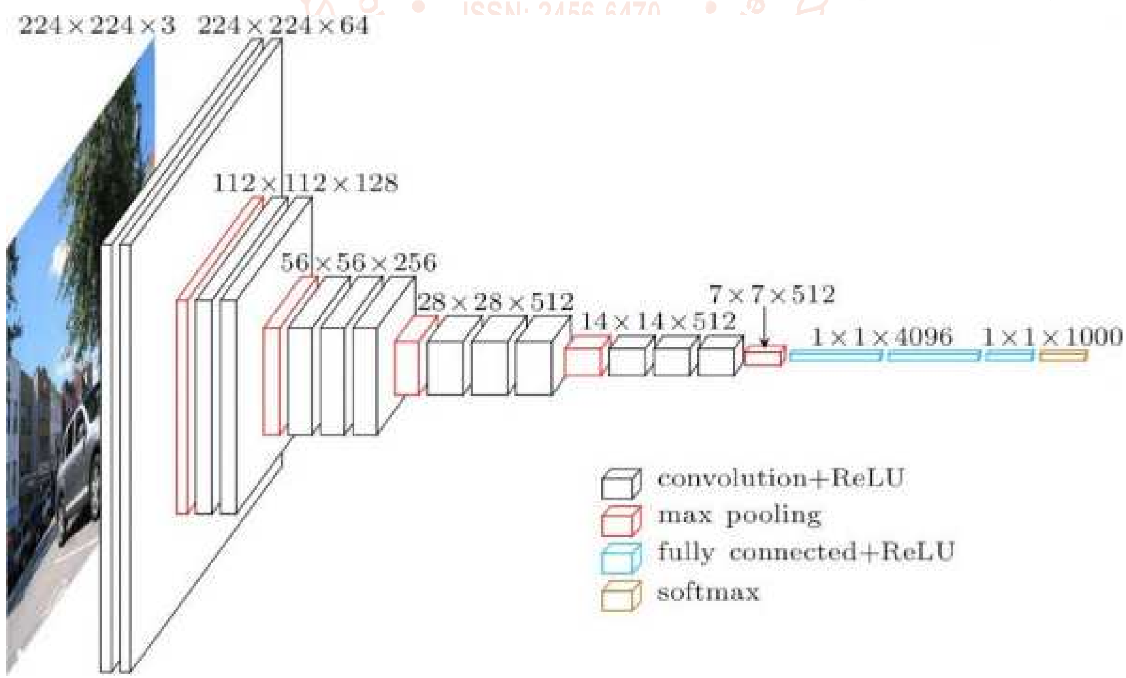

Figure 01: VGG16 Architecture

The VGGNet configurations are labeled as A, B, C, D, and E. All configurations share the same overall architecture and differ primarily in terms of depth. In terms of the width of the convolution layers [5], the number of channels starts at 64 in the first layer. After each max-pooling layer, the number of channels doubles, progressively increasing until it reaches 512 in the deeper layers [10].

Software Description

MATLAB 19 (b) is a high-level technical computing language and interactive environment that offers various capabilities such as algorithm development, data visualization, data analysis, and numerical computation [6]. It provides strong support for working with matrices and matrix operations, making it a powerful tool for data analysis and visualization.

One of the key features of MATLAB 19 (b) is its extensive collection of toolboxes, which are sets of programs designed to support specific tasks. The image processing toolbox is particularly relevant for handling images and offers functions, commands, and techniques tailored to image analysis [6]. In MATLAB, functions play a crucial role and are used to perform specific tasks by accepting input parameters and producing output results. Additionally, users have the flexibility to create their own functions when necessary. MATLAB treats matrices as its standard data type, considering all data to be matrices in some form. Images, while strings are essentially matrices of characters, with the string length determining the matrix dimensions.

EXPERIMENTAL RESULTS

The performance of various CNN architectures, including VGG16 and SVM models, was evaluated in this study. The models were initialized with zero biases and random weights with zero mean [7]. Dropout was applied to the fully connected layers to mitigate over fitting. By considering these performance parameters, the classifier's accuracy, precision, sensitivity, and specificity can be evaluated, providing insights into its classification capabilities.

Table 01: Comparison Result with Existing Work

Database		Approach	Accuracy (%)
CASIA-INTERVAL	EXISTING	SVM	74
	PROPOSED	VGG16	90.91

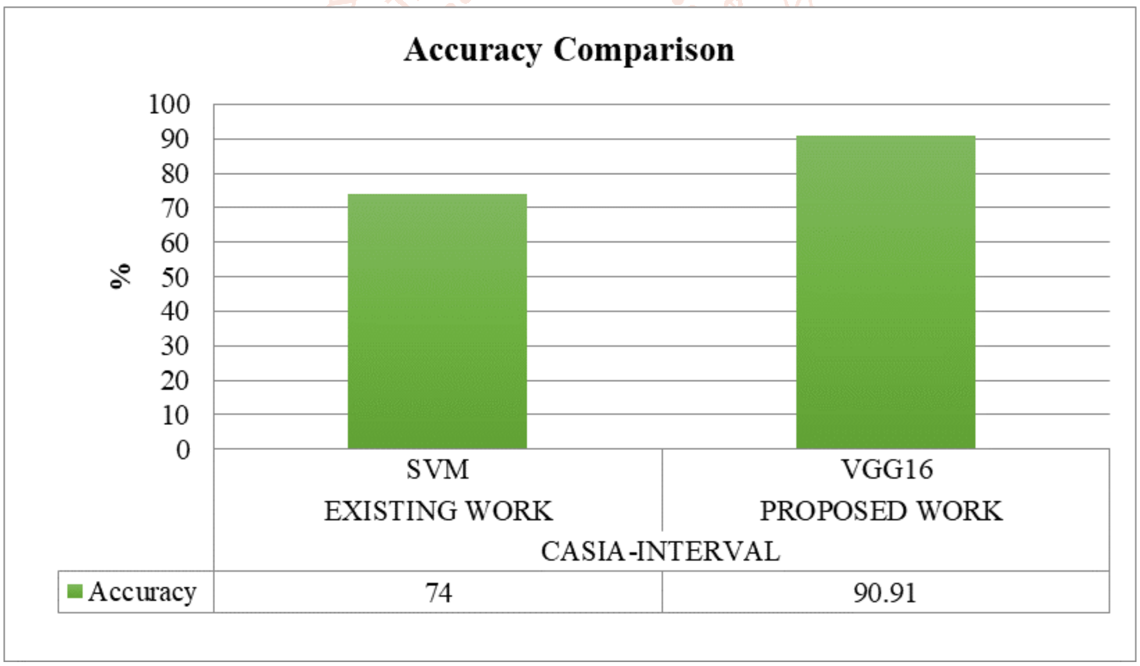

Figure 02: Comparison Result with Existing Work

This implies that the VGG16 model demonstrated the highest classification accuracy among the tested architectures. Additionally, Table 02 presents a comparison of different factors derived from various datasets, providing further insights into the evaluation and comparison process [7].

Table 02 Comparison Result with Different Dataset

	Approach	Accuracy (%)	Precision (%)	Recall (%)	F1 (%)	Specificity (%)
CASIA-INTERVAL	VGG16	90.91	91.44	91.0	89.49	91.38
UBRIS.V2		84.25	83.99	86.95	86.15	84.39
MMU Database		87.15	83.26	84.12	85.15	86.00

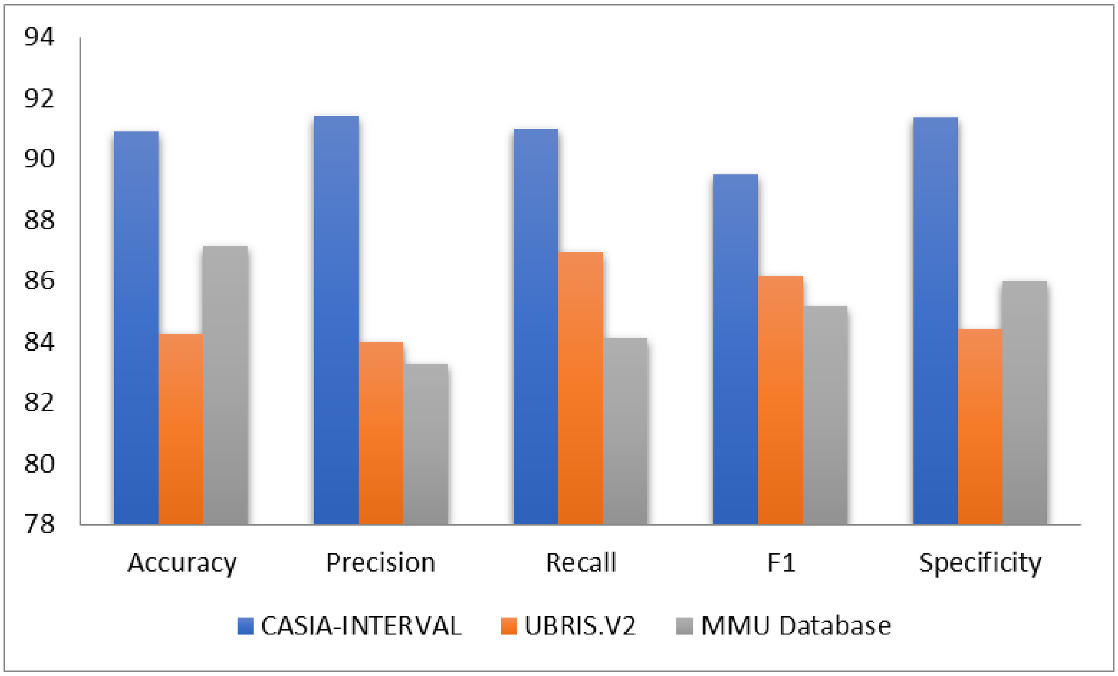

Figure 03: Performance Graph

The evaluation was performed on the CASIA-INTERVAL dataset and compared with the UBRIS.V2 and MMU databases [9]. The results indicated that CASIA-INTERVAL achieved the highest accuracy and specificity. Furthermore, an attempt was made to utilize the conventional VGG16 architecture with pre-trained weights obtained from a model in ImageNet [8].

CONCLUSION

The proposed system utilizes the GLCM and VGG16 for iris recognition. By combining these features with other texture generation processes, the feature extraction process becomes more effective. The recognition of iris is achieved using the kernel function of the VGG16 classifier. The system accurately recognizes iris features in video, even in the presence of challenges such as illumination and contrast variations. It also detects the liveliness and race of the person with high accuracy. Extensive experiments are conducted using the CASIA Iris-, UBIRIS.v2, and MMU databases to evaluate the performance of the iris and eye recognition system using VGG16 architecture. The proposed system outperforms other existing technologies on each database. Additionally, an iris segmentation architecture based on CNN combined with VGG16 and VGG19 is proposed to further improve the accuracy of the recognition system.

FUTURE WORK

The Biometric Authentication can be improved by including more number of possible features and other valid measures. Pupil dilation is found to have an effect on the accuracy of iris recognition particularly if the number of dilation is completely different at enrollment than at verification. Wearing contact lenses also modify the color and look of the attention also can decrease the recognition rates.

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