Assimilating region of interest for fused biometric modalities through cie l*a*b* color space

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Abstract. Idiosyncrasy in recent times has been a challenge that is not quite easily effectuated in many domains and work structures. Security compromises have led to immeasurable loss and altered the deportment of individuals. In order to counter such circumstances, biometric modality analysis and utilization stimulate an inimitable framework to enhancement of security mitigated impostures. Nonetheless, the existing indagation has always instituted the single biometric modality processing and evaluation. Although the previous work of pre-processing and post-processing for biometric modalities such as fingerprint, iris, gait, and other physiological and behavioral modalities have been considered through explicit algorithmic and computational processing, the rate of precision fallacy and contriving unique identification has been a lingering question. This paper focuses on augmenting the efficacy of identification through the fused biometric modalities of fingerprint and iris, along with unsheathing the region of interest (ROI) by designating color masks using the CIE L*a*b* color space and delta disparity computation. The histogram analysis is implemented to analyze the pixel intensity, and the pixel matched extraction is surface plotted using MATLAB.

1. Introduction

The praxis of effectuating authenticated identity protocols and framework using corporeal data is implemented through the domain called as Biometrics. This field of computation is intriguing for a variety of purposes ranging from its attribute of uniqueness to mitigated use of an added key or security mechanism. Since it is embedded in the human body, it works as an automated system of recognition relying on the comportment attributes. The biometric system institutes a minimal percentage of fallacy and inaccuracy due to the sui generis features that vouchsafes for the ineradicable facets of computation. With such advantageous proclivity, various modalities are explored for diverse applications and working methods. Nonetheless, the most common amongst the different modalities which are studied is the fingerprint and iris. Both of these modalities hold the tendency to develop patterns at the embryonic stages of development and remain to exist through the lifecycle of a human being. As these modalities hold characteristics that are not volatile, they are used as an unswerving recognition system for various applications. The viability of a system is trifurcated into aspects such as – authentication, authorization, and accountability. These components play a vital role in corroborating the communicating devices or the identity of individuals. The below figure delineates the different biometric modalities that are frequently used for various explorations [1].

Fig 1. Biometric Modalities
Contrary to the utilization of security cards, keys, passwords, and pins, biometric modalities are innately grafted into the human body. These biometric modalities may vary based on their behavior and can be stratified into physiological and behavioral. The complexity challenge of hacking biometric systems is multifold, as they cannot be cloned, duplicated, and has minimal chances of pilferage. However, these systems also can have a few cons such as ambiguous interpretations for facial recognition when there are identical twins, injuries in the modality may fail the system to stimulate the right identity, and vulnerability exposure when a single modality entity is worked on. To encounter the disadvantages, a multi-modal biometric system has taken over in many applications and working architectures.[2]

Previous work relating to this area of study entailed the fusion of the same modalities along with their processing mechanisms. Nevertheless, this paper instruments the novel approach of explicating the fusion of biometric modalities such as the fingerprint and eye, and aids in extracting the region of interest from the coalesced identity which is created. The International Commission de l’Eclairage (CIE) is a global body that institutes and consigns recommendations about the standards of picture and color intensities [9]. The CIE model of systems effectuates the color space using three coordinate parameters such as the XYZ, L*a*b*, and the L*C*h [10]. This study pivots on the L*a*b* color stack in highlighting the ROI space and the masking of the outer region. The histogram analysis is graphed to analyze the differences, and the pixel intensity disparity is explored by the delta computation. This paper is structured as follows: section II explicates the empirical study of various explorations regarding the ROI implementation by various authors. The third section accentuates the current implementation pertaining to the method of ROI extraction along with incorporating the color space in the masked region. The last two sections illustrate the results and the conclusion for the performed simulations respectively.

### 2. Empirical review

The region of interest and biometric image processing has been analyzed by diverse researchers. Few of the literature surveys closely relating to this domain of interest is presented below:

#### Vincenzo Conti et al [4]

Expounded on the multimodal identification approach through frequency relied methodologies; the ROI extraction in this study detailed the emphasis on unique delineation of the fingerprint and iris features. The exploration of FKP and iris images to be preprocessed to mitigate noise was scrupulously executed using the Gabor filter [5]. This study was authored by Singh.S et al, and explicated the multi-biometric modality pre-processing approach through ROI and noise removal to obtain better accuracy. The extraction and pre-processing were further juxtaposed with the Neuro-fuzzy neural network classifier to gain better insights. The fusion of palm and iris was researched by Alsubari, A et al,[6] who implemented the feature level fusion using the NVPA method. Various other implementations such as Local binary variance pattern (LBVP) histograms for biometric modality pre-processing in a vector level, Haar wavelet and histogram equalization from ROI Normalization for fingerprint images [7], [8] have been some of the referred articulations for this study.

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Fig 2. Existing Implementational review
3. Proposed indagation

The proposed indagation entails the method of extracting the ROI, analyzing the histogram to match the intensity of color pixels in the delta images, and thereby using the intensity to surface plot the graph. The below framework explains the sequential step of processes that the study implements.

![Diagram explaining the proposed model](image_url)

The biometric fusion of fingerprint and iris is mapped in the L*a*b* color space [9] to analyze the variations in the pixel intensities of the image. The L*a*b* color space of CIE represents the lightness, red/green value, and the yellow/blue value respectively. The L* is scaled between the darkest color of black to the brightest pixel value for white, with the darkest black at L* = 0, and the brightest white at L* = 100. The color channels, a* and b*, can have neutral gray components with values swinging between the positive red and green at the negative axis, and yellow present in the positive axis and blue lying on the negative pole respectively [10]. The color bands are then extracted into a 2D array comprising the color component in each structure. This evaluation of the color value is usually represented quantitatively with the Delta standards incorporated in the L*a*b* color image. Each of the components are generated as a delta image, and are calculated as follows:

\[ \Delta \text{Image} = \text{Channel value(\Delta CV)} - \text{Color space standard (\Delta CS)} \]  

The overall Delta E image is computed by

\[ \Delta E = \sqrt{(\Delta L - \Delta L S)^2 + (\Delta a - \Delta a S)^2 + (\Delta b - \Delta b S)^2} \]  

where \(\Delta L, \Delta a\) and \(\Delta b\) are the channels which are generated and \(\Delta L S, \Delta a S\) and \(\Delta b S\) are the standards from which they are subtracted. The delta image thus contrived after the computation of mean and standard deviation, is analyzed with the delta image of the ROI extracted region. The disparity thus generated is analogized in a histogram graphing method. The difference between the masked creation delta image and the ROI delta image is termed as the Delta Tolerance level. This delta tolerance level is proffered as the response by the user by analyzing the histogram. The chosen level given as input by the user is then checked for its scale verity, and the pixels within the selected range are extracted. The threshold matched output is thus generated, and the surface plotting of the ROI masked region forms the outcome which is graphically illustrated for better understanding on a 3D axial platform.

4. RESULTS

The various results pertaining to the analysis of the ROI, histogram, and delta masked computation obtained in MATLAB are depicted in the figure below.

![Image of results](image_url)
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Fig 4. Simulation result

Each of the outputs thus received is relevant to the step-wise architecture delineated in section III. It is to be noted that each of the images taken can have varying pixel ranges, and therefore the delta tolerance would also vary accordingly. The histogram analysis plays a cardinal part in the process of thresholding due to the user opting to move the vertical bar to the value up to which the pixels are to be unsheathed. The images of fingerprint and iris have been procured from web databases and amalgamated before the initial process of ROI segmentation and color-mapping.

5. Conclusion

The study has helped in cognizing the factors pertaining to the extraction of ROI along with emphasizing on the assimilation of intensity variations in pixels. The prominence of this indagation is the creation of an outer mask which helps to circumvent the unwarranted regions of the image and focus entirely on the area which holds the necessary patterns of the modalities. The delta mask creation and delta tolerance values have depicted that although the original images are converted to true color images, the gray component triggers more of the a* channel, rather than the L* and b* channels. The future work of exploration is targeted towards incorporating more real-time images and deriving features from the modalities through the other channels.

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