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# Biometrics Face Recognition Using Method of Wavelet and Curvelet Transforms with COVID-19

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**ABSTRACT**

During last two decades the subject of face recognition has become a major issue. It has been used in several important real-world applications such as database security, video surveillance, smart card, internet and intranet. The people's ability to recognize a face is reduced if the person has a mask covering the lower part of face, so it may be focus now on, the eyes and the individual features on upper part of face. To extract the features, the Wavelet and Curvelet transforms proved its efficiency due to its higher for detection of curves and lines, which recognize the human's face, these features are used to identify the enrolled persons and it should be stored in the template system to be used later in the recognition system. The result of this paper is to recognize the face of person with mask. The system performance was evaluated depend on face database (kaggle) for face-recognition with face mask during COVID-19 period. The results indicate that the proposed system showed good results, and it outperforms the other algorithms that used in face-recognition.

## 1. INTRODUCTION

To determine the identity of a particular person and authenticate him through his facial features from a photo or video clip, this is done by means of facial recognition through an analytical software. All faces consist of mouth, two eyes, nose, and many features that are in the same location. The process of verifying or identifying a person by personal attribute or physical identity this called Biometric identification [1, 2]. To determine the geometry of the face, the software uses biometrics. It observes of several facial features, then calculates a number to express the combined relative distances. A "face print" is the end outcome. To quickly confirm the identity of a person is by cross-referencing the output of the mathematical formula with the databases known to the person. To improve customer experience and increase sales, face scanners are increasingly used to identify celebrities and preferred customers. Face identifiers provide usefulness in security, safety, retail, customer loyalty and law enforcement. recognize terrorists and criminals for years [1-3]. Wanted criminals have been apprehended thanks to facial recognition technology. Face analysis is likewise an important aid for robbery prevention and protection in transportation and in retail. The main challenge facing the countries of the world exposed to the Coronavirus is the increasing number of infected people who make the health care system work at its maximum capacity, which increases the possibility of the health system failing or closing completely. Establishing an intelligent monitoring system is critical to the COVID-19 pandemic [4]. Surveillance technology is constantly evolving, especially facial recognition.

In the COVID-19 pandemic period, companies are scrambling to adapt their technologies for monitoring systems with the spread of wearing a mask permanently, which is a new challenge for these systems during the period of this pandemic [4, 5]. Both the public and private sectors must carefully assess the use of facial recognition and other biometric technology in the fight against COVID-19. People are now solely identifiable by their eyes, brows, and hair, which is an issue for the human eye, which is prone to finding parallels in many faces with similar features. Computer systems are also affected by this issue [6]. When the mask covers the lower half of the face, the feature extractor should cover the upper half of the face, which includes the eye and eyebrow, and can still be utilized to improve facial recognition.

## 2. LITERATURE REVIEW

There are many studies for recognized the face of human.

This study of Hejazi [7] identifies two methods for extracting facial characteristics using two separate multiresolution analytic tools: The Curvelet transform and the Wavelet transform. The resulting features are fed into two well-known classifiers for training: the artificial neural network (ANN) and the hidden Markov model (HMM). Curvelet features for Two levels reach precision rate of 98% and 100% with HMM classifier, and 97% and 100% with ANN classifier, for AT&T and Essex Scowl datasets.

Al-Ani and Al-Waisy [8] introduced face recognition method by using wavelet-Curvelet technique. The wavelet-Curvelet technique based on the similarities embedded in the images that utilize the wavelet-Curvelet technique to extract facial features. Subsequently, for the purpose of recognizing the different faces, the Nearest Classifier (NMC) was adopted. Main methods were used and applied to two databases, the first

database was created by researchers and the second database (ORL). The recognition rate of 93.6 and 98 were obtained when using the first and second databases, respectively

Imtiaz and Fattah [9] introduced Face Recognition Scheme Based on Local Dominant Feature Extraction which efficiently exploits the local spatial variations in a face image utilizing Curvelet transform. Even for images containing partial occlusions, expressions, and nonlinear illumination fluctuations, the proposed technique achieves high recognition accuracy.

Guha and Wu [10] introduced a method which combined the wavelet with Support Vector Machine (SVM) and Curvelet with Support Vector Machine (SVM). The results showed the superiority of Curvelets over wavelets in facial recognition applications. Face-extracted Curvelet features have also been found to be strong against noise. The rate Recognition Accuracy is 90.44%, 82.57%.

Abdullah et al. [11] presented algorithm to increase the competence of the algorithm of Elman neural in face recognition that based on face recognition using Elman neural network and image decomposition using Curvelet transform, Principle component analysis. The results obtained indicate that the adoption of Curvelet transformations provided better results than the use of wavelet transformations, The rate of face recognition 94%.

Biswas and Sil [12] introduced a novel method for face recognition using Curvelet transform (CLT) and contourlet transform (CNT) which enhance face recognition rate under various challenges in pre-processed face images implemented CLT and considering scale of four and angle eight, the researcher using different statistical features are extracted from the detail subbands. Recognition the face images using support vector machine (SVM) classifier. the proposed feature extraction method improves recognition accuracy efficiently handle the effect of Gaussian noise as tested on JAFFE, ORL and FERET database.

Ghazal and Abdullah [13] present a new proposed face recognition is improved in a variety of situations by integrating Fast Discrete Curvelet Transform (FDCvT) and Invariant Moments with Support Vector Machine (SVM). This method depends on two things. First, the edge cutout of an image can be represented efficiently by using the Curvelet transform which is a multi-resolution method. Second, there's the Invariant Moments analysis, which is a statistical method for determining picture translation, rotation, and scale invariance. Moreover, based on the extracted features, SVM will be used to classify the face image. To evaluate the performance of the suggested method, this process is applied on each of ORL and Yale databases. The accuracy of the system that achieved up to 96.25% on the ORL and to 96% on the Yale databases.

Wang et al. [14] introduced a new method this work proposes three types of masked face datasets, including Masked Face Detection Dataset (MFDD), Simulated Masked Face Recognition Dataset (SMFRD), and Real-world Masked Face Recognition Dataset (RMFRD). The proposed masked face recognition technique based on two aspects. One is the full use of uncovered useful face features and the other is built dataset. The researcher used various attention weights to the key features in visible parts of the masked face, such as a face contour, ocular and periocular details. This efficiently tackles the issue of uneven face discriminative information distribution. The generated multi-granularity masked face recognition model is achieving accuracy up to 95%.

## 3. STAGES OF SYSTEM RECOGNITION

### 3.1 Preprocessing

To make the facial image data more suitable for extracting the discriminatory features required in the identification process, several processes have been performed at this very important stage. The first step in this stage is the conversion of color image to gray level image. The second step the image of face boundary is extracted from the gray image and noise removal process [15].

### 3.2 Feature extraction

For the purpose of summarizing most of the information contained in the original feature set and providing the possibility of describing objects as well as the possibility of performing the recognition and classification processes, the feature extraction process must be used. Feature extraction is a great way to decrease on the quantity of duplicated data in a data set. A good feature gives the same (or nearly the same) value for all instances of one class and a different value for other classes. If the object is shifted or rotated, the feature value should not change [7, 8]. Because it gives a good representation of the image data in terms of both spatial and frequency localization. The wavelet transform is excellent for the analysis of natural images. Natural images are smooth locally, and their frequency characteristics change over time in space. Feature extraction has always been significant [7], and it remains a challenging phase in image identification.

Curvelet transforms are used to perform multi-resolution analysis. Its main advantage when reconstructing edge details in an image is its ability to use a small number of parameters. An angle and a scale are assigned to each coefficient matrix [9]. In Figure 1, there are many coefficients for the edges. Whilst, less coefficients are needed to account the edges as curvelet.

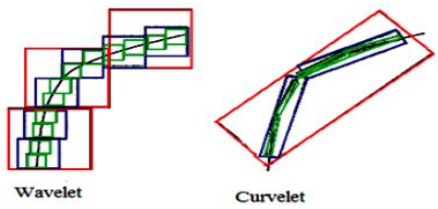


**Figure 1.** Different between Wavelet & curvelet

The Curvelet labeled 'c' in the diagram is nearly perfectly aligned with the curved edge, giving it a high coefficient value. Because they are so widely apart from alignment, the coefficients of Curvelets ‘a' and ‘b' will be close to zero.

It is common knowledge that a signal that is localized in the frequency domain is spread out in the spatial domain or vice versa. When it comes to Curvelets. Curvelets can be used to describe objects with 'curve interrupted smoothness,' that is, objects that are smooth except along a general curve with bounded curvature. Curvelets are so good at modeling curved discontinuities that the representation becomes as sparse as if the object weren't unique. In comparison to wavelets, the sparsity and efficiency of Curvelet representation of curved singularities is clear as shown in Figure 1. Curvelets give a sparse representation at any scale j. The majority of facial images are 8 bit, which means they contain 256 gray levels.

Edges will appear in such images where two very close regions with different pixel values have differing pixel values; these edges are generally curved for faces. Curves are better at extracting essential edge-based properties from face photos than wavelet transforms because curves are better at approximating curved singularities. Curvelet transform is used in a variety of face recognition approaches to extract features. The low-frequency components are captured on the approximation Curvelet face, while the high-frequency features are captured on the remainder of the Curvelet face in various orientations. Curvelet transform at scale 3 and angle 8 or 16 is sufficient to deconstruct faces. Images can be decreased in size before being subjected to feature extraction if necessary [16, 17].

Wavelets having predominantly vertical, horizontal, and diagonal orientations) are used in typical orthogonal wavelet transformations, independent of scale. Because images do not always have isotropic scaling, wavelets' limitations necessitate the use of other multi-scale representations. Curvelets' most intriguing feature is that they were created specifically to depict things with 'curve-punctuated smoothness' [17]. Objects that are smooth except for a general curve discontinuity; images with edges are an excellent illustration of this type of item [18].

### 3.3 Face recognition

A facial recognition system is a software program that can match a human face in a digital image or video frame to a database of faces. It falls largely within the field of biometrics, which is concerned with verifying and identifying a person's identity through unique appearance or behavioral characteristics. Due to differences such as position and illumination fluctuations, occlusions, facial expressions, aging, and low image quality, the test images for a specific individual differ from the training samples for that same person. Such difficult problems must be addressed by computational models for facial recognition. Faces pose, for example, are a particularly challenging subject in this regard because most of them look alike. They have the same set of characteristics, such as eyes, noses, and mouths, that are roughly arranged in the same way [19].

A face recognition system is consisting of into two stages, they are training and Testing stages [20]. A set of known faces (data set) is utilized to construct a representative feature-set or template in the training step.

## 4. METHODOLOGY

The approach taken in this project tries to integrate both former algorithms the Figure 2 refers to the system of recognition.

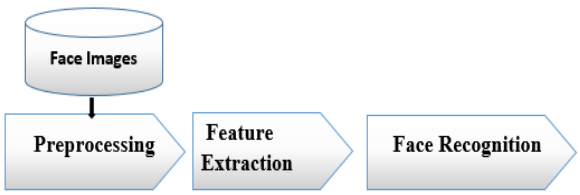


**Figure 2.** The system of recognition

### 4.1 Preprocessing stage

- Convert colored images into gray scale, each face image,
- crop the face region,
- quantize into 8 gray levels, and resize it,
- Enhancement: The output of digital image enhancement is to a processed image that is used for a given application. Median Filtering: The median is just the middle value of all the values of the pixels in the neighborhood.

### 4.2 Feature extraction stage

Wavelet is used in signal processing for recovering weak signals from noise. However, wavelet has been employed in image compression to compress images to a larger extent than is normally possible with other approaches [10]. The Discrete Wavelet Transform (DWT) is a special case of the wavelet transform that can give a compact representation of a signal in time and frequency that can be accurately estimated [15]. The signal can be expressed in terms of waveform and scaling functions at different scale, in a hierarchical manner through the use of two-band multi-resolution wavelet transform. The equation for wavelet transform is [21, 22]:

$$WL(n,k) = \sum_{p} WL(p,k+1)h'(n-2p) + \sum_{l} WH(l,k+1)g'(n-2l) \quad (1)$$

After wavelet transform the Curvelet transform was applied. The main advantage for Curvelet transform is the ability to use relatively small number of coefficients to reconstruct edge details at an image. Each matrix of coefficients is characterized by both an angle and scale. The Curvelet transform can be implemented as follows [19]:

Implement 2D-FFT 2D FFT (Fast Fourier Transform) to obtain Fourier samples:

$$\hat{f}[n_1.n_2], -\frac{n}{2} \le n_1.n_2 < \frac{n}{2} \quad (2)$$

Interpolation for each scale-angle pair (j, l) interpolate (or resample) $(\hat{f})$ $[n_1.n_2]$ to obtain.

$$\hat{f}[n_1.n_2] - n_1 tan\,\theta \quad (3)$$

Localization Multiply the interpolated function $(\hat{f})$ with a window function $\tilde{U}$ j $[n_1.n_2]$ effectively localizing $(\hat{f})$ near the parallelogram with orientation θ 1, to obtain:

$$\tilde{f}\text{ j, 1 }[n_1.n_2] = [\,\hat{f}\,[n_1.n_2] - n_1 tan\,\theta]\;\tilde{U}\text{ j }[n_1.n_2] \quad (4)$$

The method of wavelet- Curvelet based feature, depend on kaggle database. Figure 3 represent the database from kaggle [23].

a. original images b. gray images c. sharpener mask

**Figure 3.** kaggle Database (gray and sharpener mask)

## 5. DISSECTION

This study contains several stages; each stage consists of a set of steps in the preprocessing the images were prepared by convert the images to gray level and resize the images to (300, 300), then crop the background and white area from face images and implemented the wavelet transform on the face images in order to convert images from time spatial domain to frequency domain and divide it into four areas (LL, LH, HL, HH) and then choose the LL that contains most of the image information and achieve image compression and then implement a Curvelet transform on a part of LL in order to perform the process of extracting the important features in the face image as in the Figure 4 below:

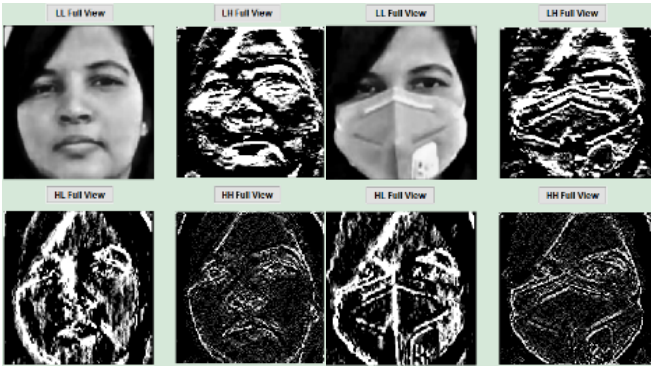


**Figure 4.** (a) Represent apply wavelet without mask (b) wavelet with mask

The method of wavelet- Curvelet based feature consist many steps:

• Decompose all face images using Wavelet transform to four part (LL- low low, LH- low high, HL- high low, HH high high) [24].
• Take the LL part and implement the Curvelet transforms.

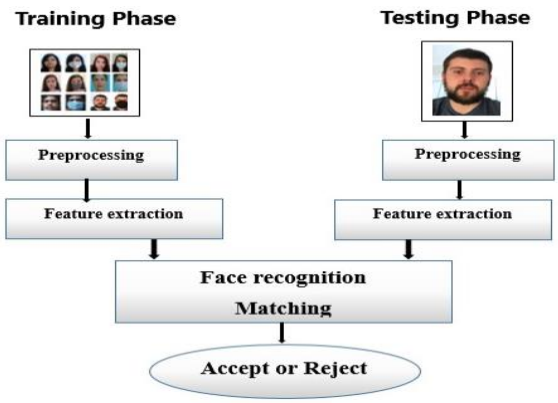


**Figure 5.** Diagram represent the system of recognition

Two levels Curvelet decomposition applied to all face images, approximated coefficients will be the feature vector. II, coefficients at scale three will be the feature vector. In the testing stage will be compared the characteristics; an unknown facial image is matched to previously observed faces. The raw or preprocessed face images are used as input for wavelet transform and Curvelet-based feature extraction. After that, the images are divided into Curvelet sub - bands of various sizes and orientations. By using Curvelet at scale 2 (coarse and fine) and angle 8 can decomposes a face image of size 11292. One approximation coefficient (75*61) and eight detailed coefficients (four of size 66*123 and the rest of size 149*54) are used in this technique. Curvelet faces are deconstructed images by using Curvelets as a Figure 5.

In this research, the matching process was accomplished using correlation test, the results showed that the ratio of matching for face recognition was acceptable 95% for face images without mask while the ratio of matching for face images with mask was 90% (Figure 6). The result of matching for face images without mask and face images with mask to the same person show in the Table 1 as below:

**Table 1.** Result of matching

| persons | Corr 1 | Corr with mask | Corr without mask | Corr without mask | Corr without mask |
|---|---|---|---|---|---|
| No.1 | 1 | 0.7975 | 0.7899 | 0.803 | 0.917 |
| No.2 | 1 | 0.7653 | 0.8291 | 0.871 | 0.942 |
| No.3 | 1 | 0.8111 | 0.8562 | 0.869 | 0.971 |
| No.4 | 1 | 0.8316 | 0.7901 | 0.832 | 0.981 |
| No.5 | 1 | 0.8206 | 0.8581 | 0.862 | 0.967 |

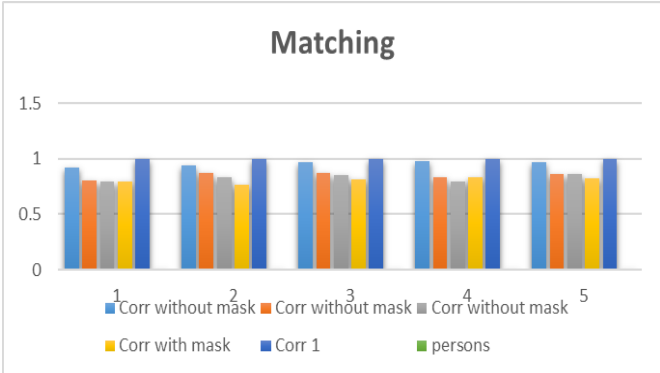


**Figure 6.** Result of matching for face images

## 6. CONCLUSIONS

In this paper the proposal system for face recognition depends on kaggle data set which consist from 50 image represented 25 persons. Wavelet – Curvelet transform methods used to extract features from images under consideration, which represent 10 features, this algorithm based on the matching process via correlation in the images. The obtained results include an efficient recognition using wavelet-Curvelet. the results showed that the ratio of matching for face recognition was acceptable 95% for face images without mask while the ratio of matching for face images with mask was 90%. These programs are implemented via MATLAB 2017. The challenge was the face is not explaining due to mask. This method can recognize the persons until with the images of face with mask.

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## REFERENCES


[1] Raj, T.M., Vinitha, A., Suganya, N. (2020). Face recognition using wavelet decomposition transforms and reduction rate. Journal of Critical Reviews, 7(4): 888-890. http://dx.doi.org/10.31838/jcr.07.04.169

[2] Dharani, P., Vibhute, A. (2017). Face recognition using wavelet neural network. International Journal of Advanced Research in Computer Science and Software Engineering, 7: 101-107. https://doi.org/10.23956/ijarcsse/SV7I5/0115

[3] Find Face mobile biometric. (2020). NtechLab is a world-renowned expert in facial recognition solutions.

[4] Roy Band. (2019). Face recognition, Community Manager, Middle Europe.

[5] Clare Sellars. (2021). Use of facial recognition technology increasing, https://www.lexology.com.

[6] Talahua, J.S., Buele, J., Calvopiña, P., Varela-Aldás, J. (2021). Facial recognition system for people with and without face mask in times of the COVID-19 pandemic. Sustainability Journal, 13(12). https://doi.org/10.3390/su13126900

[7] Hejazi, H.H. (2010). Face recognition using Curvelet and Waveatom. The Islamic University of Gaza, Faculty of Engineering, Computer Engineering Department. A Thesis for the degree of Master of Science in Computer Engineering.

[8] Al-Ani, M., Al-Waisy, A. (2012). Face recognition approach based on wavelet - curvelet technique. Signal & Image Processing: An International Journal, 3(2): 21-31. https://doi.org/10.5121/sipij.2012.3202

[9] Imtiaz, H., Fattah, S.A. (2012). A curvelet domain face recognition scheme based on local dominant feature extraction. International Scholarly Research Notices, 2012: 1-13. https://doi.org/10.5402/2012/386505

[10] Guha, T., Wu, Q.M.J. (2010). Curvelet based feature extraction. 1ECE, University of British Columbia, BC, Canada 2ECE, University of Windsor, ON, Canada. https://doi.org/10.5772/8940

[11] Abdullah, A.S.S., Abed, M.A., Al Barazanchi, I. (2019). Improving face recognition by Elman neural network using Curvelet transform and HSI color space. Periodicals of Engineering and Natural Sciences (PEN), 7(2): 430. https://doi.org/10.21533/pen.v7i2.485

[12] Biswas, S., Sil, J. (2017). An efficient face recognition method using contourlet and Curvelet transform. Journal of King Saud University – Computer and Information Sciences, 32(6): 718-729. https://doi.org/10.1016/j.jksuci.2017.10.010

[13] Ghazal, M., Abdullah, K.M. (2020). Face recognition based on Curvelets, invariant moments features and SVM. TELKOMNIKA Indonesian Journal of Electrical Engineering, 18(2): 733-739. https://doi.org/10.12928/TELKOMNIKA.v18i2.14106

[14] Wang, Z., Wang, G., Huang, B., et al. (2020). With the National Engineering Research Center for Multimedia Software, School of Computer Science, Wuhan University, Wuhan 430072, China.

[15] Abbas, A.R. (2018). Intelligent age estimation from facial images using machine learning techniques. Iraqi Journal of Science, 59(2A): 724-732.

[16] Ja'afar, H. (2020). Discrete curvelet transform algorithm for image compression system. International Journal of Advanced Trends in Computer Science and Engineering, 9(1.1 S I): 166-169. https://doi.org/10.30534/ijatcse/2020/3091.12020

[17] Cohen, R. (2011). Analysis and recognition in images and video face recognition using curvelet transform. arXiv:1107.2781v1 [cs.CV] 14 Jul.

[18] Mandal, T. (2008). A new approach to face recognition using curvelet transform. University of Windsor, Scholarship at UWindsor, Thesis.

[19] Sulaiman, A. (2011). Design and implementation an efficient face recognition. Al-Anbar University, College of Computer, Computer Science Department, Master thesis.

[20] Al-Ani, M., Al-Aloosi, W.M. (2013). Biometrics fingerprint recognition using Discrete Cosine Transform (DCT). International Journal of Computer Applications, 69(3): 44-48. https://doi.org/10.5120/11849-7598

[21] Alaluosi, W.M. (2021). Recognition of human facial expressions using DCT-DWT and artificial neural network. Iraqi Journal of Science, 62(6): 2090-2098. https://doi.org/10.24996/ijs.2021.62.6.34

[22] Zhou, L.J., Liu, Z.M., Nie, T.Y. (2014). Face recognition based on Curvelets and local binary pattern features via using local property preservation. Journal of Systems and Software, 95: 209-216. https://doi.org/10.1016/j.jss.2014.04.037

[23] https://www.kaggle.com/datasets, accessed on 12 May 2022.

[24] Al-Rawi, S.S., Sadiq, A.T., Alaluosi, W.M. (2016). Feature extraction of human facail expressions using Haar wavelet and neural network. Iraqi Journal of Science, 57(2C): 1558-1565.