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Vein palm recognition model using fusion of features

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ABSTRACT

One of the most promising mechanisms in the field of security and information safety is authentication based on palm vein. The main reasons that vein palm becomes an authentication method is because of its distinctive privacy, as it is difficult to manipulate or change its results, because of the location of the vein within the palm. With the use of this technology, it has become easy to maintain data from unauthorized access and unwanted persons. In this work proposed model are suggested that contain four stages to reach the results: in the first stage is the pre-processing stage where histogram equation was used to enhance the image and the properties are shown, the second stage is the extracting the properties where, Gabor filter and 2-discrete wavelet filters are suggested for features extraction, where it is considered one of the most important filters used to extract the features, as well as in the third stage "PCA" are used for data or features reduction, because of its advantages in analyzing the features and reducing the spacing between them. As for the last stage, the Euclidean distance used to measure the spacing. The results were acceptable and convincing, since the similarity ratio 96.2%. These results were obtained after several tests and using the Gabor filter with 2D-discrete wavelet transform and principal component analysis (PCA), I got the best results.

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1. INTRODUCTION

Humans have tried in the past to access and devise tools through which to maintain their property and private money as well as their places and because the technology was not at the level required to resort to tools but not the required security as they went to the keys and locks to maintain the security of their property from the arrival of unauthorized people [1]. With the advancement of time and the marked advancement of technology, more security tools have emerged, as progress has been a villa in the field of Internet networks and the use of modern technologies from computers, mobile devices, and others. But at the same time, these devices need programs and methods to verify the identity of the user, to follow the entry effectively and securely and prevent unauthorized persons from accessing the required data. Perhaps one of the most prominent sciences used in this field is the vital measures for determining the identity of the user and validating them [2]. The identity of the authorized person can be confirmed by providing acceptable and considered evidence that the specified conditions for accessing the data are fulfilled. Perhaps the most prominent techniques used to maintain the security and integrity of data from unauthorized access is the pattern of the palm vein, where the venous patterns are located in the palm and it is one of the most secure techniques because it is difficult to

steal and manipulate them after all the vein is under the skin and is not affected by the advancement of a person's age and cannot be used as an alternative to it [3]. The characteristics used by the vein depend on several filters to extract the most important features, the Gabor filter, and the Gaussian filter. The pattern of palm veins in the security field can be considered one of the areas that can be developed and utilized to maintain data security and integrity because it is considered one of the most promising methods in this field [4]. The database used in this work selected from the institute of control and information engineering, Poznan University of Technology, Poland [5].

2. RELATED WORK

The researcher in the proposed work, he is suggested and studying the vein palm recognition, majorly this work is divided into three phases: In the first stage, which is the pre-processing stage where using CLAHE and 2-D Gaussian high pass filter to enhance the entire images. In the second phase, the feature extraction. Several filters were used, perhaps the most prominent of which is the Gabor filter, which is considered a filter to extract features from the vein. Mechanisms can be used to reduce the dimension between the set of features and show the properties better, and the most important of these mechanisms are used principal component analysis (PCA) and linear discriminant analysis (LDA). In the last stage, the matching process takes place, using Euclidean distance as a minimum distance, which is one of the most prominent mechanisms for measuring similarity and he has achieved 94.49% accuracy [1].

The researcher in [6] work, they are focusing on vein palm recognition based on SURF as a features extraction the proposed model was done through three stages to verify identity in the first stage, the images were processed through the histogram equalization, and in the second stage, the features were extracted through three algorithms scale invariant feature transform (SIFT), speeded-up robust features (SURF) and affine-SIFT (ASIFT), and in the last stage, the Euclidean distance used to verify the similarity, where good results appeared in the performance between Private database and multi-spectrum database, According to the results, we may conclude that the proposed vein imaging system does not produce suspicious unrelated vein areas which might create another clinical problem for the patients [6].

The researcher in [7] work, he is present the system to verify the palm vein in the proposed work where in the first stage a candidate Gaussian-secondly derivative (GSD) is proposed to improve the vein image and then in the second stage which is the stage of extracting features the Gabor filter is used as a filter and also the use of Fisher analysis to extract the advantages from intravenous (Gabor Fisher vein feature (GFVF)) as it is used in the last stage, the cosine function pocket completely to measure the similarity and make sure of the matching process [7]. In research [4], a modern method has been proposed to define the identity of the palm vein: as a first stage, the presentation method was used to improve the images and then a Gabor filter was used as a filter to extract the features and Fisher's analysis discriminated (FDA) was used to reduce the spacing between the characteristics of the directions and then in the last stage it was used Euclidean distance to measure the similarity and find out the results [4].

3. PROPOSED MODEL

The proposed model consists of four phases: the first phase preprocessing based on adaptive histogram equalization, in the second phase feature extraction based on two different techniques Gabor filter liner and 2D-discrete wavelet transform, and combine the features to achieve a promising result. In the third phase used "PCA" as feature reduction, to select and summarize the good features and unique features. In the last phase, the minimum distance is tested to find the similarity one of the most famous techniques is used in the proposed model is Euclidean distance. Figure 1 shows the proposed model phases.

3.1. Preprocessing based on adaptive histogram equalization

The adaptive histogram equation is used to improve the image and enhance it before the phase of part of preprocessing, but after the process of reformulating and updating it was used on a large scale [8]. The idea of the adaptive histogram equation is summarized as follows, the main image is divided into two images. Using the probability density function, the two sub-images are then equalized, and in the last stage, obtained the results in one image after the two-image equation process [9]. Considered as one of the most important features of the adaptive histogram is the preservation of the components and brightness of the images, for direct use [10]. The proposed model used adaptive histogram equalization to increase the accuracy, which would improve the image, as the histogram equation is one of the techniques devoted to improving the vascular extraction, and this is why noted its widespread use in this field [11], Figure 2 shows the pre-processing phase result.

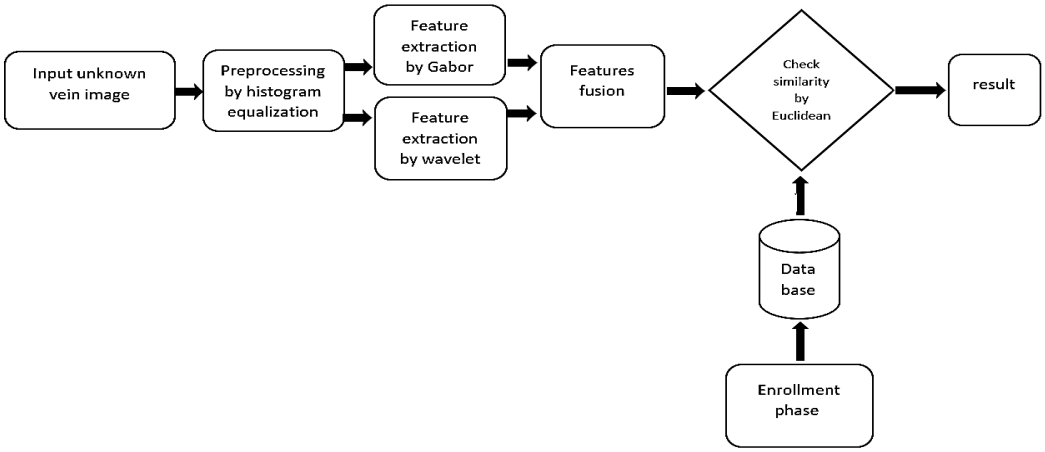

Figure 1. Proposed system layout

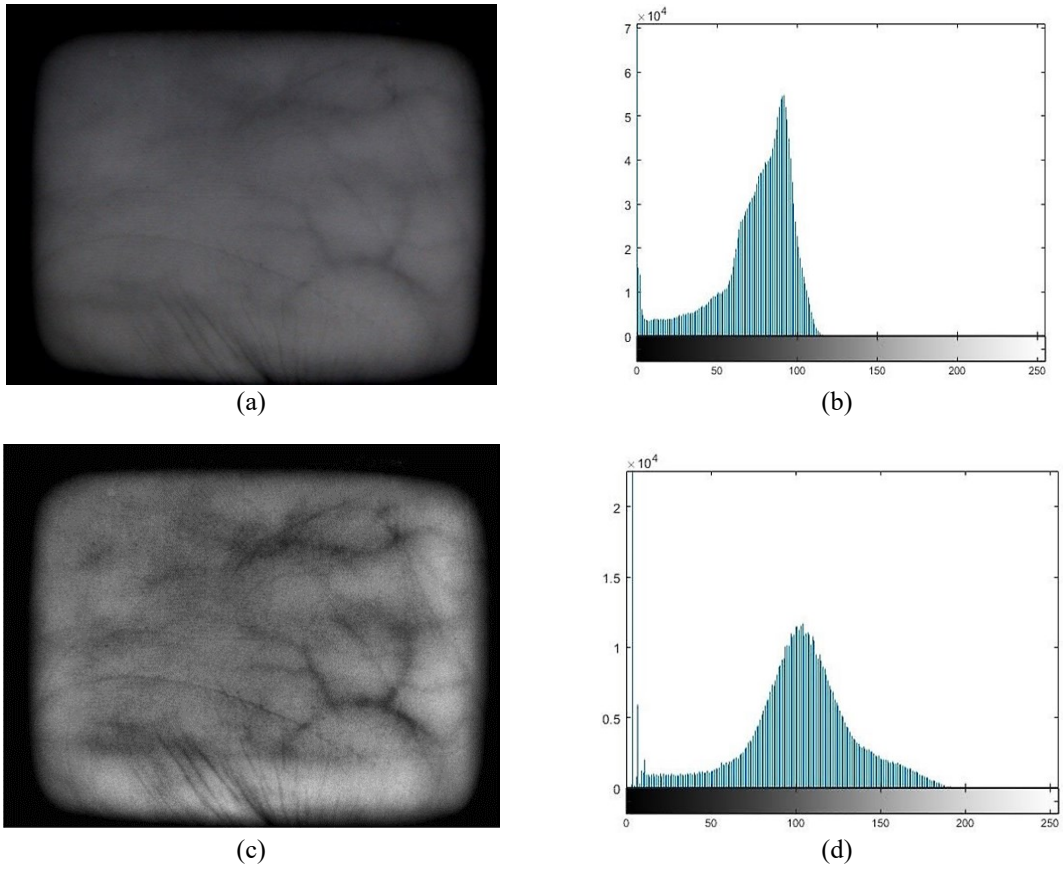

Figure 2. (a) Original image, (b) Histogram of the original image, (c) Enhanced image, (d) Histogram of enhanced image

3.2. Feature extraction based on Gabor filter and 2D-discrete wavelet transform

The stage of features extracting of palm vein pattern recognition system is one of the most important stages due to its importance in identifying and analyzing tissue. In this phase, the proposed model has relied on the Gabor filter and the 2D-discrete wavelet transform:

3.2.1. Gabor filter

The Gabor filter is one of the most famous filters used to extract the features from the palm vein, as it is used to analyze the texture and estimate the contrast in the vein as well as it is used to analyze the tissue, it is more likely that the use of the Gabor filter is used in image processing because of the noise present due to

the low contrast of the images of the palm vein. [1], There are several characteristics of the Gabor filter. Perhaps the most prominent is the tunable filter pressure filter pass in addition to that, it consists of multiple measurements [4]. Experiments have proven that Gabor filters are powerful in defining properties, so they have been used widely in mechanical fields, to obtain significant texture information [12]. Through the study of the Gabor filter, it can be divided into two main parts: the first part is usually called the real part, as well as it is called the symmetrical part, through which it analyzes the hills in its form, and the other part is the imaginary part which is usually used for edge analysis and is also called the symmetric strange part, there is usually in Dark spots can use the symmetric part to extract features from them [7]. A two-dimensional Gabor filter is a two-component combined together real part and imaginary part. A complex plane wave and a Gaussian-shaped function. As shown in (1),

$$g(x,y) = \left(\frac{1}{2\pi\sigma_x\,\sigma_y}\right)\exp\left[-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)+2\pi jWx\right] \quad (1)$$

where б x "and б y denote the scaling parameters of the filter in the horizontal (x) and vertical (y) directions, and W denotes the central frequency of the filter. The Fourier transform of the Gabor function g (x, y)" is defined as:

$$G(u,v) = exp\left[-\frac{1}{2}\left(\frac{(u-w)^2}{\sigma_u^2}+\frac{v^2}{\sigma_v^2}\right)\right] \quad (2)$$

wheres σ u 2πσ x =1/ and σ v 2πσ y =1/. The Gabor filter has two-part imaginary and real part. The imaginary part "odd symmetric", Gabor filter is used for edge detection. The real part "even symmetric" Gabor filter is mostly used for detecting the ridge in the image [1, 4]. The Gabor filter uses you to analyze the tissue, meaning that it analyzes mainly just the presence of certain frequency content of the image, especially the presence of trends in the point area or area of analysis [13].

3.3.2. 2D-discrete wavelet transform

2D-discrete wavelet transform is considered an important method of extracting features, as it is one of the filtering factors, and it can be considered the most popular, because of its characteristics, perhaps the most prominent of which is the approved transformation of image compression [14]. Wavelets are often used to reduce 2-D light signals, so had noted that they are used in image processing extensively to filter out noise, especially white Gaussian noise [15]. To implement the proposed compression process, a Haar wavelet or Daubechies wavelet can be used where a high percentage of the image compression process is achieved, as is customary in the image processing process used to wrap the MATLAB environmental computing.

As is, this thing is proportional to the pixel values of the squares [14]. If the retained energy is 100%, this happens when the threshold value is zero, and this means that the information has not changed. On the contrary, if the value changes and the energy is lost, this is known as loss of pressure [16]. Wavelet analysis is a simple portion that identical and imitative copies of the original (or native) wavelet. Once checked the wave images, are caned clearly notice the signs with sharp changes that can be better analyzed using irregular waves [17, 18]. 2D-discrete wavelet transform technology is used for noise and data compression as well as for signal analysis, it also has a simple wave structure, which makes it a favourite in wave analysis, and reduced data size [19]. When using discrete wavelet transforms, the wavelets are converted into frequency data and divided into two bands: a lower frequency band and a higher frequency band Also, the waves are similar to the waves with vibrations that have to observe widening around the original [20].

3.3.3. Feature reduction based on principal component analysis (PCA)

Principal component analysis (PCA) used as a post-extraction feature analysis to reduce the distance between data values, and it is considered one of the statistical analysis methods [7]. This method uses a vertical transformation to convert a set of different numerical values (that are linearly related) to a set of nonlinearly linearly related numerical values called basic components [21]. It is sensitive to the process of changing the relative size of the basic components. The transformed core components must be less or equal to the features before the conversion, so the PCA is a process to clarify the features more before the matching process [22]. Principle component analysis is used to simplify data by linear conversion to new dimensions with a maximum number of variables so that the new dimensions consist of basic components that are compatible with the range of sensors [23].

3.3.4. Minimum matching based on Euclidean distance

In this stage, the characteristics and similarities are measured. The use of the Euclidean distance is due to the Pythagorean principle, where it indicates the location of two points on one line and the identification

of one of the points to be the main point. The length of the direction between the two points is measured by the distance alone and through which the original direction will be determined [24]. In this proposed work, the Euclidean equation is used to measure the similarity between the properties of the images entered and the images in the database [25]. The Euclidean distance between two points, x1, and x2, with j dimensions, can be calculated as show in (3). In engineering concepts, the equation can be illustrated as a straight line consisting of two oils, where karate coordinates are used as symbols of these points through which the straight line is formed.

$$Euclidean\_dis = \sqrt{\sum_1^j (x_{1j} - x_{2j})^2} \quad (3)$$

4. EXPERIMENTAL RESULT AND ANALYSIS

In the proposed model the experimental test of this work implemented and tested on PUT Vein palm dataset [1], the total number of entire images consisted of 1,200 pictures, the images were collected from the right hand and the left hand from 50 volunteers and the pictures were taken through 3 sessions 4 pictures each time with at least one week between each session, the experiments were carried out and therefore to determine the identity of the user and knowing the authorized person [1]. The first experimental result of the dataset is a preprocessing based on adaptive histogram equalization to enhance the visibility of vein utensils to detect the features. Figure 2 shows the steps of enhancement of each image with their histogram. The second experiment is feature extraction based on the fusion of the Gabor filter and 2D dwt coefficient to extract the optimal features of each vein images, the raw features of the images are reducing it by using PCA. The accuracy of the dataset based on multiple algorithm technique shows in Table 1.

The testing phase was implemented on different cases as shown above, for both enhanced left and right-hand features extracted based on different techniques. First i have proposed Gabor coefficients as features stand alone as the table shows the accuracy was 85.5 for a right hand and 84 for left. As well as when used 2D-DWT as features the accuracy was higher than the first experimental test on features selection and extraction. Then the previous features techniques are tested with PCA as a features reduction the performance accuracy was a promising and the higher accuracy was 96 %, finally, the features based on fusion coefficient of both features extraction techniques was the highest with 96% and 96.2 % for both right and left vein palm. The receiver operating characteristic (ROC) of the false accept rate and false reject rate shows the optimal threshold of 4.7 of the recognition. Figure 3 and Figure 4 shows the ROC curve for right and left vein palm images. The summary of comparing the accuracy that achieved by the proposed model, with other techniques, as shown in Table 2. The proposed model achieves higher accuracy when used fusion of features than the refrence [1].

Table 1. Accuracy result of the PUT vein

Dataset	Features based on Gabor	Features based on wavelet	Wavelet + PCA	Gabor + PCA	Fusion of Gabor and wavelet	Fusion of Gabor and wavelet + PCA
Right palm Image	85.5	88	94	95.66	95	96
Left palm Image	84	87	95	96	96.6	96.2

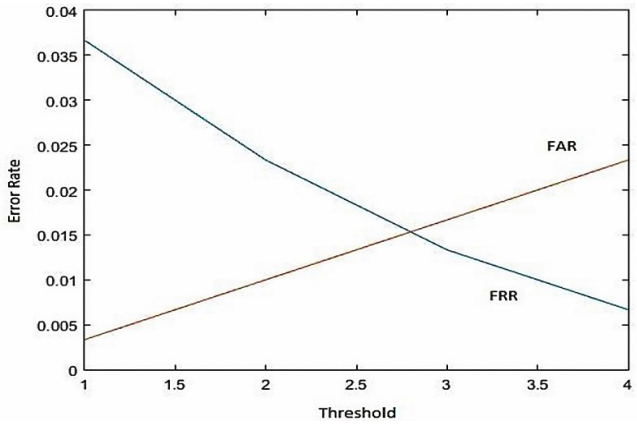

Figure 3. ROC Curve for right hand

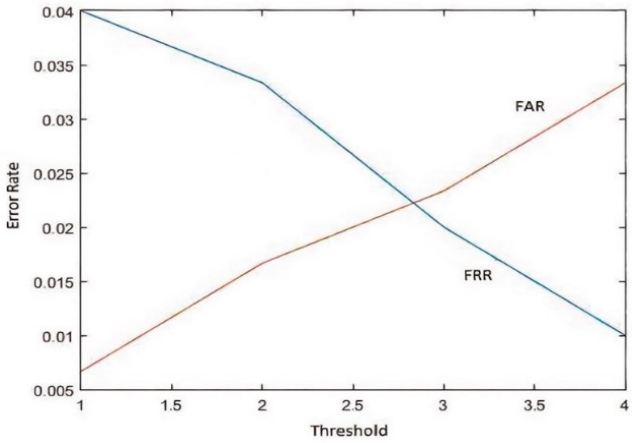

Figure 4. ROC Curve for left hand

Table 2. Model comparison based on accuracy

Algorithm	Left hand	Right hand
M.Abed [1]	96	95.66
Proposed model	96.6	96

5. CONCLUSION

In this work, the proposed model that are suggested are tested the performance based on the database, the images are selected from the Institute of Technology Control, University of Poznan, Poland, where they tested the palm of the hand as a system for intravenous identification (PUT). The database consists of 1200 pictures, half of them are for the right hand and the other for the left hand. Was done in three sessions four pictures for each person, and at least one week between each series, the pictures in the PUT database have a size of 1280 * 960 resolution and is saved as a 24-bit bitmap file, in this work the proposed model has use Gabor filter and wavelet as a fusion features because of the fusion increase the accuracy of recognition when we used both algorithm and its achieved 96.2% accuracy, comparing with Gabor or wavelet. The training and testing contain 50 % of the images in the dataset. In the last phase used Euclidean distance to measure the similarity, the results were good and identical.

REFERENCES

[1] Abed, Mohammed Hamzah, "Wrist and palm vein pattern recognition using gabor filter," *Journal of AL-Qadisiyah for computer science and mathematics*, vol. 9, no. 1, pp. 49-60, 2017.
[2] Pan, Mi, and Wenxiong Kang, "Palm vein recognition based on three local invariant feature extraction algorithms," *Chinese Conference on Biometric Recognition*, pp. 116-124, 2011.
[3] Tahmasebi, Pejman, Ardeshir Hezarkhani, and Mojtaba Mortazavi, "Application of discriminant analysis for alteration separation; sungun copper deposit, East Azerbaijan, Iran," *Australian Journal of Basic and Applied Sciences*, vol. 4, no. 4, 564-576, 2010.
[4] Al-juboori, *et al.*, "Palm vein verification using Gabor filter," *International Journal of Computer Science Issues*, vol. 10, no. 1, 2013.
[5] Kabaciński, Rafał, and Mateusz Kowalski, "Human vein pattern correlation-a comparison of segmentation methods," *Computer Recognition* Systems, vol. 4, pp. 51-59, 2011.
[6] Pan, Mi, and Wenxiong Kang, "Palm vein recognition based on three local invariant feature extraction algorithms." *Chinese Conference on Biometric Recognition*, pp. 116-124, 2011.
[7] Al-Juboori, Ali Mohsin, Xiangqian Wu, and Qiushi Zhao. "Biometric authentication system based on palm vein." *2013 International Conference on Computer Sciences and Applications*, pp. 52-58, 2013.
[8] Martinez, Dominique, "Online adaptive histogram equalization." *Neural Networks for Signal Processing VIII. Proceedings of the 1998 IEEE Signal Processing Society Workshop (Cat. No. 98TH8378)*, pp. 531-538, 1998.
[9] Csapodi, Márton, and Tamás Roska, "Adaptive histogram equalization with cellular neural networks," *1996 Fourth IEEE International Workshop on Cellular Neural Networks and their Applications Proceedings (CNNA-96)*, pp. 81-86, 1996.
[10] Raut, Shriram D., and Vikas T. Humbe. "Statistical analysis of resulting palm vein image through enhancement operations," *International Journal of Information Engineering and Electronic Business*, vol. 5, no. 6, pp. 47-54, 2013.

[11] Shamsudeen, Fousia M., and G. Raju. "A novel equalization scheme for the selective enhancement of optical disc and cup regions and background suppression in fundus imagery,"*Telecommunication, Computer, Electronics and Control*, vol. 17, no. 4, pp. 1715-1722, 2019.
[12] Fischer M., M. Rybnicek, and S. Tjoa, "A novel palm vein recognition approach based on enhanced local Gabor binary patterns histogram sequence," *2012 19th International Conference on Systems, Signals and Image Processing (IWSSIP)*, pp. 429-432, 2012.
[13] Nazarkevych M., Oliarnyk R., Dmytruk S., "An images filtra-tion using the Ateb-Gabor method," *2017 12th International Scientific and Tech-nical Conference on Computer Sciences and Information Technologies (CSIT)*, vol. 1, pp. 208-211, 2017.
[14] Wang, Lingyu, and Graham Leedham, "Near-and far-infrared imaging for vein pattern biometrics," *2006 IEEE International Conference on Video and Signal Based Surveillance*, pp. 52-52, 2006.
[15] The Hong Kong Polytechnic University (PolyU), 2013. [Online]. Available: http://www4.comp.polyu.edu.hk/~biometrics/HyperspectralPalmprint/HSP.htm.
[16] Gupta, Dipalee, and Siddhartha Choubey. "Discrete wavelet transform for image processing, "*International Journal of Emerging Technology and Advanced Engineering*, vol. 4, no. 3, pp. 598-602, 2015.
[17] Singh, Priyanka, Priti Singh, and Rakesh Kumar Sharma, "JPEG image compression based on biorthogonal, coiflets and daubechies wavelet families," *International Journal of Computer Applications*, vol. 13, no. 1, pp. 1-7, 2011.
[18] Abed, Mohammed Hamzah, "Iris recognition model based on Principal Component analysis and 2 level Haar wavelet transform: Case study CUHK and UTIRIS iris databases," *Journal of College of Education/Wasit*, vol. 1, no. 27, pp. 485-500, 2017.
[19] M. Schimmack, S. Nguyen, P. Mercorelli, "Implemented wavelet packet tree based denoising algorithm in bus signals of a wearable sensorarray," *Journal of Physics-Conference Series*, vol. 659, no. 1, pp. 12-21, 2015.
[20] Altaher, Ammar Wisam, and Sabah Khudhair Abbas, "Image processing analysis of sigmoidal Hadamard wavelet with PCA to detect hidden object," *TELKOMNIKA Telecommunication Computing Electronics and Control*, vol. 18, no. 3, pp. 1216-1223, 2020.
[21] Alizadeh, *et al.*, "Distinct types of diffuse large B-cell lymphoma identified by gene expression profiling," *Nature*, vol. 403, no. 6769, pp. 503-511, 2000.
[22] Ibrahim, *et al.*, "A filter bank based approach for rotation invariant fingerprint recognition," *Journal of Signal Processing Systems*, vol. 68, no. 3, pp. 401-414, 2012.
[23] Sudarmaji, *et al.*, "The application of general MOS gas sensors for discriminating formalin content," *Telecommunication, Computer, Electronics and Control*, vol. 16, no. 6, pp. 2905-2912, December 2018.
[24] Ding, Chris, and Xiaofeng He, "K-means clustering via principal component analysis," *Proceedings of the Twenty-first International Conference on Machine Learning*, 2004.
[25] Al-Juboori, *et al.*, "Palm vein verification using multiple features and locality preserving projection," *The Scientific World Journal*, vol. 2014, no. 1, 2014.