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RECOGNITION FINGERPRINT BASED ON GABOR FEATURES EXTRACTION

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Abstract

In this paper, we present a novel algorithm to identify an individual person using fingerprint matching technique. We use fingerprint segmentation and Gabor filter to extract Gabor features from a finger image We use our fingerprint hash and Gabor filter to extract Gabor features from fingerprint image captured by the sensor in JPG format. The proposed algorithm presents 0.9805 % accuracy of fingerprint authentication which is much better than the existing methods of fingerprint matcher.

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I. Introduction

Personal identification system based on real-time fingerprint recognition is becoming the most important and the most popular. So, the researchers found a new matching algorithm in fingerprint recognition in real time. Although, fingerprint recognition is associated with criminal verification and police work, it is considered to be more reliable than other methods of recognition such as voice, face and signature, especially after the development of technology. It has become more accepted in civil applications such as financial security and in applying for a driver's license [1].

Recently, the most important biometric algorithm is the fingerprint-based identification which has drawn a fundamental value of attention. For centuries, People have utilized fingerprints for personal identification and the validity of fingerprint identification has been well settled. Fingerprint technology is so common in personal identification that it has almost become the synonym of biometrics. Fingerprints are considered to be unparalleled through individuals and across fingers of same individual. Even thought, identical twins own similar DNA, they are believed to have different fingerprints. According to these observations, an increased utilization of automatic fingerprint based identification have been grown more [2].

In the nineteenth century, he had found the use of fingerprints. In that period Sir Galton was able to identify the characteristics of a set of fingerprint points, from which it is possible to identify the fingerprint. Which are named Galton points for him. Where it became the basis in the system of fingerprint recognition using sub-points to represent the fingerprint image, was which known the minutiae.

The fingerprint is a group of ridges and valleys that are parallel and separated again and finished are sometimes. It turns out that there are one or more areas that illustrate the shape of the ridges and valleys when analyzing fingerprint in global level. These shapes are characterized by high curvatures such as terminations, intersections, bifurcations, and others. These are called individual regions, which classify to three the topologies; vortex, ring, and delta. At the local level, there are so-called minutiae other important details that can be found in the fingerprint pattern.

The goal of this paper is to modify and enhance the Gabor features algorithm presented by [2] for obtaining better accuracy of fingerprint recognition.

In this paper, we create a novel algorithm to identify individuals using finger print recognition. The proposed algorithm is depending on Gabor features algorithm presented by [2]. In the proposed algorithm, we modified and improved this algorithm by implementing a finger print segmentation before applying the Gabor filter for having the specific features used for identification.

The rest of this paper is organized as follows: a literature survey related to this work is presented in Section II. Section III presents the proposed framework. Section IV presents the experimental activities implemented in this work. Section V offered result and discussion. Finally, a conclusion is presented in section VI.

II. Literature Survey

Neeraj Bhargava and Ritu Bhargava, (2012) [3], presented a fingerprint recognition algorithm using minutiae matching technique. The presented work establishes relation between two fingerprints based on ridge ending and bifurcation points. The created algorithm has two main steps: at the beginning to compute existing points in an image; and then, to find the location of these points. Also, this algorithm contains a matching process comparing the points data of two fingerprint impressions. In this work, minutiae based fingerprint matching technique is studied in detail. The authors claim that this work shows analyzer can identify the fingerprint image by minutiae point calculation as well as position evaluation of minutiae points. In this work, the authors did not mention any results related to the finger print recognition.

A management mechanism utilizing mosaic images to maximize the efficiency of limited template data is presented by (2018) [4]. The authors created an algorithm to enhance the accuracy of matching surpassing the general template composing. The used a database of 100 people, acquired by a small-sized capacitive sensor. The authors claimed that they decreased the false acceptance cases implementing minutiae and it prevented wrong images is composed as mosaic images. Also, the claimed that they can achieve good matching accuracy.

The researchers adopted a set of Gabor filters in fingerprint matching (2004) [2]. It also uses local and global fingerprint details. Fingerprint matching depends on the Euclidean distance between two vectors. The performance of biometric system can be shown as a Receiver Operating Characteristic (ROC) curve that plots the Genuine Accept Rate (GAR) against the False Accept Rate (FAR) at different thresholds on the matching score. The authors mentioned an example for the created system accuracy which is at 1% FAR, the Gabor filter based finger print matcher provides a GAR of 91% while the minutiae based matcher provides a GAR of 73%. The Gabor-based acceptance rate is higher than that of minutiae rate and takes less time.

Fingerprint recognition is an important topic for biometrics research (2011) [6]. Determining the mechanism of matching between two fingerprints needs to reduce the False Rejection Rate (FRR) and the False Acceptance Rate (FAR). The development of computing capabilities has led to the development of the Automatic Fingerprint Identification System (AFIS). The researcher tried to give a wide range of the problem of fingerprint recognition from processing, design, and implementation as well as what is expected in the future. The development of computing capabilities has led to the development of AFIS. The researcher tried to give a wide range of the problem of fingerprint recognition from processing, design, and implementation as well as what is expected in the future. For more than a century, fingerprint authentication has been studied. Because of the development of automated fingerprint recognition systems, it has become widely used. The unique and important research opportunities that covered many areas such as encryption, image processing, sensor development, and computer vision are the result of the increasing demand to reduce the failure rates of automatic fingerprint recognition systems.

From the aforementioned literature, we can conclude that the researcher stressed that fingerprints are the best measures and they are good, but their potential has not been fully realized. However, many problems are considered to be major challenges for fingerprint authentication, including Real-time identification in large applications, remote fingerprint authentication, and development of secure fingerprint templates and scalability. In this paper, we focused on increasing the accuracy of the finger print matcher based on Gabor features while using less stored finger print images of the users.

III. The proposed framework

In this work, the challenges are how to increase the GAR with less FAR using Gabor features with a very limited database of stored fingerprint images. The database used in this work is created from different students in Thiqar university for 50 different people. Every person gives only five finger print images. We enhanced The finger print matcher created by [5] using a finger print segmentation method created by [7]. As shown in the algorithm of the created finger print matcher presented below, we explain the steps of fingerprint matcher below.

1. Image preprocessing

The most important characteristic of the captured fingerprint is the foreground and background. When the finger touches the surface of the sensor, we get the front part. It is a typical flow-like pattern, adopting on two elements where dark polygons point to ridges, while valleys are represented by straits. The pressure and condition of the fingertip as well as the types of sensors are a combination of factors that affect fingerprint acquisition. Since the required information is in the ridges, it is necessary to highlight the ridges to identify fingerprints. The process of separation of the front area (containing valleys and ridges) and the rear area is known as its the segmentation. The segmentation algorithm determines the segment's affiliation whether it belongs to the foreground or the rear area depending on the characteristics available for the shape.

Morphological treatment processes were based on the fractionation technique on an adaptive thresholder range image of the given grayscale fingerprint. Morphological processes in image processing have been used to identify and extract meaningful properties of the image depending on the shape or shape within the image.

A. Basic Morphological Operations

Defined the application of morphological operations to binary images, with the possibility of applying them to grayscale. A non-linear technique that uses a 3D template symbolized by S E (Structuring Element). SE is placed on the possible locations of the image and compared with adjacent pixels [7]. Dilation and erosion are important morphological factors. Corrosion and expansion are processes similar to gyrus in filtering processes. dilation work is to expand narrow regions, While, corrosion is the removal of the isolated foreground. In erosion, we place the center pixel SE on each front pixel (value 1). If any of the pixels of the adjacent pixels is the background of the pixels (value 0) we will switch the foreground pixels to the background. The erosion of image A by the structure of B is called A-B. Thus, placing the center pixel at the structuring element on each pixel in the background image is called the dilation process. If the value of any of the adjacent pixels is 1, it will switch the background pixels to the foreground. Also, the dilation of the image A through structuring Element B means A+B. It is clear from the foregoing that erosion works to reduce the size while dilation works the opposite in a binary image. Other important processes are opening and closing.

The closing refers to a dilation process followed by erosion, while the opening is an erosion process followed by dilation with the same SE. Thus, the opening has the action of removing separated foreground, while closing has the influence of tear-out holes and changing of small regions of background into the foreground. The closing and opening operations of A by structuring element B are arithmetically denoted by A-B and A+B respectively.

B. Image enhancement

In this step we used an algorithm created by [8] which is called image enhancement using median mean in order to use the output of this algorithm to image segmentation mentioned in the next section.

C. Fingerprint Segmentation

In this step we used the fingerprint segmentation algorithm created by [9] to obtain the segmented image as shown in figure 1 to be processed for the next step of the created system which is Gabor features extraction.

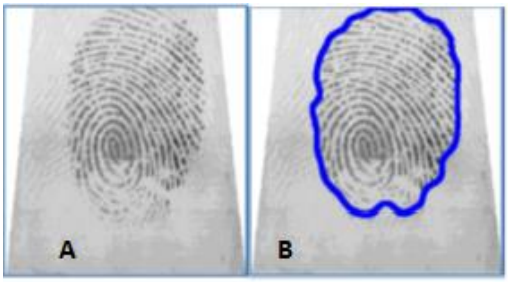

Figure 1 A- original and B- segmented image.

D. Features extractions

In this step, we used Gabor filter to extract Gabor features. The Gabor extent is very beneficial in image processing applications such as fingerprint recognition, optical character recognition and iris recognition. The all-serious feature of the Gabor filter is its stability in rotation, gradient, and translation. the Gabor filter use to extract the features from the discovered duty region. the Relations between activations for a specific spatial location are very distinctive between objects in an image. The Gabor-based filter is dragged directly from the gray-level image in the 2D spatial range. There is also the possibility of reducing the frequency of information by reducing the image produced by the Gabor filter. In the paragraph below, we explain the concepts of the implemented Gabor filter and its bank.

2. Gabor filter bank

The filter bank of Gabor considers as one of the best systems in the world, which used to elicit the properties of grizzly images. As well as, they are strong system against rotation of the Gaussian function. they are similar to the properties of human vision system particularly for frequency and orientation submit. They are also suitable for texture submit. as in

$$W_{\omega,}(C , U)= \frac{1}{2\pi\sigma^2} = \exp\left(- \frac{c'^2 + u'^2}{2\pi\sigma^2}\right) \exp(f\omega\, x')$$

$$C' = c \cos\theta + u \sin\theta\ ,\ u' = - \sin\theta + u \cos\theta$$

where (c , u) is the pixel position in the spatial domain, ω is the central angular frequency of a sinusoidal plane wave, θ is the anti-clockwise rotation of the Gaussian function, and σ represents the sharpness of the Gaussian function along both c and u directions. The Gabor filter recognize different pattern problem. We order $\sigma \approx \pi/\omega$ to specify the relationship between σ and ω in our test and attempt, so we can use the Gabor filter to elicit properties of finger images. Sometimes, it has 5 frequencies and 8 orientations. Fig. 2. shows the Gabor filter bank with 5 different levels as well as 8 different directions as well.

In the following equation give 5 frequencies (m=1,2,…….,5) and 8 directions (n=1,2,……,8) to the Gabor filter bank:

$$\omega_m = \frac{\pi}{2} * \sqrt{2}^{-(m-1)}\ ,\ \theta_n = \frac{\pi}{8}\,(n-1)$$

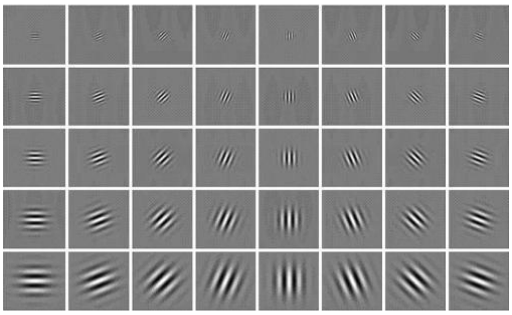

Fig. 2. Real parts of the Gabor filters at 5 scales and 8 orientations.

The input image I(c , u) is convolved with the Gabor filter Ψω,θ(x,y) to obtain Gabor feature representation as:

$G_{m,n}(c, u) = I(c, u)$□□□ □□□□□□□□$_n$ (c , u)

In this stage, they convert longitudinally in the direction of the sinusoid, but it's size changes slowly and little $G_{m,n}$(c ,u) changes with displacement [10].

After creating the Gabor filter and its bank, we used the filter function from matlab (imfilt) to extract Gabor features of matrix of 7320×5.

IV. Result and discussion

After extracting the Gabor features from every image in training and testing set, we implement a statistical method mean square error (MSE) between the training and texting images in the database to compute a threshold that will be used to identify the individual named. To evaluate the proposed algorithm and compare it with different fingerprint recognition algorithms, we implement the accuracy measurement function as shown below.

Knowing the true image of a fake image is essential. Therefore, this process must be carried out with less errors and more accuracy, and the option that gets 100% is the first option and this does not happen sometimes because of the difference in accuracy and characteristics that help to distinguish. The most important of these characteristics are accuracy, sensitivity, specificity and positive and negative probability ratios [11] as presented below.

TP: Correct diagnosis of the same person.

TN: The correct diagnosis is not for the same person.

FP: Misdiagnosis of the same person.

FN: The wrong diagnosis is not for the same person.

Sensitivity: The ability of the test to deter diagnoses correctly.

$$\frac{TP}{TP + FN}$$

Quality: its ability to properly deter proper cases.

$$\frac{TN}{TN + FP}$$

Accuracy: is the ability to distinguish between fingerprint and correct cases correctly.

$$\frac{TP + TN}{TP + TN + FP + FN}$$

Table 1 below shows the result of the proposed algorithm compared to the two fingerprint recognition algorithms created by [2] and [4]. The proposed system outperforms the two aforementioned algorithms with accuracy 7 % higher.

Result	**Accuracy %**	**Sensitivity %**	**Specificity %**
Propose algorithm	0.98	0.96	0.98
[2]	0.92	0.78	0.94
[4]	0.93	0.84	0.68

Table .1 result of the propos algorithm

V. Conclusions

For user authentication, Fingerprint recognition is one of the main techniques. We modify and enhance the fingerprint matcher created by [2] to extract the Gabor features. The created algorithm shows a notice enhancement and has 0.98 accuracy which is approximately 6 % higher from other fingerprint recognition techniques available in the market.

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