FINGER VEIN PATTERN RECOGNITION SECURITY

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Abstract - As a biometric trait, finger vein pattern-based technology is highly effective for personal identification with high security. Finger vein recognition is a method of biometric authentication that uses pattern-recognition techniques based on images of human finger vein patterns beneath the skin's surface. Finger vein recognition is one of many forms of biometrics used to identify individuals and verify their identity. In this paper, we presented the design of a personal identification system based on near-infrared (NIR) finger vein image and we introduced an observation model of finger vein imaging, upon which a self-adaptive illuminance control algorithm is proposed and integrated into image acquisition hardware.

Keywords: Arduino UNO, Near-infrared, self-adaptive illuminance control algorithm, Gabor filters.

1. INTRODUCTION

Pattern recognition is a branch of machine learning that focuses on the recognition of patterns and regularities in data, although it is in some cases considered to be nearly synonymous with machine learning. Overexposure and underexposure will cause information loss, which usually could not be recovered through image enhancement. Therefore, it is necessary to adjust the illuminance distribution of lighting to eliminate overexposure and underexposure in the image acquisition process. In this way, the information of a finger vein pattern could be retained as much as possible in the acquired finger vein image.

The terms pattern recognition, machine learning, data mining and knowledge discovery in databases (KDD) are hard to separate, as they largely overlap in their scope. Machine learning is the common term for supervised learning methods and originates from artificial intelligence, whereas KDD and data mining have a larger focus on unsupervised methods and a stronger connection to business use. Pattern recognition has its origins in engineering, and the term is popular in the context of computer vision: a leading computer vision conference is named Conference on Computer Vision and Pattern Recognition. In pattern recognition, there may be a higher interest to formalize, explain and visualize the pattern, while machine learning traditionally focuses on maximizing the recognition rates. For a good process of extracting vein pattern occurs, it is necessary and important a pre-processing of these images to avoid problems. Some works have been developed for this purpose, and the common point is the enhancement of the images.

Some of the advantages of Finger-Vein include:

1. Accurate
2. Fast
3. Secure
4. Small
5. User-Friendly

2. Block Diagram

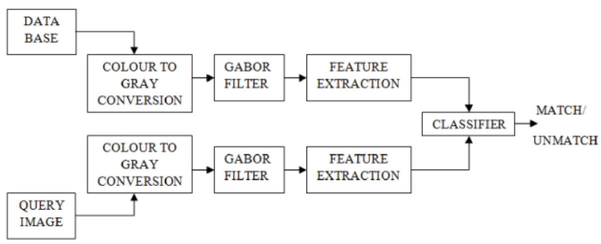

Fig.1: Block Diagram for the proposed method

3. Working

In this proposed system the acquired image is applied to the pre-processing block and the colour image is converted into a grey image. Feature extraction is done by measuring the parameters like skewness, homogeneity, contrast. The Neural Network classifier is used to identify the authorized person or unauthorized person. Receiver Operating Characteristic curve (or ROC curve.) It is a plot of the true positive rate against the false positive rate for the different possible cutpoints of a diagnostic test. This will identify the accuracy of the output. In general, two methods are commonly used for matching of line-shaped patterns: structural matching and template matching. As stated in, structural matching requires additional extraction of feature points such as line endings and bifurcations. Since a finger vein pattern has few of these points, template matching based on the comparison of pixel values is more appropriate for finger vein pattern matching. Thus, in this paper, the neural network of the proposed method and the method for finger vein identification is evaluated by estimating the mismatch ratio between the registered and the input data for the artificial finger image database. In the matching process, the extracted finger vein pattern is converted into matching data, and these data are compared with the recorded raw data. For the case of an artificial image database, the ground truth data was used as recorded raw data for each image.

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. The Gabor space is very useful in image processing applications such as optical character recognition, iris recognition and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation.

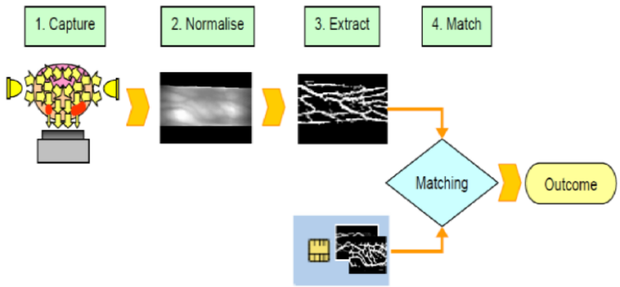

Fig.2: Procedure for personal identification

Normalization of the image

The location and angle of the finger in the image require some form of normalization since these qualities will vary each time. Two- dimensional normalization is done using the outline of the assumption that the three-dimensional location and angle of the finger are constant.

Extraction of finger vein patterns

The finger vein pattern is extracted from the normalized infrared image of the finger.

Matching

The correlations between the input pattern and all the registered pattern are calculated.

4. System Analysis

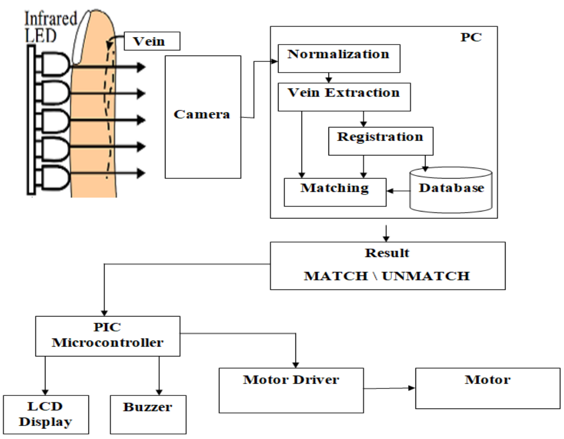

Fig.3: Principle of personal identification using finger vein patterns

General

In the image acquisition module, a finger body is illuminated appropriately by a NIR light source from above and the camera below the finger is used to capture the finger vein image. As the haemoglobin absorbs more NIR light than the surrounding tissue, e.g., fat, muscle, finger vein will be displayed as darker area and surrounding tissue will be displayed as the lighter area in the captured image. The completeness of the finger vein pattern has a big impact on the recognition rate. However, overexposure and underexposure will cause information loss, which usually could not be recovered through image enhancement. Therefore, it is necessary to adjust the illuminance distribution of lighting to eliminate overexposure and underexposure in the image acquisition process

Feature Extraction

The positions in the locus space where high values are stored are those tracked frequently in the line-tracking procedure. That is, the positions with high values in the locus space have high probabilities of being the positions of veins. Therefore, the paths of finger veins are obtained as chains of high-value positions in the locus space.

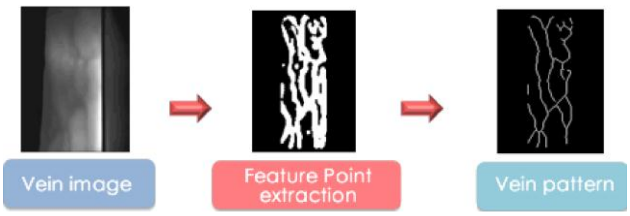

Fig.4: Feature Extraction of the vein image

Parameter Measurement

These terms are validation metrics used for verifying the quality of a segmented image. In a scenario where you want to compare a segmented image with ground truth, then taking the ground truth image as a base of comparison you can make an assumption of taking foreground as "white" pixels and background as "black" pixels in ground-truth. The terms that you referred then would mean 1. True positive (TP): pixels correctly segmented as foreground 2. False positive (FP): pixels falsely segmented as foreground 3. True negative (TN): pixels correctly detected as background 4. False negative (FN): pixels falsely detected as background True-Positive Rate = TP / TP + FN False-Positive Rate = FP / FP + TN True-Negative Rate = TN / TN + FP False-Negative Rate = FN / FN + TP For good classifiers, TPR and TNR both should be nearer to 100%. Similar is the case with precision and accuracy parameters. On the contrary, FPR and FNR both should be as close to 0% as possible. These metrics are then used to calculate sensitivity, specificity and accuracy as:

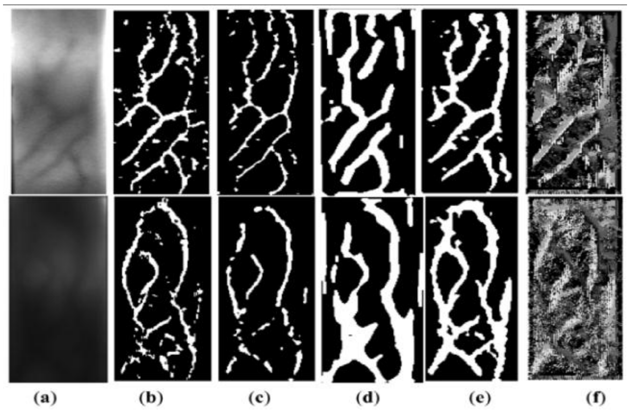

Fig.5: Performance Metrics

Sensitivity:

The sensitivity tells us how likely the test is come back positive in someone who has the characteristic. This is calculated as True positive/true positive+ False Negative

Specificity:

The specificity tells us how likely the test is to come back negative in someone who does not have the characteristic. This is calculated as True negative/true negative+ false positive

Skewness:

Skewness is a term in statistics used to describes asymmetry from the normal distribution in a set of statistical data. Skewness can come in the form of negative skewness or positive skewness, depending on whether data points are skewed to the left and negative, or to the right and positive of the data average.

Contrast :

Contrast is the difference in luminance or that makes an object (or its representation in an image or display) distinguishable. In visual perception of the real world, contrast is determined by the difference in the colour and brightness of the object and other objects within the same field of view.

Accuracy:

Accuracy is the proximity of measurement results to the true value; precision, the repeatability, or reproducibility of the measurement. The following performance metrics are used in this paper to measure the effectiveness of the proposed technique. The closest match with any of the correct training image has been considered as the correct match of the test image. The Recognition Rate (RR) is calculated by,

$$RR = \frac{\text{Number of correct images}}{\text{Number of test images}} * 100$$

$$\text{Precision} = \frac{\text{True Positive}}{(\text{True Positive} + \text{False Positive})}$$

$$\text{Recall} = \frac{\text{True Positive}}{(\text{True Positive} + \text{True Negative})}$$

5. Result

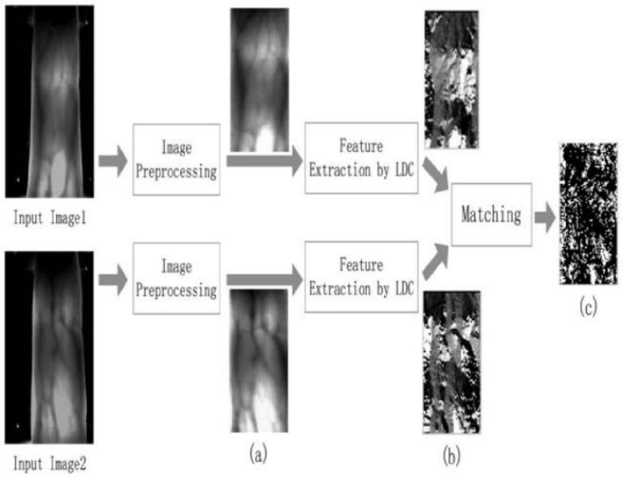

Fig.6: Result of identification

6. Conclusion

In case of a fingerprint, the condition of the finger surface (e.g. dryness, sweat) and skin distortion degrades the recognition accuracy. Performance for face recognition depends hugely on facial expressions and illuminations, which can change by occlusions or face-lifts. The biometrics like the fingerprint, iris, signature, hand shape, voice, and face does not necessarily provide confidentiality since the features used in these methods are exposed outside the human body. Hence these methods are susceptible to forgery. From the point of view of security and convenience, the finger-vein is a promising biometric pattern for personal identification. We described a personal identification method based on patterns of veins in a finger. By using the ROC curve the parameters were measured for the accuracy.

7. Reference

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