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Versatile and Economical Acquisition Setup for Dorsa Palm Vein Authentication

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Abstract

Various biometrics were employed in many applications for security purposes, amongst palm vein biometrics is one of the best methods for unique identification of a person owing to the indestructible quality of the inner vein structures. In this paper, we have proposed our own setup for capturing vein structures of human dorsal palm using a web camera modified into a near infrared camera. The illumination for capturing images is provided with the help of 30 Infrared LEDs. The objective of this paper is to produce a versatile and an economical way for obtaining vein images rather than using a high priced Near Infrared Camera and can easily deployed in any small scale applications. This setup can be used to acquire finger veins too simultaneously. We have modified the web camera by removing the infrared filter present in it and replacing it with a visible light filter. The quality and performance of the newly acquired samples are tested with two different feature extraction methods namely Correlation filter and Speeded Up Robust Features (SURF) algorithm. Correlation method has obtained very good results than SURF in identifying the genuine samples.

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Keywords: Palm vein; Biometrics; Acquisition; Near Infrared camera; Infrared light source;

1. Background

A large number of biometric identification systems exist based on different types of pattern recognition. Various developed unimodal biometrics include iris, fingerprint, retina, voice, face, gait, palm and hand patterns. The choice of pattern recognition used in the identification system depends on the properties of universality,

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uniqueness, permanence, collectability, performance, acceptability and circumvention[1]. Among the various biometrics used many are opting for palm prints and palm vein structures for biometric identification[6-14]. In this regard, the use of hand vein patterns for identification has proved to be infallible as they are found to evade changes mostly even with age[1]. The experiments conducted by Wang, Leedham and Cho[3] brought to light the fact that Far infrared imaging is more sensitive to temperature and ambience change whereas near infrared imaging was more efficient in capturing the vein structures. The hand vein structures are visible under infrared light as the deoxygenated hemoglobin when exposed to infrared radiation absorbs infrared rays of wavelength 760nm lying in the near-infrared region of the infrared spectrum[2]. Amioy Kumar et al[4] have proposed an online authentication system at low cost with promising results thereby widening the range of use of biometrics in modern applications. Yuan and Li[5] have addressed the problems caused by tilting or rotating of images while taking input images which in turn affect the authentication process in the real time scenarios. They have introduced a new method for feature extraction using robust affine transformation which gave better identification results.

In this paper, we have proposed a low cost, yet reliable authentication system by recognizing hand vein patterns by using a web camera as a near infrared camera. The system can be used for applications where an economic system with high reliability is required, since an ideal biometric system cannot be used in all fields owing to the high development cost involved.

2. Proposed system

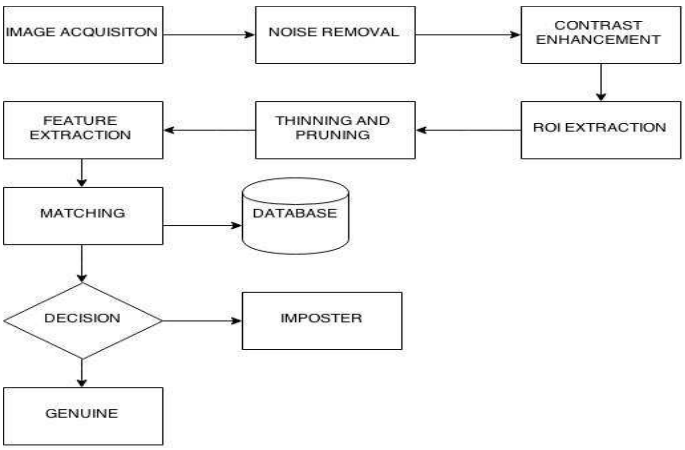

Fig. 1. Flow Diagram of Proposed System

To implement vein pattern authentication system, the first important step involved is to acquire the vein patterns which can be viewed only with a near infrared camera. To construct the same, a common web camera is taken and modified to capture vein patterns under near infrared wavelength.

2.1. Setup configuration and description

INTEX WEBCAM IT-LITE-VU is used here for the image acquisition process. It has 1/7" CMOS sensor with frame rate of 30fps and its focus distance ranges from 4cm to infinity. The lens view angle is around 54 degree. The camera produces an image around 15 megapixels. This camera is designed for taking images in the visible spectra by blocking out the infrared light using an IR filter. The camera is converted into an IR camera by removing the IR filter and placing a filter for visible light. The best filter for visible light is to use a new negative photographic film which blocks out visible light and allows Infrared light to pass through the camera.

To view the vein patterns under a near infrared camera we need an infrared source emitting infrared rays in near-infrared region. This illuminates the underlying vein patterns and can be viewed under the near-infrared camera. We have used about 30 light emitting diodes which emits light rays of near infrared wavelength of the range 700-

900 nm. In this way, the vein patterns can be viewed with precision if the light source is around 780nm. We have connected the 30 infrared LEDs serially in a breadboard powered by 18V battery source.

Fig. 2. (a) Complete Setup; (b) Top view of the setup; (c) Array of LEDs.

2.2. Image acquisition

A black background is chosen to improve the perspective of the acquired hand images. The camera is mounted horizontally parallel to the base on which the hand is placed at a height of 34cm. The array of infrared LEDs emits infrared rays in all directions. In order to regulate the amount of light falling on the hand, a breadboard is placed in an angle of 60 degrees to the platform on which the camera is mounted. The hand is placed on a slope at an angle of 50 degrees to the base to provide acute focus on our region of interest which includes the knuckle tips and the surface of the dorsal palm.

The setup is arranged as described above and the hand is placed on the horizontal slope at the base for capturing image as shown in the figure 2b. The hand is held steady with minimum motion for better experimental results. The thumb finger is placed inside and the hand is folded into a fist with optimal pressure to enhance the visibility of the vein structures in the acquired images. The images acquired from the web camera are of dimensions 640x480.

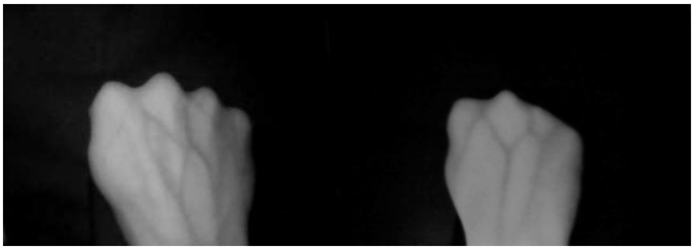

Fig. 3. (a) Male subject; (b) Female subject.

2.3. Pre-processing

The images acquired have been reduced to dimensions 320x240 so as to improve the visibility of the vein patterns and is presented for further processing. The images are then passed through a median filter initially for removing noise, followed by a low pass and a Gaussian filter for smoothening the image. Thereafter, improved the contrast of the image by Contrast-Limited Adaptive Histogram Equalization and binarized using Otsu threshold. On this binarized image, canny method is applied for detecting edges and the image is cropped to locate the region of interest. These images are again filtered and applied with adaptive threshold. Further, the obtained output sample is then thinned to provide the final output region of interest which is presented for feature extraction.

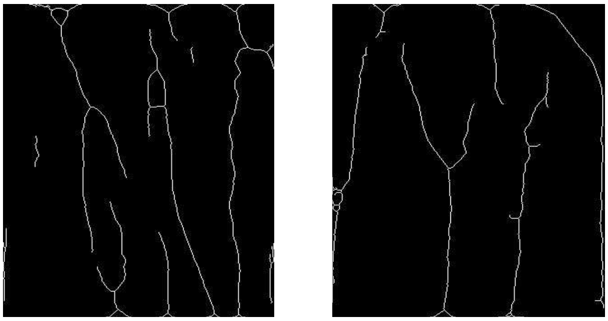

Fig. 4 (a) region of interest of fig 3(a); (b) region of interest of fig 3(b).

2.4. Feature extraction

2.4.1. Speeded up robust features algorithm

The Speeded Up Robust Features algorithm[15] has been used to provide a statistical model of the estimated matching. This algorithm is an extension of Scale Invariant Features Transform. Here, the point features of an image are extracted and stored as a feature points in the database. The algorithm generates the feature points for the image which is used for comparison and displays the matched features between the two. This algorithm is known for its speed and robustness in detecting image transformations.

2.4.2. Minimum Average Correlation Energy filters:

The Minimum Average Correlation Energy (MACE) filters[16] are a class of commonly used advanced correlation filters that are used to extract features from a set of trained images and construct a single template. These filters have been commonly used in iris and fingerprint authentication system. This template is used for comparing the features obtained from the test images. These filters have been proved to be robust to illumination variations and are one of the commonly used methods for creating a trained database with low memory requirements.

3. Experimental Results

A database of 10 people with 5 images per person has been taken through the constructed setup and has been evaluated for performance by the following two methods:

3.1. Speeded up robust features algorithm

In this method, 2 samples are trained per person, that is, a total of 14 images for 7 different persons. The feature points for every image in the database is obtained by the SURF algorithm and the strongest features in each image are extracted and placed in a KD Tree Searcher object for fast searching of nearest features for nearest neighbors. For the test image, two nearest neighbors in the database are identified and the distances are computed. The count of the number of features matched is shown in the form of a bar histogram. The highest value in the bar histogram gives the corresponding nearest match of the test image. This algorithm is able to fairly predict the match of a particular test image and obtained with an accuracy rate of 94%. Sample result is shown in Fig 5. However, this method poses a constraint in that it can be used only for persons registered in the database, as it predicts only the nearest possible match of the test image with those in the database and is not trained to recognize an imposter.

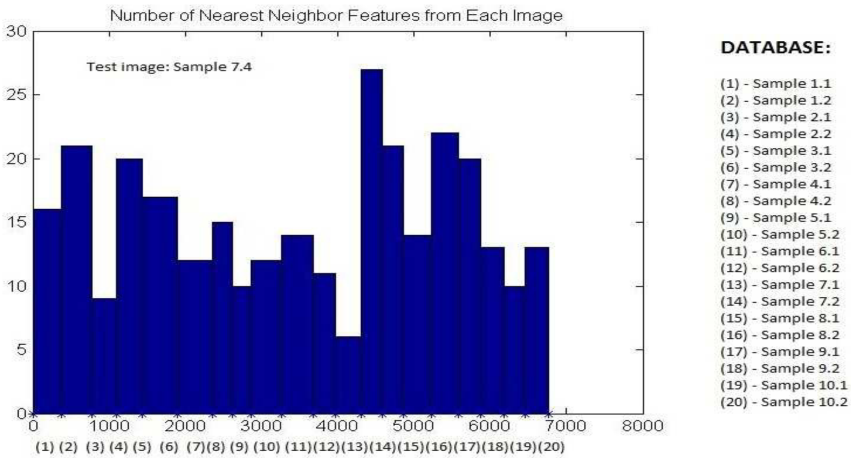

Fig. 5. Statistical Result of SURF Algorithm

3.2. Correlation filter

The system is trained with 2 samples per person. The images of a person are loaded into a class, with each class containing two images of the same person. The test image is given and the algorithm computes the peak correlation energy for each class and displays the values, which are tabulated as follows.

Table 1: Using Correlation Filters for Authentication

	Database of 10 Subjects									
Test image taken	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10
Sample 1	**25.3316**	5.6154	5.1026	5.1618	6.6945	7.9472	4.8735	6.4894	4.0502	6.6385
Sample 3	5.7254	5.3967	**22.9069**	4.6677	6.1204	4.4889	4.9299	4.8015	3.8099	5.7714
Sample 7	5.1566	7.1427	8.0875	6.7973	8.2839	9.4940	**43.7933**	4.9711	5.4151	6.2250
Sample 10	6.2893	4.2938	5.4548	4.7231	11.76	8.9736	5.3719	6.41	6.2924	**21.6356**

This algorithm proves to be extremely efficient in providing an accurate match for trained images. We are trying to modify this algorithm in such a way that it recognizes imposters, which proves to be a major constraint in the present algorithm.

4. Conclusion

This paper focuses on a dorsa palm vein authentication with a simple and cost effective acquisition setup to be deployed in any small scale application intend to provide secured authentication. From the experimental results, we can infer that we have obtained satisfactory results for genuine ones through the proposed setup. This definitely controls False Acceptance Rate. However when database size increases, a consequent drop in the performance of the system is observed. This can be improved by employing better feature extraction and training algorithms. Our future work involves in improving the quality of the images taken by eliminating any rotation or tilting in the images during image acquisition phase. We are also trying to extend our present algorithm to recognize imposters so that a better false rejection rate can be achieved and experiment for a large dataset s well with various occluded samples.

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