An Algorithm for Determining SIFT Matching Score for Dorsal Vein Recognition System

Tarshi Jain, Rajendra Kumar, Ram Chandra Singh

Abstract: ***Vein pattern recognition has been an increasingly biometric branch nowadays. This technology has many advantages over other biometric technologies. This technology works only on alive person. Vein pattern of every person is unique even in case of twins. Whole procedure of registration for verification of a person gives a hygienic opportunity. Vein pattern of a person remains constant throughout the life until and unless, physically damage. Recognition through veins cannot be affected from aging, color and physical environment because veins are present underneath the skin. NIR cameras of wavelength of 700 nm to 1000 nm are used to capture the images of vein patterns. When infrared radiation falls on the veins, these get illuminated in dark color due to the absorption of radiation by the hemoglobin present in the veins. The SIFT (Scale-Invariant Feature Transform) algorithm has given very good results in feature extortion and matching but it does not provide matching score of features. In this work, we proposed an algorithm to determining the matching score of pattern matched through SIFT algorithm. For experimental purpose, we performed image acquisition, pre-processing, feature extraction and filtering to eliminate noise from the images. We tested our algorithm on the database of 160 persons and we calculated performance of our algorithm in terms of FAR and FRR 2.7% and 4.5% respectively.***

Keywords: ***Biometrics, Dorsal Vein, Security, Pattern Matching***

I. INTRODUCTION

In the fast-growing attractiveness of computerizedsystem, the most absolute thing is data and the security of data is the main concern of today's scenario. Many cases of spoofing have been studied from the past researches and many criminals' cases of robbery, theft and even murder came up to society. Using i-cards, voter cards, and passports for the recognition purposes become an outdated task as well this system is not effective because they can be theft and lost very easily. Using of PINS, password, and UPI nowadays are in fashion but it can also be cracked and forged easily [1, 2, 3]. So, these both types of methods are interpolated and infringed easily.

Biometrics is the branch of information technology that measures and analyzes the unique biological and physical behaviour of an individual. These features are used for personal identification and for individual identification. This field gives excellent way to secure people information, their identity, their sensitive data and all related confidential items that can only be accessed by authorized persons. There are many unique identifiers present in human being that include fingerprint [14], ear, iris, hand geometry, DNA, voice, signature, veins etc. Every identifier has its own advantages and disadvantages [1, 4].

Vein recognition is the newest recognition system in the field of biometrics which is used for the personal authentication and personal identification. This technology pulls the interest of many researchers because of their convenience and efficiency. They concluded that the vein pattern of each individual on the earth is unique even in twin sibling [5]. This technology has numerous numbers of advantages over other biometrics. This technology works on the alive person because hemoglobin present in veins absorbs the near infrared light and due to which the veins gets illuminated to the NIR camera. Veins cannot be damaged because they are present underneath the skin. Vein pattern do not change with time it remains constant. It is secure because it is very difficult to counterfeit. Acquisition setup is free from physically contact this gives an untouched and hygienic opportunity while in case of fingerprint and palmprint we need to touch the machine. This technology works on every kind of skin it remains unaffected when person have rough and dry skin or even any physical injury [6]. It might be affect when some external operation or vein operation happened.

Prior to SIFT, the LBP (Local Binary Pattern) feature matching algorithm was widely used and produced very good results. Y. Ziang and Zin Liu used LBP method for lively detection in fingerprints [12]. A new method SURF is new innovation in biometrics for feature match faster than SIFT but number of feature points in SURF are less that SIFT. Therefore, to increase accuracy and finding maximum feature points, we used SIFT algorithm in our work. Shalaka Haware and Alka Barhatte applied SURF algorithm for retina based identification [13].

The overall work is divided in seven sections. Section II includes image acquisition, Section III includes pre-processing, Section IV includes feature extraction, Section Vpresents matching score algorithm after applying SIFT for feature match, Section VI includes results and Section VII includes conclusion.

II. IMAGE ACQUISITION

Acquisition of images is the capturing and collecting the images. The vein pattern images are acquired by placing hand under the near infrared camera (NIR). The near infrared camera having the wavelength between 700 to 1000 nanometres and is generally used to capture the hand/finger vein images [7]. The infrared rays coming from the camera falls on the hand and the vein gets darkened as the hemoglobin present in the vein is sensible to the NIR light and absorbs the light rigorously.

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This way the acquisition of hand vein images is done and we get good quality images. Hand vein can be classified into three types' i.e. finger vein, palm vein and dorsal hand vein.

We have used dorsal hand vein patterns in our work. We have used the near infrared camera (VF-520 of 850 nm) for vein pattern capturing. We have collected the database of 160 persons in which 80 are children of age 4 to 14 years, 45 are the males of age above 14 years, and 35 are the female of age above 14 years. We have considered 4 images from each person in which 2 are of left hand and 2 are of right hand. We have set the resolution of image 320 × 240 in .png extension. For small scale testing setup, we perform experimental results on 25 persons and applied pre and post processing methods on them. Acquisition system of our proposed system is shown in Fig. 1.

Fig. 1: Experimental setup of proposed system

III. PREPROCESSING

In this phase the collected images have to go through the pre-processing phase. Pre-processing is the technique in which some methods are applied on the image to make image ready for further processing. In pre-processing, first we find the ROI (Region of Interest) of the images and then apply image enhancement technique. ROI are the interesting points in the image or sub region of the image to be process and left the other regions of the image unchanged.

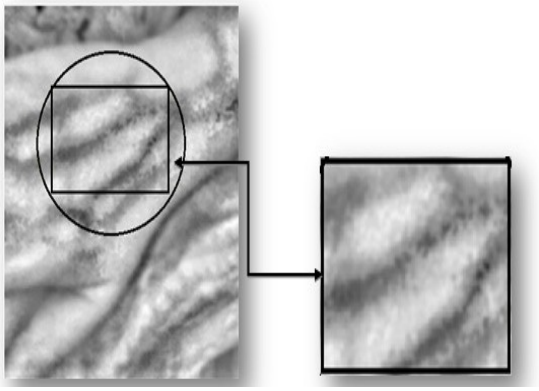

Fig. 2: ROI Localization

An ROI (Region of Interest) is the section of the image that we want to filter or to perform some specific operation. We can define the ROI in the binary image by setting 1 to the pixels belongs to interest points and 0 to pixels belongs to the non-interest points.Fig 2 shows the ROI localization of the input image.

Second pre-processing technique is image enhancement. Image enhancement is the way to enhance the image, picture and any other digital image etc. It can be done through the removal of noise, adjusting the edges, sharpening the corners and brightening the image. It helps in recovering the visibility of each and every corner of an image. Image enhancement gives the outlook to the image to become more visualize effective for the further image analysis [8, 9].

In our work, we have used Histogram Equalization for image enhancement. Histogram Equalization is the technique in which the contrast of the image is improved. It is way of adjusting the pixel intensities to enhance the contrast of the image. Let *p*be denoted as the normalize histogram. The pixel intensities lie between 0 to L-1 where L is the highest intensity value of the pixel, it may 256. Let p denote as the normalize histogram.

$$p = \frac{no.\ of pixel intensity of n}{total no.\ of pixels}$$

where n = 0, 1, 2, ……, L-1

IV. POST- PROCESSING

Feature extraction technique is one of the most essential module in the digital image processing. It is a dimensionality reduction technique in which only processing can be done on the interesting points.Reducing the dimensionality and finding the most convenient point in the image is come under the feature extraction techniques.Features in the image can be described as the points, dots, objects, edges etc. which gives the part of information that is related to the computational job of any particular application. This technique is specially used when the database is too large to process and gets converted into reduced feature set as shown in Fig 3. When all the above techniques are completed successfully, then matching is done and results are concluded.

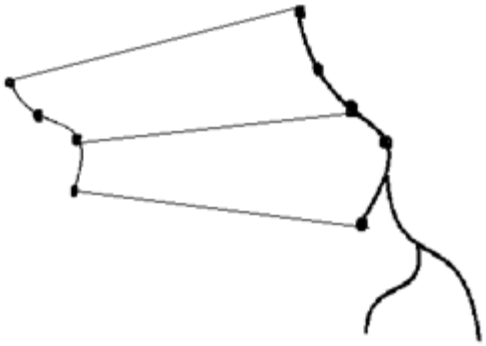

Fig. 3: Feature extraction from vein pattern

V. SIFT & MATCHING SCORE

SIFT is a special type of technique which is already being investigated for its reliable and robust results. In SIFT algorithm, both feature extraction and the matching technique together applied on the image.This algorithm comes up with many new concepts like the image is rotation invariant, size invariant and location invariantmean if the image is rotated, we can get the samecorners and same edges each time [10,11].

SIFT algorithm is use to detect and find the features in the digital image. After finding the features, locate the keypoints to the image. These keypointsare also called descriptors. These descriptors are free from alteration. This technique is broadly used in computer vision for matching the two images placed infront of each other.The keypoints extracted in the images are robust to the scaling, rotation included it is invariant to the lighting changes also, that makes this algorithm effective and make it easy to matched closely to the features belonging to the same image in a huge record.

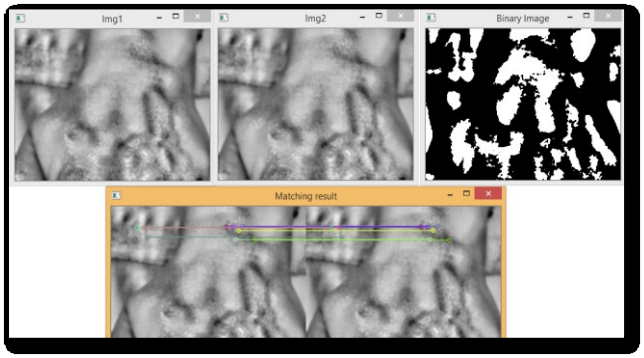

Fig 4: Thresholding and matching using SIFT algorithm

The proposed matching score finding algorithm is as follow:

vein_pat_match_algo()
{
count = 0
for (*i* = 1*; i* <= *n; i*++)
// *i* and *j* are the two loops for counting the number of lines
{
for (*j* = 2; *j* <= *n*; *j*++)
{
$d(i)=\sqrt{(y2-y1)^2+(x2-x1)^2}$
// *d*(*i*) is the Euclidean distance between the line
//whose coordinates is (*x*1,*x*2) and (*y*1,*y*2)
$d(j)=\sqrt{(q2-q1)^2+(p2-p1)^2}$
// *d*(*j*) is the Euclidean distance between the line
whose coordinates is (*x*1,*x*2) and (*y*1,*y*2)
m(*i*) = (*y*2-*y*1)/(*x*2-**x**1) // *m*(*i*) is the slope of i^{th} line
m(*j*) = (*q*2-*q*1)/(*p*2-*p*1) // *m*(*j*) is the slope of j^{th} line
}
}
if $((\Delta(i,j) \cong 0) \&\& (d(i)-d(j)=0))$
// if the value of $\Delta(i,j) and difference$ of *d*(*i*)
and *d*(*j*) is equal to 0 then count increase by 1
{
count = *count* +1
}
Match_per = (*count* *100) / *n*
// calculate the matched percentage
print *Match_per*
}

The algorithm determines the matching score on the basis of features match representation by number of parallel lines.

VI. RESULTS

We have created the database of 160 persons and we have tested the experimental results on 25 persons and one person has 4 images (2 images of left hand (L1, L2) and 2 images of right hand (R1, R2)). Total images we take for research work is 100 images and total matching come out to be is (100 images×100 times) =10,000 results.

Total imposters score (including male, female and children) = 9800

Total genuine score (including male, female and children) = 200.

The FAR and FRR are calculates as:

$$FAR = \frac{Imposter\ scores\ exceeding\ threshold}{Total\ imposter\ scores}$$

$$FRR = \frac{Genuine\ scores\ falling\ below\ threshold}{Total\ Genuine\ scores}$$

The table I represents the FAR and FRR calculated on threshold 40 to 90 with an interval of 10%. The features were extracted through SIFT algorithm and matching score was computed by our proposed algorithm.

Table-I: FAR and FRR of Imposter and genuine scores

S. No.	Threshold %	FAR	FRR
1.	40	0.0793	0.0400
2.	50	0.0277	0.0450
3.	60	0.0092	0.0450
4.	70	0.0021	0.0800
5.	80	0.0000	0.1150
6.	90	0.0000	0.2200

The FAR and FRR graph of Imposter and genuine scores is given in fig. 5.

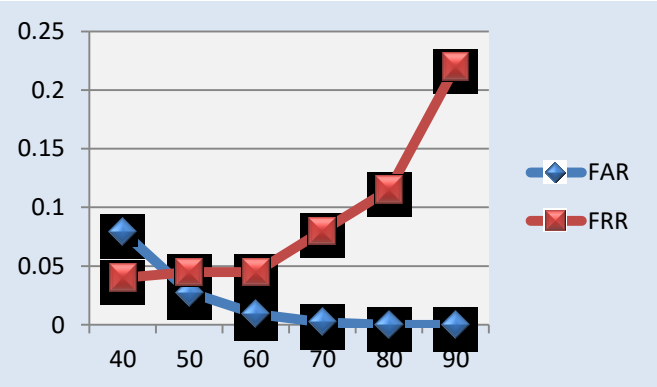

Fig 5: FAR and FRR graph

VII. CONCLUSION

We find that in comparison to other biometric features, recognition through veins gives the correct features in the human body which cannot be intrude easily. By applying our algorithm along with SIFT on dorsal vein patterns, we found very excellent results with the accuracy rate of 97.99% and the FAR and FRR is 2.7% and 4.5% respectively while the images matched were taken from same distance and same angle. Which means that algorithm proposed in this work well in favorable conditions. We use SIFT algorithm for the matching purpose.

Come to the future work this research can be continued, the matching score algorithm needs to be modified when images being matched are taken from different distances and from different angles. We can collect the database of skin patient and having diseases like Diabetes, hypertension, etc. to know how much these diseases effects on the vein structure of the person. And thirdly, we can use multi-security system in place of single-security system means we can merge this technique with another biometrics to make the system more and more secure.

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