Parallel extraction hand vein biometric parameter's using a low cost IR imaging system

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ABSTRACT

This paper presents a new and low cost approach to authenticate individuals using hand vein images. The proposed method is fully automated and employs palm dorsal hand vein images acquired from a low cost , near infrared contactless imaging; the aim of our work. In order to evaluate the system performance, a prototype was designed and a dataset of 34 persons from different ages above 20 and different gender, each has 10 images per person was acquired at different intervals, 5 images for left hand and 5 images for right hand. The vein detection process consists of an easy to implement a device that takes a snapshot of the subject's veins under a source of infrared radiation at a specific wavelength. The system is able to detect veins but not arteries due to the specific absorption of infrared radiation in blood vessels. Almost any part of the body could be analyzed in order to extract an image of the vascular pattern but the hand and the fingers are preferred.

Keywords

Hand vein, Otsu, vascular biometrics, Infrared, dorsal vein, akka actors.

1. INTRODUCTION

The biometrics word has a larger meaning in the study of identification's persons from a number of characteristics[18]. A complex human inheritance, very rich in combinations, and perfectly adapted to such systems of user identification, and/or authentification [18][Ben11] [Wan05]. It's a Mathematical analysis of biological characteristics of a person to determine his identity decisively. Biometrics based on the principle of some characteristics recognition's. Fingerprints, face, iris, retina, hand, keystroke [Jai03] [Par05] and voice, provide irrefutable proof of the identity of a person they are unique biological characteristics distinguishing one person from another. The hand vein biometrics has emerged as a promising component of biometrics study.

Prior work

Such system was invented by the British engineer Joe Rice in 1984. Before the discovery to market, a study was commissioned at Cambridge Consultants to establish that the veins of the hand are unique to each individual.

The user places his hand in a room or a gauge reading. The characteristics of the veins are read by an infrared camera that takes a two-dimensional image [Ben12].

The hand vein biometrics principle is a noninvasive, computerized comparison of subcutaneous blood vessel structures (veins) in the back of a hand to verify the identity of individuals for biometric applications. Vein check measures are the shape and size of veins in the back of the hand (or front of the wrist). The vein pattern is best defined when the skin on the back of the hand is taut – when the fist is clenched.

The captured images contain not only vein patterns but also irregular shading and noise. The shading is produced by the varying thickness of the muscles. Therefore, regions in which the veins are and are not sharply visible exist in a single image. It is widely known that the thermal (far IR) imaging cameras are highly sensitive to ambient conditions and very expensive. Therefore the researchers [Par05]-[Wan05], [Tan06], [Par97] [Hua12] have focused on the solutions using near IR imaging. Table 2 presents a comparative summary of prior work on the hand vein (back surface) approaches presented in the literature.

Table 1: comparative summary of related work, on hand vein

Reference	Methodology	Imaging	databases
T Tanaka & N.Kubo [Tano6]	FFT based phase correlation	Near Infra Red.	25 users
C-L.Lin & K.C.Fan [18]	Multi resolution analysis and combination	Thermal hand vein imaging (3.4-5µn)	32 users
L.wang and G.Leedham [Wan05]	Line segment Hausdorff distance matching	Thermal hand vein imaging (8-14 µn)	12 users
Y.Ding, D.Zhuang and K.Wang [9]	Distance between feature points	Near IR Imaging	48 users
J.M.Cross & C.L.Smith [Jai03]	Sequential Correlation in vein maps	Near IR Imaging	20 users
A.Kumar & K. Venkata	Matching vein triangulation and	Near IR Imaging	100 users

Prathyusha [Kum09]	shape features	contactless	

Proposed system

In this paper, we develop a new hand vein authentication approach using the structural similarity of hand vein shape features. The block diagram of the proposed approach is shown in figure

The efficacity of the proposed method is investigated from the trial results on the real hand vein images acquired with contactless near infrared imaging. Hence the steps of image normalization and feature extraction have been studied to decrease the variants in the interclass corresponding scores.

2. IMAGE ACQUISITION

The hardware configuration has a crucial role in the frame grabbing of veins. Two aspects can be underlined. The real camera used to take the stereotype has only one important parameter, the answer to the near infrared radiation [16]. The space resolution and the framework rate are of less importance since, for the acquisition of a model of vein, the image is necessary and the details are easily visible, even to a lower resolution. In [Cri] the design of the lighting system is one of the most important aspects of the process of frame grabbing. A good lighting system will provide precise data contrasts between the surrounding veins and fabrics while keeping Illuminations of the errors to a minimum. For a lighting system, they used IR LED because they offer a high contrast and easily available. But with a LED table formed using IR LED, they do not give a uniform illumination. Various arrangements were needed stamps LED to modify lighting. The LED is laid out like a simple or double table in 2D or rectangular table or concentric networks. Concentric arrangement table LED gives a better distribution of the light with only one or more concentric network of the LED and lens of the camera in the center of the image can acquire good contrasts.
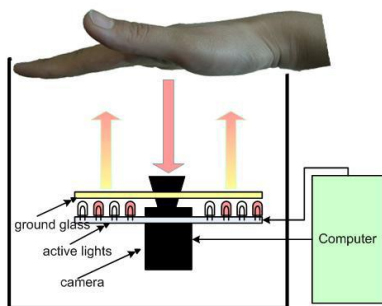

Figurre 1 : Other system similar but which collects the veins of the fingers[HIT06].

3. SYSTEM DESIGN

For the realization of our hardware framework, we noted that the system needs some conditions in order

to function correctly such as: The day light influences on the quality of the image obtained except absence of IR filter; The temperature of the environment also influences on the quality of the image, it must be ambient neither too cold heat nor around the temperature of the human body; The distance between the sensor and the object must be sufficient for a good acquisition.
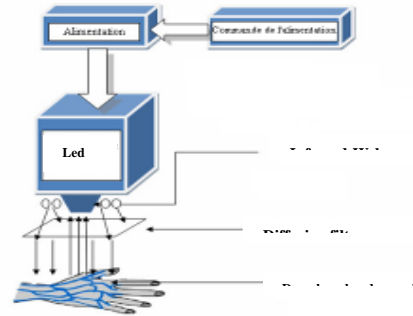

Figure 2 Hardware configuration

Our biometric acquisition system (SAB 11) is made with a case of wood; a modified webcam sensitive to the infra-red 850-900 nm waves; leds infra-red IR positioned in parallels. The transmission of information between the hardware and the software is done by an ordinary USB webcam cable.

The electric supply of the leds direct current (DC) is not a problem, it is not necessary to make an external supply circuit, it will be directly made through USB cable.
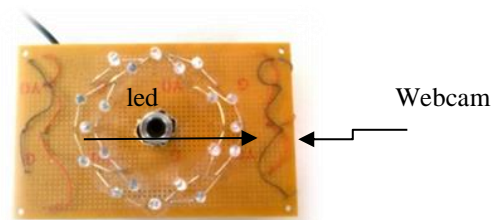

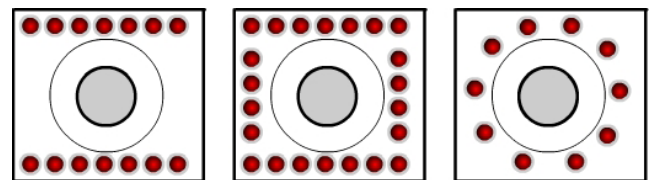
Figure 3 LEDS IR into concentric

Figure 4 Various designs of the leds

Webcams are indeed sensitive at the same time visible spectrum of light as well as spectrum IR of the light. The filter outputs only the light visible with

camera. This filter is equipped either close to lens or on the case to the chip.

A special attention must be taken while withdrawing the filter IR on the case of chip because it can damage in a permanent way the webcam. Images captured to leave IR webcam significant are indicated below in the figure. We can see that by the IR LED illumination single used in remote television can provide illumination sufficient.

First open the webcam and to start by removing the anti-infra-red filter which does not let us see the IR. Take film of photography (Negative) and cut a circle with a diameter of 1 cm. Place the circle cut in the place of the removed filter and close the whole. Now, the webcam is ready for .

-        After the modification of the webcam, and carrying out the test to collect IR images, we carried out a test on the hand Fig8.

-        Our choice was to take an image of the back of the hand with a layout of the leds into concentric in circle with day light Fig 6.

Figure 5 Capture with webcam IR	Figure 6 capture with IR Webcam & IR LED	Figure 7 Capture in the case

For our first tests, we put the webcam at a distance of 17 cm of the hand and with only one circle of IR led of number of 10 surrounding the webcam, but we obtained an image not clear and with a black circle in the medium.

Number of image	Intensity current (A)	Tension (V)
1	0.39	1.5
2	0.3	1.4
3	0.17	1.3
4	0.1	1.2
5	0.06	1.2

Table 2: Various tests

Then, we choose a tension of 1.2 V with a current of 0.06 has with which one had a good catch. Then we carried out a test by doubling the circle with 20 led, but there was always the same problem of the black circle in the medium. Fig 9

Then, if we continue to add led that will never finish, one thought of making increase the distance between the webcam and the hand has 23cm, which gave us the following result. Fig10

Figure 8 Image 5
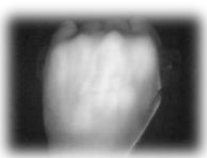

Figure 9 Image 6

Figure 10 Image 7

Figure 11 image 8

The conception finally finished after so many modifications and adjustments, the veins are visible with the IR imaging, then we can now start to make return a database of the people.

4. DATABASE

After systems design, we carry out the acquisition of the images of various people at end to have a database which will be used thereafter for the identification of the people; which are all evaluated on a common database with a common protocol.

To create the database we have first to connect SAB11 to the PC and launch the software. After, we open the door, set the hand on the wrist and close the door. Click on the button to get the image transferred to our framework. To make the capture thus five times for the right hand for the left hand. With taking

	Right hand	Left hand
First person		
Second person		

images so much the database will be effective.

Figure 12 : Sample of the database

If we compare each hand of only one individual we clearly see with the eye naked that they differ on the level from veins. If we compare two hands of two people with the eye naked we see that they also differ as for only one individual

But the identification is not also easy it is necessary to treat the images, i.e. to follow several steps extraction of the object, extraction of the veins so on.

Some step process (Laplacian of Gaussian) can be quite effective for the localization of venous structure in the acquired hand vein images.

The database has match scores corresponding to three hundred and forty files, which were acquired from trent-four people during one week.Mainly students (subjects between 20 and 30 years old) within the Institute of Maintenance and Industrial safety (University of oran Es Sénia). In each session, five recordings were taken.

5. FEATURE EXTRACTION FROM DORSAL HAND VEIN

In this part, we present a binarization algorithm for automatic extraction of the bottom region from the image adapted to a set of dorsal veins biometric images of the hand; in order to evaluate identification / authentication. We focus in this study on optimizing the time binarization images gray level, because what essentially makes a biometric system is efficient and effective is processing reply time.

We have used OTSU's method [18] as a global threshlding because the images of dorsals hand veins have equal illumination then global methods can work better. We worked on database composed of multiple images; right and left hand veins (10 to 20 images). In our case, we work with databases of 20 images per person 640 * 480 pixels. In order, to perform our biometric system for binarization step for several images, we proposed a parallel implementation of OTSU's algorithm to speed up the processing.

6. OTSU BINARIZATION'S METHOD

The aim of Otsu's method [16] is to determine the optimal threshold T from the image histogram. Therefore, the calculation of image histogram is made in first time, by counting for each gray level, the number of pixels associated.

Then, to make the process independent of the number of points in image, the histogram must be normalized as follow [Ben12] :

$$Normalize\_histogram(i) = \frac{n_i}{v255\ ..} \quad .(1)$$

n_i represents the number of pixels of graylevel i of input image.

The separation into two classes (background and hand) is done by the mean and variance.

After that, for each value of k (k ∈ [1,255]), we compute s :

$$s^2(k) = var(k) * (1 - var(k)) * (mean(255) * var(k) - mean(k))^2$$
$$(4) \qquad\qquad (2)$$

Finally the threshold value T is obtained when, for a given k ($k \in [1,255]$) we have:

$$s^2(k) = max(s(k)^2). \ (555) \qquad (3)$$

Now, we threshold image:

The pseudo-code of OTSU's method is as follow:

Comput histogram by calculating the number of pixels for each graylevel

for (i=0 to 255) {

$$Normalize\_histogram(i)$$

}

Initialize mean(0)=0,var(0)=0

for (k= 1 to 255) {

update $mean\ (k)$

update $var\ (k)$

compute $s^2(k)$

}

Threshold value is k where $s^2(k) = max(s(k)^2)$ (7)

After the sequential implementation of OTSU's method for thresholding of 20 images of definition (640*480), we noticed that the execution time is full grown (6seconds) .Since in biometric ,we identify people in real time, we have optimized this step by using master-worker paradigm where thresholding's process still be divided over each processes (workers) in parallel.optimized this step by using master-worker paradigm where thresholding's process still be divided over each processes (workers) in parallel.

7. PARALLEL OTSU'S BINARIZATION

In order to binarize several images in parallel with OTSU's method we have opted to master/worker paradigm, where the master P0 creates several workers and dispatch for each one the number of image. After, each worker can subdivide the image into several blocks (sub images) and dispatch each block to other workers in order to threshold these sub images. The figure bellow shows our approach.
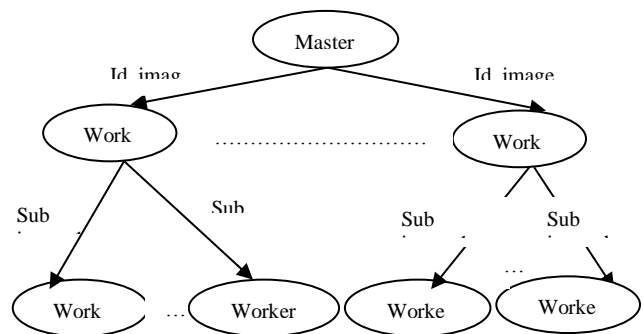
Figure 13. Master worker paradigm of binarization of several images (scatter phase)

In scatter phase, each worker of level 2 takes a sub image and applies OTSU's binarization method.

Person	Left/Right hand	Input imge	Output image of OTSU's binarization
1	Left		
	Right		
2	Left		
	Right		

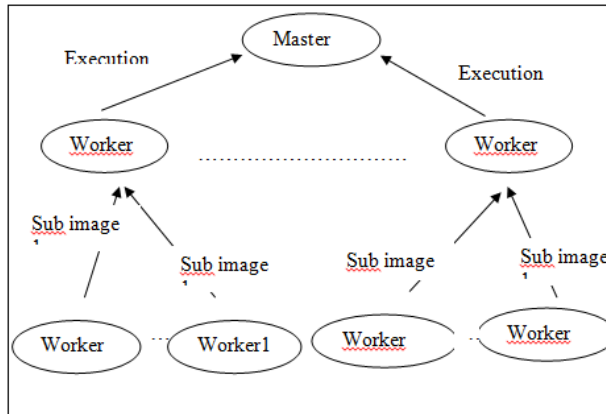
Figure 14. Master worker paradigm of binarization of several images (gather phase)

In gather phase each worker return its results resultants to its master, that will assembles the final results.

8. ROI EXTRACTION AND ENHANCED

To extract the area that contains only information of the vein pattern, we have calculated the center of gravity (xg,,yg) by (1) as made in [Kum09]. As the vein images were not clearly distinguished, we improved the contrast by linear transformation.

$$x_g = \frac{\sum_{i,j} i \times f(i,j)}{\sum_{i,j} f(i,j)} \ ; y_g = \frac{\sum_{i,j} j \times f(i,j)}{\sum_{i,j} f(i,j)}$$

(a). ROI of the vein images before enhancement

(b). ROI of the vein images after enhancement

9. HAND VEIN SEGMENTATION

Global thresholding method is not a good technique for this purpose [Cri07]. However the local thresholding is better approach for hand vein segmentation. In this study, in order to minimize the computational time of local thresholding calculation, we have used integral image [Cro95] [13] as local thresholding technique to separate the vein from background.

The main idea of the proposed method is to compute the integral image of each pixel [16] g(x,y) by (2).

$$g(x,y) = \begin{cases} I(0,y) + g(0,y-1) & if\ x = 0\ and\ y \in [1,m \\ I(x,0) + g(x-1,0) & if\ y = 0\ and\ x \in [1,n| \\ I(x,y) + g(x,y-1) + g(x-1,y) - \\ g(x-1,y-1) & else \end{cases}$$

Where I(x,y) is the intensity value of pixel (x,y). Once we have computed integral image, the local sum s(x,y) [16] can be defined as follow.

$$s(x,y) = g(x+d, y+d) + (x-d-1, y-d-1) - [g(x-d, y-d-1) + g(x-d-1, y-d)]$$

10. HARDWARE AND SOFTWARE SPECIFICATION

Experimentations have been carried out on a laptop with an Intel Core 2 Duo/2GHz CPU and 3GB of RAM. Implementation has been done with Scala language verion 2.9 and Akka actors version 2.0.5.

Scala is a functional and Object-oriented programming. It has parallel collection libraries for parallel processing of independent data. Since, Akka is Open Source and available under the Apache 2 License, it provides API for Java and Scala. We have used it because it offers a set of tools to solve

problems [Fuk] related to competition: actors, agents, software transactional memory (STM) and proposes mechanisms for fault tolerance. Akka Actors are very lightweight concurrent entities. They process messages asynchronously using an event-driven receive loop.

So, for our approach of master/worker paradigm, the master and all workers become actors that will communicate by message.

11. IMPLENTATION AND EXPERIMENTATION

We have tested our approach for the thresholding of 20 images in parallel with dimensions 640*480. The comparison of execution time of serial implementation over parallel is shown in table 1.

We have used one actor as a master and 20 Akka actors as workers of level one. In level two, each actor of level one can create several actors to binarize each sub image.

But the problem was in the choice of the number of actors to binarize an image. So the table bellow presents the results of experiments that we have run.

12. CONCLUSION

This paper has proposed an effective approach for the image acquisition of the dorsal vein patterns; according to experiments done for comparing our methods with other results. Filtered image quality is evaluated in order to find the best infrared wavelength for palm vein pattern imaging. After calculating the effectiveness index in images, it was shown that the best image quality is with the reflection method when using 760nm IR LEDs with optical filter.

Experiments with transmission method gave better results than the reflection method. However, with 760nm filter results were almost same as with the reflection method.

In this research work, a new approach based on actors for parallel implementation of OTSU's binarization for 20 images of hand vein, based on communication message between actors under the environment Scala and actors Akka, allowed us to obtain satisfactory results, however, the performance of this system can be still limited because of the communication time between actors becomes disadvantageous when the number of processes is important. So, we can say that Akka actors and Scala can be used for optimization in biometric or other situations of compute intensive or fault tolerance because Akka provides mechanisms for fault tolerance.

As a future work, we propose to use Akka actors on GPU, may it gives us more performance then the cpu for OTSU's binariszation in dorsal hand vein biometric. We can suggest too, implementing this step in FPGA and comparing the performance with Akka actors in GPU.

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