

Biometric Recognition System based on Dorsal Hand Veins

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ABSTRACT: The ‘**Biometric Recognition System Based on Dorsal Hand Veins**’ is one of the biometric techniques which introduces the design and implementation of a system for identifying a person based on their dorsal palm vein pattern. The main aim has been to build a unique, cheap and reliable system as an alternative to Contact Based systems. Near Infrared camera images have been used since this leads to clear production of veins required for the ideal working of system. The first step is to pre-process the image and find the knuckle profile using grayscale thresholding and image inversion. Image segmentation is performed on the image to get the significant edges. The image is then processed to remove noise, and using morphological operations the vein pattern is signified. The region of interest is then cropped and a 1-pixel thick skeleton pattern is obtained using image thinning which is used as a feature for matching and recognition. Triangulation method using delaunay's principle is used to find vein bifurcations and endings using local thresholding. Finally triplets are matched and used as a parameter to compare image stored in database and input image.

KEYWORDS: - Digital Image Processing, Biometric, Dorsal Hand Veins, Vein recognition.

I. INTRODUCTION

Biometrics is a field where individual is identified based on his natural traits inherent to his physical features. Biometric recognition is important in the ongoing digital age to curb security threats as no other security system provides better accuracy, reliability, as well as a sustainable system wherein a database can be created and stored. Traditional and famous biometric techniques contain finger, face and iris. Most of the biometric systems in the market today like fingerprint and hand geometry are based on contact-based design. There has always been a need to identify individual biometrics; however there is a lot of demand and change procured in the structure of biometric system as demography has been increasing at rates unprecedented and as individuals have become more migratory, techno savvy and internet accustomed. Biometric technologies have proven to be competitive in comparison with other authentication systems (e.g. Based on Pin, password, RFID etc.).

II. RELATED WORK

WHY VEIN BIOMETRICS?

Vein pattern is the network of blood carriers below an individual's skin layers. Vein patterns as a form of biometric technology was first proposed in 1992, subsequently after which a number of developments were carried out in this field. Vein patterns form distinct and distinguishable patterns across different individuals and they remain the same irrespective of age. The patterns of blood veins are unique to every individual, even among twins. There are two types of Biometric Systems namely Internal and External. External include Fingerprint, Face, Iris based systems. Finger Vein, Palm Vein, Dorsal Veins form the Internal Biometric systems. Veins are intra-skin entities, thus this characteristic makes the systems highly secure, and they are not affected by condition of the outer skin (e.g. dirt on the hand,

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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mehandi). Vein patterns are generally acquired by infrared devices, mostly Near Infrared cameras as Far infrared cameras provide degraded image quality in comparison. The infrared devices are Contact type as well as Non-contact type, of which Non-contact type provide friendly, Hygienic and easier way of use. Contact based touch type system like Fingerprint recognition and non-contact based external system like Facial recognition are the most trending in the market, but have a lot of disadvantages at their disposal. Vein recognition is an upcoming field and is estimated to catch up with its competitors, owing to its major advantages over them.

Dorsal Hand Vein Biometrics

Vein Biometrics include three types of systems namely Finger vein recognition, Palm vein recognition and Dorsal Palm vein recognition. This paper will concentrate mainly on Dorsal Palm vein recognition systems. Dorsal Hand veins are clear, significant, unique to all individuals, and hence can provide the base for a biometric recognition system. The main principle behind working of this system is the Vein pattern extraction. The blood flow through the Veins gives the vein a significant colour, a significant feature that can be recognized using an infrared camera. There are two types of infrared devices:

Far Infrared (FIR): The temperature of human veins is more than that of the surrounding parts. Therefore when the FIR light irradiates the hand, the hand vein structure is thermally mapped by an IR camera distinctively at the lower room temperature. The captured image shows a difference of temperature between surrounding tissues and the back-of-hand veins.

'Though FIR has proven to be a helpful method and has provided good quality images, the image quality for palm and wrist has been poorer in comparison with the NIR cameras'[3].

Following are some of the images taken as reference from [3] for comparison and then decision making regarding which camera database to follow, is made.

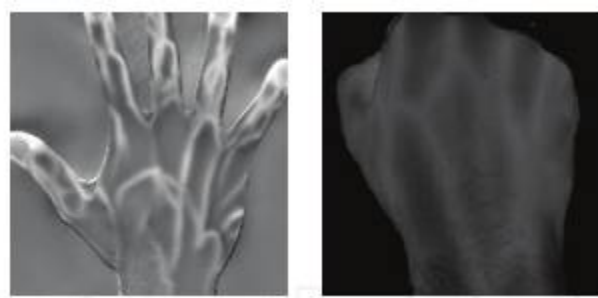


Fig. 1 FIR image outputs [3]

These images show that while capturing the veins of the back of the hand, the skin and the veins are not in stark contrast with each other. In fact, in the second image, even the hair of the back of the hand are captured, which is undesirable as more pre-processing would then be required to get rid of the distortions.

Near Infrared(NIR): In the NIR way, the light of specific wavelength is almost completely absorbed by the deoxidized haemoglobin in the vein. The veins appear as darker areas in an image taken by a CCD camera. Thus the imaging of the vein is totally depended on the blood flow, and any obstruction in blood flow would cause the image to come out blurry or low contrast. Near-infrared (NIR) imagery is a non-invasive, non contact technique. Hence NIR cameras provide better results in term of accuracy and vein pattern extraction

Thus the Vein patterns used in the proposed system will include images taken from a database that is obtained from NIR imaging cameras, available on the internet as free source.

This image output clearly gives two contrast parameters, background as clear white skin without external distortions, and clear black veins. This image is comparatively preferable for further processing.

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Fig. 2 NIR image output[3]

Literature Survey

There have been number of works and research papers on the Vein pattern extraction, each having same base of knowledge but different approaches to get much better results.

It is obvious that every system will have limitations, that are not perceived at the time, maybe leading to limitations in the technology at that specific time, or limitation of resources.

Essentially, the first step in literature survey includes 'Why Dorsal Hand Veins ?' . Every Biometric trait as we know is unique to every Individual. But all other Biometric Systems, like Finger-Print Recognition , Facial Recognition , use external body features as their main raw material. Iris Recognition uses the Iris Vein pattern to identify a person, but people yet are not familiar or used to let light fall on their eyes , consensus is that there is a certain amount of fear and skepticism to use that system. Dorsal hand-vein recognition system is safe, non contact, non-Forgeable and Working on basis of internal veins and blood-flow. Following were few of the Esteemed Authors that were able to build such a system.

Colbert et al[8] only used knuckle profile extraction and feature extraction of the knuckles . This limited the accuracy ,and knuckle damage could disrupt the efficiency of the system, although this work has been patented being the most significant work then. Lung lin et al[9] used thermal imaging techniques, which could suffice in the normal temperatures, but colder conditions would take the contrast much higher than can be handled, thus giving unacceptable image outputs. M.Rajalakshmi[4] et al have used Adaptive Histogram equalization and Median Filtering, but no special Edge detection techniques have been used , which can cause the accuracy to go down . Few other papers were referred, wherein either an old intermediate step was used or a finishing step, that could give smoother results , was not used.

III. PROPOSED METHODOLOGY AND DISCUSSION

The proposed method is a combination, as well as addition of new and latest available toolboxes and commands as available in the latest versions of softwares. This system , being a new one, has several advantages over the prevailing older systems. As identified generally, this methodology is based on the Triangulation method, and the subsequent block diagram gives an outline of the steps to be followed while implementing the methodology.

It can be seen that the two most important and basic steps that govern the working of the methodology used for this system, or any system based on image processing are:

- 1)Acquisition of a database
- 2)Storage of database
- 3)Live Acquisition of image and comparing with Database, or comparing existing image in database with images in database

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Vol. 5, Issue 9, September 2016

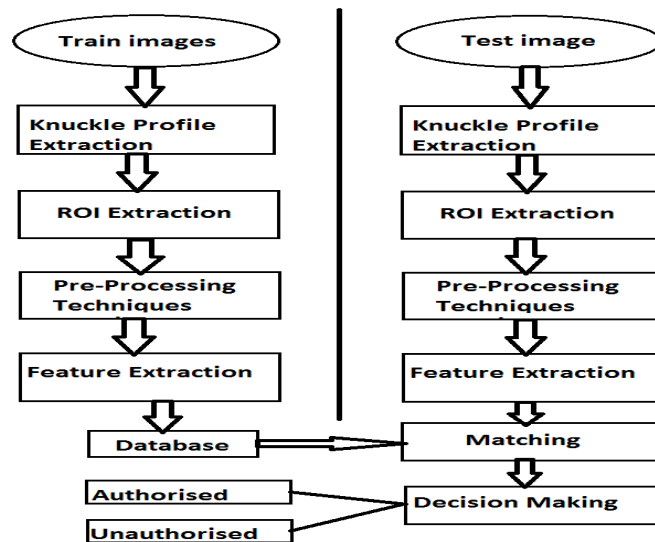


Fig. 3 Block diagram of the system

The block diagram is explained in detail , with the steps and original screenshots of an active system , in the following section.

SIMULATION

Step 1: Image Acquisition: Image can be acquired using an NIR camera. Such a setup is costly, and a Modified Webcam gives very low quality images. Thus a database can be formed using an NIR setup from certain institute or from the internet. Here system uses 9 images of dorsal palm vein patterns from internet.



Fig. 4 Image acquisition

Step 2: Knuckle Shape Extraction: Conversion to grayscale is optional , to be done only when the image is RGB format. The image is then Binarized using Otsu's Thresholding method. This thresholding divides image into Foreground and Background Pixels, thus assigning Pixels nearer to the black level as 0 and white level as 1, converting image to binary. The thresholding identifies minimum variance between these pixels to aptly identify them. Edge Detection is carried out on this image to get the final knuckle profile. This knuckle shape extracted from the acquired image can then be inverted as required for the ease of processing depending upon the 1 or 0 approach. The approaches do not matter much though.

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This system uses the traditional White 1, Black 0 approach .



Fig 5 Knuckle shape extraction

This knuckle shape is thus sturdy and forms the basis of ROI extraction, being the only feature that can be used as a base for determining the span of veins to be used.

Step 3: Region of Interest Extraction and Thinning : ROI can be cropped from the input image now , using adaptive cropping in MATLAB. After the necessary part(Part with main veins i.e. The one under the index, middle and ring finger) is cropped ,AHE(Adaptive Histogram Equalization) is performed to get a contrast stretched, even contrast image. This image is then morphologically thinned to get the vein patterns that are exactly in 1-pixel thick configuration. The following image will reveal the necessary bifurcation and end points.

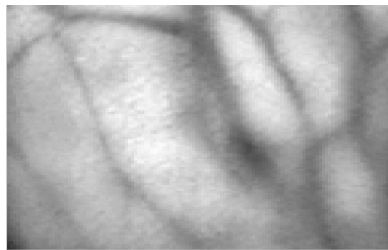


Fig. 6 ROI extraction



Fig. 7 Thinned Image

Suggested noise reduction techniques are Median Filtering or LOG Filtering. This system uses Median Filtering to reduce the high freq. components.

Step 4: Bifurcation points and End Points : Now, from the above image it is clear that if a certain point on the vein has only one pixel around in its 8-neighbourhood, then that pixel is going to be an endpoint. Similarly it is clear that if a point on the vein has more than two pixels in its 8-neighbourhood, then that point is got to be a bifurcation point

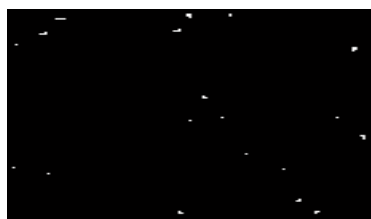


Fig. 8 Bifurcation Points



Fig. 9 End points

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Using this logic, an algorithm was designed to depict the end points and bifurcation points of the input image vein patterns as above.

Step 5: Delaunay's Triangulation : Once the end-points and bifurcation points are obtained, the triangulation which is the most important part of the minutae extraction , is carried out. Delaunay's Triangulation is a method in which triplets are formed with respect the adjacent points in the given area and follows certain properties while forming them.

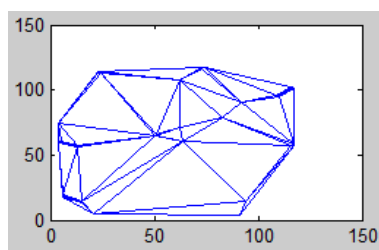


Fig. 10 Bifurcation points Triplets

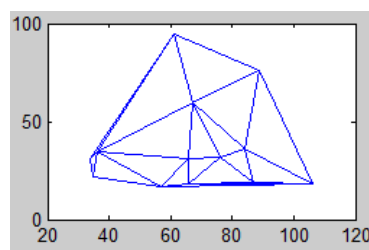


Fig. 11 Endpoints Triplets

IV. RESULTS

Matching algorithm: As we apply the Delaunay's Triangulation on every image we get the no. of triplets or triangles in the image. Thus we create a 'Trained set' by training every image we have to store the Endpoint triplets and Bifurcation point triplets of each and every image in a matrix. Thus as a new image or Test image is taken as input from the NIR camera or the database. This test image goes through the same process till the Delaunay's Triangulation. Once we get the no. of Endpoint and Bifurcation point triplets of the test image, they are compared with the matrix in which we have stored the BPs and EPs of the trained images. The least Difference or Threshold is decided (Ideally should be '0'), and if an image within that threshold is found in comparison to the test image, then the test image is said to be an image from an Authorized User , else if no image is found within the threshold , then the comparison fails and the test image is said to be an Un-Authorized user. A specific GUI is built in MATLAB for the convenience of the user the specific program components are linked to the respective buttons.

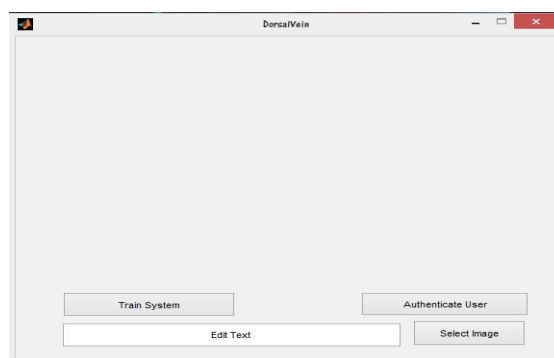


Fig 12. GUI (Graphical User Interface)

This GUI thus contains simple buttons mainly useful for the system. The pushbuttons are Train System- which is used to train the system of the database, i.e to feature out the triplets and count them. Then there is a Select Image pushbutton which is used to select the image from the memory or from the live scan. An then there is Pushbutton to Authenticate the user.

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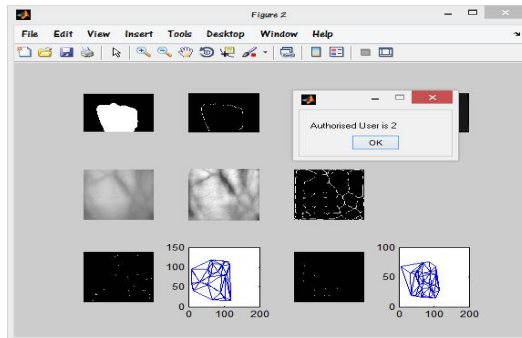


Fig. 13 Authorized User

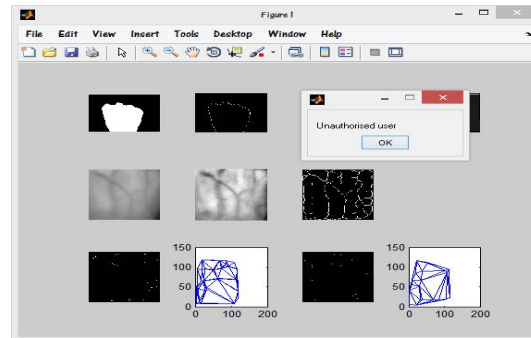


Fig. 14 Unauthorized User

Thus we have two possible results as shown above, the first one is where the user is authorized, i.e. an image pattern or a template similar to his is found in the database, and the other result is the one that is un-authorized which means that his template is not found in the database.

V. CONCLUSION

Dorsal hand vein pattern offers high security and is reliable for identification, hence advantageous over other biometric systems.

Accuracy, Non-contact as well as low maintenance system is achieved.

Permanent Database as well as a system suitable for use in day to day applications is achieved.

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