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LBPV for Newborn Personal Recognition System

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ABSTRACT

An increased anxiety in security in modern ages has primarily resulted in vast attention being given to biometric-based authentication techniques. Biometrics refers to the automatic authentication of human beings based on their physiological and/or behavioral characteristics. This paper proposes a newborn footprint matching system based on the extraction of texture features using LBP. Newborn and infant footprint based individual authentication is a critical issue where multiple births occur, birthing centers, hospitals, which is an understudied problem. This study proposes a novel online newborn personal authentication system based on baby footprint authentication. The proposed system can authenticate the digital footprint images with low-resolution. In comparison to the prevailing systems, our online newborn footprint authentication systems employ low-resolution footprint images to accomplish effective personal authentication. The novel newborn authentication system comprises of two parts: an image acquisition and a proficient algorithm for fast newborn footprint authentication. A robust ROI extraction method is defined. The features are extracted using Local Binary Pattern system for newborn footprint and the images are classified using Support Vector Machine and Global Matching K-NN. The investigation results exhibit the feasibility of the proposed system.

***Keywords* -** Biometric, newborn, infant, footprint authentication.

I. INTRODUCTION

In network society, there are several instances in which the individual recognition is required, e.g., information security in a computer or mobile phone, access control to a building, visitor management, and electronic payment, etc. Biometrics is the most significant and effective solutions for this task. In general, biometric is a field of technology that employs automated schemes for authenticating a person based on a behavioral trait or physiological [1].

In actual applications, the characters that are frequently measured in different methods are hand geometry, face, iris, handwriting, voice, fingerprints, etc. [1]. Newly, some interesting biometrics modules have been expanded by utilizing new features including palm print, hand vein, and finger-knuckle-print, etc. [2–16]. Most biometric methods mentioned earlier, however, are established for adults. Infants and newborns based biometric recognition is an understudied problem. Therefore, few literatures tell about newborn and infant biometrics that can be found from scientific document databases and markets. It is very important to study biometric methods for newborn personal recognition due to the following reasons: (1) crimes linking baby switching or the abduction of infants. (2) Identification of newborn is a serious issue for hospitals and birthing centers.

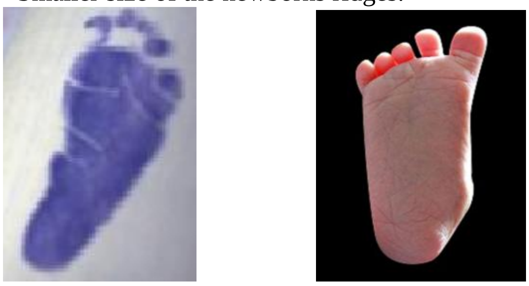
Here, there is a description why other human characters such as palm print, face, iris and fingerprint, have not been used for baby personal authentication. Although fingerprint recognition has been widely, effectively used, it is not viable for newborns. The major reasons for newborn's fingers are very small. Hence, newborn's fingerprint cannot be clearly captured. Up to now, face recognition with high accurateness is still an intricate task even for adults due to expression, pose and illumination. Mainly, newborn's face may have an extreme variation within a number of days after birth. Thus, for newborn personal authentication face recognition is not suggested. In the meantime, the use of the iris as identification feature is also a challenging technique for newborns, especially the premature. The iris pattern only stabilizes after the child's second year [16]. Palm print recognition is not suitable for newborns as it is frequently hard to let a newborn open his hand. From the above observations, footprint authentication is very attractive for newborn personal authentication, since it is high availability, wide acceptance, very low cost, a noninvasive method.

II. CUSTOMARY METHOD

The currently followed method of footprint acquisition in hospitals is by using ink spread on the baby's foot of newborn which is copied on a paper. This is stored in a file forming the medical database. This method is offline. The offline newborn footprint is exploited as the effectiveness of the image quality is poor. Challenges in – Newborn footprint identification

- Should be stored in inadequate materials (ink, paper, cylinder);

- Untrained individual for footprint attainment;
- Newborn's skin enclosed with an oily substance;
- Smaller thickness of the newborn epidermis;
- Smaller size of the newborns ridges.



(a) (b)

Fig 1: (a) Offline foot print image (b) online footprint image

Figure 1 illustrates the inked footprint and captured footprint. It can be observed that some of the thin lines are not clear in inked footprint. Due to bad image quality of offline foot printing, it is nearly difficult to obtain desirable recognition rates. It is very difficult to form image database, store and retrieve the offline footprint images as they have to be stored in the papers.

III. PROPOSED METHOD

Compared to other traits of newborn, footprint recognition is very attractive for personal authentication. Since the Offline foot printing has some drawbacks, so an online method based on digital image acquisition is preferred. Usually, in an online footprint recognition system images are recorded using digital camera. In this paper, we propose an online newborn low-resolution footprint authentication system. The samples of footprint are analogous to the samples of palm print to some extent. Thus, we can also employ texture-based methods for footprint authentication.

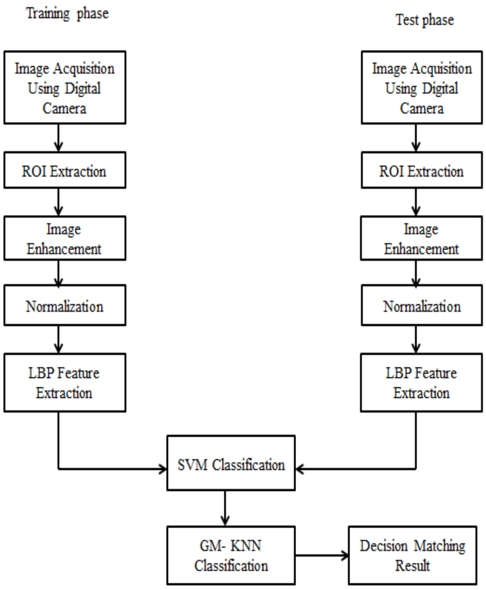


Fig2. Proposed block diagram

The remaining paper is structured as follows: Section IV illustrates the image acquisition and preprocessing process. Section V gives a brief review of feature extraction technique based on Texture analysis and Classification techniques. To validate the feasibility and effectiveness of the projected method, experiments are conducted and reported in Section VI with experimental result.

IV. IMAGE ACQUISITION

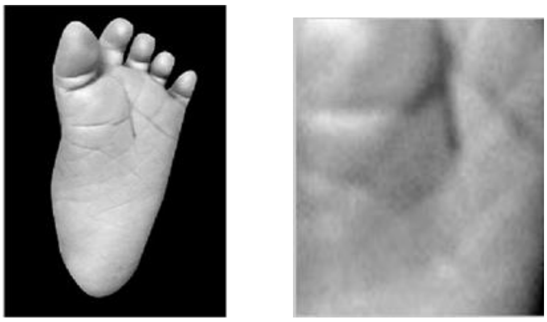
Image acquisition is the first step. Image capturing setup is very simple. The newborn footprint images were captured using digital camera. The image-capturing work was done in RSRM Hospital, Chennai. To capture the newborn footprint images, two persons are required. One has to register pictures using camera. The other has to hold the foot of the newborn. It can be observed that the online footprint image quality is much better than that of ordinary inked footprint image. So, it is likely to accomplish favorable recognition rates using online method.

In image acquisition step, a critical problem is to select an appropriate period to capture images. If a newborn is starving or crying, she/he will continuously move her/his feet, hands, and whole body. In this period, it is problematic to capture footprint images with required quality. When a newborn is quiet or sound asleep, the task of image catching will turn out to be easy. In this paper, all images were caught when newborns were quiet or sound asleep.

IMAGE PREPROCESSING

The main steps involved in image processing are as follows

i) Color image to Gray scale image conversion
ii) ROI extraction
iii) Image enhancement
iv) Normalization



(a) (b)

Fig 3. (a) Gray scale image (b) Pattern Vector

Enhancement

Image enhancement improves the contrast of the image. This also includes median filtering, entropy filtering and equalization so on. In this particular work, under enhancement we mainly concentrate on entropy filter, conversion of matrix to intensity image with median filtering.

Normalization

The normalization is used to reduce the possible imperfections in the image due to sensor noise and non-uniform illumination. By using this function, we can remove the global intensity of an image also expands an image or part of an image by adjusting the horizontal and vertical resolution.

V. FEATURE EXTRACTION (LBP)

Feature extraction plays a significant role in image identification and verification. There are many features exhibited in a foot. Texture analysis is an active research topic in the fields of computer vision and pattern recognition. Footprint can be represented by some line features from a low-resolution image. In the feature extraction module, the preprocessed image is used to extract the features. The feature extraction algorithms are applied to get features of the biometric image. There are various feature extraction techniques like Independent Component Analysis, Linear discriminate component, principal component analysis, wavelet transform, Gabor, LBP etc. According to the biometrics selected and its application the feature extraction technique can be applied.

Local binary pattern also efficient for texture feature extraction. Here, LBPV rotation invariant is used to extract the textures from the foot image. The texture features are represented graphically by Histogram.

Suppose the texture image is N×M. The texture image is symbolized by constructing the histogram as followed in Eqn (1):

$$p(s) = \sum_{u=1}^{M}\sum_{v=1}^{N} f'(LBP_{A,B}(u,v), s), s \in [0, s] \quad (1)$$

$$f'(i, j) = \begin{cases} 1, i = j \\ 0, otherwise \end{cases} \quad (2)$$

where s - Maximal LBP pattern value
A - Number of neighbors
B - Radius of the neighborhood
u, v - The pixel
p - Histogram.

LBP Variance (LPBV)

This is powerful because it exploits the complementary information of local spatial pattern and local contrast. However, $VAR_{A,B}$ has continuous values and it has to be quantized. This can be done by first calculating feature distributions from all training images to get a total distribution and then, to guarantee the highest quantization resolution. The LPBV descriptor proposed in this section offers a solution to the above problems of $LBP_{A,B} = VAR_{A,B}$ descriptor. The LBPV is a simplest but proficient joint LBP and contrast distribution method. As can be seen in Eq. (1), Calculation of the LBP histogram P does not involve the information of variance $VAR_{A,B}$. The LBPV histogram is can be calculated as,

$$x'(LBP_{A,B}(u,v), s) = \begin{cases} VAR_{A,B}(u,v), LBP_{A,B}(u,v) = s \\ 0, otherwise \end{cases}$$

(3)

Where VAR- Variance
LBP- Local Binary Pattern
A- Number of nieghbors
B- Radius of neighborhood
u,v- Pixel

The dataset is constructed with 6 newborn (classes) and each class has 2 footprint pictures with slight variation like zoom, change in position. The captured footprint images are stored by Jpeg format with resolution 300*451. All experiments are implemented by MATLAB.

TRAINED SET

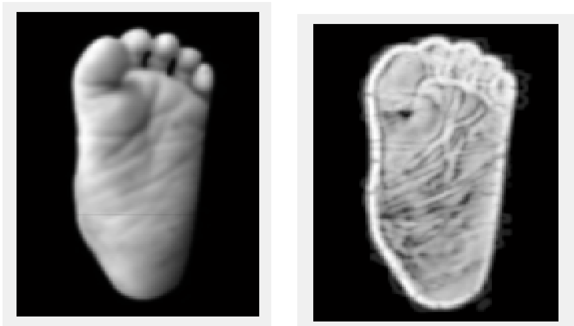


Fig. 4.3: (a) Trained image
(b) Extracted LBP image

Here the trained dataset is created with atleast 2 samples of each infant; apply filter and LBP extraction technique to extract the texture features of the footprint. Followed this LBP Histogram is obtained. The following plot shows the bar graph representation of the LBP histogram of the single trained image.

Fig.4.4: LBPVriu versus Variance

TEST SET

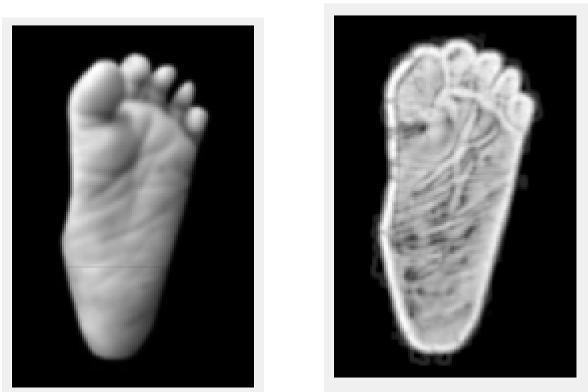


Fig. 4.5: (a) Test image
(b) Extracted LBP image

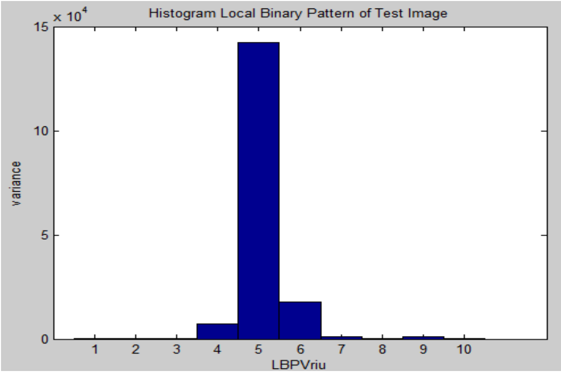
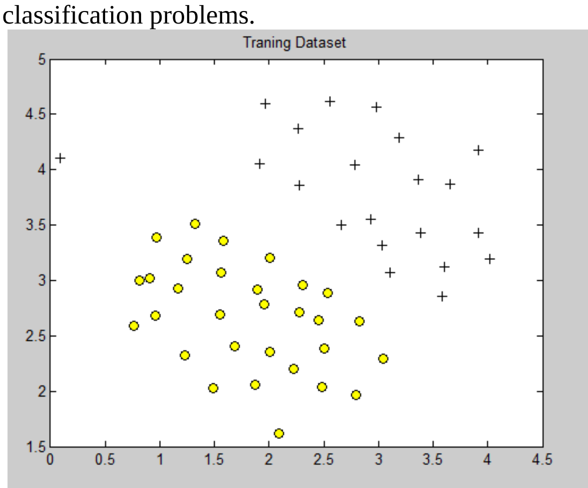


Fig.4.6: Histogram of LBP – Test image

The above graph shows the histogram of the test image after extracting the texture features of that particular image. Test image is not trained and hence classification accuracy is not cent percent.

CLASSIFICATION SCHEME

The SVM classifier is well founded in the statistical learning theory and has been successfully applied to various object detection tasks in the computer vision. SVM finds a separating hyper plane with the maximal margin to separate the training data in feature space. The classification of the SVM is determined by the support vectors; thus, it is usually more robust. However, in most cases, the SVM obtained better results. In addition, the computational complexity of the SVM depends on the number of support vectors and not the dimension of feature vectors. When the dimension is very high, the SVM is computationally less expensive. However, the SVM is designed for two-class problems. Classification method is also an essential process in texture classification. SVM can be considered as a modern classification approach which features a lot of benefits, such as kernel trick and soft-margin classifiers. SVM has been proved by many researchers as a very powerful classification approach especially in binary classification problems.



The above figure illustrates that the samples are classified in to 2 classes. Class 1 represents few groups of samples denoted by small-circled yellow and Class 2 represents remaining groups of samples that is differentiated by plus symbol.

If there are more than two classes, some strategy, such as reorganizing a multiclass problem into multiple two-class problems, needs to be employed. Therefore, it is normally simple to deal with multiple- class problems with the KNN than the SVM.

KNN – K nearest neighbor

K-Nearest Neighbor (KNN) algorithm is one of the most popular learning algorithms in data mining. The k-NN classifier is employed for minimum Euclidean distance between the feature vector and all the prototype training data.

Algorithm on Basic KNN Algorithm
Input:

D: Training set
n: Number of patterns in D
x: Test pattern

Output:

l : label of x

1: for i D 1 to n do
2: Compute d(x, xi), the distance between x and xi ;
3: end for
4: Select the set of k nearest training patterns for x;
5: $l = \arg\max_{v \in L} \; f(v = class(c_{xi}));$

f(.) is an indicator function that returns the value 1 if its argument is true and 0 otherwise.

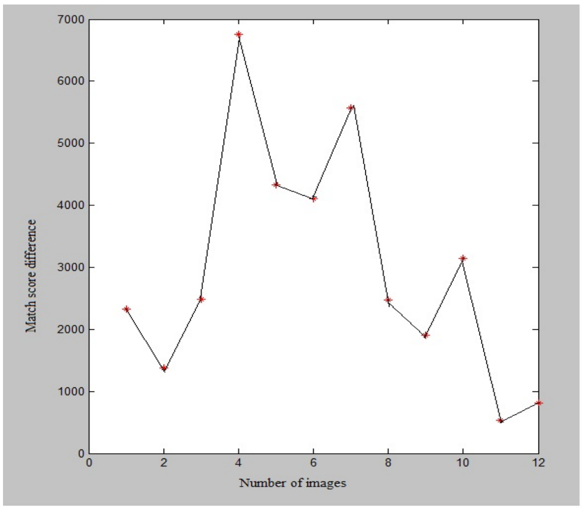
6: return l ;

The NN is one of the easiest machine learning algorithms. In the classification, it is only determined by the sample closest to the test sample. Thus, when there is big overlapping in classes, the NN works pretty well.

VI. EXPERIMENTAL RESULT

This experiment has conducted a study on texture classification, by using Local Binary pattern and SVM as the feature extraction and classification method. The final experimental results using the above algorithm and Global matching KNN for classification have proved that such texture classification approach is worth to be implemented in real life applications.

The above plot shows the final result of the KNN classification along with global matching. Xaxis represents Number of images and Y-axis represents Match score difference ranges in thousands. From graph it is very clear that 11th image has minimum match score difference, hence this image seems to be closer to test image.



VII. CONCLUSION AND FUTURE WORK

Newborn baby samples are collected and their texture features are extracted using Local Binary Pattern method and LBP Histogram is obtained for both test and trained images by simulation. Then SVM Classification method is used to find the class to which the test samples belong. Further to specify the matching, Global Matching KNN Technique is used. The footprint biometric data can be a very promising tool for identification of newborn. The proposed method obtained a recognition accuracy of 97%. The accuracy of the proposed system can be further enhanced by considering large database, or by having better image acquisition protocol. This method is a low cost solution to the newborn violence rather than the expensive DNA procedures.

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