GENDER IDENTIFICATION SYSTEM FOR CRIME SCENCE ANALYSIS USING FINGERPRINTS

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Abstract: Gender identification or classification is a challenging task in computer vision as the biometrics of male and female such as fingerprints, face, vein have many variations. Among the various biometrics, fingerprints are commonly available in a crime scene. In this, study, gender identification system for crime scene analysis using fingerprints is presented. Initially, the fingerprints are de-noised by median filter and Otsu thresholding is employed to binarize the fingerprints in the preprocessing stage. Then, the features are extracted by Box-Cox transformation method. Finally, the classification is made by logistic regression classifier. A better classification accuracy of 96% is achieved by the gender identification system using Box-Cox transformation and logistic regression classifier.

Keywords: Fingerprints, gender identification, Box-Cox transformation, Logistic regression classifier.

I. INTRODUCTION

Multiple facial regions based gender classification using facial images is discussed in [1]. The input image is converted into gray scale. The geometric normalization is made for the image pixels. The illumination variations are reduced by histogram equalization. The classification is made by Support Vector Machine (SVM) classifier. Gender classification system using hybrid approach of geometric properties and Haar cascade classifiers is described in [2]. The input facial images are extracted by geometrical properties and Haar cascade classifiers. Illumination variations are removed by Weber illumination normalization technique. The classification is made by SVM classifier.

SVM and 3-dimentional geometrical features based gender classification is discussed in [3]. The input 3-dimentional facial images are extracted by geometrical features. Then the extracted features are classified by SVM classifier. Gender classification using iris image is discussed in [4]. At first, the preprocessing is made by Hough transform to remove localization. The features like texture and statistical features are extracted from input iris images. Then Discrete Wavelet Transform (DWT) is applied for the enhancement. The classification is made by SVM classifier.

Gender classification using fingerprints based on Gaussian Mixture Model (GMM) and wavelets is discussed in [5]. The input fingerprint images are decomposed by DWT. Then rank features are separated from detailed sub band coefficients by rank features. Then the gender classification is made by GMM. Human radiation wave analysis based gender classification is discussed in [6]. Initially, the mean frequency data is applied for the input human radiations. Then data preprocessing s made. Classification is made by k-nearest neighbor classifier.

Local Directional Pattern (LDP) based gender classification is described in [7]. The input facial images are extracted from the LDP then the face regions are

divided into small regions and LDP is concatenated into a single vector. SVM classifier is used for classification. Gender classification for SVM learning approach for pseudo example is described in [8]. The active appearance model is applied for the input images. The texture and shape features are extracted by using statistical analysis. The histogram equalization is applied for illumination variations. The Principal Component Analysis (PCA) is used for dimensionality reduction. SVM classifier is used for classification.

Gender classification and face recognition in personal memories is presented in [9]. Firstly, the features are extracted by pose estimation technique and color. Then the normalization technique is applied. The dimensions are reduced by using PCA. The SVM classifier is used for classification. Offline handwriting images based gender classification using textural features is discussed in [10]. The Gabor filter is applied for noise removal. The standard deviation and mean features are extracted. The classification is made by using feed forward neural network.

Two-dimensional Gabor wavelet transform and SVM based gender classification is discussed in [11]. The input face images are extracted by two-dimensional Gabor transform. The SVM classifier is used for the classification. Gender classification using age information is described in [12]. Initially, the features like local binary pattern, geometry and appearance features are extracted. The SVM classifier is used for gender classification.

A system to identify the gender of the suspect in a crime scene analysis using fingerprint is presented in this study. The methods and materials used for gender classification are discussed in section 2. Experimental results and discussion of gender classification system is described in section 3. The last section gives the conclusion of gender classification system using fingerprints.

II. METHODS AND MATERIALS

The gender identification system for crime scene analysis using fingerprints of male and female is presented. This system is built by three main stages they are pre-processing, feature extraction and classification. In preprocessing stage, the median filter is applied for input fingerprint images to remove noises and Otsu's thresholding is used for edge detection. The features are extracted by using box-Cox transformation technique. The logistic regression classifier is used for the classification. Figure 1 shows the overall work flow of gender classification system.

A.   Preprocessing

Preprocessing is an important stage in gender identification system using fingerprints. Initially, the input fingerprint images are converted into grayscale image. Then, the median filter is applied to remove noise. To detect the edge information, a global thresholding approach Otsu's thresholding is applied. Otsu's thresholding is also used for brain tissue segmentation [13]. Then the edge detected image is the input to the feature extraction stage.
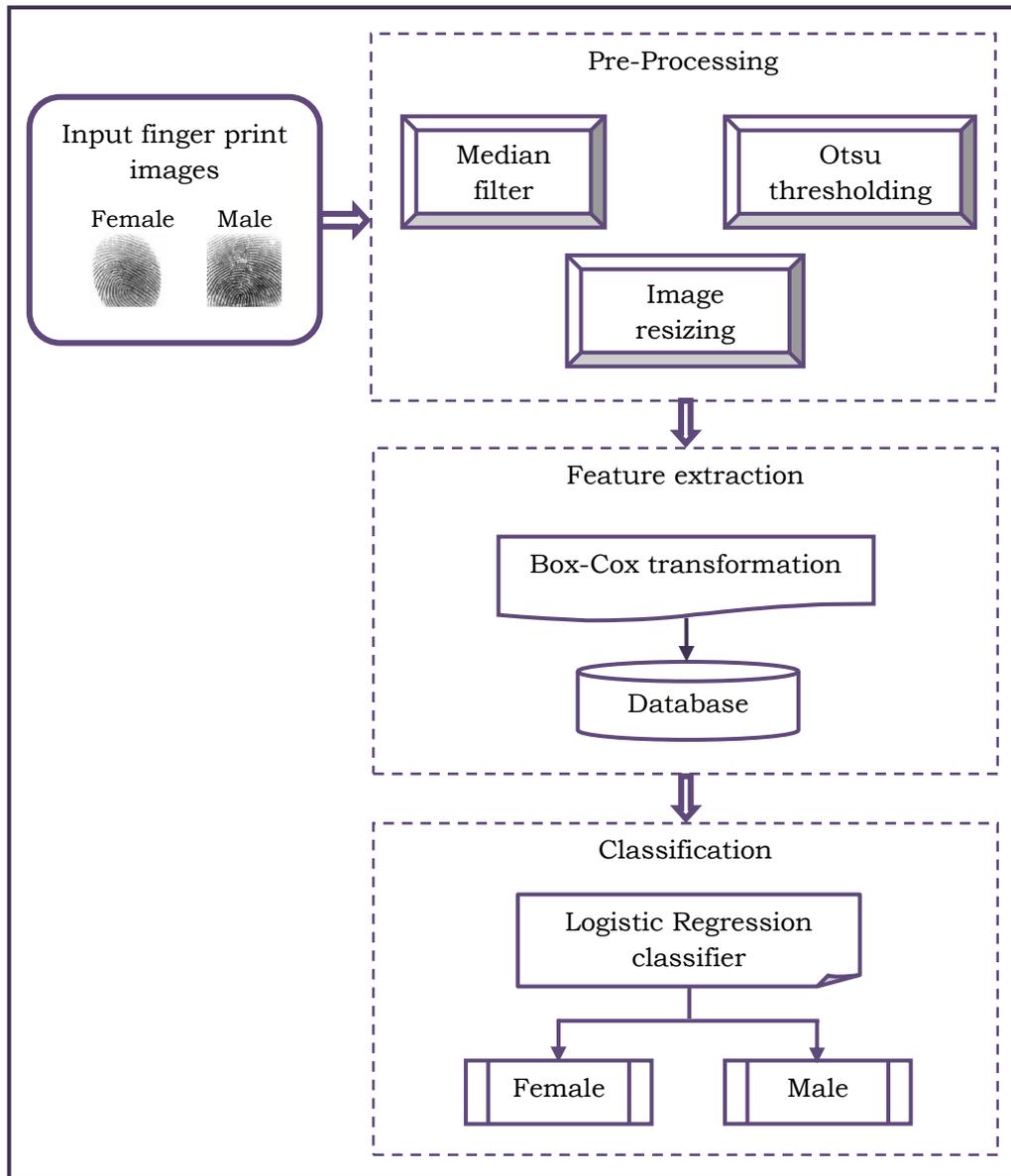
Fig. 1 Gender identification system - workflow

B.   *Box-Cox transformation technique*

Box-Cox transformation is a valuable method for the distribution of unknown variable. The Box-Cox transformation of the variable z is represented by ω , and is defined by,

$$z'_{\omega} = \frac{z^{\omega} - 1}{\omega} \qquad (1)$$

where z^{ω} is the turkey transformation, when $\omega < 0$, both z_{ω} and z'_{ω} may change the sign of z^{ω} to preserve the order. When $\omega = 0$, then the Box-Cox equation can be rewrite as,

$$z'_{\omega} = \frac{e^{\omega \log(z)} - 1}{\omega} \approx \frac{\left(1 + \omega \log(z) + \frac{1}{2}\omega^2 \log(z)^2 + ...\right) - 1}{} \to \log(z) \qquad (2)$$

Here z'_{ω} is $z = 1$ and maps the point $z'_{\omega} = 0$ for all the values of ω. The one-parameter Box-Cox transformations is given by,

$$z_i^{(\omega)} = \begin{cases} \dfrac{z_i^{\omega} - 1}{\omega} & if \ \omega \neq 0, \\ \ln z_i & if \ \omega = 0 \end{cases} \qquad (3)$$

The two-parameters of Box-Cox transformation is given by,

$$z_i^{(\omega)} = \begin{cases} \dfrac{(z_i + \omega_2)^{\omega_1} - 1}{\omega_1} & if \ \omega_1 \neq 0, \\ \ln(z_i + \omega_2) & if \ \omega_1 = 0, \end{cases} \qquad (4)$$

The first transformations hold for $z_i > 0$, and the second hold for $z_i > -\omega_2$. The parameter ω is defined by profile likelihood function. Box-Cox transformation is also used in visual encoding [14] and also in forecasting practice [15]. In this study, the Box-Cox transformation is used for extracting dominant features from fingerprints. After transformation, the extracted features are stored in the feature database which is used as the input for classification.

C. *Logistic regression classification*

Logical regression is a supervised classification algorithm. The binary dependent variable is modeled by logistic function which uses logistic regression. In logistic regression classification the target variable can take only a discrete amount of features from the given set. It is a regression model. The regression model is built by the probability of the given data. In linear regression the data follows a linear function the logistic regression model follows a sigmoid function. The logistic regression is given by,

$$k(y) = \frac{1}{1 + e^{-y}} \qquad (5)$$

Logistic regression performs a classification by decision threshold method. The thresholding value setting is an important aspect of logistic regression and depends on the classification problem. Logistic regression is also used in telecom customer churn prediction [16] and pedestrian detection method [17]. In this study, the logistic regression is used for the gender classification using fingerprints.

III. RESULTS AND DISCUSSION

The performance of the gender identification system using fingerprints is discussed in this section. The database contains fingerprints from 80 females and 100 males with different ages. The fingerprints are collected by the scanner using the Fingkey Hamster II scanner of 500 resolution dpi. Fingerprints in database are 260x300 pixels of size. The fingerprint from each person is collected for analysis and classified individually. Figure 2 and Figure 3 shows the fingerprints collected fingerprints from the database.

Fig. 2 Sample fingerprints in database - Female

Fig. 3 Sample fingerprints in database - Male

At first, the input fingerprint images are preprocessed and edge detected by using median filter and Otsu's thresholding respectively. Then the Box-Cox transformation technique is applied to extract features. It uses ω values for transformation. Table 1 shows the classification accuracy of gender classification using fingerprints based on Box-Cox transformation and logistic regression classifier.

TABLE 1 Classification accuracies based on Box-Cox transformation and logistic regression classifier

Input image size	ω value	Classification accuracy (%)
16x16	2.4	83.50
16x16	2.2	88.00
16x16	2.0	90.00
32x32	1.8	94.00
32x32	1.6	82.00
32x32	1.4	96.00
64x64	1.2	95.00
64x64	1.0	93.50
64x64	0.8	94.00
128x128	0.6	95.00
128x128	0.4	90.50
128x128	0.2	95.00
Average classification accuracy (%)		**91.37**

For performance analysis, the fingerprint images are resized into 16x16, 32x32, 64x64 and 128x128. It is observed from Table 1 that an average identification rate of 91.37% is obtained by using Box-Cox transformation and logical regression classifier. The maximum classification accuracy of 96% is obtained while using 32x32 pixel sized fingerprint images and ω value of 1.4. The minimum classification accuracy is 82% for 32x32 pixel sized fingerprint image and its ω value is 1.6.

IV. CONCLUSION

An efficient method for gender classification using fingerprint images is presented for crime scene analysis using Box-Cox transformation and logistic classifier. The input images are resized into four different sizes 16x16, 32x32, 64x64 and 128x128 pixels for performance evaluation. At first the median filter is used for noise removal, the otsu's thresholding and binarization is made for edge detection. Then, the Box-Cox transformation method is applied with the different ω values. Then these features are stored in the database and used as input for classification. Then logistic regression classifier is used for classification. Results shows the better classification accuracy of 91.37% using the Box-Cox transformation and logistic regression classifier.

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