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Review on Matching Infrared Face Images to Optical Face Images using LBP

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Abstract

In biometric research and many security areas, it is very difficult task to match the images which is captured by different devices. Large gap exist between them because they relates with different classes. Matching optical face images to infrared face images is one of the difficult task in face biometric. Large difference exists between infrared and optical face images because they belong to multiple classes. Converting the samples of multimodality into common feature space is the main objective of this project. Different class of images is relating by coordinating separate feature for classes .It is mainly used in heterogeneous face recognition. The new method has been developing for identification of heterogeneous face identification. Training set contains the images from different modalities. Initially the infrared image is preprocessed by applying Gaussian filter, difference of Gaussian and CSDN filters are apply on infrared face image. After preprocessing next step to extracting the feature by using LBP(local binary pattern) feature extraction then relevance machine classifier is used to identify the best matching optical image from the corresponding infrared images from the optical images dataset. By processing this technique our system efficiently match the infrared and optical face images.

Keywords

Image matching, infrared and optical face images, LBP (local binary pattern), RVM (relevance vector machine classifier).

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1. Introduction

Image processing [1] is very large area in engineering field and effectively used in various biometrics and security area. Image processing is used in various and one of the fields where researchers focus now a day is biometrics. Image matching is one of the sub areas under biometrics. Image Matching is the process of matching the images captures by same and different devices. Image similarity matching is broadly used in security areas. An image similarity measure identifies the degree of similarity between intensity patterns in two images. There are different images similarity measure such as cross co relation, square intensity differences etc. this measure is selected based in the modality of images such as same modality images or multi-modality images.

There are various different method have been developed by the researchers for face identification and face matching. Technique used in Identification of photo images are Multi scale Markov Random Field (MRF) model[4] and KNN classifier with geometry based feature[5] and support vector machine along with Gaussian filter in pre-processing[6], patch based mapping[9]. Techniques used in matching of photo image with the corresponding sketch image are canonical correlation accuracy technique [12] and support vector machine [6] and LDA for classification [15]. CFDA technique used for matching infrared and optical face images [2].various different methods used for identification and matching is discuss in Literature review.

While comparing the facial feature of image with the dataset a facial recognition system recognize and verify the person from images. Some face identification system only save the data in the image which is useful for recognition by compressing the image data and performs matching of image with this compressed data .One of the technique template matching is used for this purpose. Whereas some algorithm extracting the feature such as size of nose, eyes etc and based on these feature they perform matching. Principle component analysis, hidden

markov model, fisher face algorithm are some of the popular recognition algorithm. Appropriate lightning condition require for traditional optical imaging devices for work properly. Practical face recognition should not achieve this appropriately. Automatic face recognition system mainly uses infrared imaging devices. The infrared images are low lightning images at night and indoors type of images. The important application of heterogeneous face recognition is based on the infrared-based ARF systems matches the infrared images capture by using infrared devices with the gallery of face images taken with the optical imaging device also refer as cross modality face recognition. The different images of same person captured by using different devices is mismatches because the large difference is exist between these images as captured by different devices as they belongs to different modality refer as modality gap. These are the main challenging issue in heterogeneous face recognition.

In Heterogeneous Face Recognition system large population having frontal photographic images which is used in many security and intelligence scenarios in order to matching different modality images with the large dataset of frontal image photo. Heterogeneous face recognition having the high intra class variability because of different modality this is the most difficult problem in HFR which is overcome by using the expanded opportunities of face recognition technology. The main issue of heterogeneous face recognition for performing the comparison with huge dataset with different modalities when there is only one modality of input image is present. For example oral details provided by deponent about a person and based on that sketch is generated which is used as input to various different modality of dataset which is the major issue in the heterogeneous face recognition to perform the matching.

There are various identification and recognition algorithms which is splits into two broad ways geometric and statistical. Geometric mainly consider various different features whereas the in statistical for discarding the variance it correlate the values with templates. The initial step is to convert the images into values and these values is used for correlation. The remaining part of this paper include: Section 2 include the literature survey which describe the different techniques and algorithm which is developed for matching the multimodality images Fallowed by the flow of proposed work in section 3 which include our approach of effective matching of images using LBP feature extraction and RVM classification. Further in section 4 include conclusion based on the study and in section 5 having future work include the future directions of research.

2. Literature Overview

Different algorithms have been proposed to minimize the modality gap between multimodality images. The images captured by using the same devices comes under the same modality images as they belongs to same class whereas the same images which is captured by using different devices comes under multimodality images as they belongs to different class. For example optical and infrared images are come under multimodality images because they captured by using different devices.

In 2014, Zhifeng Li et al. [2] recognition performance of optical and infrared face images improved by introducing the new technique known as common feature discriminant analysis which reduces the modality gap between the images instead of converting one modality to another. In CFDA for distillation of feature descriptor they use vector quantization and hyper plan method. Which perform the unequal partition of continuous vector space and then feature classification is done by using discriminant analysis technique.

Figure 1: Infrared face images

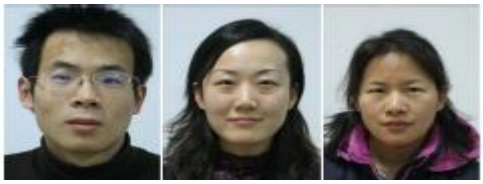

Figure 2: Optical face images

In 2003, Xiaoou Tang and Xiao gang Wang[3] identifies the sketch images from synthesized pseudo sketch. In order to perform matching effectively they perform conversion of photo image into sketch. For identification of sketch from pseudo sketch they used

Bayesian classifier and PCA. They reconstruct the face images considering the Eigen faces in PCA illustration. From training set Eigen faces can be measure as a linear combination of training samples the illustrated face images can be shown. In2009, [4] they uses Multi scale Markov Random Field (MRF) model for recognition of photo sketch. They partition the photo or sketch image into overlie patches. Scale of local face structure is determined by using the size of each patch. Then perform identification using MRF model. Sourav Pramanik and Debotosh Bhattacharjee[5] proposes method for identification of face sketch geometric face feature such as lips, eyebrow, nose etc are extracted and their width, length ratio are calculated in order to obtain the feature vector. They perform the subs traction of canter of the feature vector from every feature vector for calculating the mean feature vector. For recognition of face sketch they use K-NN classifier. In 2014, M. Janani et al.[6] used Support vector machine(SVM) classifier along with Gabor filter for feature extraction. They work with gallery and probe images and identify the degree of similarity between them and in order tom improve the accuracy of face recognition they perform the transformation of these feature into linear discriminated sub space.

In 2005, Qingshan Liu et al. [7] for matching the probe sketch with pseudo sketches they used KNDA based nonlinear discriminating classifier. In 2010, B. Xiao et al.[8] and in 2005, Q. Liu et al. [9]For sketch and photo recognition authors proposed patch based mapping which changes one class to another. In 2000, Tenenbaum et al. [10] for generating the common content space for collection of multimodalities they used bilinear Model (BLM) by singular value decomposition. In 2011,Sharma et al [11] provide the advantages over CCA(canonical correlation accuracy) method they maintain the variance more better at the same time of linear subspaces calculation where higher correlation are exist between cross modality images. The author used partial Least Square method for these reason. In 2009, Li et al. [12] for cross pose faces recognition they used CCA technique. In 2012,Lei et al.[13] for heterogeneous face recognition they introduced the coupled discriminant analysis is adequate subspace learning framework .In[14] Non linear kernel similarities is used to represent different modality images such as probe and gallery images.

Wei Zhang et al.[15] perform the matching of photo image with the corresponding sketch image. For matching they convert the one class into another. Taking out features from sketch and photo images at that time they reduce the gap between classes while presenting the new advance classifier. They perform the encoding for obtaining the feature such as local face composition. Author used in this paper the couple information-theoretic encoding. Coupled information-theoretic projection tree is a technique through which couple information theoretic encoding is obtained. SVM [6] and LDA are used for classification.

3. Proposed Approach

This section illustrates the approach of matching the infrared and optical face images using LBP feature extraction and RVM classification. Instead of taking both infrared face images and optical face images together and performing all the operation such as pre-processing for example filtering for removing noise and then different techniques and algorithms for extraction the features and then performing effective matching of both the images simultaneously. Our Approach is having two different dataset such as infrared face images dataset and optical face images dataset. Input to the pre-processing is the infrared image from infrared face image dataset and pre-process this image by applying three different filters Gaussian filter, difference of Gaussian and CSDN (Center Surround Devise Normalization) filter in order to extract the better feature after removing noise because infrared images are indoor type of images, these images are low lightning and blurred images so pre-processing is necessary.
The flow diagram illustrates the concept.

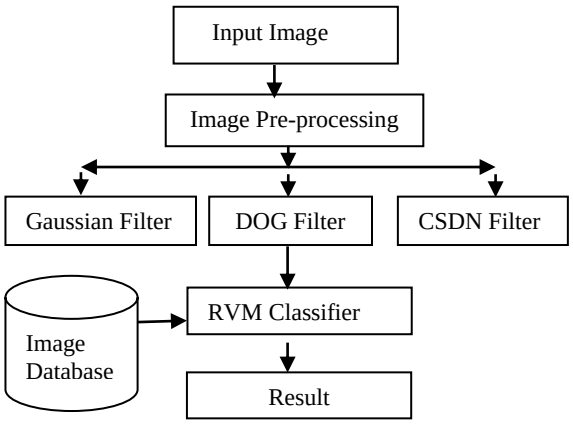

Figure 3: Flow diagram of proposed approach

3.1 Pre-processing

To get good quality of output and improving the image quality it is necessary to remove the noise, enhancing the contrast etc from image by preprocessing the image and applying different filters on image, normalizing the frequency of the image, removing reflections. There are different filters used for these purpose which is illustrated in literature survey. In this approach infrared image is pre-processed by three different filters Gaussian, DOG, CSDN filter.

3.1.1. Gaussian filter

Gaussian filter perform overall smoothing of the image. It is identical as convolving the image with Gaussian function. The important property of Gaussian filter is that Gaussian functions have less expectable group delay. By convolution with Gaussian function Gaussian filter modify the input signal. It is optimal time domain filter.

$$g(x,y)=\frac{1}{2\pi a^2}*e^{-\frac{x^2+y^2}{2a^2}} \qquad (1)$$

Where, x and y is the parallel pivot length from origin and perpendicular pivot length from origin and a is the standard deviation.

3.1.2. DOG filter

DOG filter enhance the quality of the image work on blur images. In the original image it calculates the difference of one blur version from another blur version. During the Gaussian kernel transformation with various standard deviation the gray scale images get blur which result conceal of some spatial information such as high frequency information. Calculating the difference by DOG filter that special information is maintained. It is a band pass filter removes blur from original image and makes the image soften.

To calculate the Difference of Gaussian of image I for two dimensions the formula is as follows:

$$P1=I*\frac{1}{2\pi a^2}*e^{\frac{-(x^2+y^2)}{2a^2}} \qquad (2)$$

$$P2=I*\frac{1}{2\pi k^2 a^2}*e^{\frac{-(x^2+y^2)}{2k^2a^2}} \qquad (3)$$

$$K_a(x,y)=P1 - P2 \qquad (4)$$

3.1.3. CSDN filter

DOG filter affect the contrast of the images center surrounded device normalization filter stable the contrast of the image. Every pixel has intercommunication with the neighbor pixel.

3.2 Feature Extraction

In image processing feature extraction is very important in terms of minimizing the dimensionality. In image processing feature extraction is most important area of application. Various different algorithms were used for extracting the feature from digital images and from video stream. Features includes intensity based feature, texture feature etc. There are different algorithm for feature extraction such as principle component analysis [3], LDA, SIFT feature extraction, LBP etc. Classification, segmentation, matching all based on feature extraction.

In this approach feature is extracted from preprocessed image using LBP feature extraction.LBP work on grey scale image.LBP operator mark each and every pixels from gray scale image as 1 or 0 depend upon the interrelation of pixel with their surrounding pixels

The following steps are considered while creating the LBP feature vector.

1. The given image is splits into cells. Every cell having 16*16 pixels.
2. Every pixel in the cell is check with their surrounded pixel if the center pixel value is less then surrounded pixel then the center pixel is mark to 0.If it is greater than the surrounded pixel the it mark as 1.
3. Construct the histogram for every cell.
4. Standardize the histogram.
5. To generating the overall feature vector integrate the histogram of every cell.

$$LBP_{p,r}=\sum_{p=0}^{p-1} s(g_p - g_c) \qquad (5)$$

$$S(x)= \begin{cases} 1 \text{ if } x \geq 0 \\ 0 \text{ otherwise} \end{cases}$$

Histogram of LBP feature extraction is obtained by using fallowing formula:

$$H_i=\sum_{x,y} I * f(x,y=i), i=0,..,n-1. \qquad (6)$$

Normalized histogram is obtained by using fallowing formula:

$$N_i = H_i \,/\, \sum_{j=0}^{n-1} H_j \qquad (7)$$

3.3. RVM Classification

Classification involves identification and categorization of object. There are various different algorithms for classification such as SVM [6], K-NN classifier [5], Bayesian classifier [3] etc. In this approach RVM classification is used for effective matching. Relevance vector machine have identical function like support vector machine but RVM uses minimum parameter then SVM [6] .SVM [6] include the set of free parameter which is not used in RVM. The output is probabilistic in case of RVM it uses the Bayesian interpretation. Speed of RVM is more as compare to SVM. It is identical as Gaussian process model with covariance function.

$$h(x,x') = \sum_{j=1}^{N} \left(\frac{1}{a}\right) y(x,a) y(x',a) \qquad (8)$$

Where, y represent the kernel function and a is the variance and $x_1 \ldots x_N$ represent the input vector.

1. RVM classification uses Bayesian interpretation and generates a probabilistic output and classification is also probabilistic.
2. RVM uses minimum function then SVM.
3. Relevance vector machine has similar function like support vector machine but RVM uses minimum parameter then SVM and the classification is also probabilistic.
4. Speed of RVM is more as compare to SVM.

RVM classifier is used to identify the best matching optical image from the corresponding infrared images from the optical images dataset.

4. Result Comparison

Table 1: Comparison of various techniques

S.No	CFDA[2]	ITE[15]	HOG[16]
1	CFDA[2] with nearest neighbour 68.76% accuracy	CITE[15] with nearest neighbour 61.03% accuracy	HOG[16] With nearest neighbour 42.33% accuracy
2	CFDA[2] with PCA[3] 77.53% accuracy	CITE[15] with PCA[3] 70.82% accuracy	HOG[16] with PCA[3] 56.19% accuracy
3	CFDA[2] with two level matching 80.19% accuracy	CITE[15] with two level matching 72.53% accuracy	HOG[16]with two level matching 62.14% accuracy

Above table illustrate the result comparison of different techniques used for face identification and matching. CFDA [2], HOG [16], CITE [15] with nearest neighbour, PCA and two level matching schemes are compared in terms of accuracy. Our approach will have been effectively performing matching of infrared and optical face images.

5. Conclusion and Future Work

Matching infrared face images to optical face images is difficult task in face matching. In this approach initially training and testing images is pre-processed by three different filter and then feature is extracted by using LBP feature extraction and the feature will be used by RVM classifier to perform effective matching. For training and testing we have two dataset consist the images of different modalities optical and infrared face images. Future work includes matching sketch photo and high and low resolution faces images.

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