Classifying Discriminant Features for Gender Determination

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ABSTRACT

Face recognition is the important means of interaction, and Gender determination is the accompanying capability of human being in recognizing the person. The adults have the ability to determine the gender even if some of the distinct features of a person like make-up, hair and accessories are occluded or removed. Since the face contains useful gender information, we are presenting this approach of gender determination, which is optimistically helpful in face recognition. It helps to accelerate and improve the performance of face recognition. In this approach the SVM is used as a classifier and PCA is implemented on the prominent face parts for dimension reduction The motivation for implementing such system is to reduced the computational cost and improve accuracy by lowering the size of dataset.

Categories and Subject Descriptors

I 5.2 [Design Methodology] : Classifier design and evaluation , Feature evaluation and selection

General Terms

Algorithms, Performance

Keywords

Face Recognition, Gender Determination, SVM classifier, PCA.

1 INTRODUCTION

Despite significant advances in Face recognition technology, it has yet to put wide use in commercial and security applications. Even though face recognition is the most non-intrusive and easy biometric methodology, the error rates are too high. The changes in the lighting condition, facial orientation and facial expression increase both false rejection rates (FRR) and false acceptance rates (FAR). In most of the cases the computerized face recognition system outperform human results because human's face recognition capability depends on the external factors like motivation fatigues, training and speed [1]. Still humans are able to use extra information while recognizing the face of the subject. The gender determination is also the excellent capability of a human being, without making use of the external features, merely by looking at the inner face of a person one can recognize the [2], gender. The proposed approach to determine the gender gives the extra capability to the face recognition system, thus only the inner face (eyes, nose & mouth) is used as an attribute to determine the gender. To reduce the dimensionality, the Principal component Analyser is used and the Support Vector Machine (SVM) algorithm is used as a classifier since it gives better performance for gender classification as compared to another learning algorithms [4].

2 THE APPROACH

The approach for our work is hybrid; for image representation the combination of geometrical and statistical methodology. Considering the discriminant capability of face parts [2], The prominent face parts are extracted using the grids and dimensionality is reduced using PCA algorithm.

The experiments were carried out on frontal images of 40 subjects (25 males and 15 female), the facial images (125 X 125 pixels) were captured under controlled lighting condition.

The overall process is shown diagrammatically in the figure A. Initially the query face image is taken as an Input image, based on the empirical rule about the ideal balance of a human face stated in [5], the grids are used to divide the face in to equal parts & extract the inner face and the other face parts.

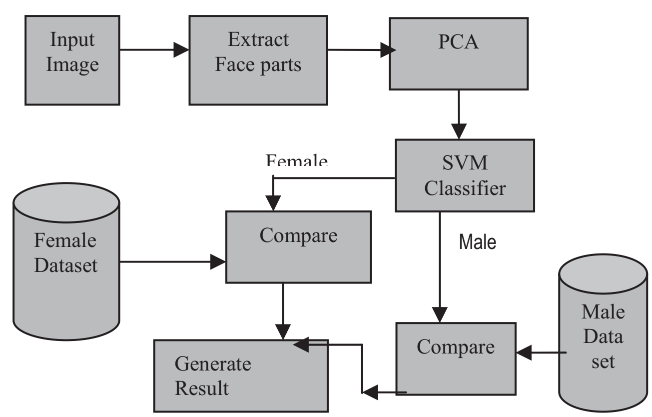

Figure 1. Block Diagram showing an approach.

Once a representation in a reduced dimension space is obtained, the significant Eigen vectors are fed for the classification. It allows representing classes as a set of points in a high dimensional space where the class boundaries can be expressed as hyper planes. For the linearly separable case, SVMs provide an optimal hyper plane that separates training patterns while minimizing the expected error of novel patterns. As stated in [2]

[3] the face parts play vital role in gender recognition, but the results depend on the specific components like dataset, classifier, and face part description. The work of yashima amdreu & Ramon Mollineda in [4] is based on the above concept. They carried out the experiments using different facial parts i.e. Eyes, Nose, Mouth, Chin, Right eye, Internal face, External face and Full face using six different classifiers & the best result obtained by SVM trained with internal face. Inspired by their work, in our approach SVM is selected as a classifier & the internal face is extracted & considered as an attribute.

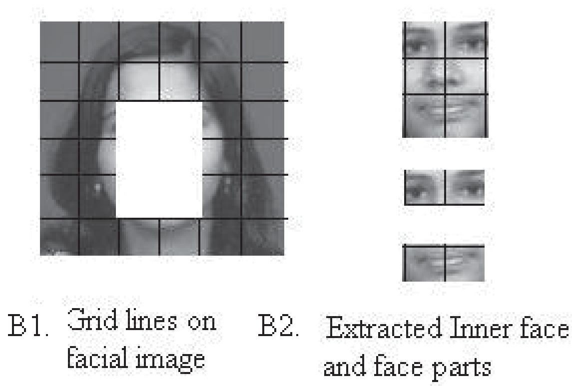

Figure 2. Extracted Inner Face and face parts

3 SVM AS A GENDER CLASSIFIER

Classifiers are built by taking a set of labeled examples and using them to come up with a rule that assigns a label to any new example. As described in [8], In general problem we have a training dataset (*xi, yi*); each of the *xi* consists of measurements of the properties of different types of objects, and the *yi* are labels giving the type of the object that generated the example. The cost of mislabeling each class affects the decision that is made.

In this system the two-class classifier is proposed, and SVM is used for classification.

Support Vector Machine is a learning algorithm specially used for pattern classification In [9] it is demonstrated that SVM classifiers are able to learn and classify gender from a large set of low resolution images with very high accuracy. They also compared the performance of SVM classifier with human performance, and it is found that SVM outperform human result for low resolution images.

The fundamental concept behind SVM algorithm is to minimize the classification errors by finding the optimal linear hyper plane.. In a linearly separable dataset, there is some choice of *w* and *b* (which represents a hyper plane) as

yi(w.xi + b)>0 for every example point.

There is one of these expressions for each data point, and set of expressions represents a set of constraint on the choice of *w* & *b*. These constraints express the constraint that all example with a negative *yi* should be on one side of the hyper plane and all with a positive *yi* should be on the other side. In fact, because the set of examples is finite, there is a family of separating hyper planes. Each of these hyper planes must separate the convex hull of one set of examples from the convex hull of the other set of examples. The most conservative choice of hyper plane is the one that is furthest from both hulls. This is obtained by joining the closest point on the two hulls, and constructing a hyper plane perpendicular to this line. [8]. This hyper plane as far as possible from each set, in the sense that it maximizes the minimum distance from example points to the hyper plane as shown in the figure C. The data points, which determine the hyper plane, are known as support vector.

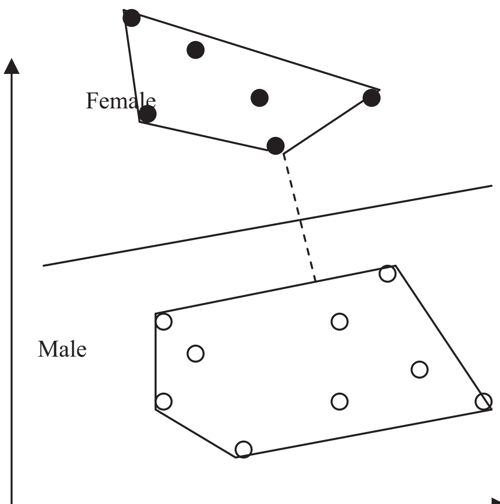

Figure 3. Hyper plane construction by SVM

In our approach the SVM classifier makes use of hyper plane to separate two genders as two classes.

The Algorithm for the linearly separable problem:

Suppose we have a training set of N examples
{ (x1,y1),….(xn,yn)} where yi is either 1 or –1

And the expression to solve the dual optimization problem is :

$$maximize \sum_{i}^{N} \propto_i - \sum_{i,j=1}^{N} \propto_i - \frac{1}{2} \sum_{i,j=1}^{N} \propto_i \ (y_i y_j x_i . x_j) \propto_j$$

$$subject\ to\ \ \propto_i \geq 0$$

$$and \sum_{i=1}^{N} \propto_i y_i = 0$$

$$now\ w = \sum_{1}^{N} \propto_i y_i x_i$$

and for any example point x_i where $\propto i$ is nonzero, we have that y_i $(w_. x_i + b) = 1$, which yield the value of b.

Determining the sign of w by using the following expression, the point can be classified.

$$= sign\left(\left(\sum_{1}^{N} \propto_i y_i \, x . x_i\right) + b\right)$$

$$sign\left(\sum_{1}^{N}(\propto_i y_i x.x_i + b)\right)$$

Constructing an optimal hyper plane is equivalent to finding all the non zero $\propto_i$, Any vector x_i that corresponds to a nonzero $\propto_i$ is a *supported vector* (SV) of the optimal hyper plane. A desirable feature SVMs is that the number of training point which are retain as support vectors is usually quit small, thus providing a compact classifier.

In the proposed approach SVM for gender determination performs more accurately for low-resolution images.

4 RECOGNITION EXPERIMENTS

For the experiment two separate datasets are collected. One dataset contains the female facial data, whereas another is considered as male database. Total 40 (25 male & 15 female) subject's images were captured with the size of 125 X 125 pixels. After gender determination the appropriate dataset has selected and the comparison is made with the extracted vectors of query image.

The experiment was carried out on two separate face parts; eyes and mouth as well as on the inner face image. It is found that the eyes including eyebrows contain the significant gender information; the mouth contains more prominent information for males than females. Whereas the inner face contains the most useful information, Figure C shows the error rates plotted against the facial parts for male & female.. In this system the identification result is also totally depends on the accuracy of gender determination because the selection of dataset is based on the gender of a person. The error rates for male and female subjects are shown in the table 1.

Table 1 : Error Rates for different face parts.

Gender	Error rate (%)		
	Eyes	Mouth	Inner face
Male	11.8	14.49	8.5
Female	11.1	15.20	7.82

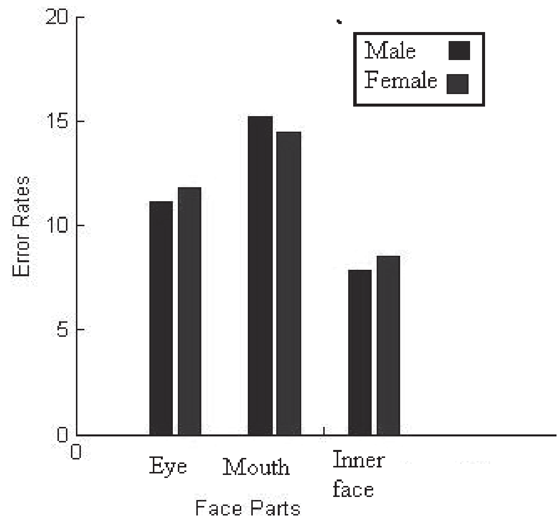

Figure 4. Errors rates

5 CONCLUSION

As per the results obtained we conclude that the face parts individually don't give the promising output but collectively as inner face they contain prominent features and useful gender information. The gender-based datasets contain less number of images for comparison, which in turn reduces the computational cost and improves accuracy.

6 FUTURE WORK

In this approach we have used the limited size of dataset, as well as we have used the standard grid pattern to extract the face parts and inner face. Our future work will tackle the larger dataset and in parallel we will try to implement more efficient methodology to extract the compact inner face within a smaller region.

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