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Automatic Facial Recognition Photo Tagging using Two Spaces Color and Eigenface Algorithm

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Abstract: In this research, we proposed a system to automatic facial recognition photo tagging. Automatic tagging in photo is challenging of both side the face detection and the face recognition standpoints we need face detection and then recognition. We rely on the Color space YCrCb as well as the Color space HSV to extract skin region. Then we examined skin face candidate by searching for the eyes using a Viola Jones algorithm. When we detect an eye, this region will be a face. Regions that do not have eyes are dismissed because they are likely to be either legs or hands. Later, we divide faces to tag it then save them as a database or used as faces of query to be tagged. Eigenface algorithm does the process of recognition. Using two space color improves extracting skin. The Viola Jones algorithm ensures the accuracy of eyes searching results. But it requires long processing time. In this research the search performance of the algorithm is improved to achieve quick results. Therefore, result has been very good when tagging the same photo.

INTRODUCTION

In recent years, significant development efforts in the field of image analysis and understanding the content have been done, especially, research related to detection and recognition of facial images. Delving into this area has attracted many researchers. Such research is no longer monopolized only for the production of special software for security purposes such as software for detecting criminals at airports or in banks but it has exceeded the use of these technologies to search the web networks and social networking which contain a huge number of facial photos and tag it. The web space has become a massive database which cannot be ignored to search for images. Automatic tagging in photo is challenging from both the face detection and the face recognition standpoints.

In this research, we are dealing with color images to extract the skin. Since, speed is the main factor when dealing with Web environment, it is necessary to search for quick search algorithms, most of precise algorithms lack of accuracy, these algorithms require quite long processing time, so, we provide a proposal to get a combination of the speed and simplicity of skin color algorithms with the accuracy of Viola Jones algorithms. in order to extract skin areas, it is possible only in case of color images. The first phase is converting the image to the YCrCb color space and then the skin is extracted according to a certain threshold. And after that the image is transferred to the query HSV color space and in a certain threshold the skin is extracted in this image. And operator is applied to resulting image. In the second phase Viola Jones algorithm is used to detect the eyes in the

extracted regions thereby ignoring the entire image and focusing on areas of skin increases the speed of the algorithm. In the third phase using the Viola Jones algorithm, face can be easily detected. In the fourth phase, faces will be saved in database or used as a query to tag it.

Literature review: Sebastian etc., presented a system for automate photo tagging in Facebook. depending on Viola-Jones algorithm for face detection and Fisherface and SVM for recognition. Tripathi *et al*.[1] used a method of detecting faces depending on the color of the skin and templates. They extracted skin areas depending on the color space YCbCr and templates. Their method provided higher accuracy than the algorithms of individual skin color. However, repositioning faces plays a significant role in the accuracy of this method.

Raghuvanshi and Agrawal[2] (Singhraghuvanshi) present a system to detect and identify faces based on skin color and facial features. Skin areas were extracted through the spaces of color RGB, YCbCr, CEILAB (L*a*b) and HSV. Then, it undergoes a number of tests on extracted areas to find the faces by neglecting small areas which do not represent a face. They examine the number of holes in a region and use only specific areas that have a spherical shape similar to face shape. This method is rapid and simple way which does not need long time but it lacks of the precision and accuracy.

Paull[3] presented a face recognition system by using Principal Component Analysis (PCA). PCA is a statistical approach used for reducing the number of variables in face recognition. In PCA, every image in the training set is represented as a linear combination of weighted eigenvectors called Eigenfaces. These eigenvectors are obtained from covariance matrix of a training image set. The weights are found out after selecting a set of most relevant Eigenfaces. Recognition is performed by projecting a test image onto the subspace spanned by the eigenfaces and then classification is done by measuring minimum Euclidean distance. A number of experiments were done to evaluate the performance of the face recognition system.

Shah *et al*.[4] presented the deployment of face recognition on mobile phones. Mobile phones are becoming the convergent platform for communication and personal sensing such as clicking pictures. Due to this, the invent of digital camera is reduced to much greater extent. We envision auto face tagger, a mobile phone based on collaborative system that senses the people and context in a picture. This study describes about a prototype of auto face tagger on Android Phones.

MATERIALS AND METHODS

Face detection: It's hard to categorize ways to detect faces because of the lack of a universal standard for the classification. However, we can divide the algorithms to detect faces four varieties:

- Knowledge-based methods
- Face characteristics and features based methods
- Templates matching methods
- Face appearance based methods

The previous works were based on skin color and the number of holes in the face which represent eyes. But there were many problems such as the issue of skin extraction by using single color space which leads to skin false consideration of some parts which are not skin.

The biggest problem was the process of searching for eyes. In binary images, any two symmetrical holes are considered as eyes. But in many of the pictures, this two holes are neglected through Eroding and Dilating operations and that's why sometimes, we get wrong results. This issue has been resolved in this work using eyes detection algorithms instead of detecting holes. This algorithm has come up to high precision of accuracy (nearly 99%) but it takes long processing time. We accelerated this algorithm through narrowing down the search for eyes only in the facial area. Thus, reducing 20-95% of the time needed for the entire image to be scanned. As shown in Fig. 1, the face detection goes through different phases:

Picture preparation: In this stage, we prepare the image by applying a number of filters such as:

EqualizeHist: This filter improves the contrast in the picture by distributing density over the entire area of density in the image.

SmoothMedian: This filter removes the noise from the image by removing the high values of the density.

Skin areas extraction: The input image is converted to the YCbCr color space where the skin has been extracted and for the following threshold.

$$140 \le Cr \le 165 \quad (1)$$

And:

$$140 \le Cb \le 195 \quad (2)$$

And then it is disposed of regions displayed like the skin, which is so, small in size that it obviously does not represent the face by Eroding and Dilating. However, some wrong results have occurred where some areas were

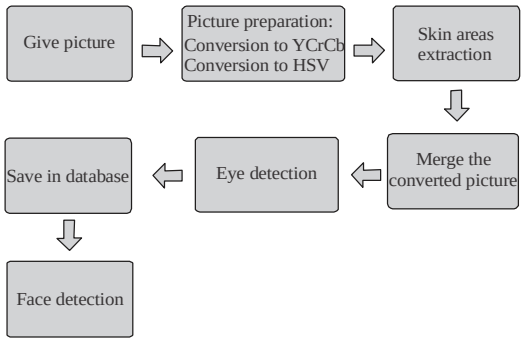

Fig. 1: The process

Fig. 2: Represent the skin color

Fig. 3: Represent the input image

displayed while they do not represent any skin but they have appeared to be areas of clothes with colors similar to skin color this is evident in Fig. 2. Figure 3 represents the input image.

Therefore, this issue is resolved by sharing this space with a second space HSV as the distinctive information related to the skin are present in the H for threshold:

Fig. 4: Related information to the skin

Fig. 5: Better result of one color space

$$1 \le H \le 14 \tag{4}$$

The result was as shown in Fig. 4. The result in the previous form is not good because many areas are displayed as areas of skin which are in fact just a wall or some areas of dresses. So, the previous problems have been resolved by extracting candidate areas to be skin by color space YC_bCr and then extracting the candidate areas to be skin by color space HSV and then and merges the two. Images thus, we get a better result than use of one color space as in Fig. 5.

This process would require double time that it needs to use one color space but the use of color to discover skin areas does not require a lot of time of processing and is one of the fast algorithms, so, this problem can be ignored in comparison with other algorithms.

By reference to Fig. 1, we notice that the areas which is not skin areas are neglected and displayed as skin area when we use this YCbCr color space, in addition to

leaving out the walls areas which HSV space presented as skin color regions. Thus, skin areas are extracted by using of two spaces.

Eyes detection: After extracting skin areas from the given image in the previous stage, we divide the image and obtain these areas and store each area of skin in a separate image. Then, we examine these regions of the skin area to check whether there are eyes in this region or not. If we find the eyes, it means that this area is a face, otherwise this area would be ignored and considered as either a hand or a foot or other area.

We used a Viola Jones algorithm which is considered as one of the most efficient algorithms in discovering objects in the picture or video. This algorithm was provided by both Paul Viola and Michael Jones. These algorithm use machine learning techniques by providing a series of positive and negative images for training and use this image in discovering objects in other pictures.

OpenCV libraries contain many of the works that are already related to detecting faces and eyes and others. These data are stored in an XML file that was used haarcascade_eye.XML file. We download this file and then convert the image to grayscale image and store in an array. If the eyes are detected in the area of the skin is the face of this region it will keep on to the next phase, otherwise this region are ignored.

Face recognition: The face recognition process is an easy task for a human being. Studies have shown that three-year children are able to distinguish and recognize faces. On the contrary face recognition is one of the most difficult tasks for computers. That is why we are studying how humans recognize and realize faces. depending on the internal features of the face such as the mouth and eyes or external features such as the shape of the head and which one is better for face recognition.

There are many algorithms used in facial recognition and three of them are applied here. Eigen, Fisher and LBPH have strengths and weaknesses:

Eigenfaces: The Eigenfaces is a powerful way to represent data. it has an important feature is the reduction of dimensions. It can restore the face of the same person from the database and achieve high precise result. It gives 96 percent of accuracy in identifying object in ATT databases. However, it does not take into account any classification, thus, a lot of identifiable information could be lost due to significant changes in lighting or even facial expressions can affect the recognition accuracy. The PCA technique chooses subspace containing most of the differences and that, therefore, the similarities in the face space cannot determine the identity of the individual[5]. Table 1 shows the algorithm accuracy, according to the image searched.

Table 1: The algorithm accuracy, according the image being searched

Image number	Restore face	Restore face with expression face	Restore face with another
25	99%	80%	50%

Fisherfaces method: In LDA, the goal is to find an efficient way to represent space face Victor. But the class information can be useful in matching operations. Fisherfaces method works well, at least for a restricted scenario we assume in our model. As a result, FisherFace algorithm is more accurate than Eigenfaces algorithm.

Local binary patterns: Both Eigenfaces and Fisherfaces are considered as totalitarian technique in face recognition processes. They deal with image data as a vector of high-dimensional space of the image where it cannot guarantee perfect lighting conditions, as well as the variance estimations for the subspace can be wrong. As result, this could have an effect on the recognition process.

Some researchers have focused on the extraction of local features of the image. Here, the idea is not to take the entire image as a high-dimensional vector but we are only describing the features of the local object. Thus, the extracted features will be a low-dimensions. It will be noted that the representation of the given image will not be affected by changes to in lighting conditions. This method has a good and active role in the two-dimensional texture analysis. Since, the main idea of local bilateral patterns is to summarize the local structure of the image.

RESULTS AND DISCUSSION

Experiment result: We are able to recognize the faces of natural colors and high and medium resolution photos. images with low-resolution or blurry photos or images of people with too much makeup, beard or glasses. Identification process is quite difficult in case of low-quality resolution photos because of lack of good features or due to makeup and modifications applied to faces because it results in wrong features. Using two color spaces have proved to be better than applying one color space as in Table 2.

Applying color space to images of different sizes in order to extract skin areas, we've found out that using only one color space is less accurate than applying two spaces. Applying YCC color space to images (1180×800) has detected clothes areas and interpreted it as skin areas. But HSV color space misinterprets clothes areas only in case of 2000×2500 dimension photos. Therefore, using two color space has solved this problem. Table 2 shows the different results when applying two color space separately and together viola and Jones algorithm is considered as one of the most precise and accurate

Table 2: Comparison two color spaces separately and together

Color space	3000×5000	3100×2500	2000×2500	1100×800	1200×1600	300×300	270×270
YcbCr	100	100	50	100	75	100	100
HSV	100	100	50	100	0	100	100
YCbCr and HSV	100	100	75	75	75	100	100

Table 3: The space that is left out of the picture which increases the speed of discovery eyes algorithm

No. of faces	No. of candidate faces	Region space to search for eyes	Dismissed region (%)
1	3	10	89
3	4	15	85
4	11	40	60
1	1	50	50
1	1	30	70
2	4	40	60
1	1	30	70
1	1	30	70
2	4	25	75
2	4	20	80
1	3	20	80
6	13	30	70
1	3	40	60
1	1	40	60
4	7	35	65
2	2	30	70
3	5	20	80
2	3	10	90
1	1	30	70
4	6	30	70
1	1	20	80
1	1	22	78
1	1	50	50
2	5	30	70
1	4	30	70
49%	90	29%	71%

Table 4: The results of eyes detection algorithm

No. of photo	No. of face	Detected face	Undetected face	Accuracy
25	49	48	1	98%

Table 5: The results of faces detection algorithm and faces with extra areas

No. of photo	No. of face	No. of candidates face	Faces	Faces with extra areas	Accuracy
25	49	90	36	13	73%

algorithms for searching for objects but it takes quite long processing time. But this Algorithm have been accelerated by limiting the searching process to areas which are most likely to be face regions where 90% of the image are ignored while looking for eyes in candidate face areas. When this algorithm was applied on 49 faces, we've found out that 71% of the photo area is ignored and the searching process is limited and focused only on the candidate face areas. Table 3 shows the dismissed area, which increases the speed of eyes detection algorithm.

When applying eye detection algorithm on 25 image which have 49 different faces, this algorithm has could find 48 faces but it fails to recognize any of them. As a result, this algorithm has a great accuracy which might reach approximately 98%. Table 4 shows the results of eyes detection algorithm.

When applying two color spaces to 25 photos containing 39 faces, ninety areas have been detected as skin areas. When using viola and Jones algorithm on this area which are likely to be faces, to see if there are eyes in this area or not 36 faces have been recognized correctly and 13 faces with some additional areas don't represent any faces. The following table shows the correctly discovered areas and the faces that have additional parts which don't belong to the face. Table 5 shows the results of faces detection algorithm and faces with extra areas.

CONCLUSION

Regarding face detection, we can conclude that the higher resolution the photo has, the more accurate the detection is which has some effects on performance. But in case of low-resolution images, the skin extraction process using a color space YCbCr and HSV becomes less accurate as well as affected by changes in lighting, but great deal of changes in lighting can have influence on all the other algorithms that count on color space. What is special on this work is using color space in narrowing down the region that we want to search for eyes in applying only one space color might refer to areas which are not a skin. Eye detection algorithm takes less time because it searches it searches only for eyes in skin areas and ignores other parts of the photo.

While eyes detecting process are still not troubled by photo resolution or lighting changes but requires more calculating time and processing. This problem has been resolved through narrowing down the areas in which we search for eyes; therefore, skin areas extracting and the accurate eye-detecting-algorithm is what makes this work distinguished.

Face recognition process is not affected greatly by photo resolution and that is normal because low-resolution images still have some features and properties on the contrary of high-quality photos that have more features and properties which gives more margin in the recognition process. Three categories have been used but each category has its own pros and cons.

Where the Eigenface is applied when we want to search for the same photo. This algorithm has been proved to have great efficiency in recognizing and detecting the identical images.

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