“REDUCTING THEFT AT ATM USING AN IMPROVED LOCAL BINARY PATTERN HISTOGRAM ALGORITHM”

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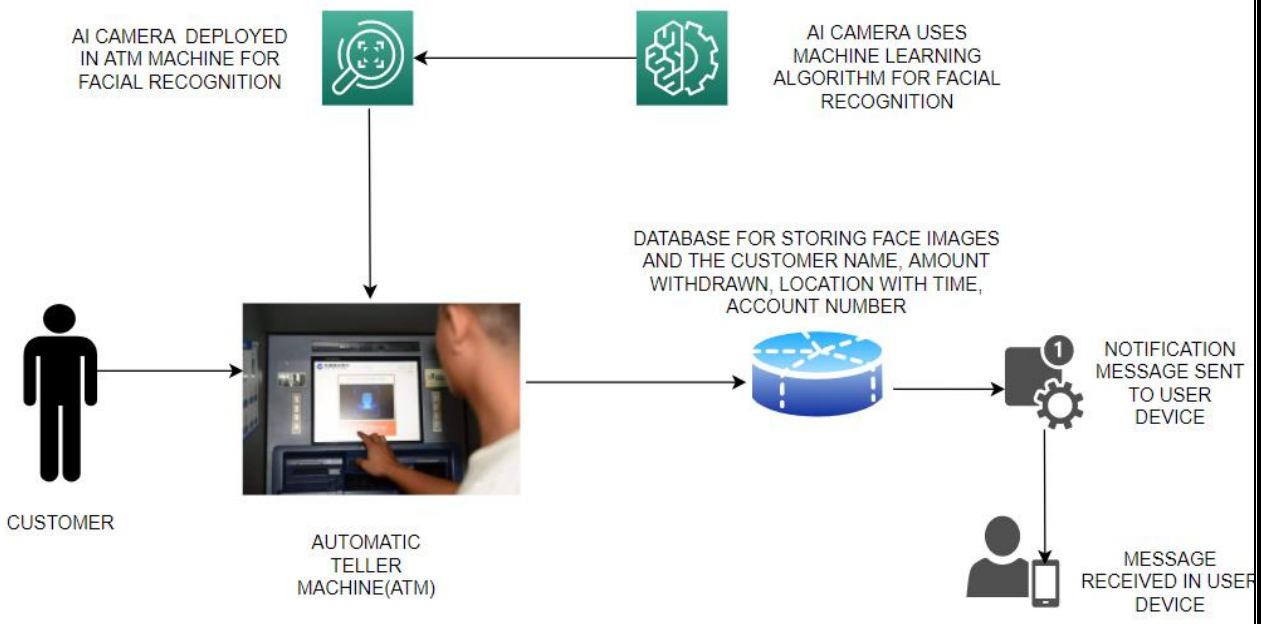
Abstract

- ✓ Face Recognition is a computer application that is capable of detecting, tracking, identifying or verifying human faces from an image or video captured using a digital camera. Although lot of progress has been made in domain of face detection and recognition for security, identification and attendance purpose, but still there are issues hindering the progress to reach or surpass human level accuracy. These issues are variations in human facial appearance such as; varying lighting condition, noise in face images, scale, pose etc.
- ✓ A new method using Local Binary Pattern (LBP) algorithm combined with advanced image processing techniques such as Contrast Adjustment, Bilateral Filter, Histogram Equalization and Image Blending to address some of the issues hampering face recognition accuracy so as to improve the LBP codes, thus improve the accuracy of the overall face recognition system.
- ✓ Our experiment results show that our method is very accurate, reliable and robust for face recognition system that can be practically implemented in real-life environment as an automatic attendance management system.

Architecture



Working

- ✓ **Usual process of taking money has been processed.**
- ✓ **In addition to that, AI based camera has been mounted in the ATM to detect the alive faces.**
- ✓ **AI Camera which has been mounted will be a separate process in ATM.**
- ✓ **Images will be stored in the database.**
- ✓ **It should be like a protocol, that everyone's face has to be taken in database before the money is withdrawn at the ATM.**
- ✓ **Finally, user will be notifies about the location with time and amount withdrawn from their bank account.**

Local Binary Pattern

- ✓ Simple theory with computational simplicity, invariant with respect to any monotonic transformation of gray scale, has powerful rotation-invariant analysis with a uniform pattern and discriminates excellently between different various kinds of texture as in, but It is known that the LBP is not as robust as the viola-jones and other algorithms for face detection as highlighted in, because of issues such as noise, illumination variation, background, pose, scale and occlusion etc.
- ✓ In addressing the issue of illumination variation, mitigated illumination variation in facial recognition by combining the strengths of robust illumination normalization, local texture-based face representations, distance transform based matching and kernel-based feature extraction and multiple feature fusion, but the solution addressed only illumination issues.
- ✓ To address issues of noise in facial recognition, employed shear lets and LBP for dealing with heavy noise in face recognition, by taking advantage of robust features and edge detection capabilities of shear lets in the presence of high level of noise.
- ✓ In this method, each face is divided into blocks, individual classifier is used for each block and then combines the similarity scores from all the blocks for better performance, but the solution is limited to noise only.

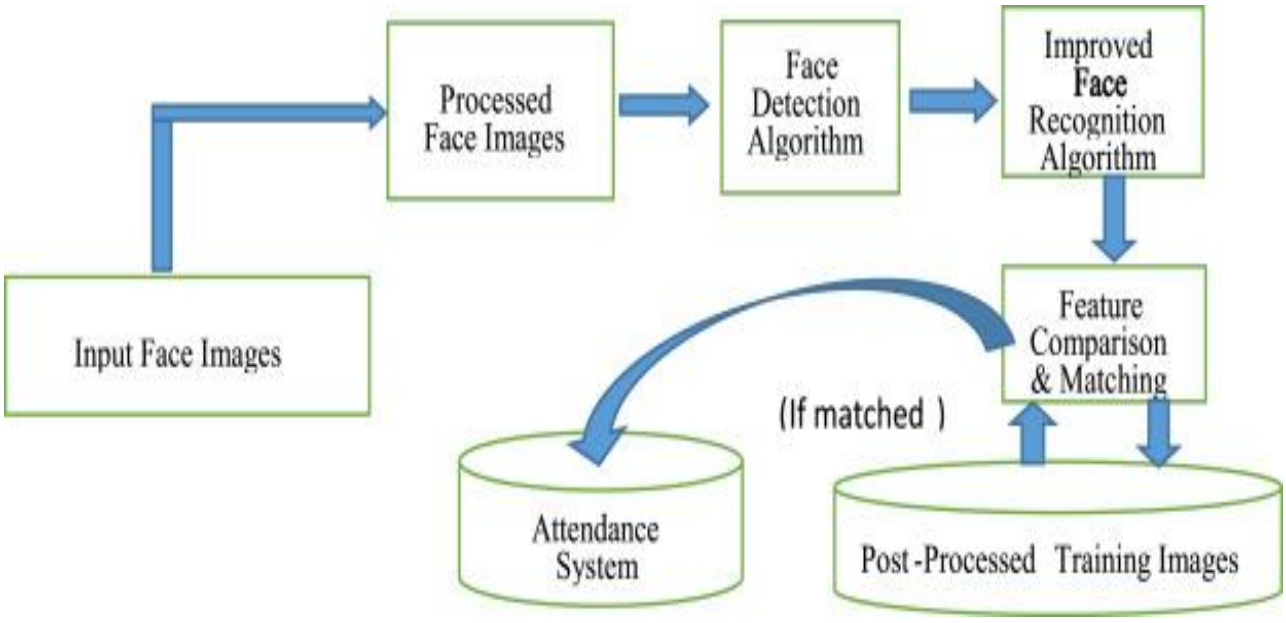
Improved LBP algorithm

- ✓ In our work, we acknowledge the fact that capability of the LBP face recognition algorithm highly depends on the accuracy performance of

feature extraction and comparison stage, which also highly depends on the quality of both the input face images and the training/reference images participating in the face comparison process.

- ✓ In order to improve the face recognition accuracy of the LBP algorithm, we exploited the following image quality properties of our input and reference face images: illumination, sharp, noise, resolution, scale and pose, so as to obtain the best quality images that will expose better details of image features for more accurate feature extraction and comparison.

Flowchart of algorithm



The above figure shows the flowchart of the algorithm. As depicted in the flowchart, the captured input face images are processed using our proposed image processing techniques, then the face detection algorithm is applied to detect faces. Once faces are detected, the face recognition algorithm aided

with our proposed method will be applied to recognize faces. Once faces are recognized, the metadata of the recognized faces will be extracted to mark attendance using the attendance system.

Proposed methodology

Our first improvement approach is to apply the Contrast Adjustment method on our input face images as defined in equation (1). We tested this method with different values of alpha and beta to select the one that gives the best detection and recognition accuracy result, which are 1.5 (α) value and 0.0 (β) value.

$$g(x,y) = \alpha * f(x,y) + \beta \tag{1}$$

In the second approach, we compared effects of these three types of filters: Gaussian Blur Filter, Median Filter and Bilateral Filter on the accuracy performance of our face recognition system. We selected the filter that gives the best result in our case, which is the bilateral filter as defined in equation (2).

$$F(x,y) = \frac{\sum_{x=-N}^{N} \sum_{y=-N}^{N} I(x,y)W(x,y)}{\sum_{x=-N}^{N} \sum_{y=-N}^{N} W(x,y)} \tag{2}$$

$$CF(x,y) = g(x,y) * F(x,y) \tag{3}$$

The resultant image pixels derived from the above equation are equalized using the image histogram equalization method defined in equation (4) to finally address the global lightning issues in the processed facial images.

$$Eq = H'(CF(x, y)) \tag{4}$$

where H' is the normalized cumulative distribution with a maximum value of 255 as in, finally, we applied the LBP algorithm on our detected face images for feature extraction & comparison. The first LBP operator described in literature uses a fixed 3X3 neighbourhood window, as shown in Fig. 1 below:

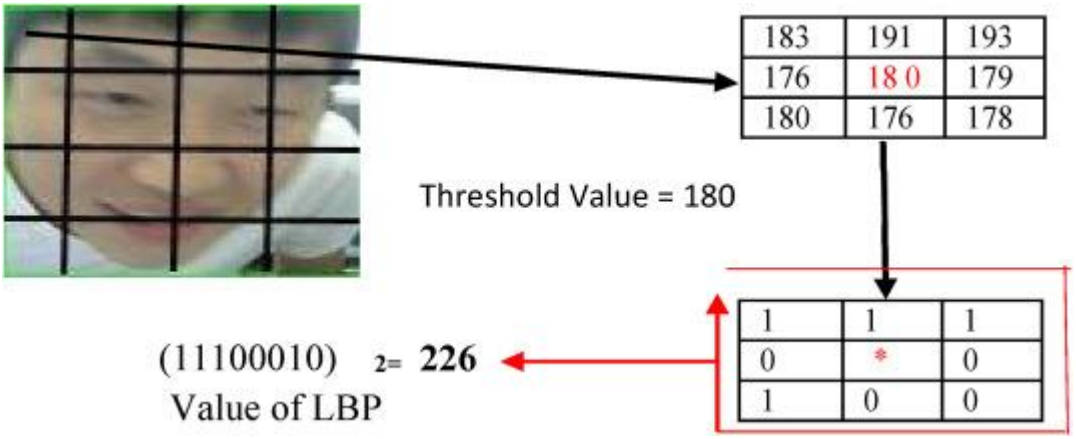


Fig. 1. The original LBP operator.

A more formal description of the LBP operator can be given as follows in equation (5):

$$\mathrm{LBPp,r}(X_c, Y_c) = \sum_{p=0}^{p-1} 2^p \mathrm{S}(i_p - i_c) \tag{5}$$

$$S(\mathrm{X}) = \begin{cases} 1 & if \quad x \geq 0 \\ 0 & if \quad x < 0 \end{cases} \tag{6}$$

In our approach, we demonstrated the effect of using equations (1), (2), (3), (4) to improve the overall quality of our input face images so as to boost the accuracy performance of the LBP face recognition algorithm as shown in Fig. 2 below.

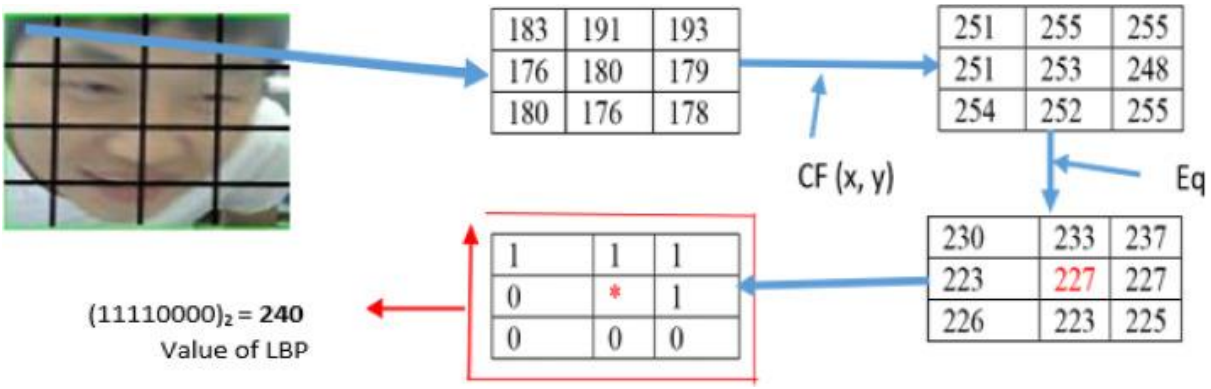


Fig. 2. The modified LBP operator.

Examining each window of the 3 × 3 neighbourhood pixels of the resultant images from equations (3), (4)), the issues of noise, illumination, sharp, and resolution were highly mitigated. We obtained higher pixel and threshold values as shown in Fig. 2, after applying equations (1)–(4) to the original input images, we obtained an improved high quality images using our method, which implies better image quality that will expose better image features and enabled more accurate image histograms for facial image comparison as shown in section 4, Fig. 3 (a) to (d), thus resulted in an improved LBP codes, that will stimulate the overall face recognition accuracy.

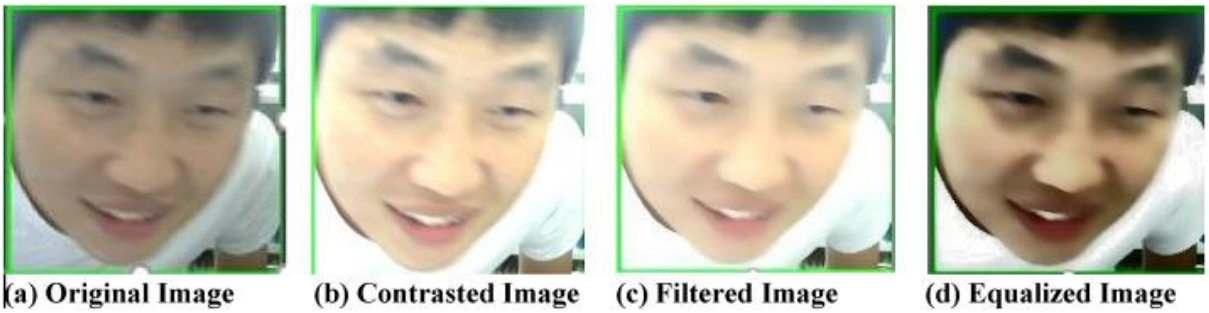
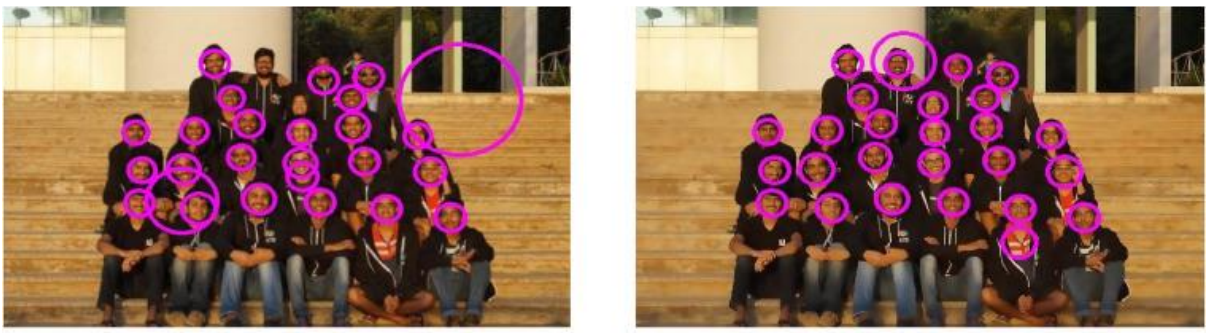


Fig. 3. Shows the original image and processed images defined in equations (1)–(4)

Experiments

- ✓ We present an effective and efficient approach using advanced image processing techniques to improve face recognition accuracy based on local binary patterns algorithm. In this section, we'll give experiment results from two interconnected parts to demonstrate our method.
- ✓ In the first part, the LBP cascade classifier is employed for multiple face detection and tracking. first, we'll capture faces from a live digital camera or sourced from a digital image and apply the LBP cascade classifier algorithm to detect faces. To improve the accuracy of the LBP face detection algorithm to the level of Haar cascade classifier face detection algorithm as in or even better while maintaining speed, we used image processing techniques defined in equations (1)–(4).
- ✓ Our experiment result for this part is shown in Fig. 3, Fig. 4 and Table 1. Using our approach, we were able to improve the face detection accuracy rate, which is an integral part of the overall face recognition accuracy rate, while at the same time reducing the number of false positives and false negatives.



(a) Face detection using Haar Classifiers (b) Face detection using our improved LBP

Fig. 4. Shows detected faces using the Haar cascade classifiers and LBP cascade classifier aided with our proposed methods defined from equation (1) to equation (4).

Table 1. Face detection evaluation result.

	Total Faces	Haar	LBP	Proposed Method
True Positive	226	208	206	**215**
False Positive	226	18	20	**11**
False Negative	226	55	41	**33**
Detection Accuracy Rate		**92%**	**91%**	**95%**

- ✓ In this experiment, the Haar classifier algorithm is used to detect faces in an image as shown in Fig. 4 (a). The Haar classifier algorithm consist of four (4) phases; integral image, Haar-like features. AdaBoost and Cascading Classifier, in which the input face images will be represented as integral images first, to compute Haar-like features, for optimization reason, the AdaBoost will be used for

feature selection, then the selected features will be passed through a cascading classifier to classify faces in an image.

- ✓ Aside the Haar Classifier algorithm, our proposed improved LBP method is also used to detect faces in an image as shown in Fig. 4 (b). Comparing the two methods in Fig. 4, it is shown that our proposed method outperformed, the Haar Classifier algorithm for Face Detection and also in the number of detected faces, represented as true positive or false positive, represented as features that are incorrectly detected as faces or false negative, represented as faces that are not detected as faces in an image. In Table 1, for face detection, the Haar algorithm, the original LBP and the improved LBP using our method are compared using a dataset of 226 images, which our method perform better in all cases.

Linear blending of training images

- ✓ After the face detection process, we'll use the LBP algorithm aided with the advanced image processing techniques defined from equation (1) through equation (4), to better extract facial features so as to compare and recognize human faces.
- ✓ In the second part, before applying the LBP face recognition algorithm on detected face images, we employed image blending technique on our training images datasets. Image blending is a linear interpolation often used to blend two images f_0 and f_1 as shown in Fig. 5, in order to improve the visual quality of images by minimizing intensity variations effects. The linear blending is defined in equation (7), where (α) and (1-α) are blend fractions used in a weighted average of each component of each pixel as highlighted in Refs.

Fig 5. Blending two different images.

- ✓ In our work, we created three different datasets each containing different orientations and conditions of faces that are confined to 181 × 181 pixels: **dataset [I], dataset [II],** and **dataset [III].** No image blending was applied in the dataset [I], the linear blending of 1.0 alpha (α) was applied on dataset [II], and linear blending of 0.5 alpha (α) was applied on dataset [III]. We tested the improved LBP face recognition algorithm on these three datasets and selected the one that gives the best face recognition accuracy result in our system, which is dataset [III].
- ✓ Prior to confining the training images to 181 × 181 pixels, we empirically tried different pixel values on the training datasets to check whether it will have any impact on the face recognition accuracy, which it does, although the impact is not that much, but the best result was selected, which is 181 × 181 pixels.
- ✓ We improved the quality of both our input face images and training images, using our proposed methods defined in equations (4), (5)). Now we apply the LBP algorithm aided with our methods to extract more detailed and visible facial features to increase comparison certainty for more accurate face recognition.

- ✓ In Table 2, we show the performance evaluation of the original LBP algorithm that was run on our dataset [I], the dataset without any image processing. We used the following metrics in our evaluation: False Negatives, Unknown faces, and False Recognition. We calculated the face recognition rate as follows: **Face Recognition Rate** = (*Total Number of Faces - a total number of False Recognition)/(Total number of Faces) * 100%.*

Table 2. Shows the performance evaluation of original LBP operator using dataset [I].

Total Faces	False Negatives	Unknown Faces	False Recognition
355	18	1	32
357	6	3	24
363	27	0	37
417	7	4	49
371	10	5	35

Face Recognition Rate = 90.49%.

In Table 3, we show the performance evaluation of our improved face recognition method using equation (3), (4)) that was run on our dataset [III], which was processed using equation (7) with an alpha (α) value of 0.5. Using the same metrics and face recognition rate formula above. Fig. 6 below shows the result of recognized faces of three (3) different people.

Table 3. Shows the performance evaluation of improved LBP algorithm using dataset [III]**.**

Total Faces	False Negatives	Unknown	False Recognition
764	1	5	1
773	0	8	0
765	0	13	0
760	0	9	1
762	2	4	0
768	0	3	1
767	0	8	1

Face Recognition Rate = 99%.

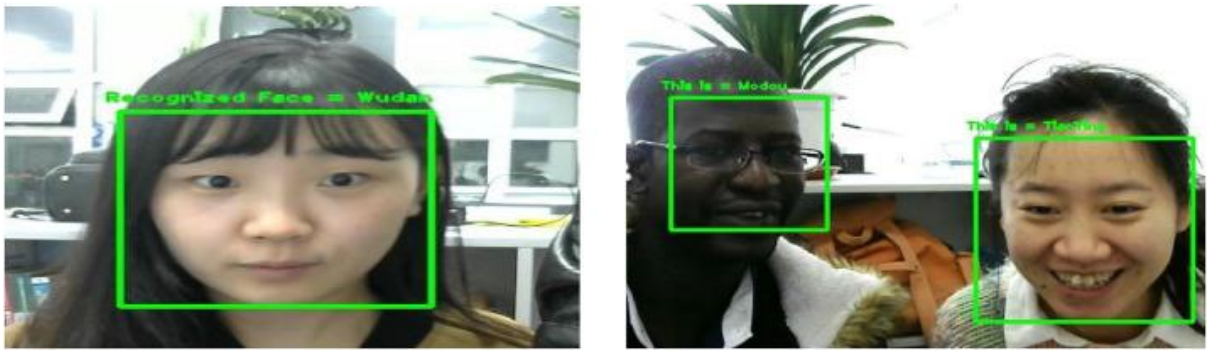


Fig. 6. Face recognition results.

Attendance system

After successfully recognizing human faces, the recognized face images will be fetched into our attendance system to mark attendance of individuals.

Attendance database

In our attendance database, we will extract each recognized face images to mark the attendance of individuals, using date and time educed from recognized face images as shown in Table 5.

Table 5. Shows database attendance records.

ID	Name	Time_In	Time_Out
1	Modou Bah	6/16/2016 09:24	6/16/2016 13:48
2	Wang Long	6/16/2016 09:31	6/16/2016 13:49
3	Tian Ying	6/16/2016 09:37	6/16/2016 13:48
4	Mrs.Wudan	6/16/2016 09:38	6/16/2016 13:47

Conclusion

- ✓ In conclusion, after preprocessing the input face images using some advanced image processing techniques such Contrast Adjustment, Bilateral Filter, Histogram Equalization, so as to have better image features and the same advanced image processing techniques will be applied to the training/template face images plus an image blending method to ensure high quality training/template face images.
- ✓ The preprocessed input face image will be divided into k^2 regions, then the LBP code will be calculated for every pixel in a region of the input face image by comparing the center with the surrounding pixel. If the surrounding pixel is greater than or equal to the center pixel, then it is denoted as binary 1, else it is denoted as 0.

- ✓ This process will be repeated for each and every pixel of all other regions, to get the binary pattern so as to construct the feature vector of the input face images. For every region, a histogram with all possible labels is constructed. These constructed histograms with all its bins represent a pattern and contain the number of its appearance in the region. The feature vector formed is then constructed by concatenating the regional histograms to one big histogram, which is unique for each individual, and is compared with the template face images to recognize faces.

- ✓ This method improves the LBP code and our experiment results show that our method is very accurate and robust for facial recognition system that can be implemented in a real-life environment. It is also important to state that our research does not address the issue of occlusion and mask faces in facial recognition, but addressing these issues could be a perfect future work of this paper.

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