
Title: ***An improved face recognition algorithm and its application in attendance management system***

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# Introduction

This research paper presents using Local Binary Pattern (LBP) algorithm combined with advanced image processing techniques such as:-

Contrast Adjustment

Bilateral Filter

Histogram Equalization

Image Blending

In doing so face recognition accuracy of LBP is improved

# Methodologies

To improve the LBP the researchers preprocess the image first

*First*, Contrast Adjustment method on input face images as follows

$$g(x, y) = \alpha * f(x, y) + \beta$$

Tested different values of *alpha* and *beta* to select the one that gives the best detection and recognition accuracy result, which are (α=1.5) value and (β=0.0) value.

*Second*, Three types of filters: Gaussian Blur Filter, Median Filter and Bilateral Filter are tested

Bilateral filter is used for face images as a filter

# Cont.…

Bilateral filter as defined in equation

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

Where $W(x, y)$is the filter weighting function, $I(x, y)$ is the input face image neighborhood pixel and the denominator is the normalization of the weighting function

*Third*, reduce noise and control contrast effects in the input images,

$$\boldsymbol{CF(x, y) = g(x, y) * \mathbf{F}(\mathbf{x}, \mathbf{y})}$$

Where g$(x, y)$ in equation  is the contrasted image and F$(x, y)$ is the applied filter

# Cont….

*Fourth*, The resultant image pixels derived above are equalized using the image histogram equalization

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

Where $H'$ is the normalized cumulative distribution with a maximum value of 255.

*Finally*, applied the LBP algorithm on face images for feature extraction & comparison.

# *How does LBP work?*

Common approach is using 3x3 window to extract a code

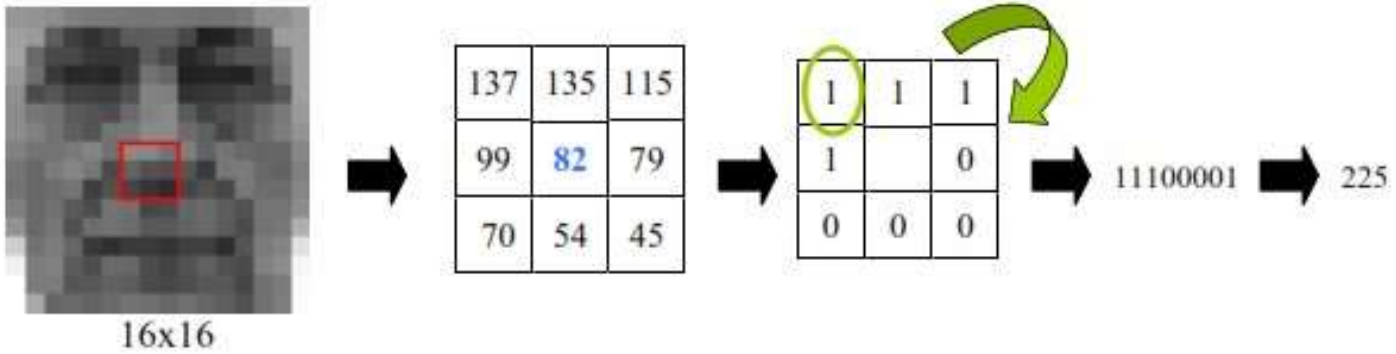
The processing involves thresholding the center pixel with its neighbors.

The resulting decimal values of the central pixel can be expressed as follows:

$$LBP(x_c, y_c) = \sum_{n=0}^{7} s(l_n - l_c)2^n$$

where $l_c$ corresponds to the grey value of the center pixel $(x_c, y_c)$, ln to the grey values of the 8 surrounding pixels, and function $s(k)$is defined as:

$$s(k) = \begin{cases} 1 \; if \; k \geq 0 \\ 0 \; if \; k < 0 \end{cases}$$




Examining each window of the 3x3 neighborhood pixels of the resultant images The issues of noise, illumination, sharp, and resolution were highly mitigated.

(a) Original Image (b) Contrasted Image (c) Filtered Image (d) Equalized Image

# Experiments

Advanced image processing techniques are used to improve face recognition accuracy based on local binary patterns algorithm.

In the research, the LBP cascade classifier is employed for multiple face detection and tracking.

Capture faces from a live digital camera or sourced from a digital image and apply the LBP cascade classifier algorithm to detect faces.

(a) Face detection using Haar Classifiers

(b) Face detection using our improved LBP

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%** |

# Cont.…

## Linear blending of training images

After the face detection process, the LBP algorithm aided with the advanced image processing techniques defined above

In the second part, before applying the LBP face recognition algorithm on detected face images, image blending technique on training images datasets was applied.

Image blending is used in order to improve the visual quality of images by minimizing intensity variations effects.

# Cont.…

The linear blending is used, it is defined as follows

$$G(x) = (1 - a) f_0(x) + a f_1(x)$$

Where $f_0$ and $f_1$ are two images to be interpolated and (α) and (1-α) are blend fractions used in a weighted average of each component of each pixel .

# Datasets

Three different datasets each containing different orientations and conditions of faces that are confined to 181x181 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],

Linear blending of 0.5 alpha (α) was applied on dataset [III]

# Results

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 |

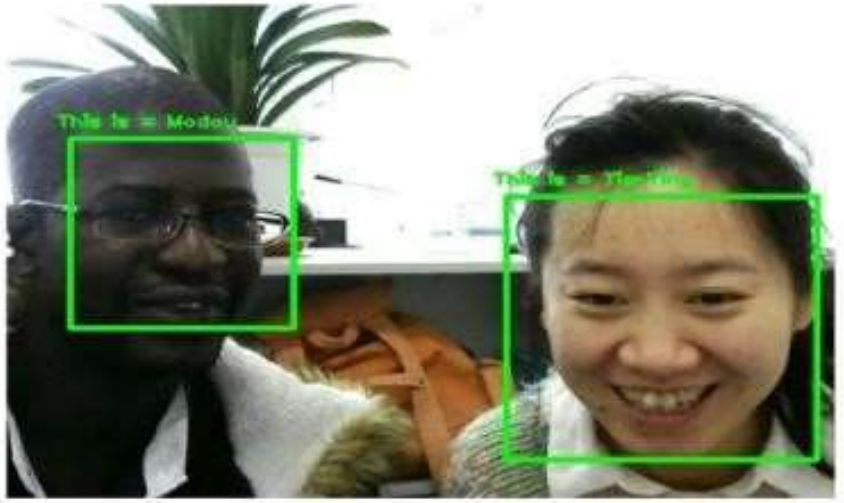
Face Recognition Rate = 90.49%.

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%.

# Attendance system


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

Image preprocessing of the input face images such as Contrast Adjustment, Bilateral Filter, Histogram Equalization yields better face recognition accuracy.

Same techniques applied to the training/template face images and

An image blending method to ensure high quality training/template face images.

This methods improves the LBP code and results show that this method is very accurate and robust for facial recognition system that can be implemented in a real-life environment like attendance system.