International Journal of Engineering Research & Management Technology

ISSN: 2348-4039

Volume 8, Issue-3 May-June 2021

Email: editor@ijermt.org www.ijermt.org

A New Approach for Face Recognition Biometric Mathematical Model

Ashish Kumar Shukla

Research Scholar, Nehru Gram Bharti University, Pragraj, Uttar Pradesh, India

Archana Shukla

Nehru Gram Bharti University, Pragraj, Uttar Pradesh, India

Raghvendra Singh

Indus Institute of Technology & Management Bilhaur Kanpur, Uttar Pradesh, India

Abstract

The face is the primary characteristic of the body that is responsible for the individuality of each person. The use of facial characteristics as biometrics in the creation of face recognition systems is possible. In any type of company, taking and recording attendance is the most demanding responsibility. In the traditional method of taking attendance, teachers go through the process of calling out individual pupils and noting whether or not they are present. Constructing a human face identification system based on CCTV (closed circle television) images using a variety of feature extraction and face recognition methods is the objective of this work. Picture acquisition from a CCTV system, image preprocessing, face detection, location determination, image extraction, and recognition are the components that make up the proposed system. Specifically, an unique face alignment approach is used to pinpoint the crucial spots inside faces, and a novel deep neural network is created for deeply encoding the face areas. Both of these steps take place in the first place. The Local Binary Pattern Histogram (LBPH) approach is used to obtain the properties of the system. The researchers then provide a hybrid Bayesian framework and Fully Convolution Network (FCN) model for the purpose of analyzing the similarity of feature vectors and attaining very competitive face classification accuracy. When assessing the efficacy of the LBPH algorithm, several parameters, including the true positive rate, the accuracy score, the false positive rate, the sensitivity score, the specificity score, and the F1-score, are considered to be very important.

Keywords: *LBPH, CCTV, FCN, Face recognition, feature extraction.*

1. Introduction

Every school, college, organization, and the university has a duty to guarantee that all students' attendance is recorded [1]. Teacher's are doing an excellent job of recording students' attendance. The practice of keeping track of one's attendance is a popular one in many industries, including companies and institutions. It takes a long time to organize and calculate the engagement of each student in traditional participation-checking techniques. Keeping track of attendance using the old-fashioned way isn't optimal. Every organization has a system in place to monitor individuals' attendance to keep an eye on their development. Each institution different strategy has for its employs. Biometric attendance systems have been deployed at some of the organizations, while manual attendance records remain in use at others [2]. Computerized biometric software that compares patterns based on a person's facial characteristics can be employed to identify or verify their identification in smart attendance systems. As the administration of facial recognition systems has improved recently, this technology has become more useful in many different contexts, including security and business operations [3]. Digital face recognition is a new field of research that relies heavily on computer-aided technology. Attendance systems can be put to good use by using facial recognition for identification reasons [4].

In order to validate the students' attendance records as being accurate, the personnel team needs to have a dependable system for approving and keeping the attendance record. This is necessary in order for the personnel team to fulfil its duty. It's common practice for schools to keep track of students' whereabouts using one of two frameworks: either a manual or an automated attendance system (MAS/AAS). It could be hard for MAS teachers to constantly review and update information for each and every student in a given class [5]. The effort of physically and numerically noting each student's presence and absence in a class with a big teacher-to-student ratio can become tedious and dull. Thus, researchers can set up a system that uses face recognition to automatically log students' attendance. It's possible that AAS will free up employees' time by relieving them of administrative responsibilities. Human Face Recognition (HFR) attendance systems need students' faces to be photographed either as they enter the classroom or after everyone is seated [5].

2. Face Recognition

The process of recognizing or authenticating an individual's identification based on their face can be referred to as facial recognition. Face recognition software enables the identification of people in still photographs, moving images, and even in real time. Mobile identification devices could be used by law enforcement officers to identify individuals throughout the course of police stops [6].

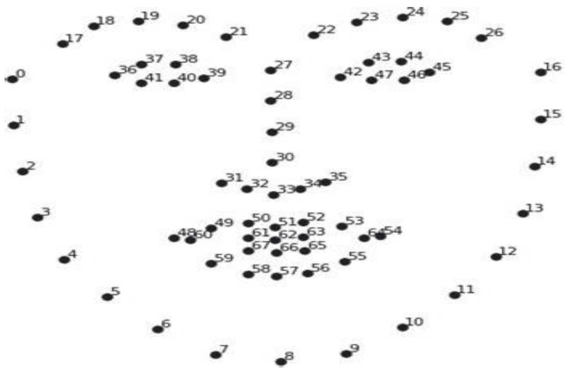

Figure 1: 68 landmarks present on the face [5]

However, facial recognition data might be prone to inaccuracy, potentially implicating innocent individuals in crimes they did not commit. Particularly poor at detecting African Americans and other ethnic minorities, women, and young people, facial recognition software often misidentifies or fails to recognize individuals, negatively affecting specific groups disproportionately [7].

Targeting persons who engage in constitutionally protected speech also includes the use of face recognition technology. Technology that can recognize people's faces will almost probably become more common in the not-too-distant future. It is possible to use it to track the movements of people all across the world, in a manner comparable to the way that automatic license plate scanners follow vehicles based on the plate numbers. Real-time facial recognition is already being utilized, not only in other countries but also in the United States during sporting events [8].

3. How Face Recognition Works

Computer programmes called algorithms are the key to the success of facial recognition software in recognizing individual characteristics of a person's face. After taking measurements of various aspects of the face, such as the distance that separates the eyes and the contour of the chin, the data is then transformed into a mathematical representation and compared to a database of previously identified individuals. As opposed to a picture of the face, a face template is a collection of data about a single face. Its purpose is to contain just the characteristics of the subject's appearance that distinguish it from other people's faces. One such score indicates the likelihood that the unknown person matches one of the face templates. You won't receive just one response from using these techniques; rather, you'll get a list of possible matches, and each of those potential matches will be rated according to how probable it is that it is the accurate identification [9].

Different face recognition systems have varying degrees of success in recognizing persons in challenging environments. These conditions include poor illumination, low image quality, and an unfavorable viewing angle [13].

Regarding mistakes, there are two essential principles to comprehend:

A "false negative" happens when a facial recognition system does not match an individual's face to an image kept inside the database. This is also known as an incorrect identification. In other words, in response to a query, the system only returns zero results in case of an error [10].

A false positive occurs when a face recognition system mistakenly identifies a person's face as being similar to a picture in its database. False positives can arise when a person's face is scanned into the system. It takes happen when a law enforcement officer uploads a photo of "Joe," but the system erroneously recognizes it as a photo of "Jack."

It is essential to take into account both the "false positive" and "false negative" rates, as there is almost always a trade-off between the two when analyzing a face recognition system. It is because there is almost always a trade-off between the two rates. If a mistaken identification results to the wrongful incarceration of an innocent person (for example, a mistake in a mugshot database), then the system need to be designed to produce as few false positives as is humanly possible [11].

Face recognition's underlying mathematic paradigm is given out below. Let's suppose we want to define a group of images of people's faces in the database $X_1, X_2, X_3, \ldots\ldots, X_n$. To represent each individual who has signed up for a set, we split it into one of L classes. We characterize a K-valued vector as,

$$\mu = (\mu_1, \mu_2, \mu_3, \ldots\ldots, \mu_L)^\tau \quad (1)$$

Where τ is the transpose operator. We establish the distance function (1) for each image. The longest distance d (μ_1 , μs) from the input form to the feature vector is of type X_L,

$$\mathrm{d}(\mu_1, \mu\mathrm{s}) > d(\mu\mathrm{i}, \mu\mathrm{s}), \mathrm{l} \neq \mathrm{j}, \mathrm{l}, \mathrm{j} = 0,1, \ldots\ldots, \mathrm{L}-1 \quad (2)$$

For the distance function (2), the class XL must exceed a pre-computed threshold value d(μl , μs) > τ_c. The face detection algorithm receives an image as its input, and it produces a series of face frame coordinates as its output (0 face frames or 1 face frame or multiple face frames).

One could obtain the coordinates of the face by using a mathematical model to find the integral picture. This would allow one to do so (Viola and Jones algorithm):

$$I_i(x, y) = \sum_{i=1}^{x.y} i(x', y') \quad (3)$$

Where $I_i(x, y)$ signify the value of the i-th element of the integral image with coordinates is the (x, y), (x', y') denotes the brightness of the pixel of the image under consideration with coordinates(x', y'). The integral image (3) is computed independently of the size or position of the picture, and it is put to use in order to expeditiously determine the brightness of specific regions of the image. The symbol "si" denotes the process of subtracting the total sum of the brightness of the pixels that lie in the white regions from the total sum of the intensities of the pixels that are in the black areas:

$$S_i = \sum_{i=0}^{y.x} r_{i,k} - \sum_{i=0}^{y.x} r_{i,f} \quad (4)$$

Where $\sum_{i=0}^{y.x} r_{i,k} - \sum_{i=0}^{y.x} r_{i,f}$ is the sum of the brightness of the pixels.

The phrase for this classifier with a threshold value τ_c is:

$$W = \begin{cases} 1, & f_i \geq \tau_c; \\ -1, & f_i < \tau_c; \end{cases}$$

(5)

A specified number of less accurate classifiers are used in the calculation to get the "best" strong classifier. An instance expression for a robust classifier is shown below:

$$W = \begin{cases} 1, & \sum_{c=1}^{c} a_c \omega_c \geq \frac{1}{2} \sum_{c=1}^{c} a_c\,; \\ -1, & \sum_{c=1}^{c} a_c \omega_c < \frac{1}{2} \sum_{c=1}^{c} a_c\,; \end{cases}$$

(6)

$$a_c = log \frac{1}{\beta_c}$$

(7)

Where ω_c is weak classifier; ac, βc are the weight coefficients of the weak classifier; If there are a total of C weak classifiers, then c = (1... C) indicates the current weak classifier. To learn arbitrarily minor mistakes, classifiers based on "weak" (5) compositions may be achieved using an iterative method that implements a "strong" classifier (6) and (7). This is how the before and after images of the item look like when the light is turned on:

$$q_i(x, y) = \frac{g_0, j(x,y)}{g_{1,j}(x,y)+1}$$

(8)

Where $\gamma, g_{(b,j)}(x, y)$ denotes the brightness value of the pixel of the array I (b,j), j is the number of the current value of the sequence, corresponding to the image of the user's face; x and y are the coordinates of the pixel in question; x = 0, 1,..., W -1, y = 0, 1,..., H 1, W and H are the number of pixels corresponding to the width and height arrays I. The pixel array identifier b = (0, 1) indicates the backlight mode in which the array was produced (bj).

There has to be an estimate of the value-wide dispersion measure. The dispersion is computed to evaluate the spread of values around the mean (mathematical expectation):

$$D(I_{0,j}, I_{1,j}) = \frac{1}{WH} \sum_{x=0}^{W-1} \sum_{y=0}^{H-1} (q_j(x, y) - q_j)^2$$

(9)

In this formula, $q_j(x, y)$ is a discrete random variable, and (q_j) represents its expected value or mean:

$$q_j = \frac{1}{WH}\sum_{x=0}^{W-1}\sum_{y=0}^{H-1}\left(q_j(x,y)\right). \quad (10)$$

4. FCN classification model

FCNs are a popular design for the task of semantic segmentation. They employ just locally connected layers for everything from convolution to pooling to up sampling. The number of variables may be decreased by avoiding dense layers (making the networks faster to train). This also indicates that an FCN may work with different image sizes, so long as the connections are all local [14].

A down sampling approach is used to collect and understand context, whereas an up sampling path enables localization.

FCNs additionally use skip connections to retrieve the fine-grained spatial information that was lost during the down sampling process.

5. Local binary pattern histogram (LBPH) feature extraction

LBP format is a detectable descriptor format that is used in the computer vision classification process. The Texture Spectrum concept was conceived in 1990, and LBP is the unique implementation of that idea.

1994 was the first year that LBP was given a representation. Since that time, it has developed a reputation for being a trustworthy identifier of texture. Specifically, the Oriented Gradient Histogram method is the one that is produced when LBP is combined with the descriptor histogram of oriented gradients (HOG). It is very clear that doing so improves the identification process for certain datasets. Figure 4 presents the flowchart of the LBPH algorithm for your perusal [12].

For encoding of visual characteristics, the picture is partitioned into cells (4 × 4 pixels). It's contrasted by having surrounding pixel values move in either a clockwise or anticlockwise way. The intensity values of the surrounding pixels are compared to the central pixel's. If the difference is greater than zero, the place is marked with a one; otherwise, it is marked with a zero. The end result is a value for a single cell that takes up 8 bits.

The matrix computation shown in Figure 3 compares the value of the matrix's center member to that of its bordering elements.

21	5	55
3	14	25
45	23	14

$is\ Value$
$> Centre\ Value$
$YES = 1$
$\rightarrow NO = 0$

1	0	1
0	0	1
1	1	0

$\Rightarrow$

1	0	1
0	0	1
1	1	0

Figure 2: LBPH creating an 8-bit number [12]

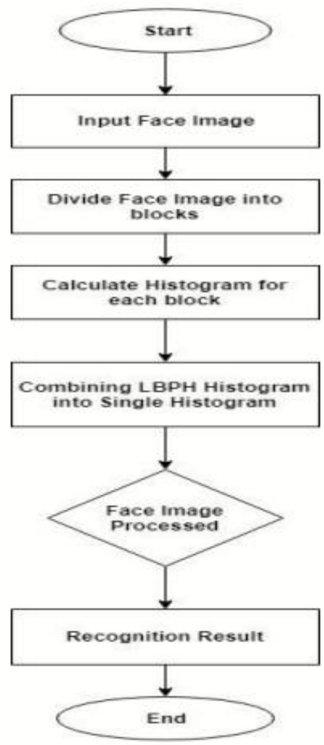

Figure 3: LBPH algorithm flowchart [12]

If the lighting situation of the picture is changed, the ultimate result will be the same as the one that came before it. In larger cells, histograms are used in addition to the frequency of value usage, which contributes to the robustness of the system. It is feasible to locate edges if the data from the cell are investigated as the quality of the data varies. It is possible to generate feature vectors by first calculating the values of each cell and then merging the corresponding histograms. Processing methods that are tied to an identifier could be used to classify images [15]. The input photographs are sorted into categories using the same methodology, and then the data set is contrasted in order to accomplish separation. Establishing a limit value makes it possible to identify a face very effectively, regardless of how well-known or unfamiliar it may be. The values of the matrix are shown below in Figure 5 as the light intensity varies.

42	10	110
6	28	50
90	46	28

$$is\ Value > Centre\ Value \quad YES = 1 \rightarrow NO = 0$$

1	0	1
0	0	1
1	1	0

Figure 4: If the brightness changes, the results will be the same [12]

6. Results and discussion

In this section, smart attendance system was performed using FCN and LPBH algorithms, and the findings are presented below for your perusal. Within the application, the training data served the purpose of developing a model, which was subsequently utilized to analyze the test data. These results were compared to those that were produced by the machine learning algorithms included in the program known as FCN and LPBH algorithms. When comparing the effectiveness of several machine learning algorithms, standardized parameter values were used. The findings were evaluated using the most prominent standards in academic research and the overarching objective of suggesting several computer models and evaluating them to predict students face for smart attendance system. Table outlines these criteria and computations for your convenience.

Table: The criteria used to compare results

CRITERIA	MATHEMATICAL EQUATION
Precision	TP/(TP+FP)
Number of Correctly Labelled Data / Total Number of Data	$(TP+TN)/(TP+FP+TN+FN)$
F-Measure	(2×TP)/(2×TP+FP+FN)
Recall	TP/(TP+FN)
Accuracy Percentage	$((TP+TN)/(TP+FP+TN+FN))\times 100$

7. Conclusion

The automated attendance system based on facial recognition that has been proposed is an outstanding model for the recording of class attendance. This method helps to reduce the potential of proxies and phoney attendance as well. In today's society, there are a great deal of options available that are based on biometric analysis. Face recognition has a high level of accuracy and requires very little input from humans. This makes it a candidate for a solution. The level of safety and protection offered by this technology is one of its primary goals. As a result, there is an urgent need for the development of a classroom attendance system that is both extremely efficient and able to recognize several faces at the same time. In addition, the implementation of it does not call for any specialized hardware of any kind. For the development of the intelligent attendance system, all that is required is a camera, a computer, and database servers.

References:

1. Satpute, Nandkishor, Nima Bharati, Ashwini Ukey, Rekha Wati, and Vijay V. Chakole. "A Review on Online Classroom Attendance Marking System Using Face Recognition, Python, Computer Vision, and Digital Image Processing." https://doi.org/10.22214/ijraset.2021.39732

2. Mahajan, Aishwarya, Prajakta More, Swapnil Kuwar, and Harshal Chaudhari. "SMART ATTENDANCE SYSTEM USING FACE RECOGNITION." Journal homepage: www. ijrpr. com ISSN 2582: 7421.

3. Azhaguraj, R., P. Arjun Kumar, S. Kadalarasan, K. Karthick, and G. Shunmugalakshmi. "Smart Attendance Marking System using Face Recognition." In 2022 6th International Conference on Trends in Electronics and Informatics (ICOEI), pp. 1784-1789. IEEE, 2022.

4. Devidas, Kulkarni Satyajit, and G. R. Surawanshi. "Smart Attendance System Using Face Recognition." FP-International Journal of Computer Science Research (IJCSR) Volume 2, Issue 2, Pages 68-72, June 2015.

5. Lukas, Samuel, Aditya Rama Mitra, Ririn Ikana Desanti, and Dion Krisnadi. "Student attendance system in classroom using face recognition technique." In 2016 International Conference on Information and Communication Technology Convergence (ICTC), pp. 1032-1035. IEEE, 2016.

6. Aliyu, Ismail, Muhammad Ali Bomoi, and Maryam Maishanu. "A Comparative Study of Eigenface and Fisherface Algorithms Based on OpenCV and Sci-kit Libraries Implementations." International Journal of Information Engineering & Electronic Business 14, no. 3 (2022).

7. Galety, Mohammad Gouse, Firas Hussam Al Mukthar, Rebaz Jamal Maaroof, Fanar Rofoo, and S. Arun. "Marking Attendance using Modern Face Recognition (FR): Deep Learning using the OpenCV Method." In 2022 8th International Conference on Smart Structures and Systems (ICSSS), pp. 1-6. IEEE, 2022.

8. Bhat, Aruna, Rahul Kumar Jha, and Vansh Kedia. "Robust Face Detection and Recognition using Image Processing and OpenCV." In 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), pp. 1273-1278. IEEE, 2022.

9. Chandrakala, Pothuraju, B. Srinivas, and M. Anil Kumar. "Real Time Face Detection and Face Recognition using Open CV and Python." DOI:10.15433.JES.2022.V13I6.43P.92

10. Wilson, Phillip I., and John D. Fernandez. "Establishing a face recognition research environment using open source software." In 2005 GSW. 2022.

11. Mitra, Dipra, Shikha Gupta, and Ankur Goyal. "Security System using Open CV based Facial Recognition." In 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), pp. 371-374. IEEE, 2022.

12. Singh, Abhishek Pratap, S. S. Manvi, Pratik Nimbal, and Gopal Krishna Shyam. "Face recognition system based on LBPH algorithm." Int. J. Eng. Adv. Technol 8, no. 5 (2019): 26-30.

13. Singh, Raghvendra, Gupta, Vandana, Tiwari, S.K.,‘Linear and Non Linear Principle Component Analysis’ Volume 5, Issue 5 October 2016, ISSN: - 2306-708X, PP 1-6.

14. Singh, Raghvendra, Gupta, Vandana, Tiwari, S.K.,‘ Image Denoising using BM3D and Principal Component Analysis’ Volume 6, Issue 5 October 2017, ISSN: - 2306-708X, PP 1-7.

15. Singh, Raghvendra, Gupta, Vandana, Tiwari, S.K.,‘ Image Denoising using Multilayered Feed-Forward Artificial Neural Network Model’ Strad Research Journal, ISSN: 0039-2049, PP-1-12.